Forests Fire and Water

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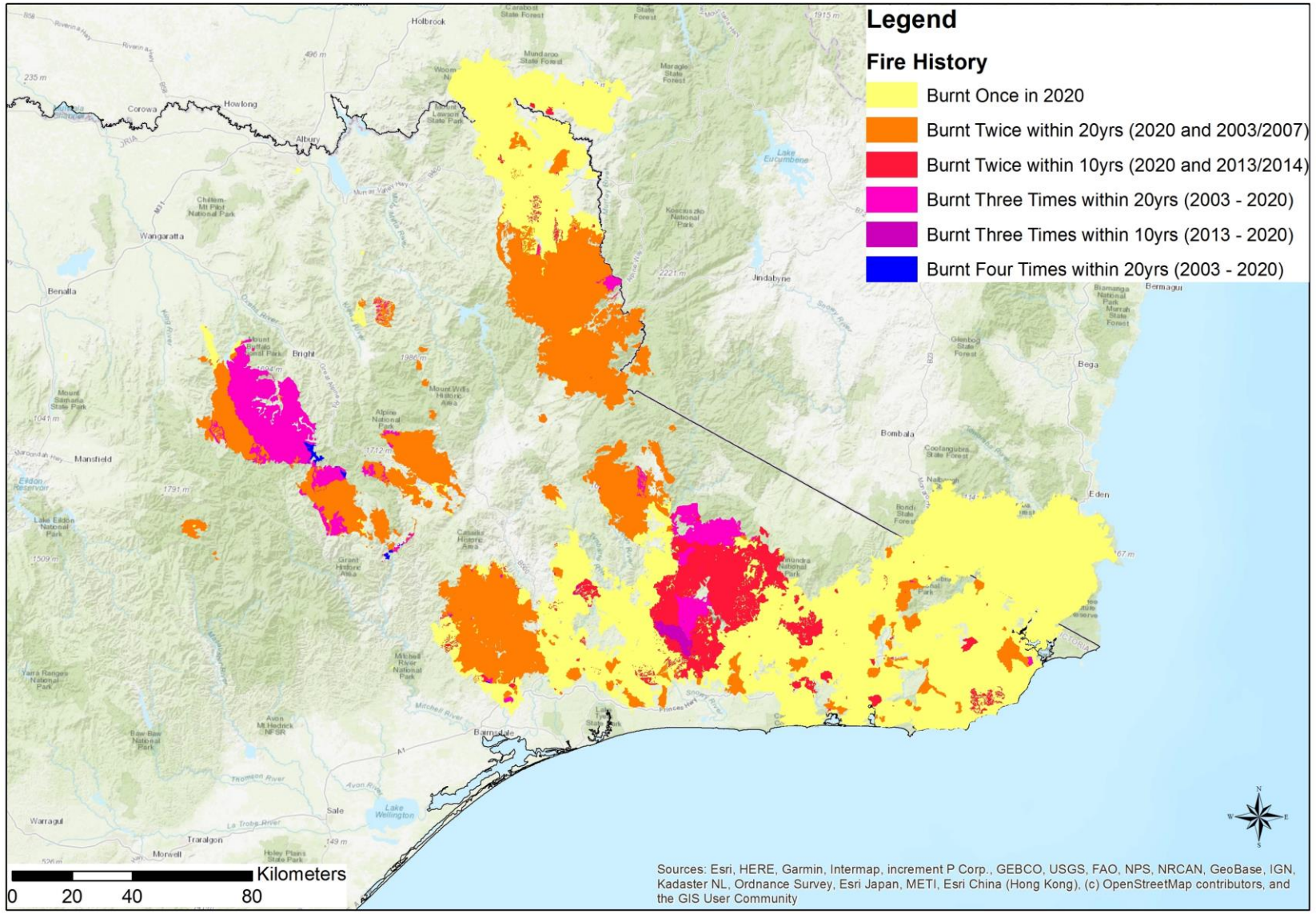
Fires….there's a lot of it about, and often!



