# Predicting Climate, Weather and Fire

## -embracing uncertainty in decision making-

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**Aus - US Joint Research Symposium**
**Fire in the Interface**
**Melbourne – Canberra**
**14 June 2010**

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Fire Spread Prediction - Issued 0430 hrs 12 Dec 2006

# Suppression planning – control line location

North East - Gippsland Complex A3 Overview

Map Produced: 0600hr 16 Dec 2006
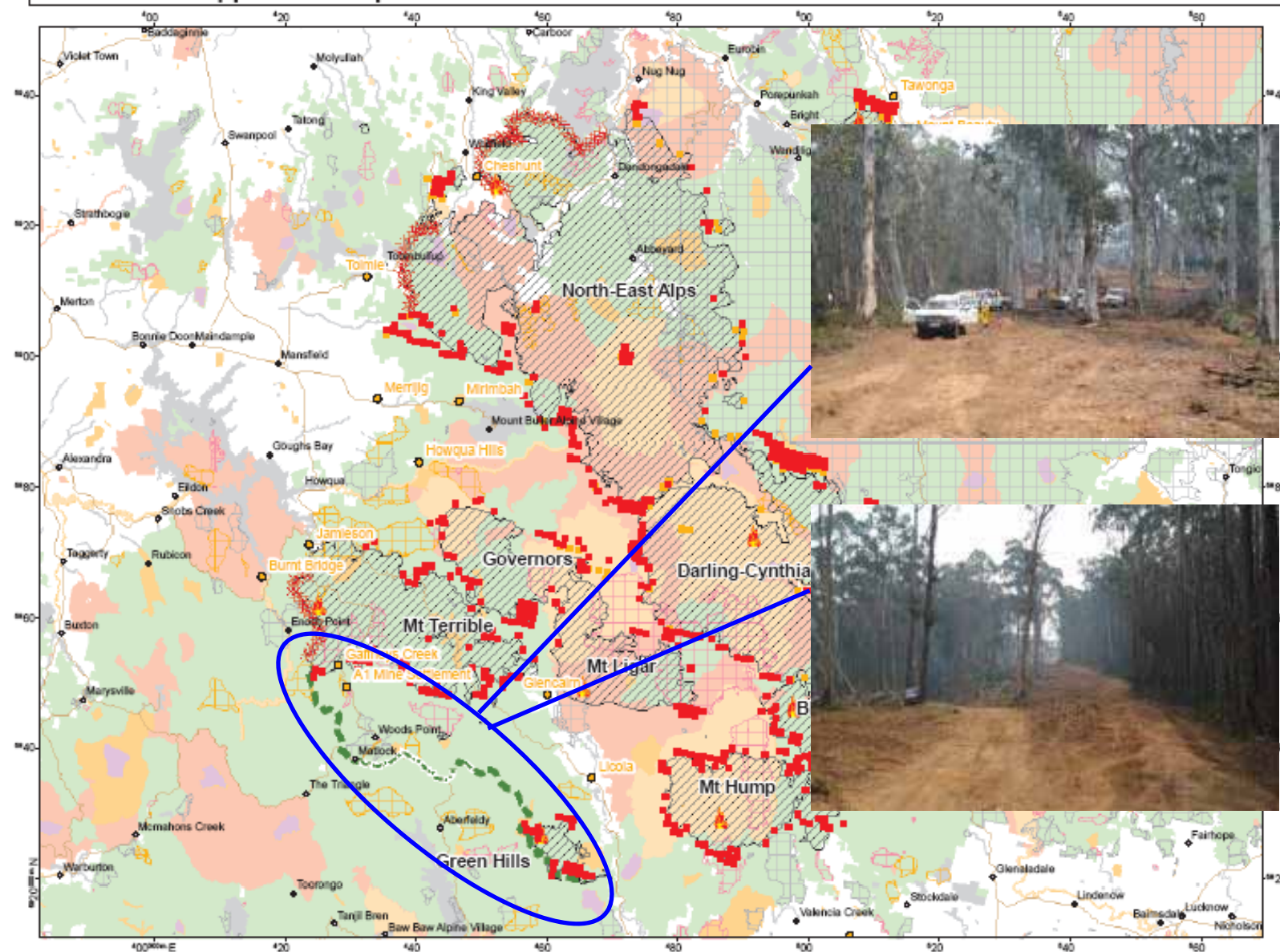
Department of Sustainability and Environment

Hotspots:
Field Obs: various
Linescan:
Air Obs:

Legend

Fire Status

Fire Origin - Going

Burnt Area

Controlled Fire Edge

Hotspots last 12 hrs

Hotspots 12 - 24 hrs

Control Line - Constructed

Control Line - Incomplete

Public Land

Public Land

Map Grid of Australia
Zone 55

0    4.5    9    10
Kilometres
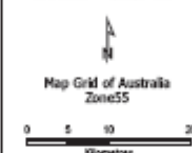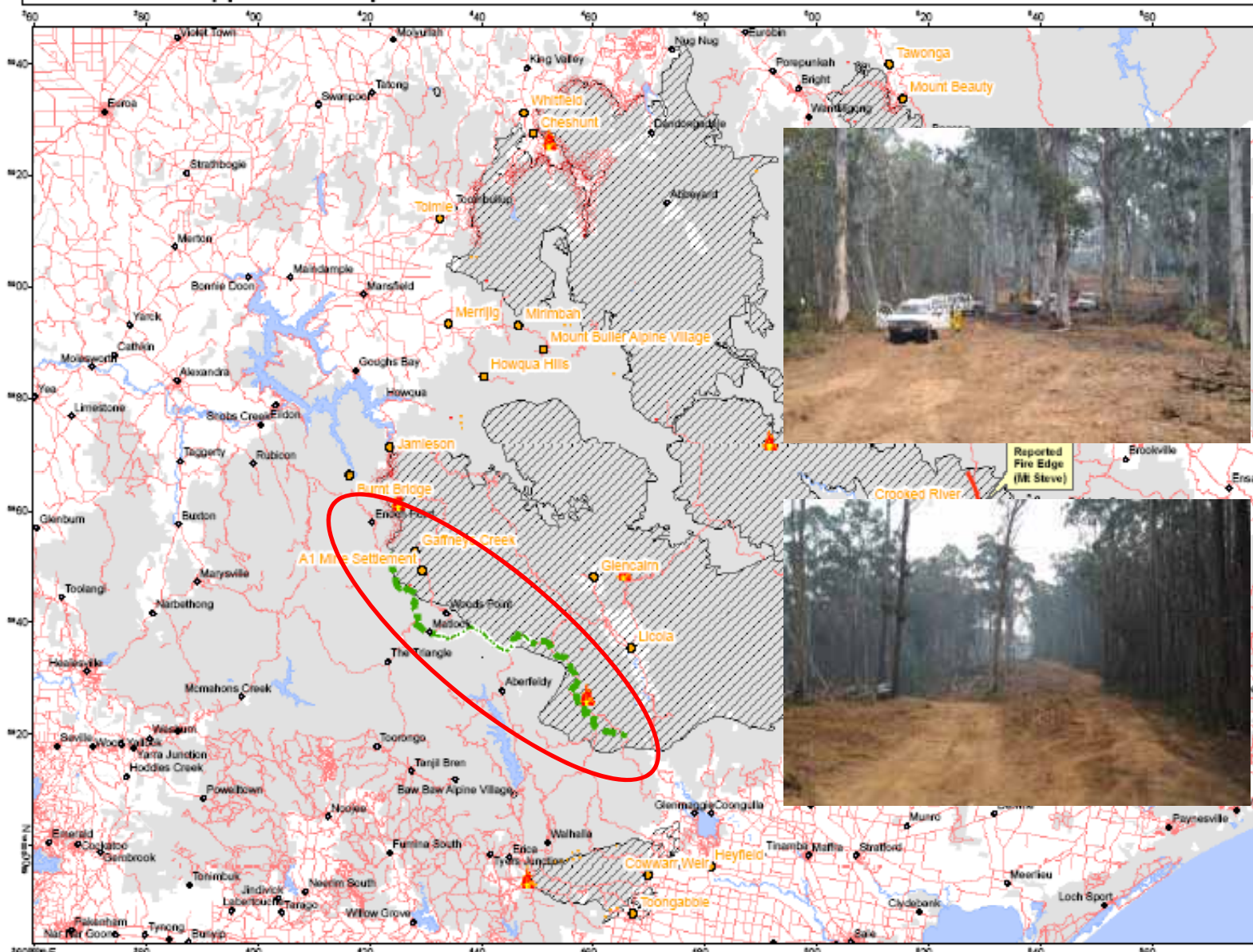
Disclaimer: Base layer information on this map has been sourced from Firemap 100k topographic map series. This material may be of assistance to you but the State of Victoria does not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for error, loss or damage which may arise from reliance upon it.

(c) The State of Victoria Department of Sustainability and Environment 2006
File: Firemap_overview_with_control_line_z55_a3_20061216_0600

# Predictive Services – Resources

- **Identified as a capability issue;**

**Outcome:**

- **Over 20,000 personnel involved;**
- **Up to 3500 during peak shifts; Strategies aimed at providing management oversight established;**
- **Resources from most states, NZ, US and BC;**
- **Military**
- **Most Vic Gov Agencies;**
- **Interstate-International liaison and support critical,**

| | | Scenario 1 Extreme Weather | Scenario 2 Moderate Weather | Scenario 3 Benign Weather |
|---|---|---|---|---|
| **Containment** | | *By End Feb* | *End Jan* | *End Dec* |
| | IMT and Logistical Support | 872 | 782 | 620 |
| | Fireline | 3560 | 3154 | 2436 |
| | ECC | 200 | 200 | 200 |
| | **Total personnel need per day** | **4632** | **4136** | **3256** |
| | | | | |
| **Mop-Up Phase** 'Under Control –1' Status | | *By Mid March* | *Mid Feb* | *Mid Jan* |
| | IMT and Logistical Support | 272 | 832 | 204 |
| | Fireline | 832 | 272 | 624 |
| | ECC | 100 | 100 | 100 |
| | **Total personnel need per day** | **1,204** | **1,076** | **928** |
| | | | | |
| **Patrol Phase** 'Under Control – 2' Status | | *By End April* | *End March* | *Mid March* |
| | IMT and Logistical Support | 136 | 136 | 102 |
| | Fireline | 416 | 416 | 312 |
| | ECC | 100 | 100 | 100 |
| | **Total personnel need per day** | **652** | **588** | **514** |

