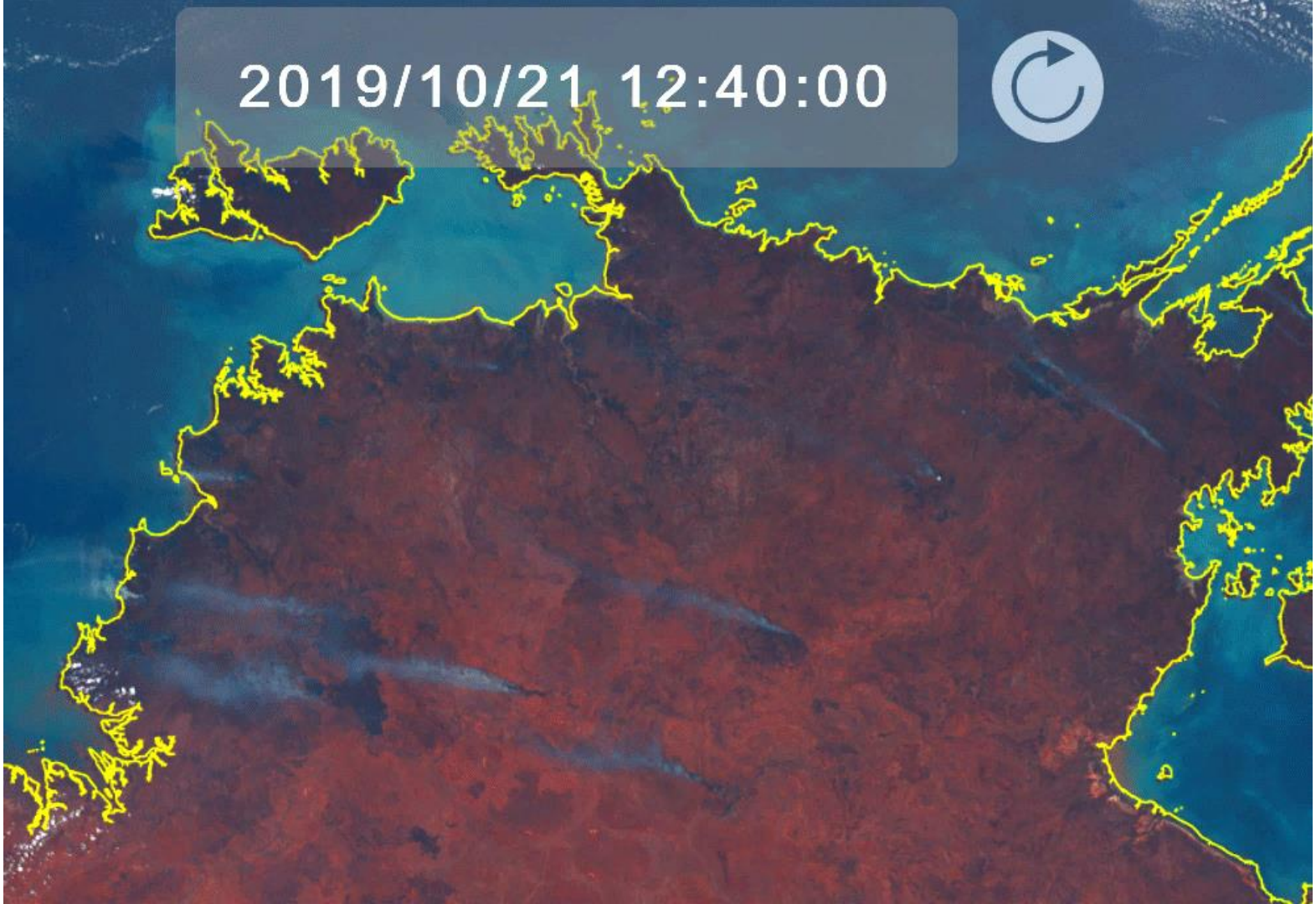
Fire behaviour simulation: a gamification approach supporting complex system learning, fire management planning and community engagement.