# Fire Behaviour and Fuel Breaks
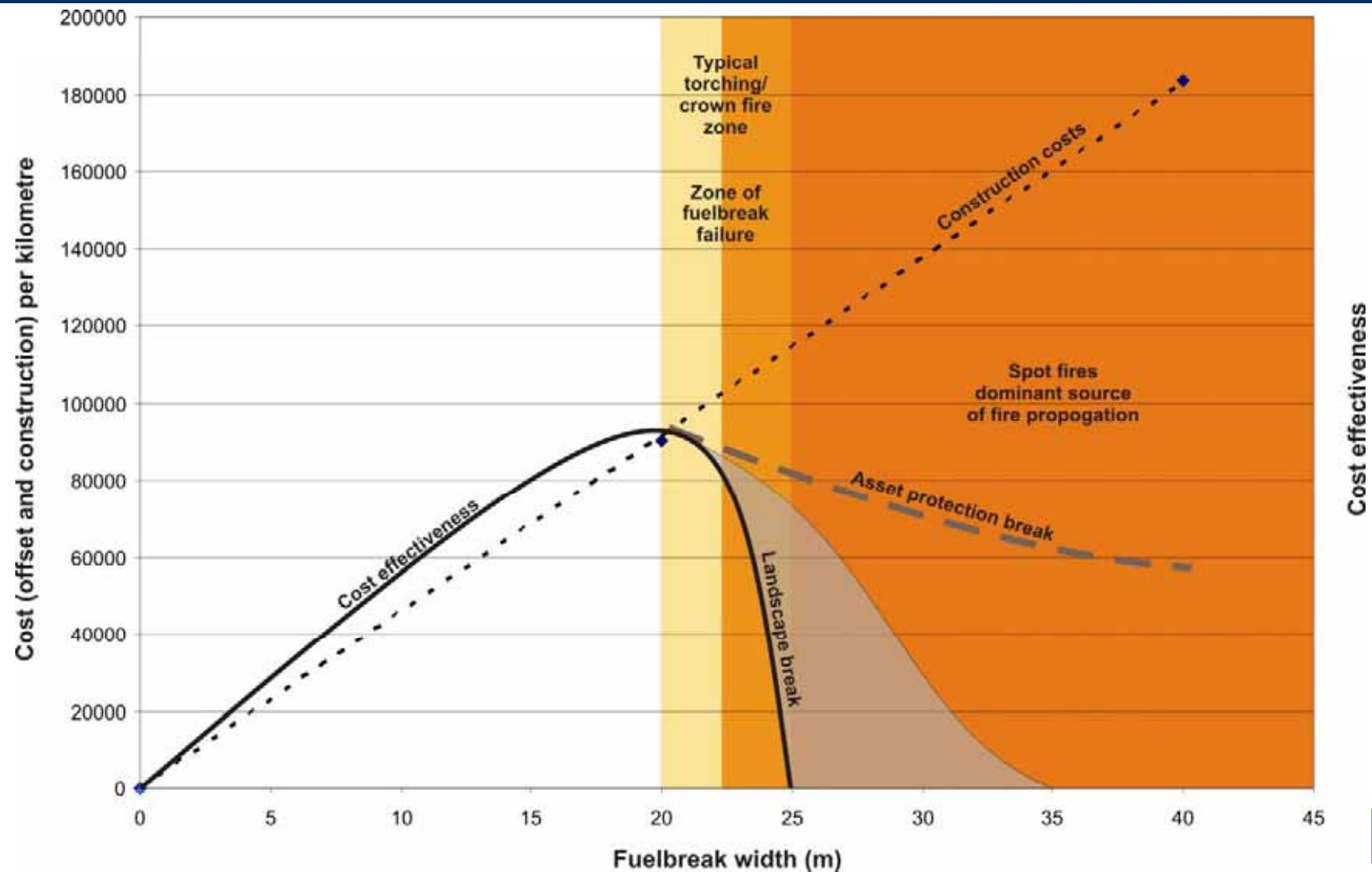
# A strategy for the future – December 2008
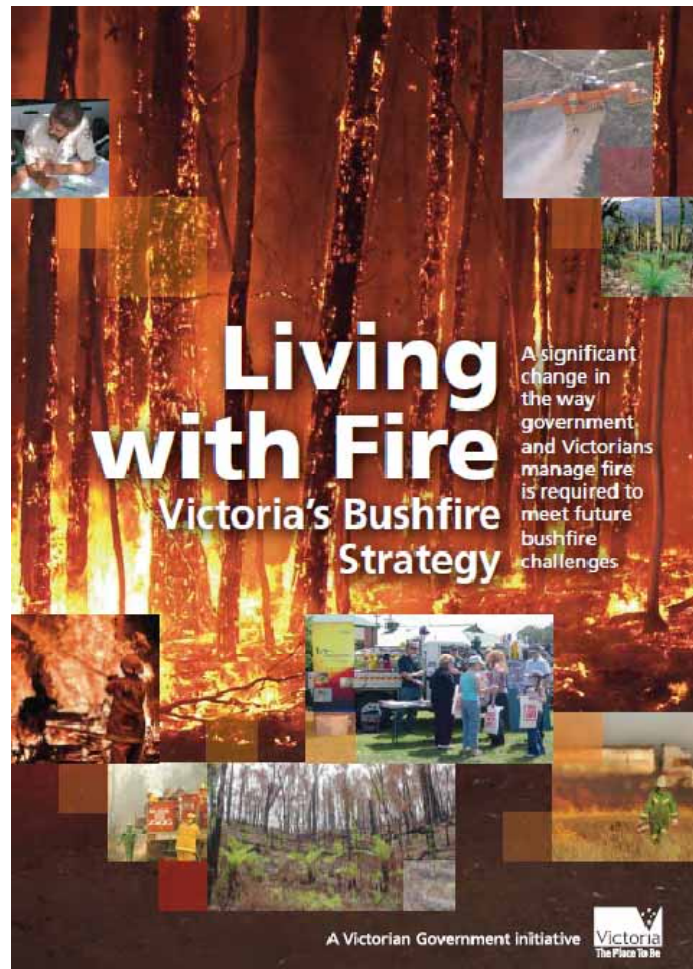


- **Objectives:**
  - Reduce the occurrence and impact of severe bushfires,
  - Promote community and ecosystem resilience,
  - Manage and adapt to current and emerging risks.

*Will be reviewed, updated (recut) following consideration of the Royal Commission findings.*

# A word or two on adaptive

Strategy

Act
(do or don't do)

Model and
Predict

Old state of system

New state of system
"changed"

Change
system model

Monitor

Learn

Adapted from: Walker, B. (1998) "The art and science of wildlife management," *Wildlife Research,* 25 (1-9).

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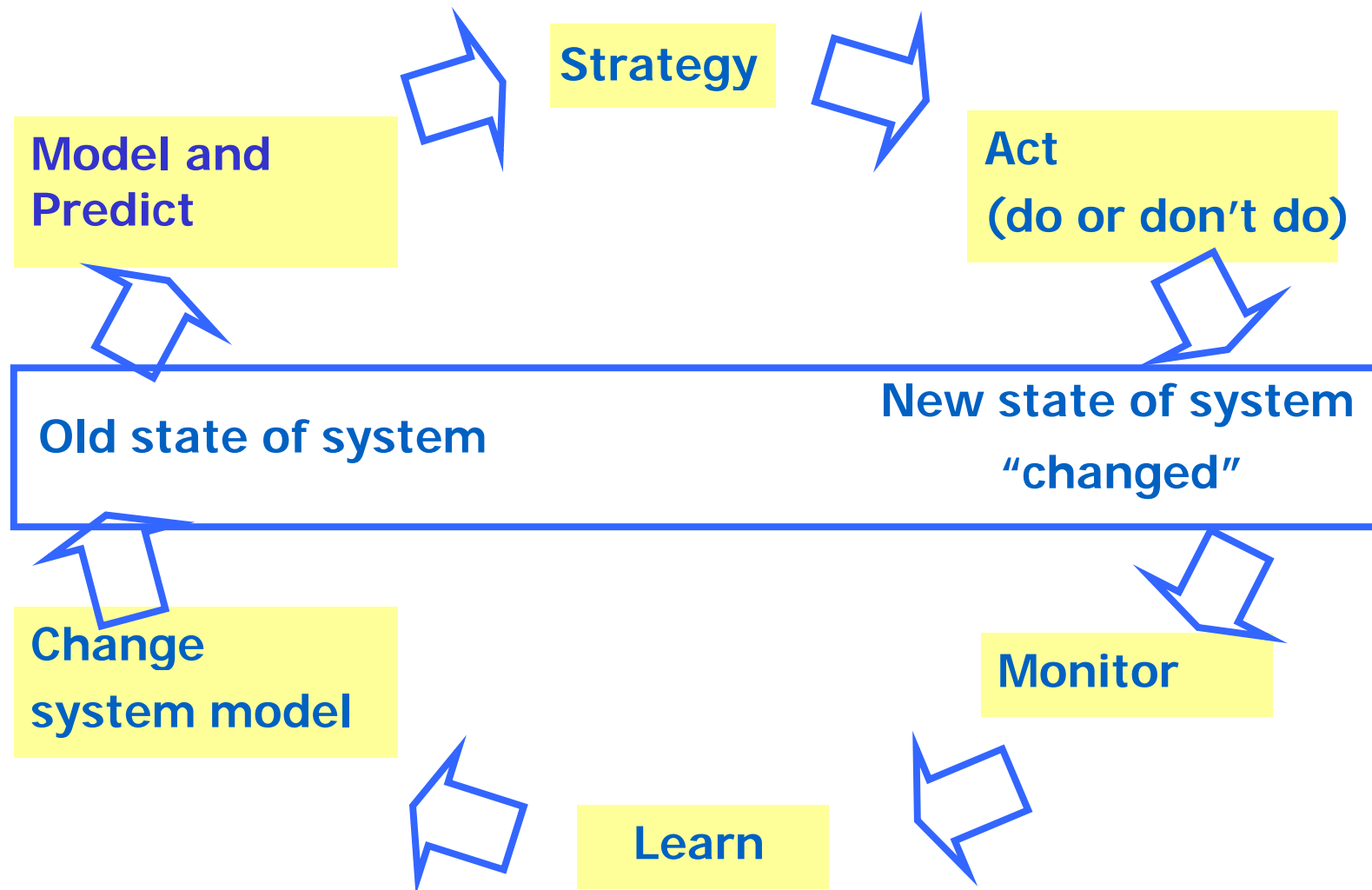
# Risk and adaptive management – models matter

- **Relies on a 'model':**
  - our best understanding of how the system works and will react to change,
  - based on science and expert knowledge – its an art and science;

- **Key points:**
  - predictions start from the past and work forward,
  - strategies start from the future (possible scenario's) and work back,
  - be pragmatic – uncertainty exists
  - avoid doctrine;
    - its an ongoing process,
    - Feedback and IMPROVEMENT critical.

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# Risk and adaptive management – people matter

- **Human factors:**
  - the mind and body influence decision making,
  - strategies and actions come from people;
- **Initial findings from La Trobe University/Bushfire CRC*:**
  - not all individuals/teams consider worst case scenario's,
  - some individuals/teams tend to underestimate risk and overestimate capacity,
  - long term scenario planning can be over looked due to short term demands,
  - inflexibility in adapting plans increases during fast moving events,
- **Studies focussed on firefighter safety - lessons can be considered more widely.**

*See:
- Omodei et al 2007. Identifying Why Even Well-Trained Firefighters Make Unsafe Decisions: A Human Factors Interview Protocol - http://www.bushfirecrc.com/documents/poster_progd%20-%20Omodei.pdf
- Johnson et al 2008. How worst case scenarios are considered by bushfire fighters: An interview study - http://knowledgeweb.afac.com.au/__data/assets/pdf_file/0003/19479/Johnson_C_-_Abs-65.pdf

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## Prevention and Preparedness are the key

**The Bushfire Strategy renews a focus on prevention and preparedness:**

- **Planning Burning is seen as critical in achieve a risk reduced risk and more resilient landscape,**
- **Understanding and describing risk, and what can be done about it is essential,**
- **Fire behaviour, weather and climate knowledge support decision making,**
- **Its about decision making.**
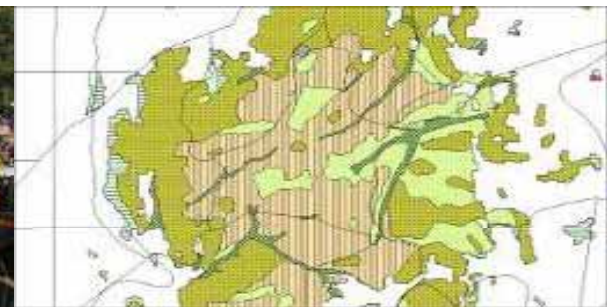
# Types of climate, weather and fire predictions

| Time Period | Prevent | Prepare | Respond | Recover | | Tactical | Strategic | Example |
|---|---|---|---|---|---|---|---|---|
| Generational (20+ years) | ⇑ | | | | | | ⇑ | Land use planning; Land acquisition, Changed planned burning regimes. |
| Bushfire Management Plan Cycle (5-10 yrs) | ⇑ | ⇑ | | | | | ⇑ | Ignition reduction programs Community resilience programs Strategic placement fire to reduce risk and enhance ecosystem resilience |
| Operations Cycle (1-3 yrs) | ⇑ | ⇑ | | | | ⇑ | ↗ | Priority activities to achieve strategic management cycle objectives. |
| Seasonal (3 month rolling) | ↗ | ⇑ | | | | | ⇑ | Highlight priority risk areas; Procure extra-ordinary suppression resources |
| Forecast Period (3 to 5 days) | ⇨ | ↗ | ⇑ | ⇑ | | ⇑ | ⇑ | Establish preparedness levels and response priorities Community warning and industry and information of potential impact – include community meetings. |
| 12 to 24 hours | ⇨ | ⇨ | ⇑ | ↗ | | ⇑ | ↗ | Community and industry warning and information of potential impact – include community meetings. Establish short term fire control strategies |
| 6 to 12 hours | | ⇨ | ⇑ | ⇨ | | ⇑ | | Community warning and information of potential impact. Tactical decision making – deployment of people and machines. |

⇑   **Most useful**

↗   **Some use**

⇨   **Marginal use**

Victoria Cumulative Monthly Rainfall Anomaly (commencing from anomaly of previous year)
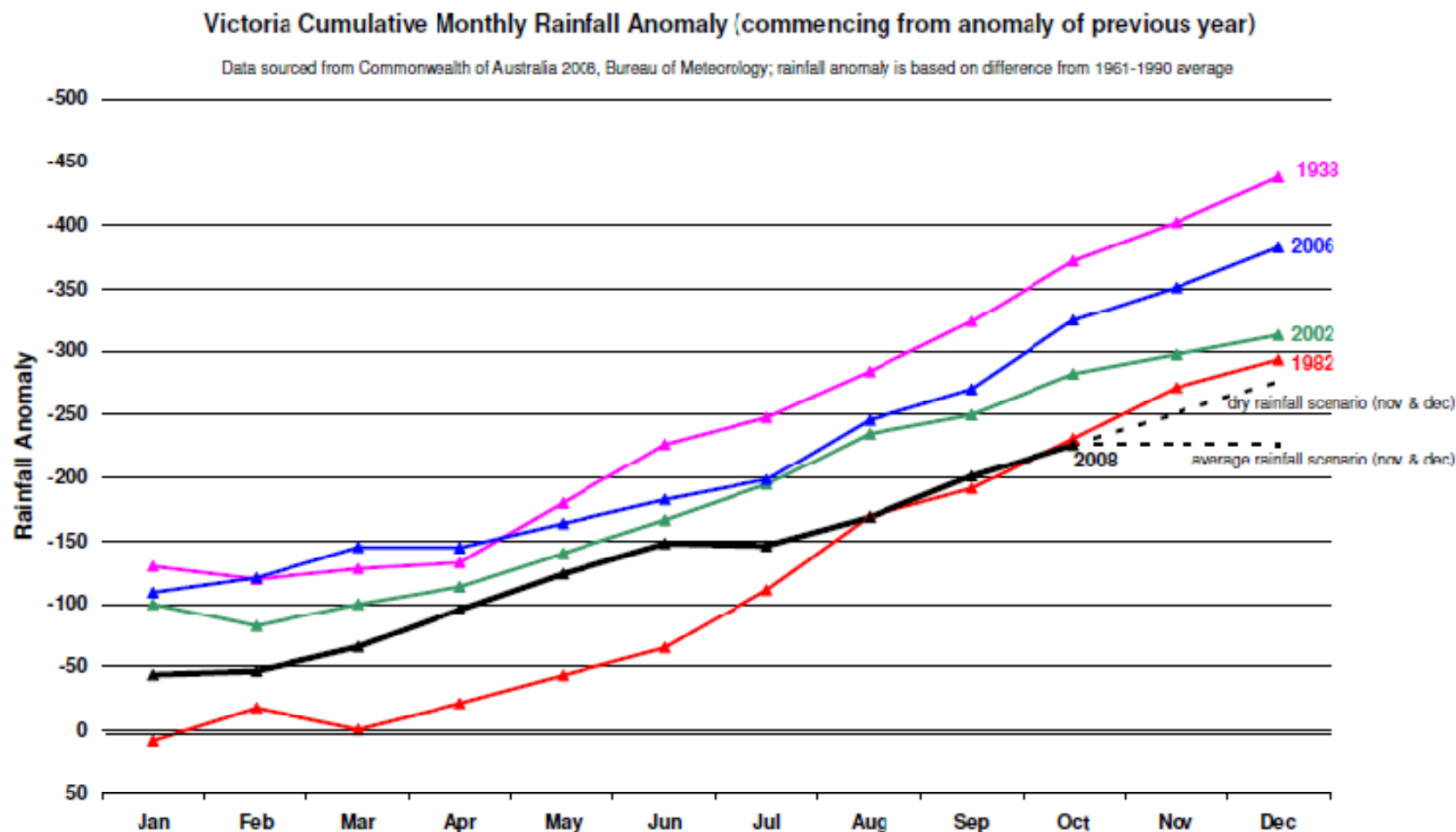
# October 08 expected bushfire risk areas



2008 Fire Potential Spread & Critical Assets
Assets of National & State Importance
Location of Assets Displayed by Criticality (an Index of 'Importance', see Bushfire Criticality Review 2007)
Fire Potential Spread as of October 2008

**Legend**

**Criticality Measure**
- National Consequence
- State Consequence
- Critical Roads
- High Voltage Transmission Lines
- Major Gas Lines
- Major Railways
- Critical Towns
- Major Towns

**2008 Fire Spread Potential**
- Very High & Extreme (VHE)

**Combined**
- VHE + State Consequences
- VHE + National Consequences

**Others**
- Metropolitan Area
- Rivers
- Water Features

## Water supplies, urban fringe at risk

# Horror fire warning

**PETER ROLFE**

MELBOURNE'S urban areas and precious water supplies have been identified as major fire danger zones ahead of a horror bushfire season expected to grip the state.

Fire chiefs have warned of an extreme season expected to come earlier and last longer following a record dry start to spring and forecasts of a hot summer.

Melbourne's urban fringe has been identified as a particular risk zone, with the Mornington Peninsula, the Dandenongs and the Alexandra and Macedon regions told they should be on high alert.

Far East Gippsland and communities north of Horsham and around Bendigo have also been warned they are at risk of severe bushfires, fuelled by the absence of spring rainfall.

Department of Sustainability and Environment chief fire officer Ewan Waller said the threat was genuine.

"We're quite concerned about those areas because they're all populated and to be dry at this time of year means the fire season will come earlier," he said.

"Conditions are deteriorating and that means a big bushfire threat."

Mr Waller said Melbourne's water supplies, including the Thomson, Sugarloaf and Silvan reservoirs, could be contaminated by charcoal and sediment stirred up by fire

"Those areas are rapidly drying out and becoming susceptible to bushfires," he said.

If dams were polluted it could have a disastrous impact on the city's supply, forcing draconian short-term restrictions.

Melbourne experienced its driest September and October on record this year, Victorian Bureau of Meteorology figures reveal.

A little more than 26mm of rain fell in Victoria during the period, surpassing the previous low of 35.2mm set in 1914.

Statewide, Victoria had its third driest start to spring of all time.