Rohan Fisher

CHARLES DARWIN UNIVERSITY AUSTRALIA

DCBR
Darwin Centre for Bushfire Research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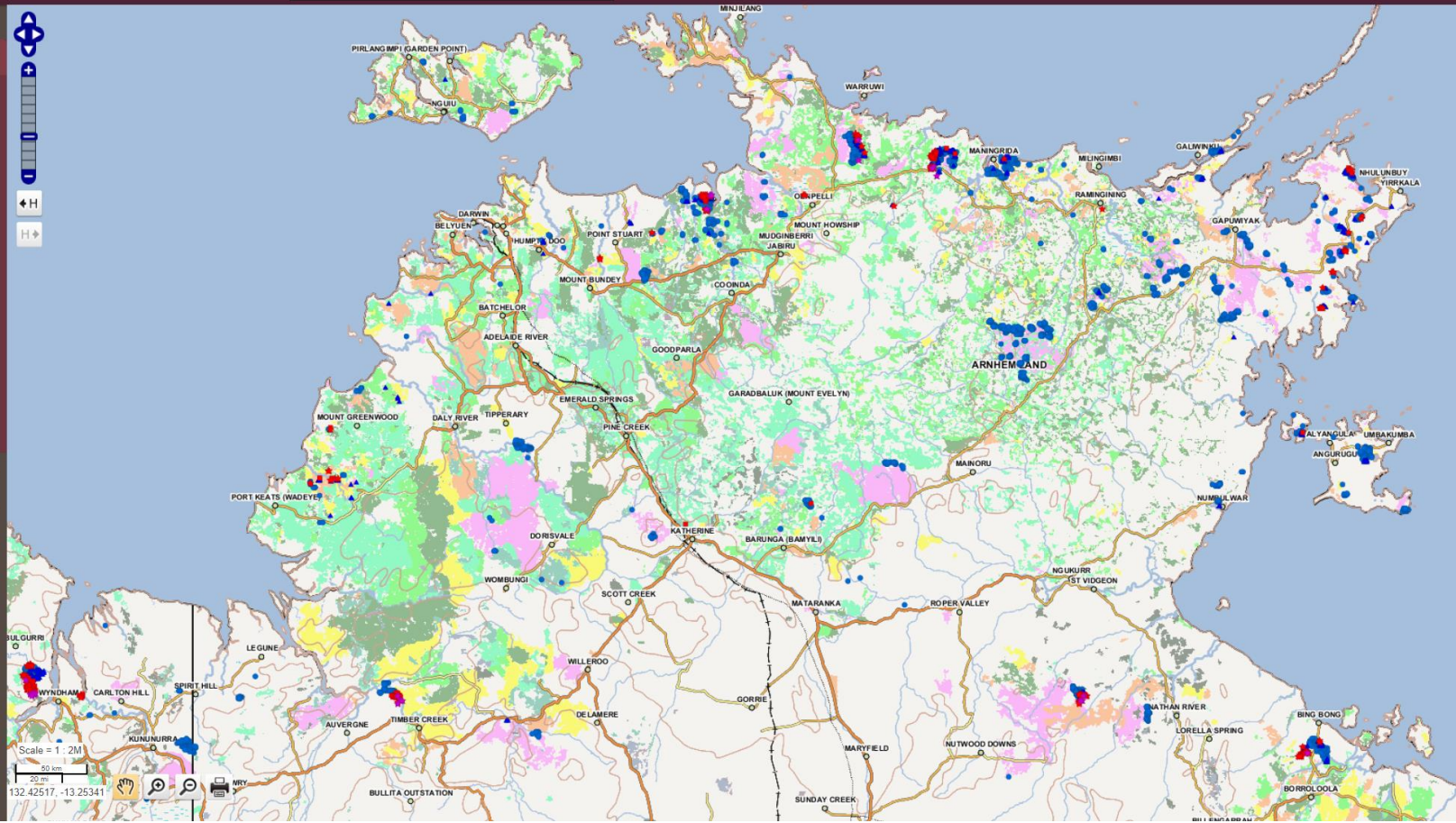
Areas

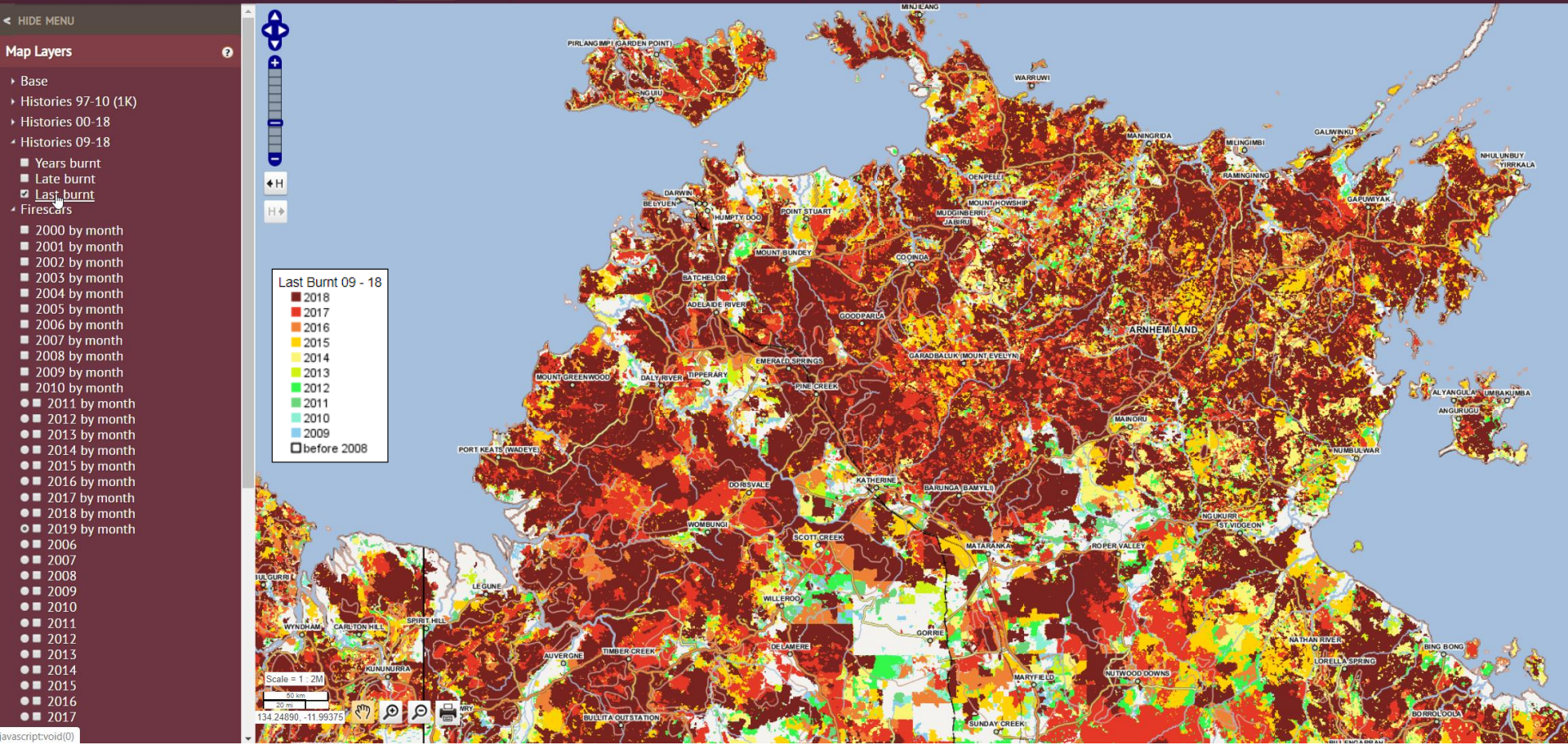
- Preset Areas
  - Cape York Pen'sla
  - North East Qld
  - The Gulf Qld
  - Central Qld
  - Central West Qld
  - West Qld
  - South Qld
  - NT North
  - NT Central
  - NT South
  - South Aust
  - WA Kimberley
  - WA Pilbara
  - WA Desert
  - WA Gascoyne
  - WA South
- My Areas