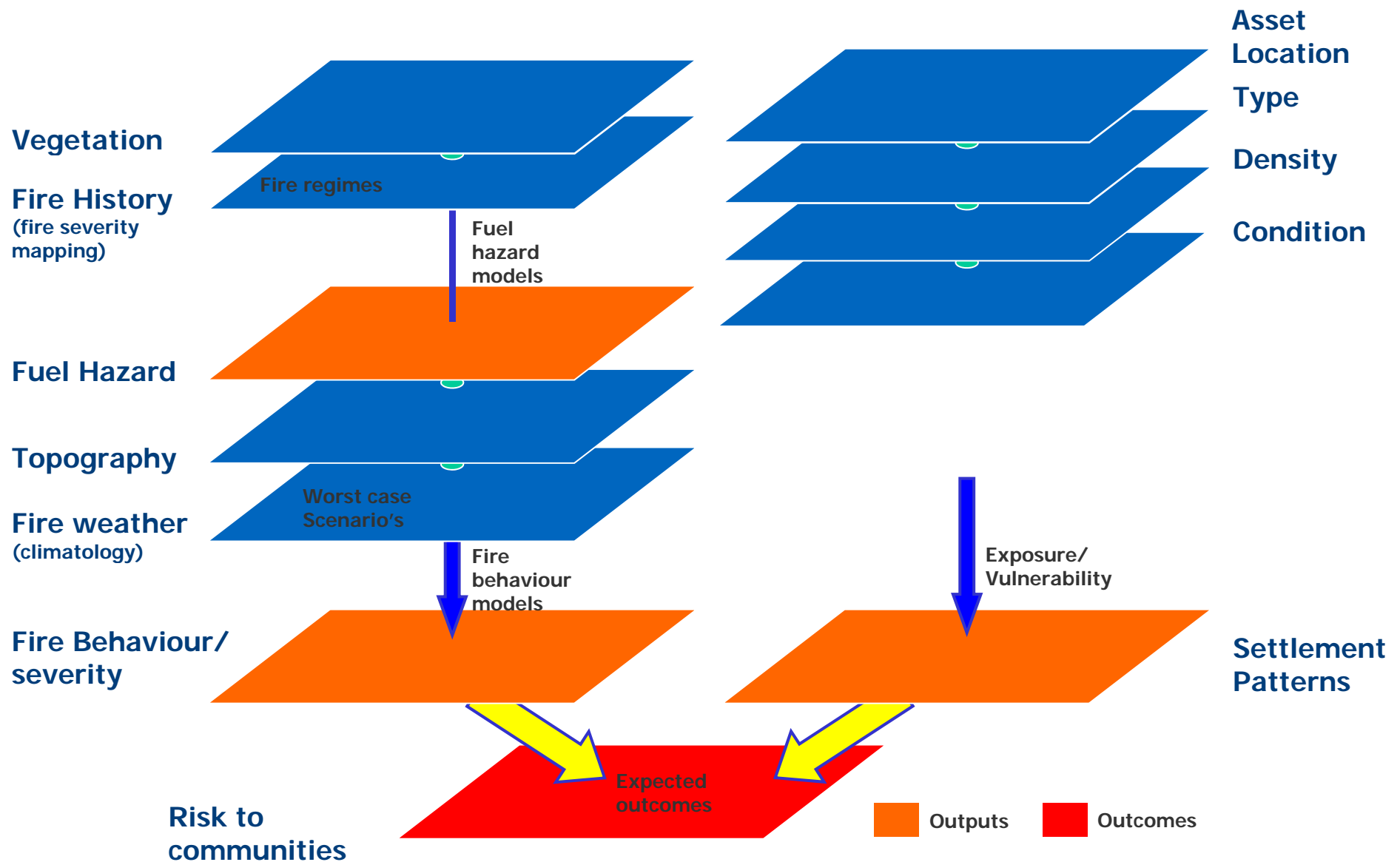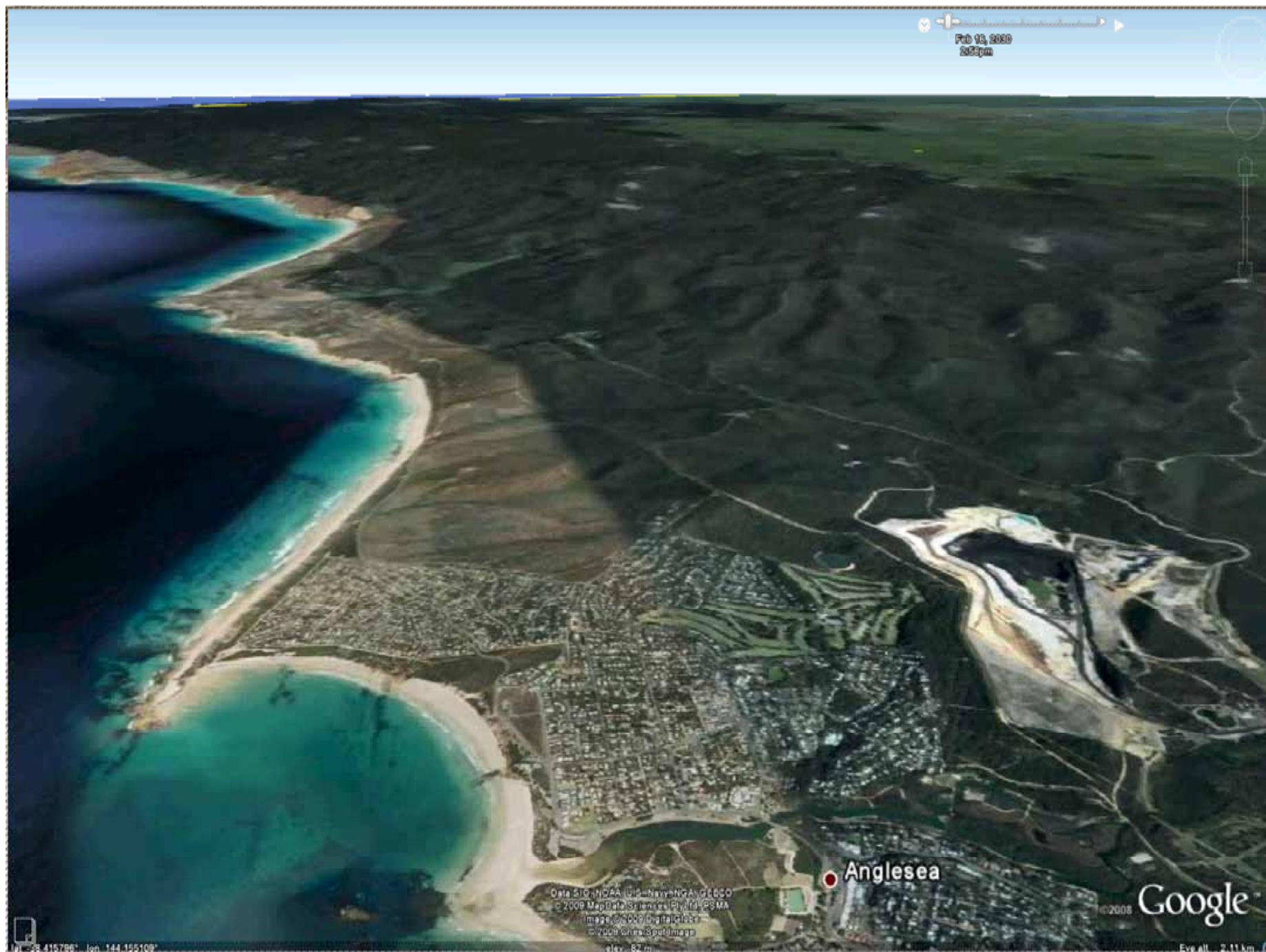Fire restrictions commenced in some parts of Victoria this weekend.
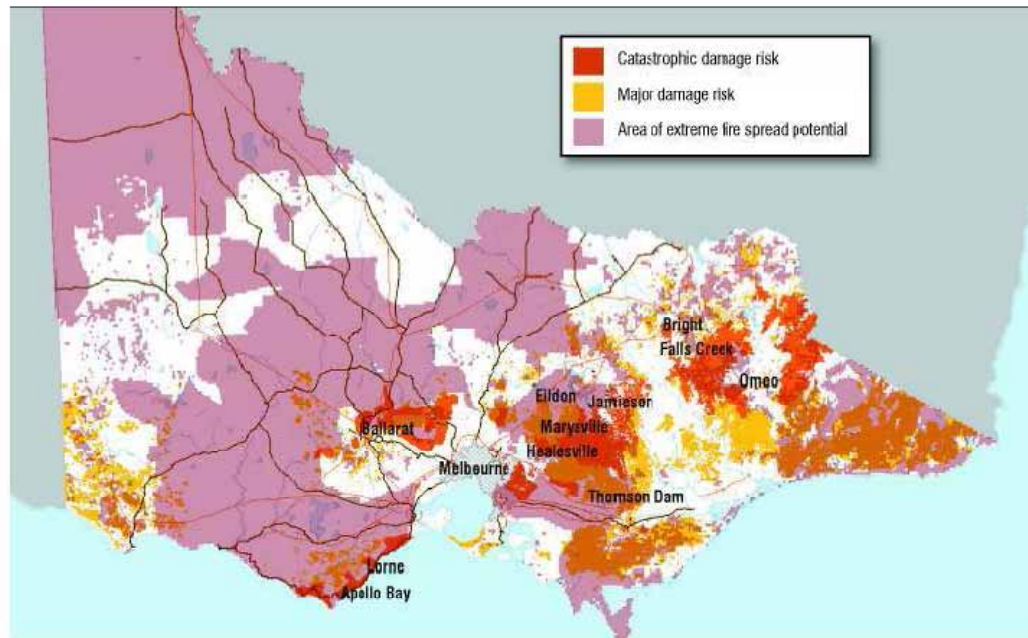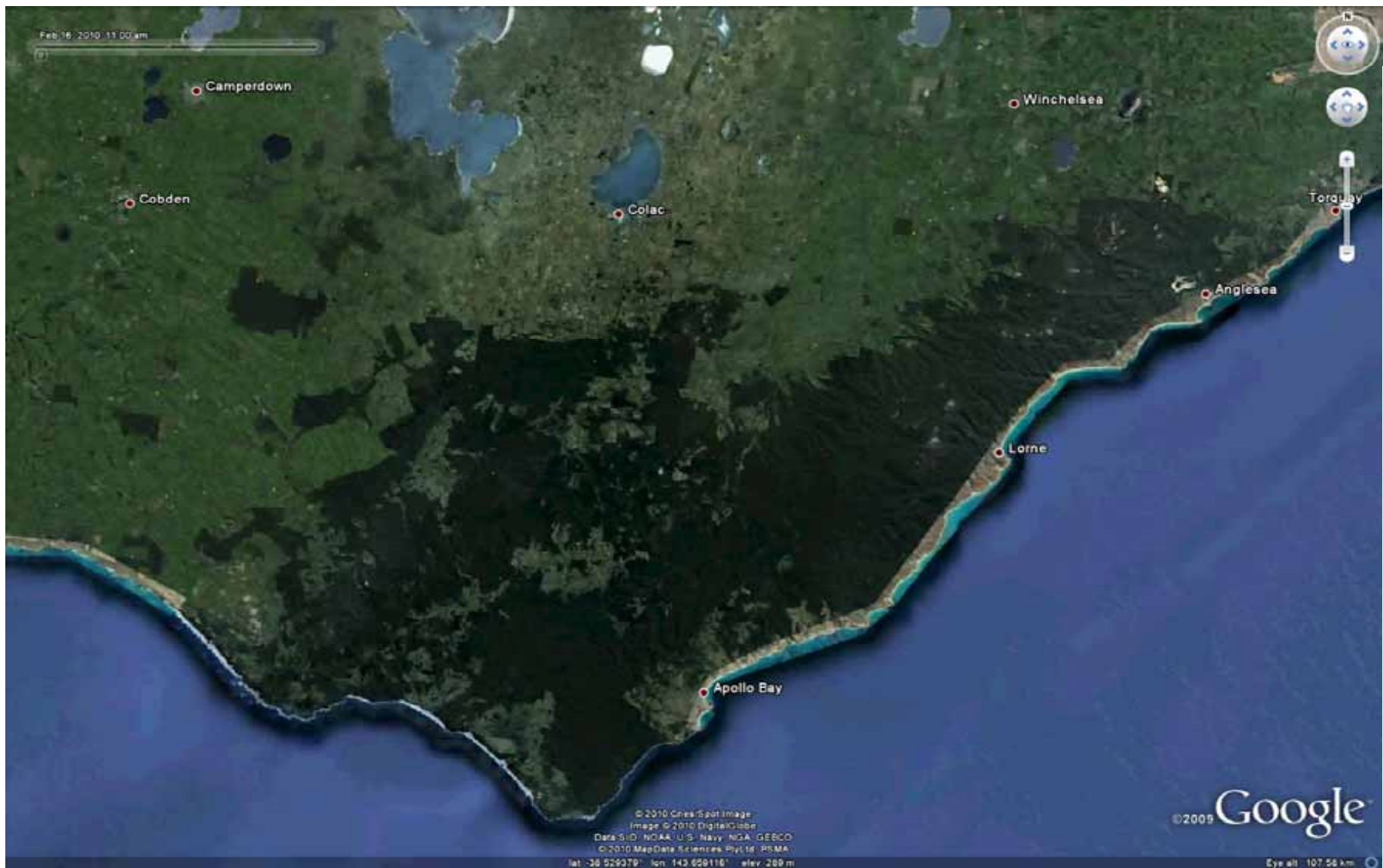


WHERE THE THREATS ARE

# A new community consequence scale

| Fire Danger Rating | Potential Fire Behaviour and Impact |
|---|---|
| **CATASTROPHIC (CODE RED) FDI 100+** | • Fires will be uncontrollable, unpredictable and fast moving – flames will be higher than roof tops.<br>• Many people will die and be injured.  Thousands of homes and businesses will be destroyed.<br>• Well prepared, well constructed and defended homes may not be safe during the fire. Construction standards do not go beyond a Fire Danger Index of 100.<br>• Thousands of embers will be blown around.<br>• Spot fires will move quickly and come from many directions, up to 20 km ahead of the fire.<br><br>**Leaving is the safest option for your survival.** |
| **EXTREME FDI 75-99** | • Fires will be uncontrollable, unpredictable and fast moving – flames will be higher than roof tops.<br>• People will die and be injured.  Hundreds of homes and businesses will be destroyed.<br>• Only well prepared, well constructed and actively defended houses are likely to offer safety during a fire.<br>• Thousands of embers will be blown around.<br>• Spot fires will move quickly and come from many directions, up to 6 km ahead of the fire.<br><br>**Leaving is the safest option for your survival.** |
| **SEVERE FDI 50-74** | • Fires will be uncontrollable and move quickly– flames may be higher than roof tops.<br>• There is a chance people may die and be injured.  Some homes and businesses will be destroyed.<br>• Well prepared and actively defended houses can offer safety during a fire.<br>• Expect embers to be blown around.<br>• Spot fires may occur up to 4 km ahead of the fire<br><br>• **Leaving is the safest option for your survival. Your home will only offer safety if it and you are well prepared and you can actively defend it during a fire**. |
| **VERY HIGH FDI 25-49** | • Fires can be difficult to control – flames may burn into the tree tops.<br>• There is a low chance people may die or be injured. Some homes and businesses may be damaged or destroyed.<br>• Well prepared and actively defended houses can offer safety during a fire.<br>• Embers may be blown ahead of the fire.<br>• Spot fires may occur up to 2 km ahead of the fire.<br><br>**Your home will only offer safety it is and you are well prepared and you can actively defend it during a fire.** |
| **HIGH FDI 12-24** | • Fires can be controlled<br>• Loss of life is highly unlikely and damage to property will be limited<br>• Well prepared and actively defended houses can offer safety during a fire.<br>• Embers may be blown ahead of the fire.<br>• Spot fires can occur close to the main fire.<br><br>**Know where to get more information and monitor the situation for any changes** |
| **LOW-MODERATE FDI 0-11** | • Fires can be easily controlled<br>• Little to no risk to life and property<br><br>• **Know where to get more information and monitor the situation for any changes** |

# Values and risk profile



Vegetation

Fire History (fire severity mapping)

Fire regimes

Fuel hazard models

Fuel Hazard

Topography

Worst case Scenario's

Fire weather (climatology)