Go to Location

Upload Boundary

Hotspot Alert




HIDE MENU
Map Layers
Base
Histories 97-10 (1K)
Histories 00-18
Histories 09-18
Years burnt
Late burnt
Last burnt
Firescars
2000 by month
2001 by month
2002 by month
2003 by month
2004 by month
2005 by month
2006 by month
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Last Burnt 09 - 18
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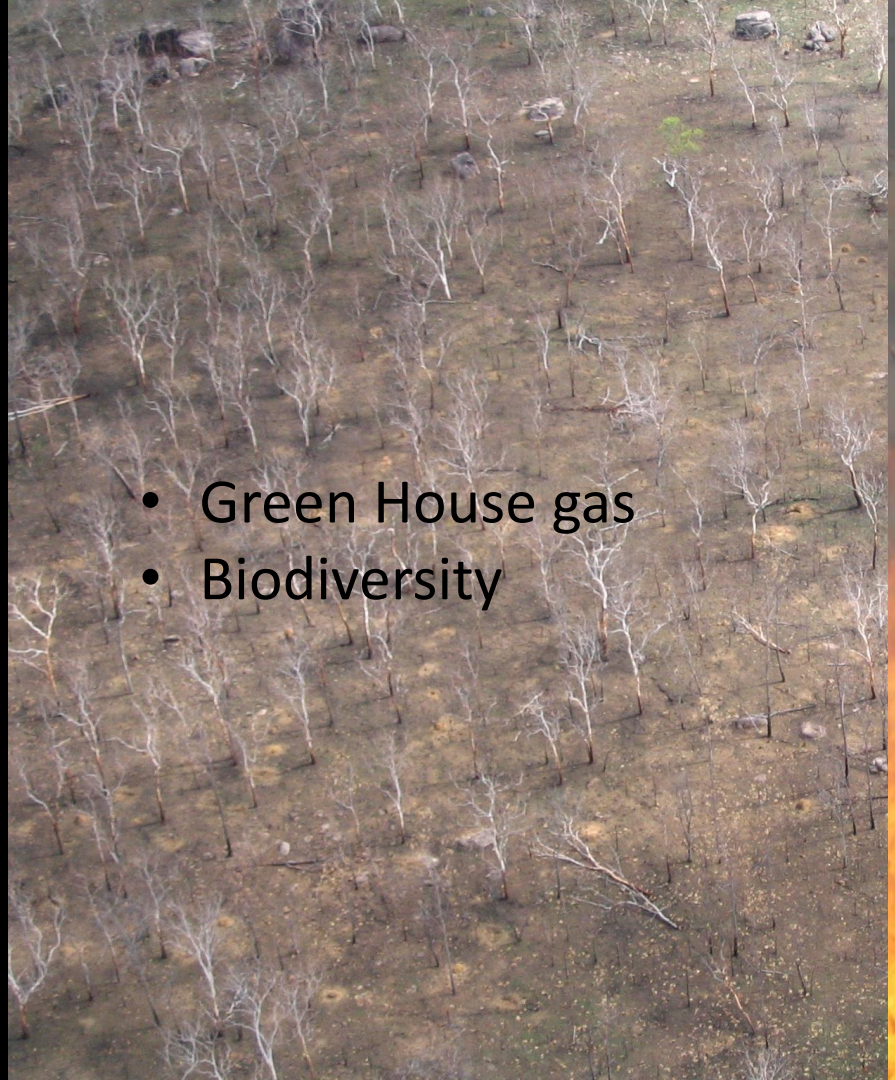
2010
2009
before 2008
MINJILANG
PIRLANGIMPI (GARDEN POINT)
NGUIU
WARRUWI
MANINGRIDA
MILINGIMBI
GALIWINKU
NHULUNBUY
YIRRKALA
RAMINGINING
OENPELLI
GAPUWIYAK
DARWIN
BEAUFORT
HUMPTY DOO
POINT STUART
MOUNT HOWSHIP
MUDGINBERRI
JABIRU
MOUNT BUNDEY
COOINDA
BATCHELOR
ADELAIDE RIVER
GOODPARLA
ARNHEM LAND
GARADBALUK (MOUNT EVELYN)
EMERALD SPRINGS
MOUNT GREENWOOD
DALY RIVER
TIPPERARY
PINE CREEK
ALYANGULA
UMBAKUMBA
ANGURUGU
MAINORU
PORT KEATS (WADEYE)
NUMBULWAR
DORISVALE
KATHERINE
BARUNGA (BAMYILI)
NGUKURR
ST VIDGEON
WOMBUNGI
SCOTT CREEK
MATARANKA
ROPER VALLEY
LEGUNE
WILLEROO
WYNDHAM
CARLTON HILL
SPIRIT HILL
GORRIE
DELAMERE
NATHAN RIVER
BING BONG
AUVERGNE
TIMBER CREEK
LORELLA SPRING
KUNUNURRA
NUTWOOD DOWNS
MARYFIELD
BULLITA OUTSTATION
SUNDAY CREEK
BORROLOOLA
Scale = 1 : 2M
50 km
20 mi
134.24890, -11.99375

- 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

	Southern Australia	North Australian Savannas
Fire management focus	Emergency response. Mitigation to save life and property.	Environmental, cultural and livelihoods
Resources	Highly resourced for wildfire fighting with a high degree of access infrastructure.	Few resources, vast landscapes with few people, roads or intervention resources.
Spatial Scale	Regional, generally <1,000km2	Landscape scale, often > 10,000km2
Temporal Scale	Fires burn over a few days, with prediction focused on a few hours.	Fires can burn for many weeks.
Fuel type and fire intensity	Very high-intensity forest fires are common.	Relatively low-intensity grass fuel fires.
Fire extinguishment	Most fire actively controlled and extinguished	Most fires self-extinguish
Cultural background of fire managers.	Predominantly state government led	Diverse cultural context with many Indigenous led land management.

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.