Fire behaviour models

Fire Behaviour/ severity

Risk to communities

Asset Location

Type

Density

Condition

Exposure/ Vulnerability

Settlement Patterns

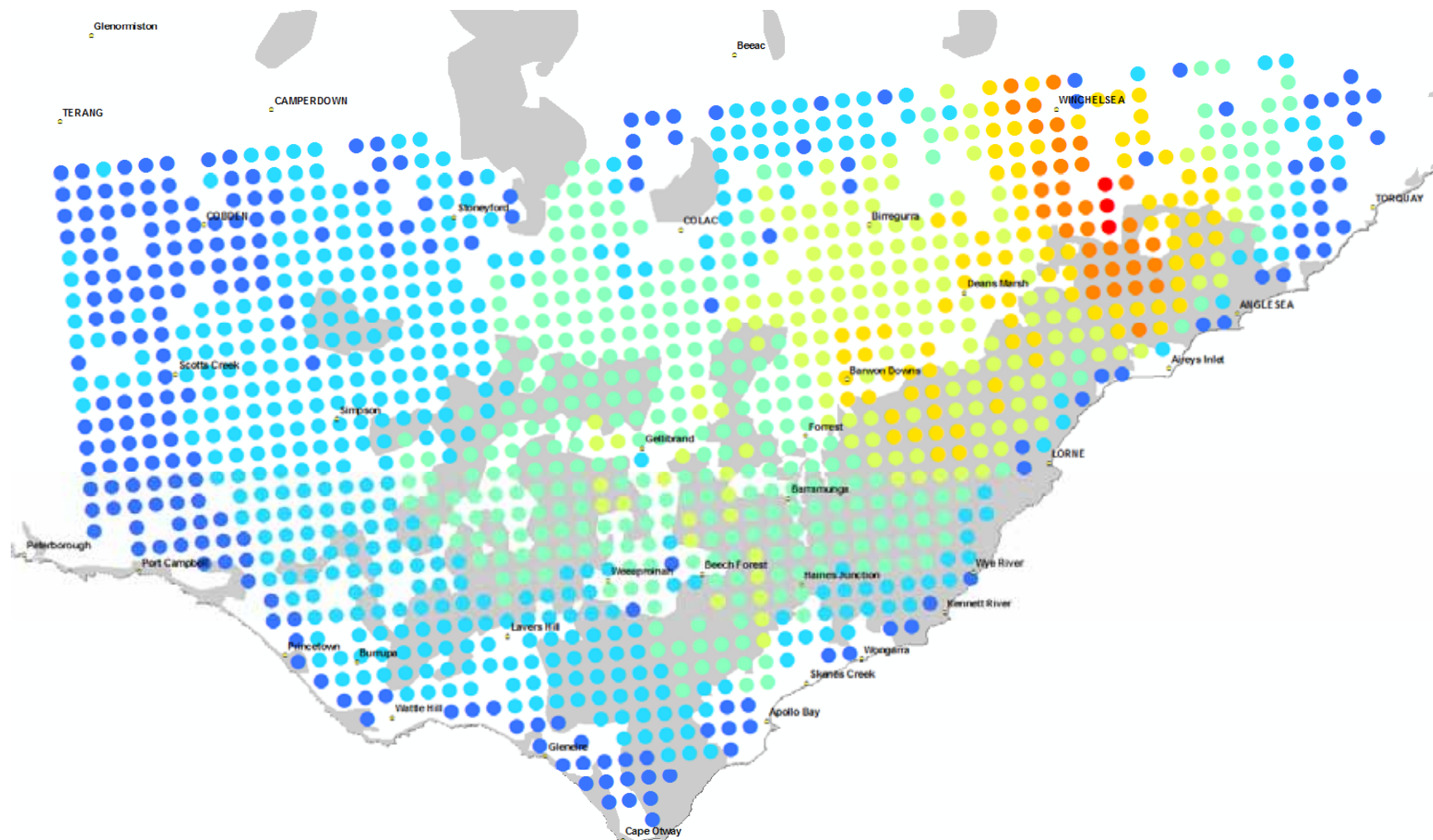Expected outcomes

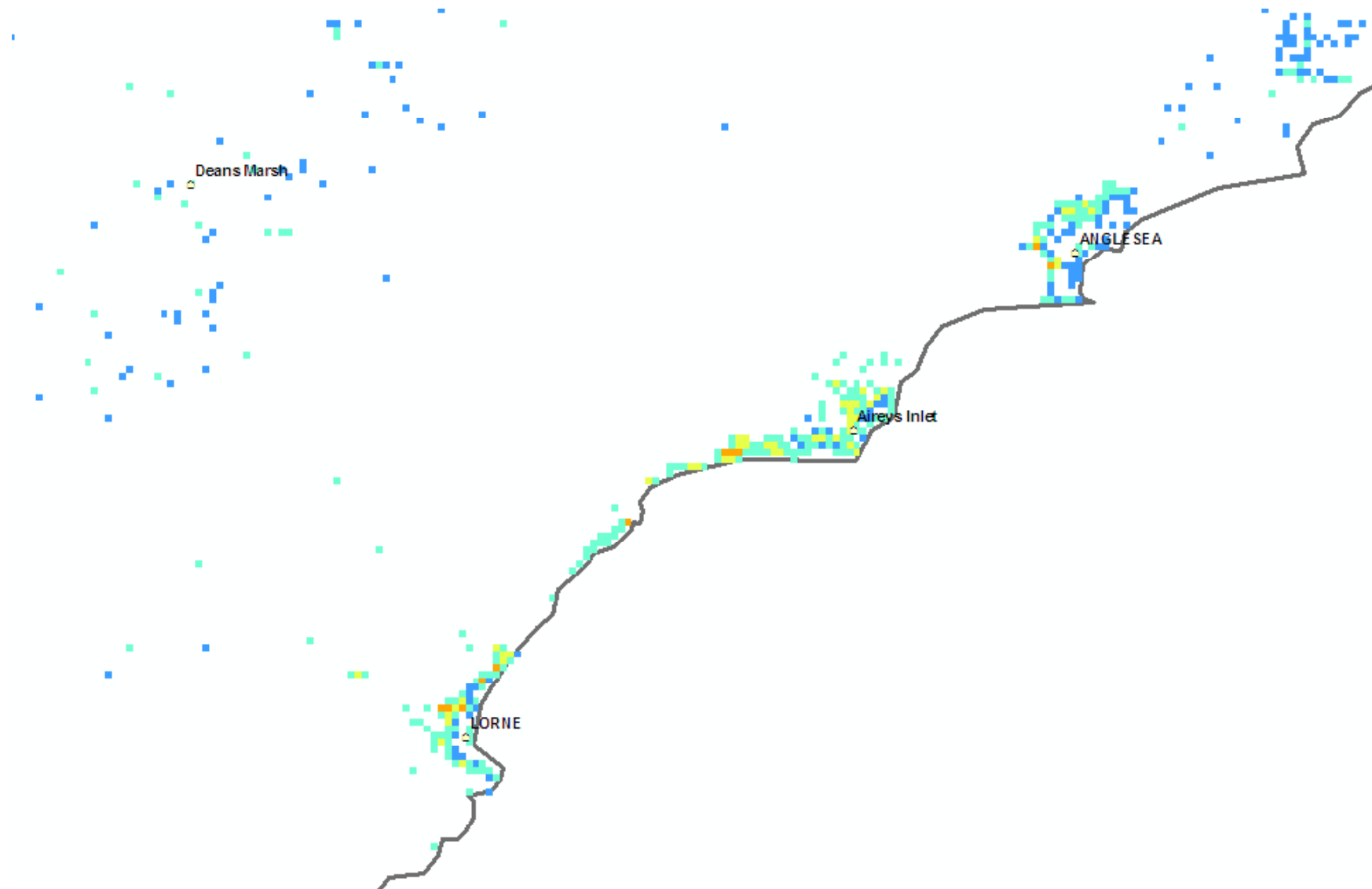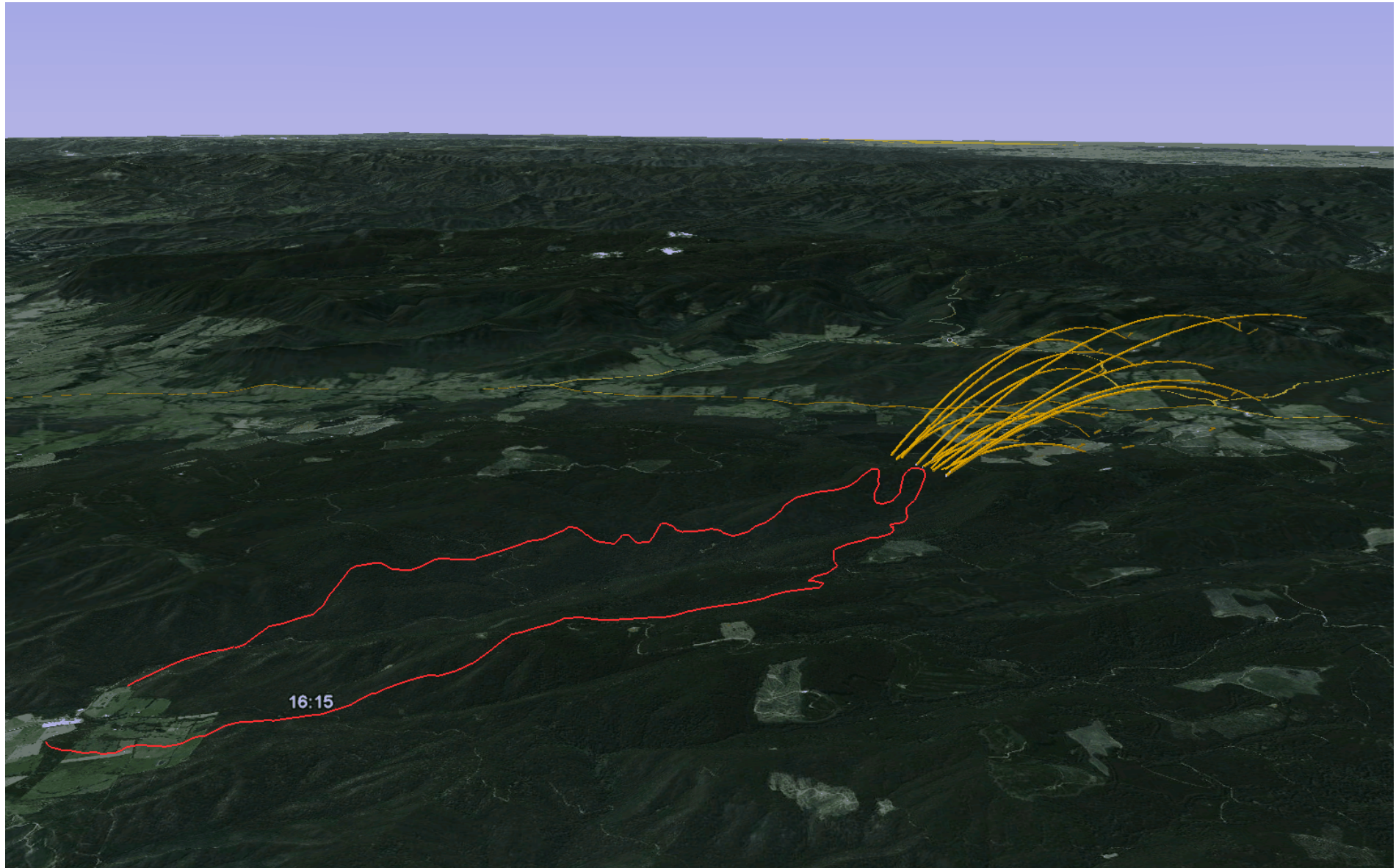Outputs   Outcomes

Anglesea

Google

# Its not about one fire – its about many fires

### Fire ignition threat – townships
#### (based 2km grid and Ash Wednesday weather conditions)

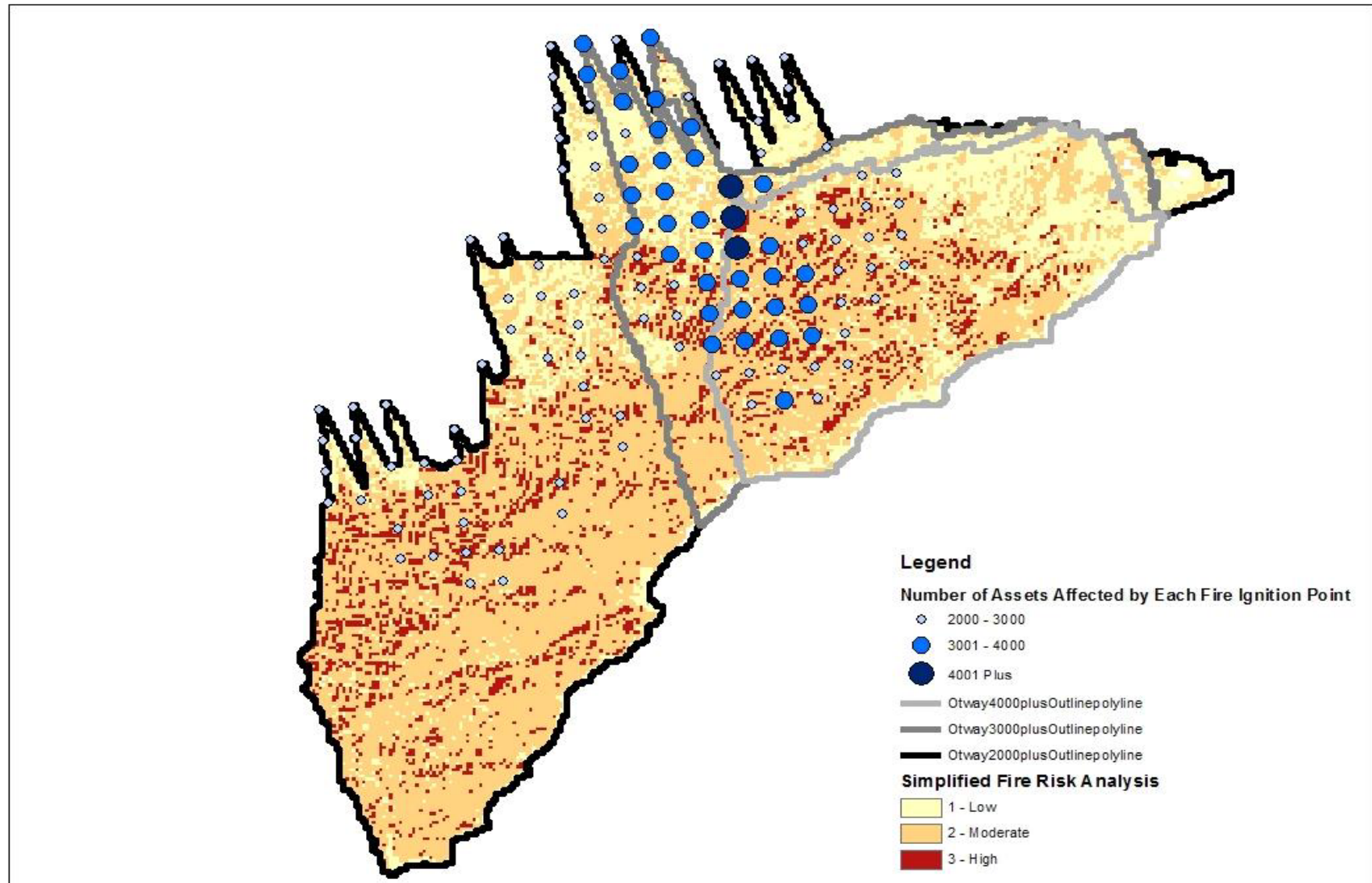# Consequences

# Fire Pathways – Linking Ignition to Impact



16:15

# High Priority Risk Areas – Major Fire Runs



Legend

Number of Assets Affected by Each Fire Ignition Point

- ◇ 2000 - 3000
- ● 3001 - 4000
- ● 4001 Plus

— Otway4000plusOutlinepolyline
— Otway3000plusOutlinepolyline
— Otway2000plusOutlinepolyline