Suppression and fire fighting

Fire behaviour models
for the Savanna Landscapes.

- Facilitate the broader use of available fire-related data sets for understanding fire and ecosystems dynamics.

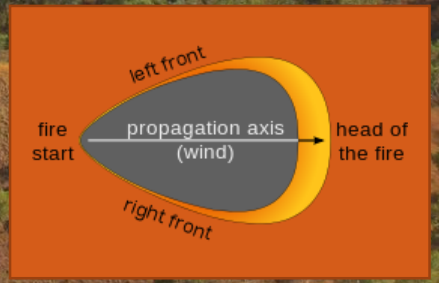
- Support the communication of fire management objectives to a culturally diverse range of land managers

- Allow the visualisation of fire behaviour at a landscape scale to support strategic fuel reduction burning.

Working with fire.

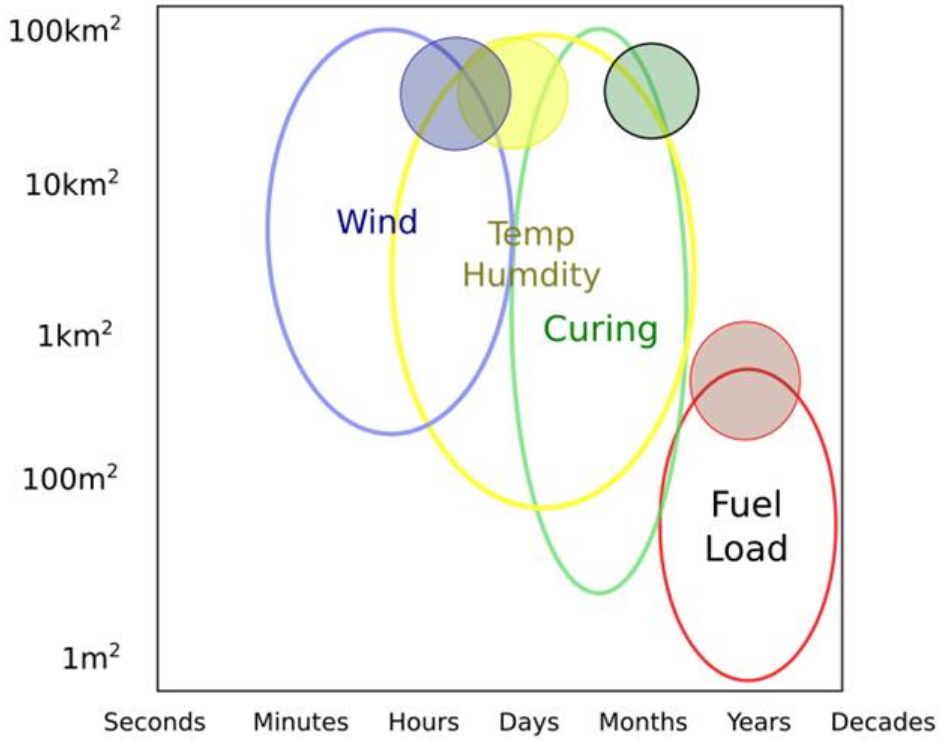
Fire behavior is complicated

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

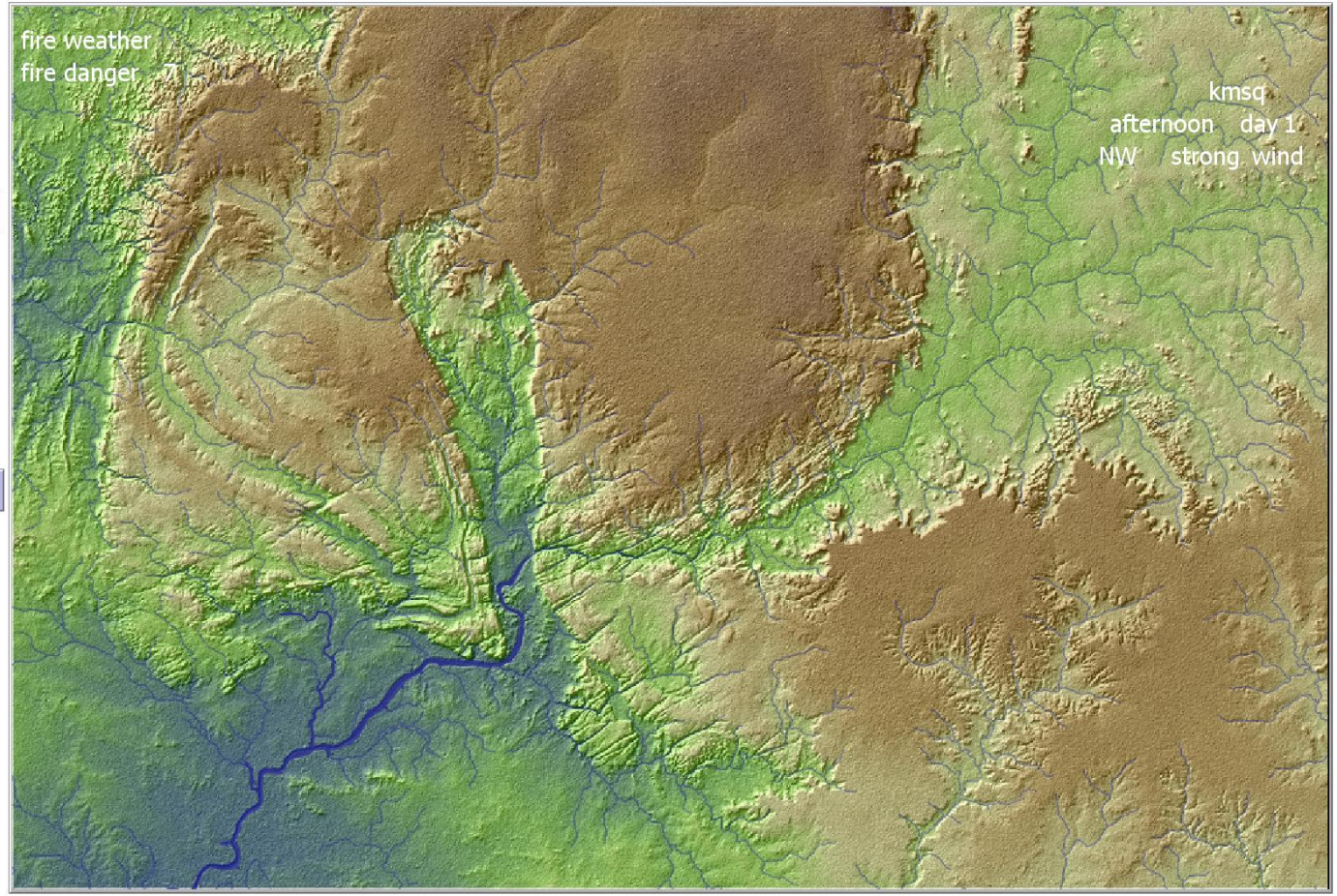
- Fuel type
- Slope
- Natural and anthropocentric breaks

NetLogo

- 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



press this button first

Load model 0

Play

Ignite 1

Save Ignition 2

GO

Ignite Saved 3

Reset

Additional Settings

On Off Protected-areas

protect-area

Lightning !

Fire Break

Fuel Load B

Record

Vid Start

Vid Save

Save Picture

Options

On Off Stop-if-no-fire

On Off time-of-day

Fire weather

Fire_Danger 8

1-3 Very Low
4-5 Low
6-7 Medium
8-9 High
10 Severe

wind-speed
strong

Change Speed

Press if changing wi
whilst the model is r

Wind-Direction
NW

set-time
afternoon

SET Fire Weather

Save fire weather
before pressing G

Landscape Maps

Places H

Places NP

Vegetation 5

Fire History 6

Wettness W

Roads/Rivers 9

Topography S

Satelite

Elevation E

Print_Grid

Previous Year Burn

monthburnt
4

viewmonth

Animimate Burns

Date
[0 0]

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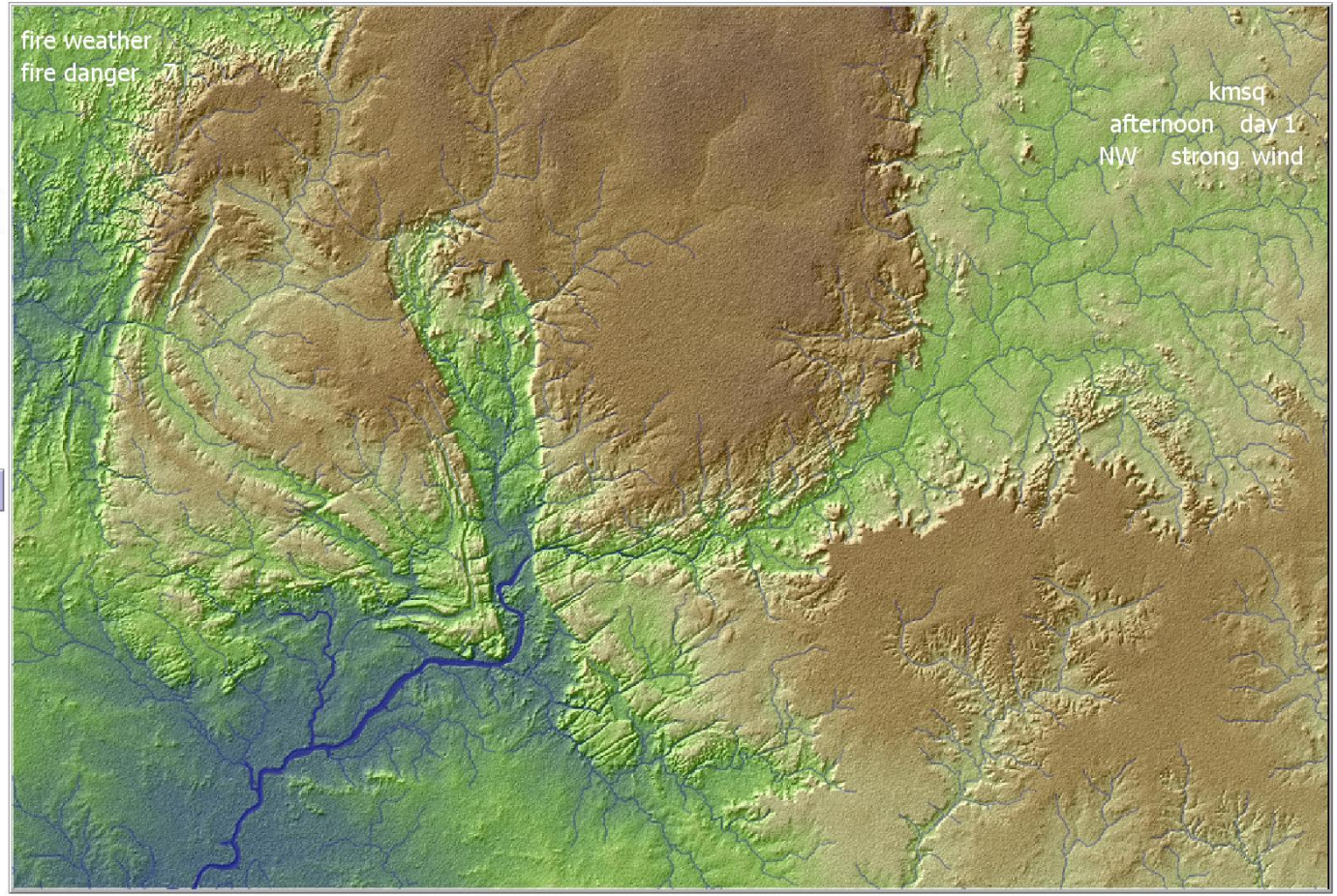