**Simplified Fire Risk Analysis**

- ☐ 1 - Low
- ☐ 2 - Moderate
- ■ 3 - High
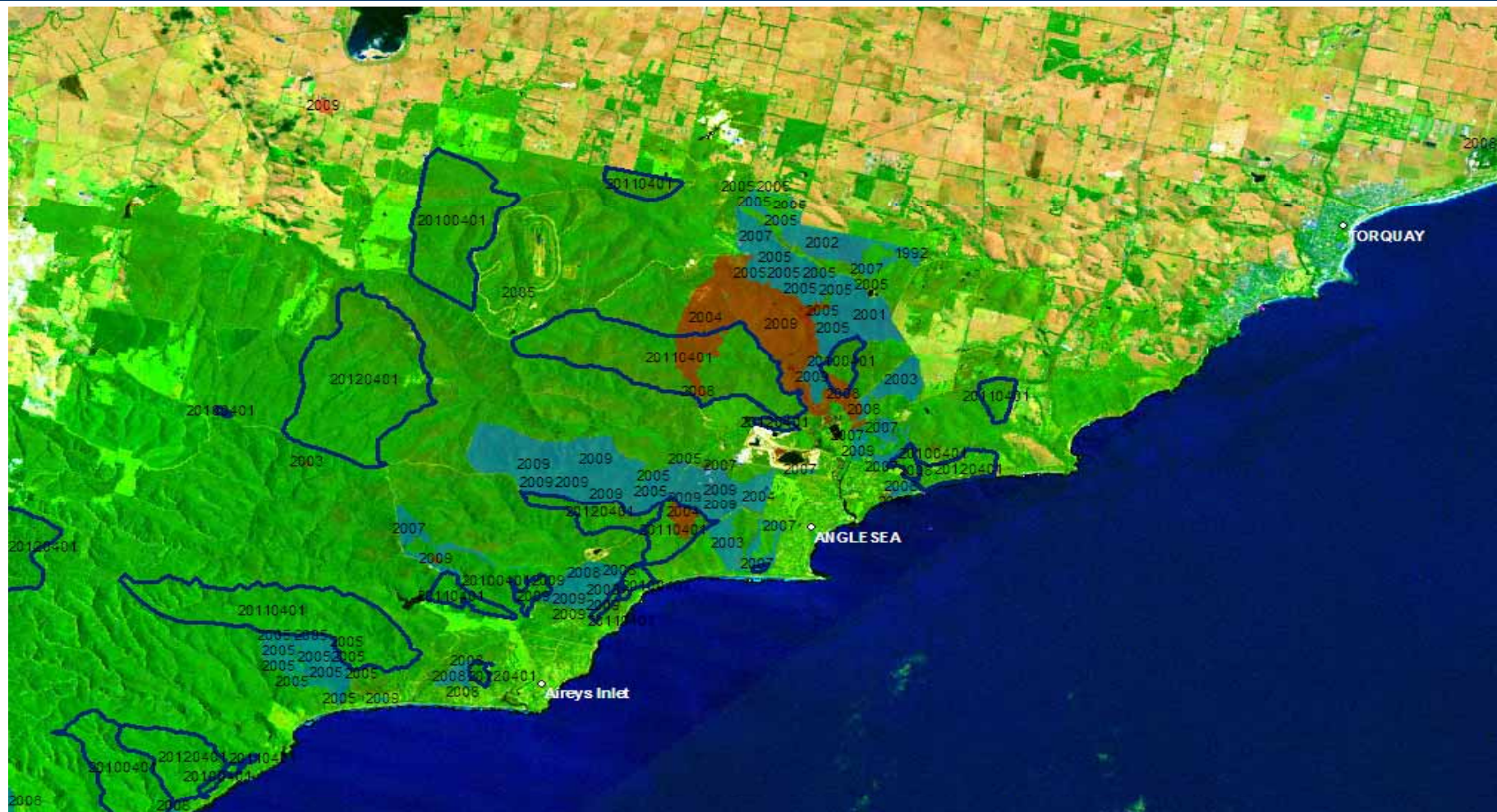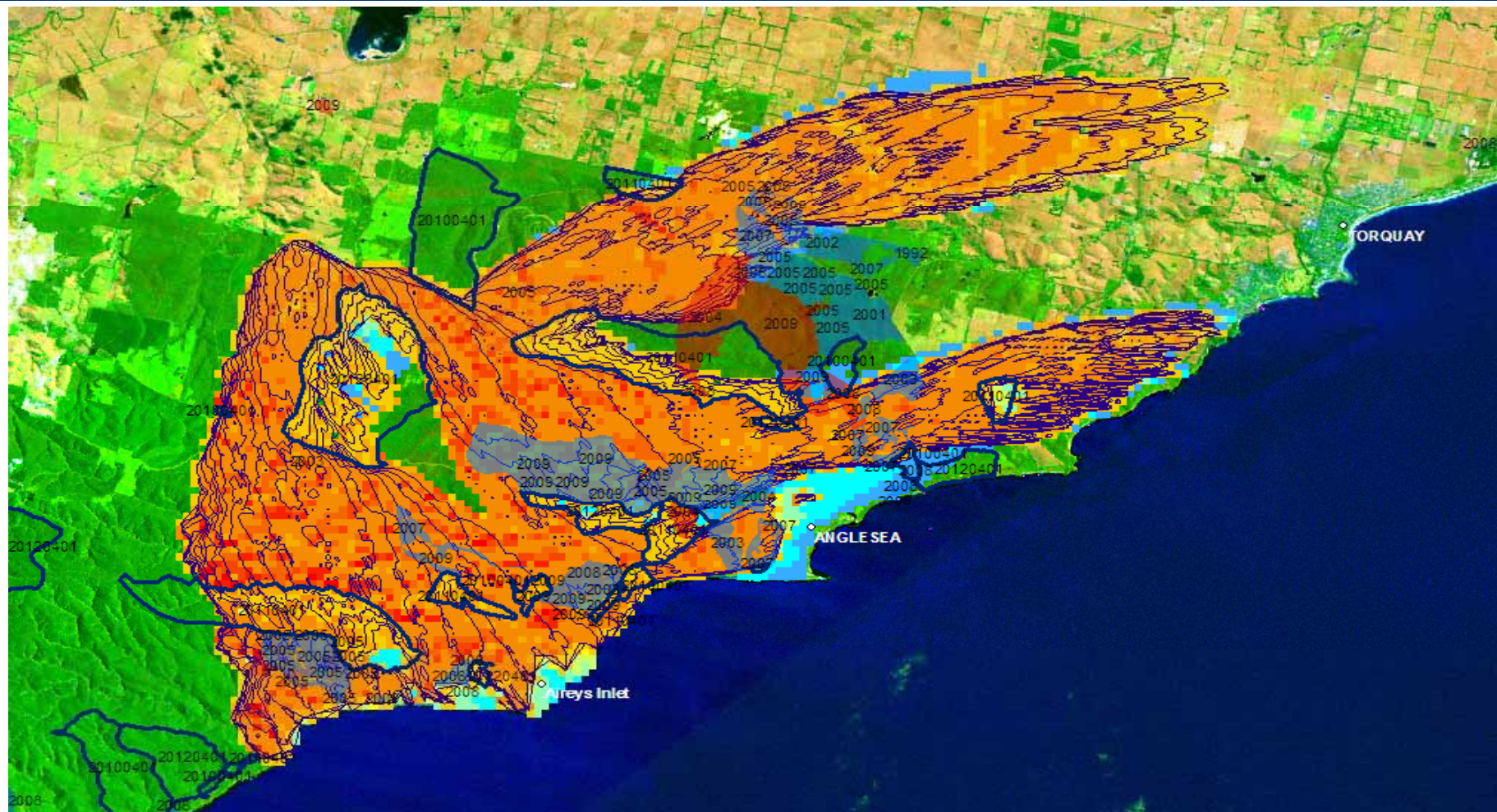
# Initial (Draft) Bushfire "Catchments"



**Higher Bushfire Risk Areas**
**Maximum Risk (based on estimated fuel hazard & potential asset/property damage)**

- × 240
- × 80
- × 27
- × 9
- Main Roads
- Watercourse
- Water Bodies
- Public Land
- Local Government Area
- Victorian Gov. Region

**Important Notes:**
Bushfire Risk Areas are derived from Phoenix modelling of bushfire ignitions across the State (based on a 10km grid) under 1983 Ash Wednesday weather conditions.

They represent the landscapes where the most severe bushfires may start, spread and potentially cause significant damage.

Areas highlighted are linked to (but not limited to) public land.

**Risk Areas - Maximum risk based on maximum fuel conditions**

(c) The State of Victoria Department of Sustainability and Environment | Disclaimer: This map is a snapshot generated from Victorian Government data. This material may be of assistance to you but the State of Victoria does not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for error, loss or damage which may arise from reliance upon it. All persons accessing this information should make appropriate enquiries to assess the currency of the data.