Fire weather

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1-3 Very Low
4-5 Low
6-7 Medium
8-9 High
10 Severe

wind-speed: strong

Change Speed

Press if changing wir
whilst the model is r

Wind-Direction: NW

set-time: afternoon

SET Fire Weather

Save fire weather
before pressing G

Landscape Maps

Places H | Places NP

Vegetation 5 | Fire History 6

Wettness W | Roads/Rivers 9

Topography S | Satelite

Elevation E | Print_Grid

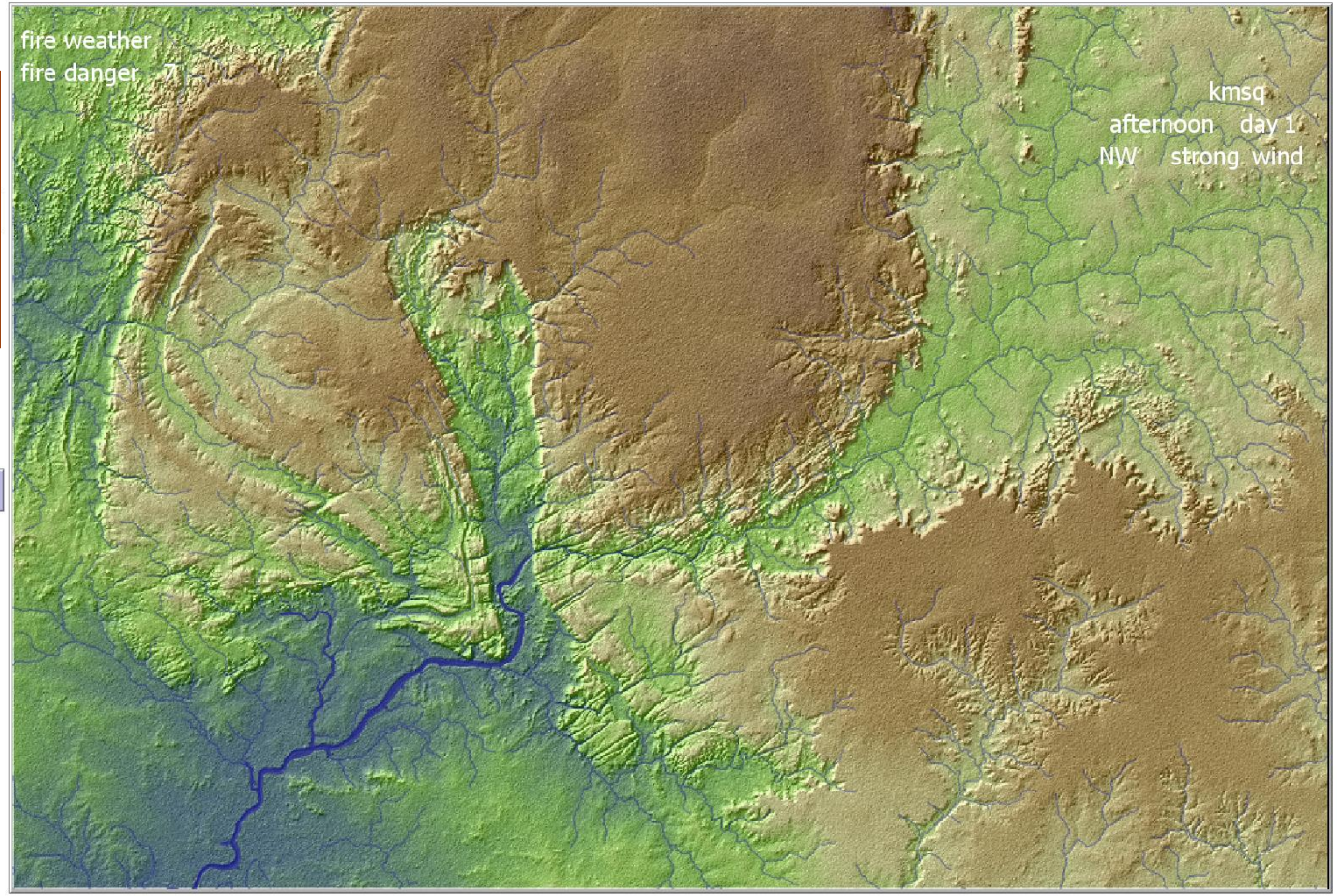
Previous Year Burn

monthburnt: 4

viewmonth

Animimate Burns

Date [0 0]



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Lightning !

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Vid Save

Save Picture

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set-time
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before pressing G

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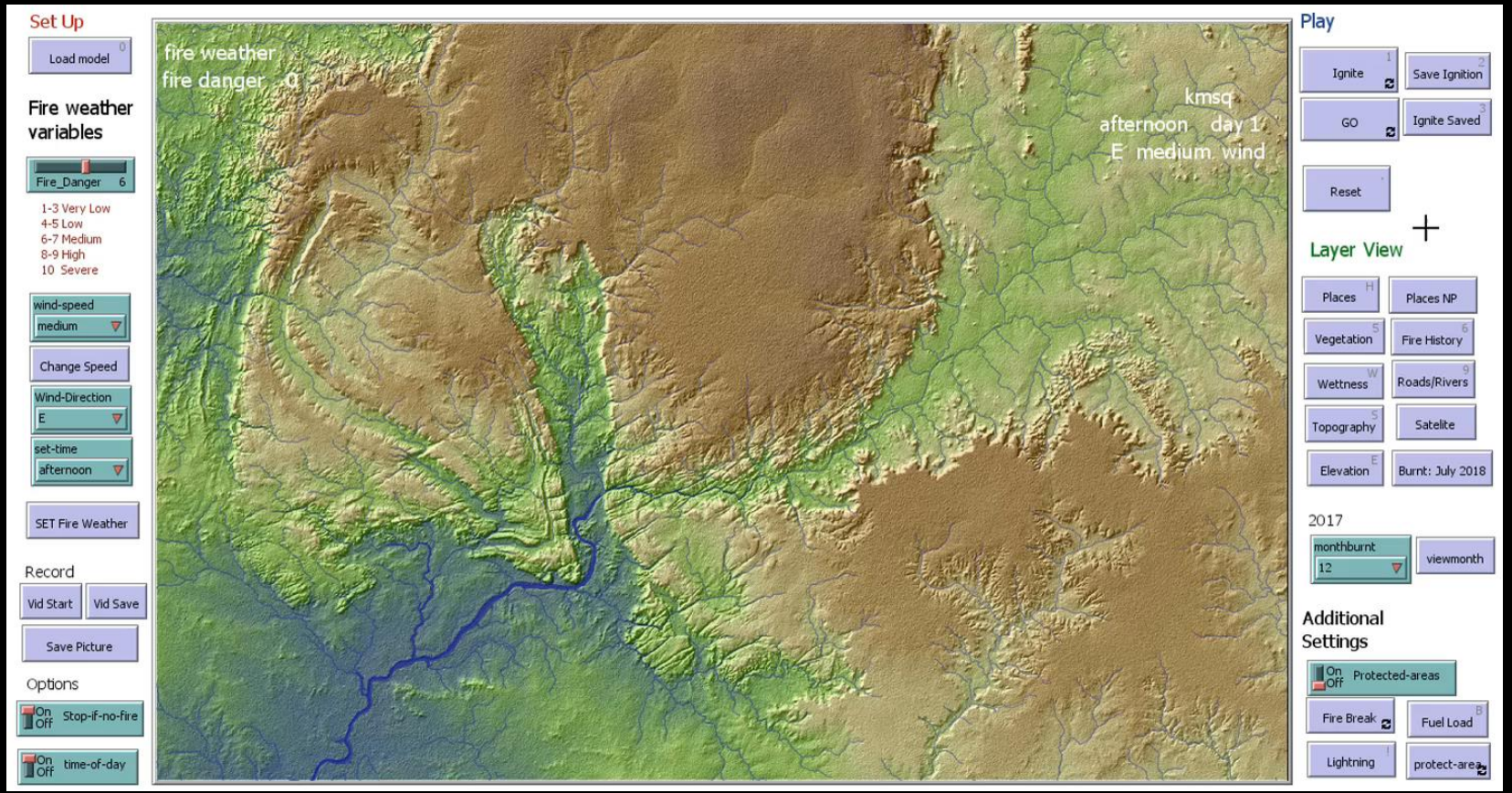
monthburnt
4

viewmonth

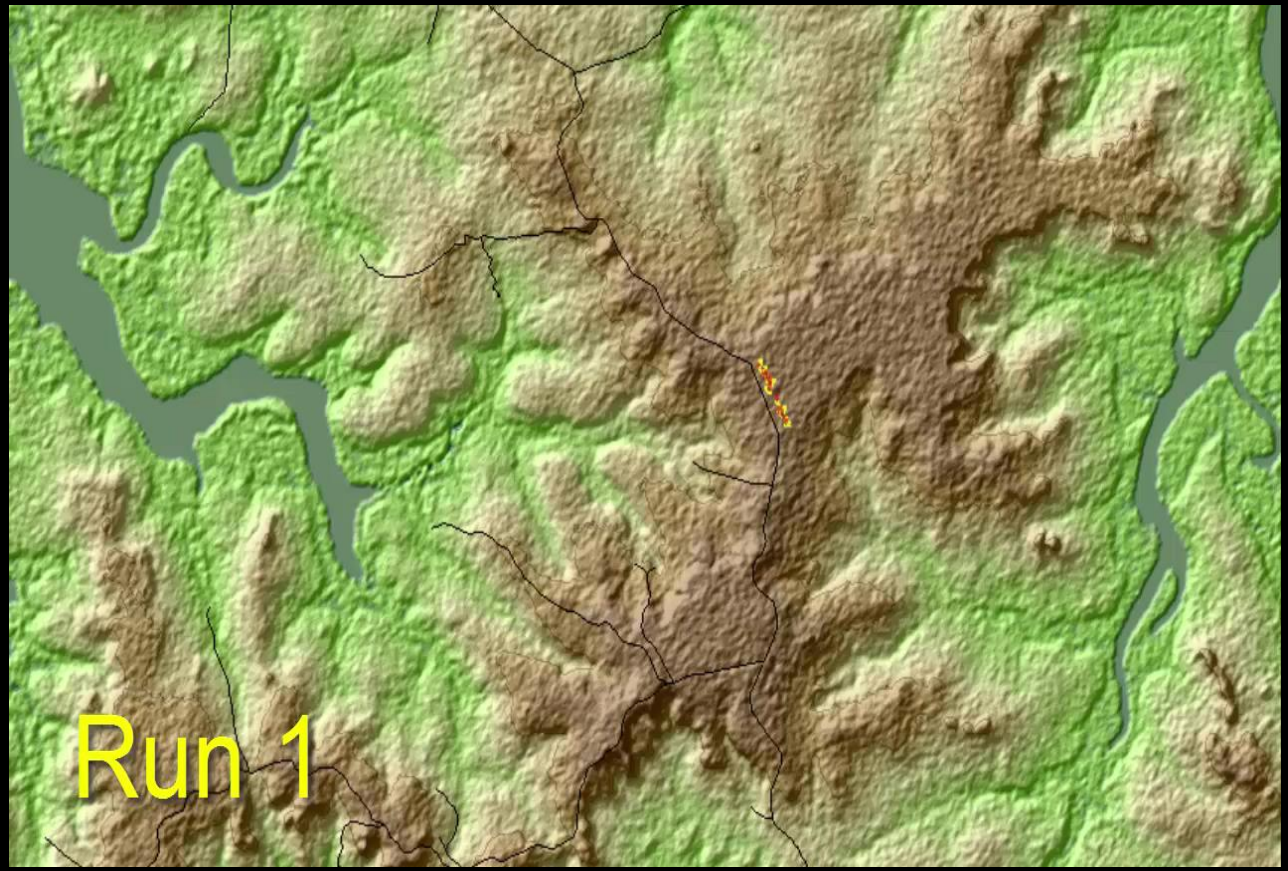
Animimate Burns

Date
[0 0]