# Risk curves – how have they changed
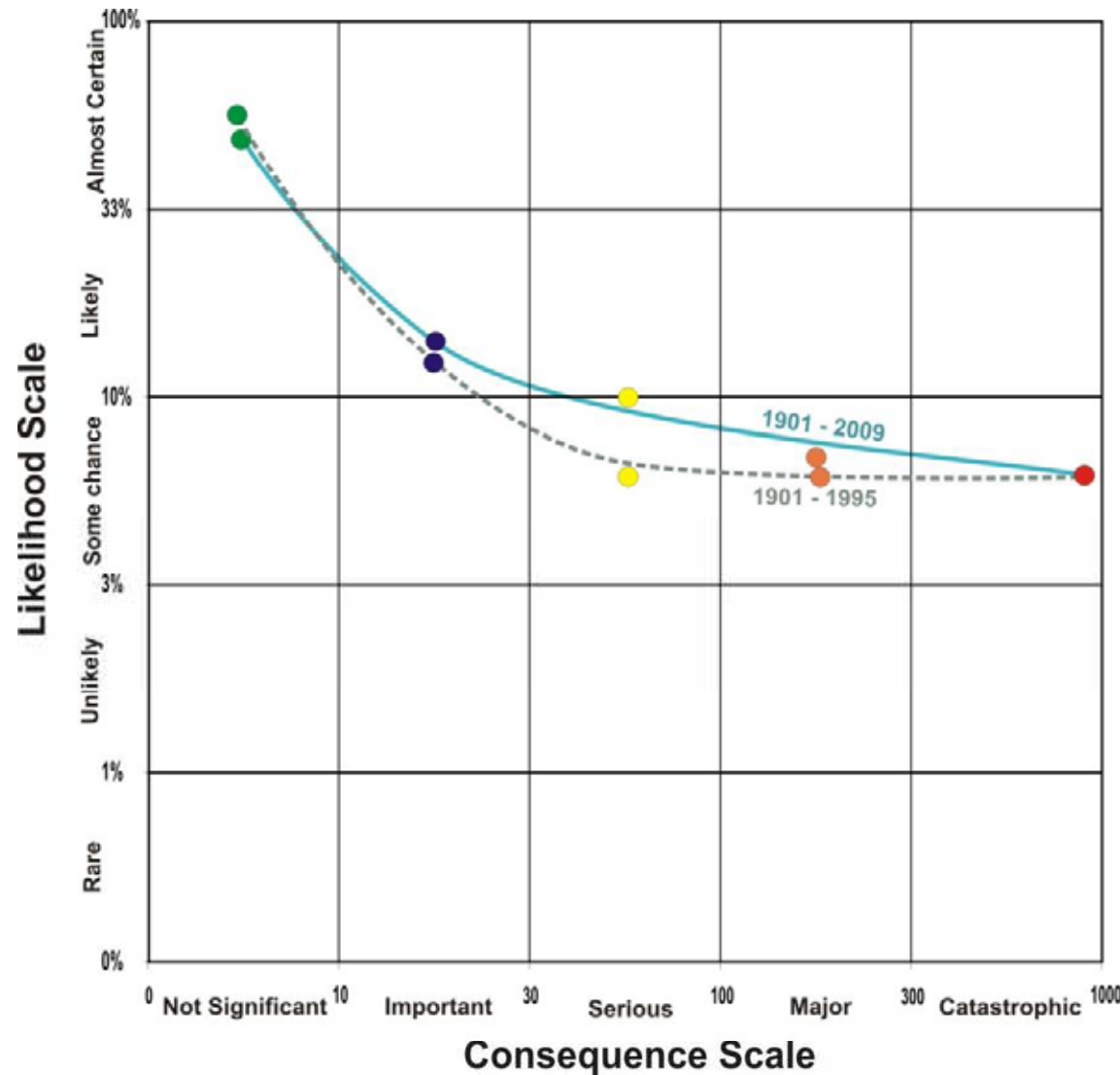


- **Long term data can be used to generate risk curves – chance of a particular season/event occurring;**
- **1901 to 2009 provides a "classic" curve with less significant seasons being the norm;**
- **1995 significant test point:**
  - **Beginning of major growth in fire impacts in the US;**
  - **Close to the start of our current drying cycle;**
  - **Assumed to represent future climate by some sectors (eg., Water);**
- **1901 to 1995 curve are similar.**

# Risk curves – how have they changed
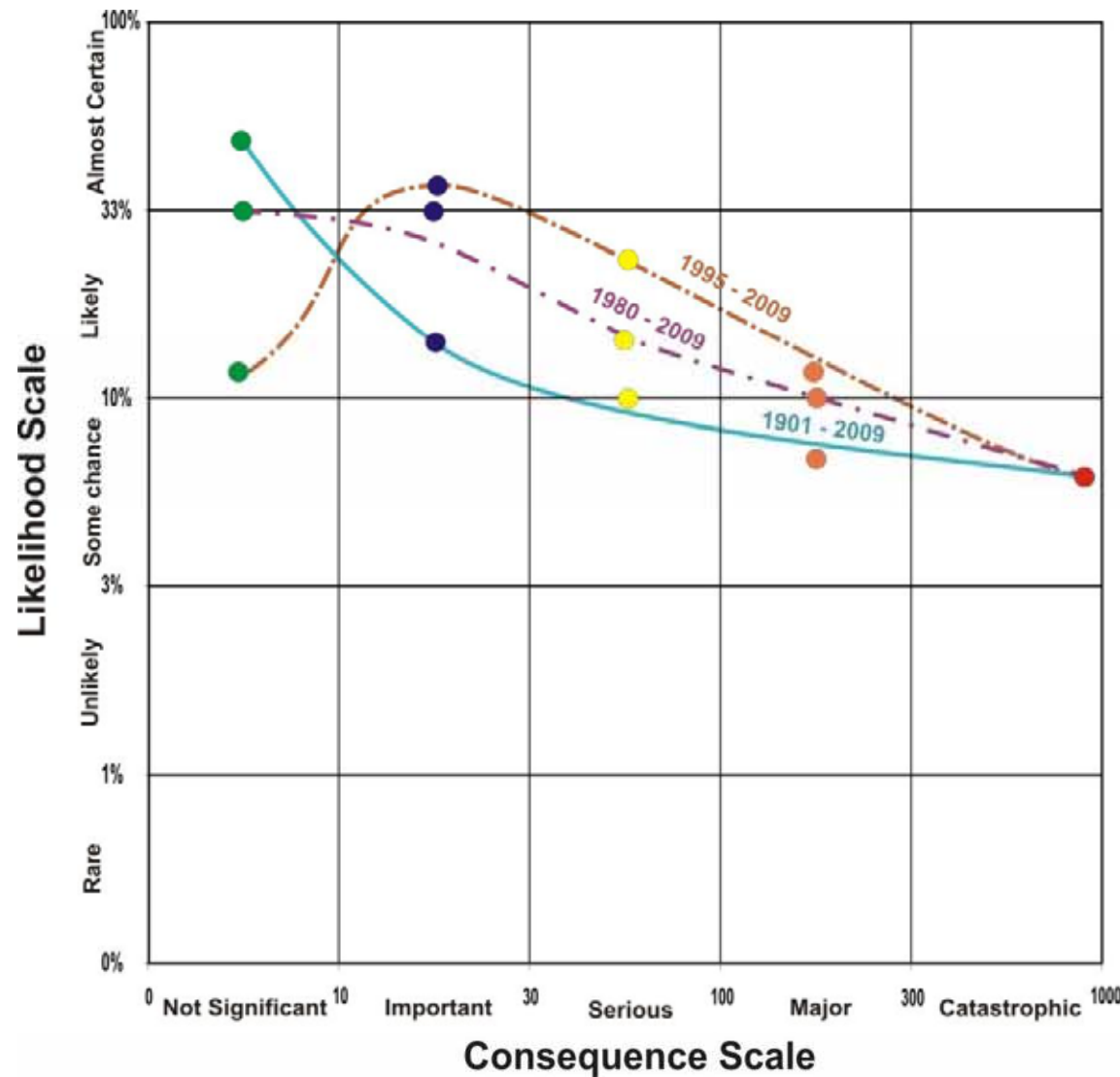


- **More recent changes possibly better assessed by past 30 and 15 years;**
  - **30 yrs considered minimum time period for a climate data set,**
  - **15 years considered an option for our future climate – used by Water Sector;**

- **Moving away from "classic" curve.**

# Risk curves – how MIGHT they change
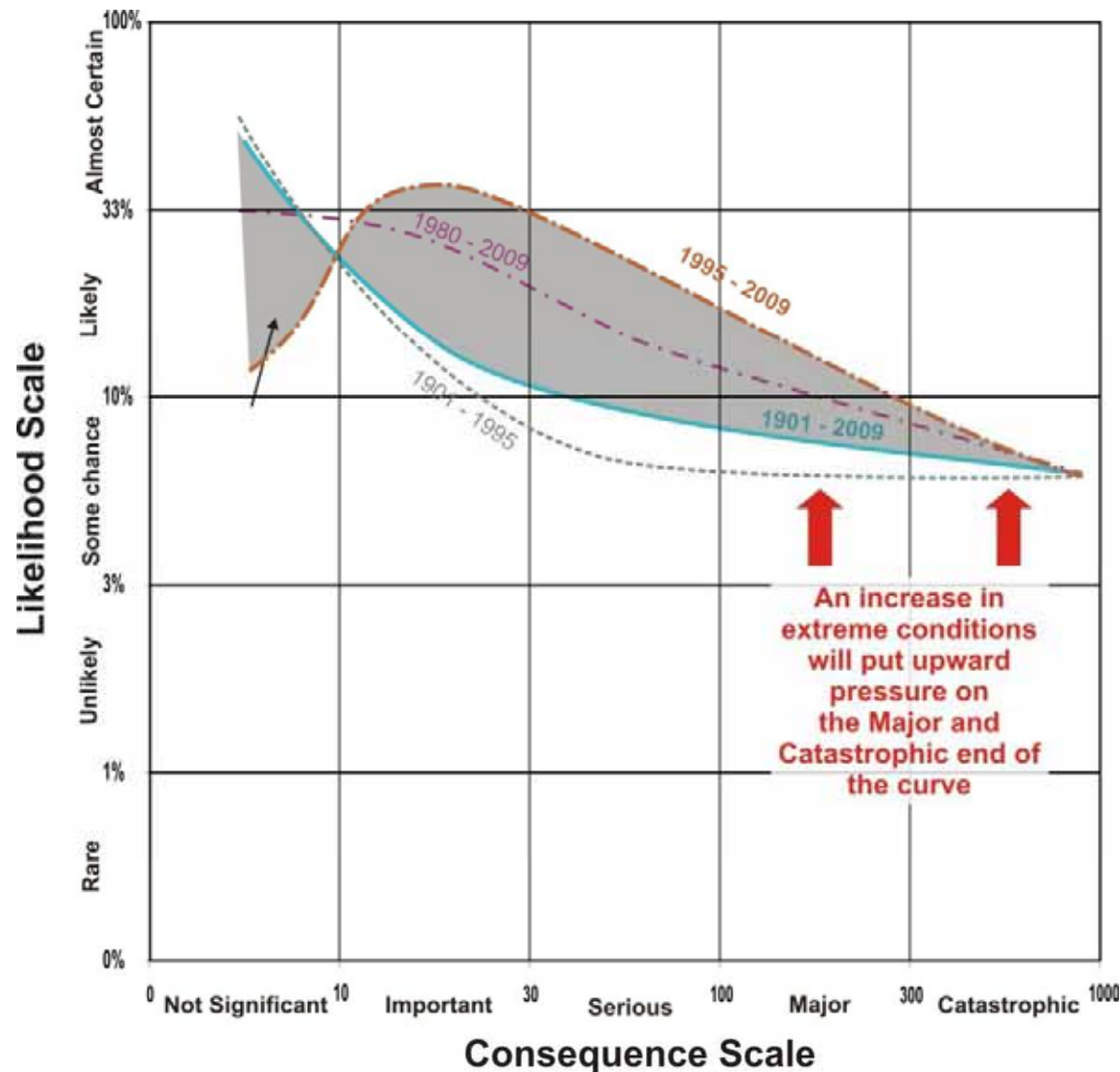


- **The return period for Catastrophic events is constantly close to 1 in every 15 years;**
- **This is consistent when viewed over:**
  - **1901 to 1995 and 1901 to 2009, and**
  - **1980 and 1995 to 2009;**

- **Catastrophic events typically occur on a few days in a given season;**
- **A subtle increase in severe events has the potential to significantly increase damage and loss.**

# Where to:



- **Where fire behaviour fits:**
  - **knowledge (inc. science) that underpins predictive capability,**
  - **organisational capability to normalise learning – not just a products,**
  - **promote a supporting culture - strengthen supporting human factors to ensure questions are asked, strategies developed followed,**
  - **Supports adaptive land, fire and emergency management.**

Outcomes

Strategies

Actions

Human factors

Predictive capability

Organisational capability

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# What's needed

- Fire knowledge (inc. science) is critical to informed decision making,

- Its not just about the fire, its about how fire interacts with people, structures, services and the environment,

- Invest across a whole landscape – through to the edge,

- Understand fire environment and social factors and how these change risk in time and space,

- Understand how we can best influence risk,

- Adaptive frameworks that support learning and decision making.