Set Up
Load model
Fire weather variables
Fire_Danger 6
1-3 Very Low
4-5 Low
6-7 Medium
8-9 High
10 Severe
wind-speed
medium
Change Speed
Wind-Direction
E
set-time
afternoon
SET Fire Weather
Record
Vid Start
Vid Save
Save Picture
Options
On Off Stop-if-no-fire
On Off time-of-day
fire weather
fire danger 0
kmsq
afternoon day 1
E medium wind
Play
Ignite
Save Ignition
GO
Ignite Saved
Reset
Layer View
Places
Places NP
Vegetation
Fire History
Wettness
Roads/Rivers
Topography
Satelite
Elevation
Burnt: July 2018
2017
monthburnt
12
viewmonth
Additional Settings
On Off Protected-areas
Fire Break
Fuel Load
Lightning
protect-area

Simulation for understanding complex systems

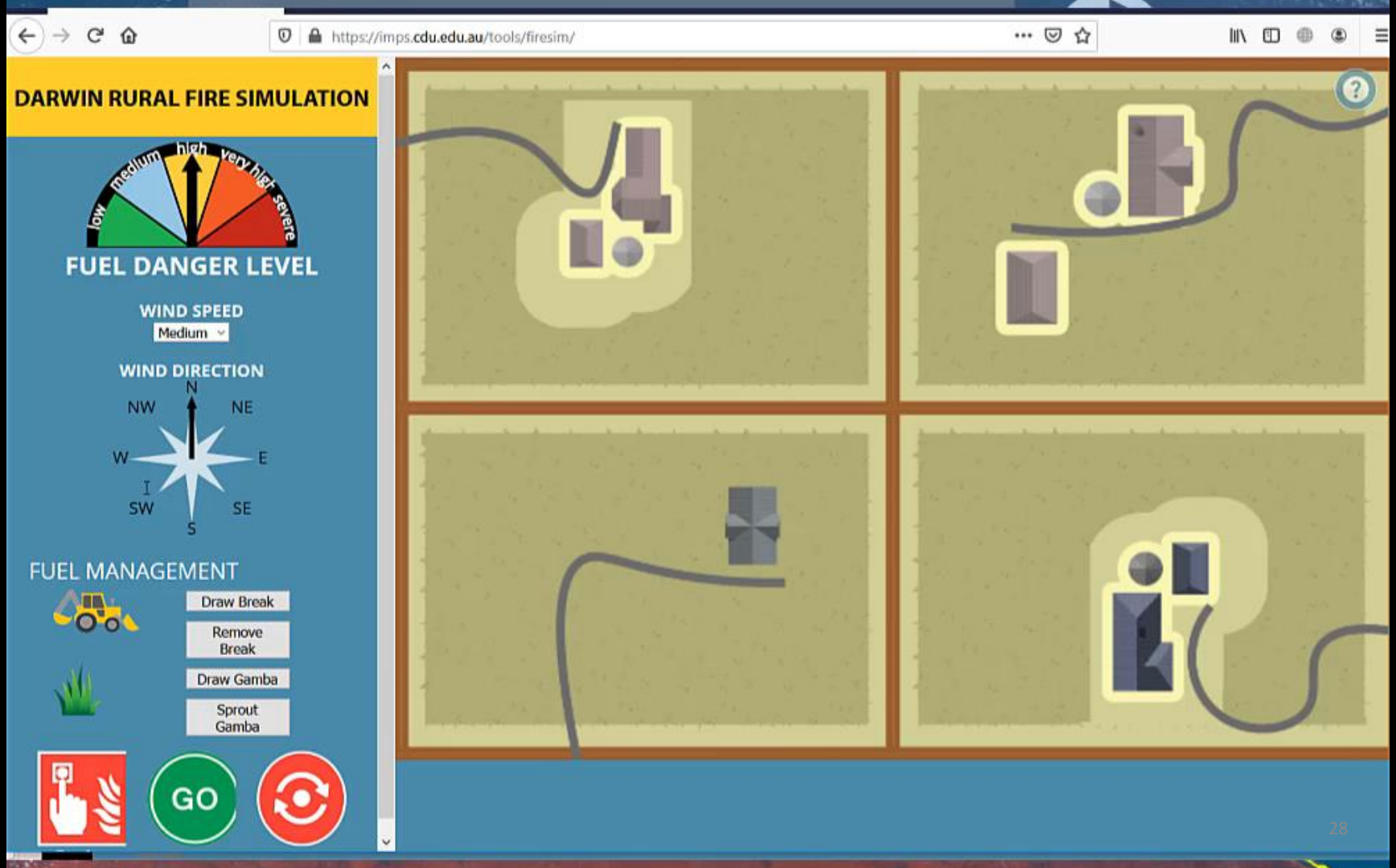
- Actions can be repeated under the same or different conditions.
- Processes can be stopped to reflect on outcomes.
- Decisions that are dangerous, infeasible or unethical in the real system can be taken in the virtual world.
- Not predictive but explanatory


Run 1

Fire simulation as a ‘serious game’.

- Supporting discussion and exchange of local knowledge
- Multi-modal learning
  - Physical 3D models
- Supports Learning by doing. ‘Heuristic’

DARWIN RURAL FIRE SIMULATION
129 ticks
low
medium
high
very high
severe
FUEL DANGER LEVEL
WIND SPEED
Strong
WIND DIRECTION
N
NW
NE
W
E
SW
SE
S
FUEL MANAGEMENT
Draw Break
Remove Break
Draw Gamba
Sprout Gamba
GO
go.cdu.edu.au/firesim


https://imps.cdu.edu.au/tools/firesim/
DARWIN RURAL FIRE SIMULATION
low
medium
high
very high
severe
FUEL DANGER LEVEL
WIND SPEED
Medium
WIND DIRECTION
N
NW
NE
W
E
SW
SE
S
FUEL MANAGEMENT
Draw Break
Remove Break
Draw Gamba
Sprout Gamba
GO

- Bottom up planning
- Local + Traditional Ecological Knowledge
- Intergenerational knowledge exchange
- Evidence based planning

Incendiarysim.net

Rohan.fisher@cdu.edu.au

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