Fire and Water

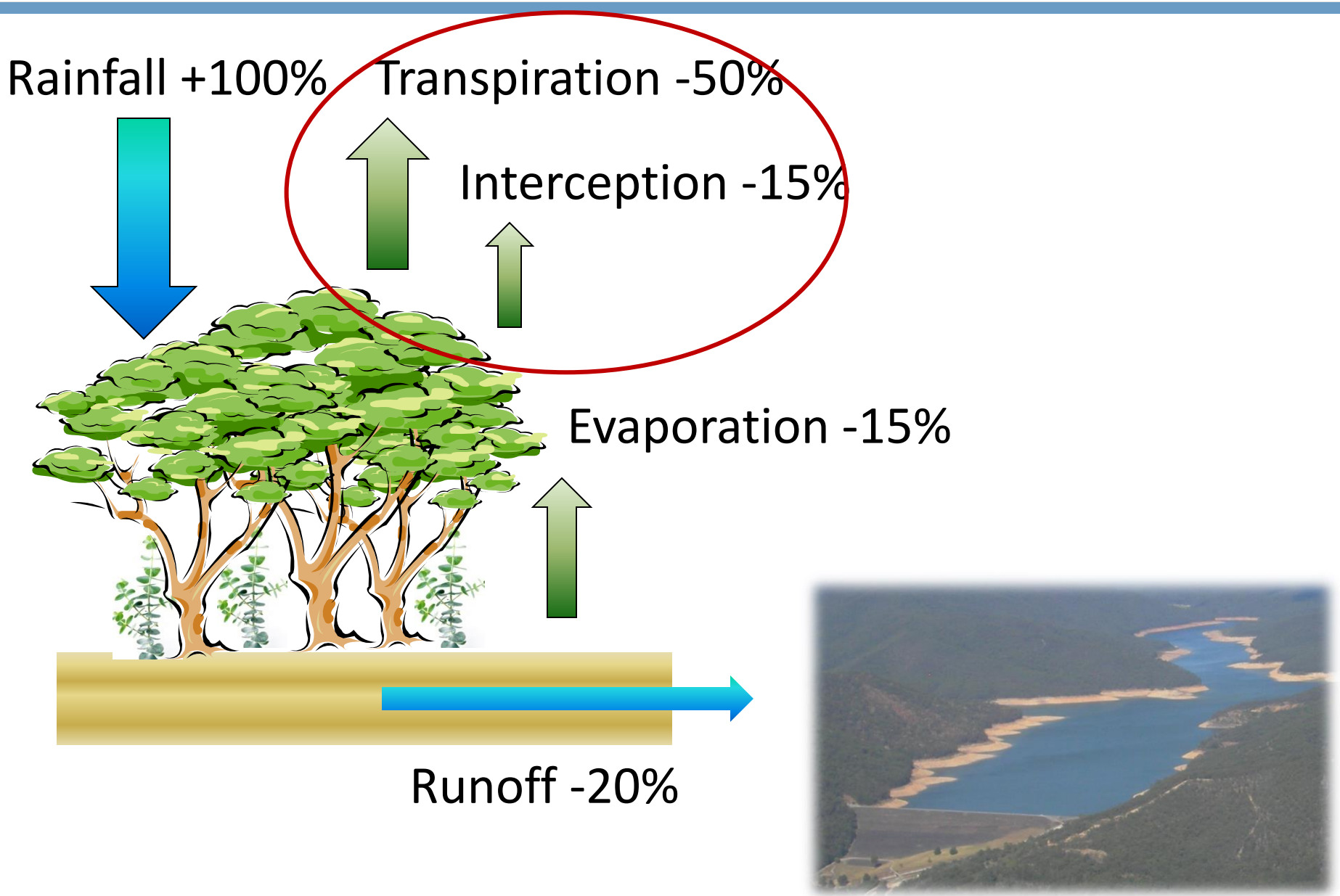
What are the issues?

Potential issues around streamflow and water quality; ie. will these values be negatively impacted by fire?

Flash flooding – where and under what circumstances?

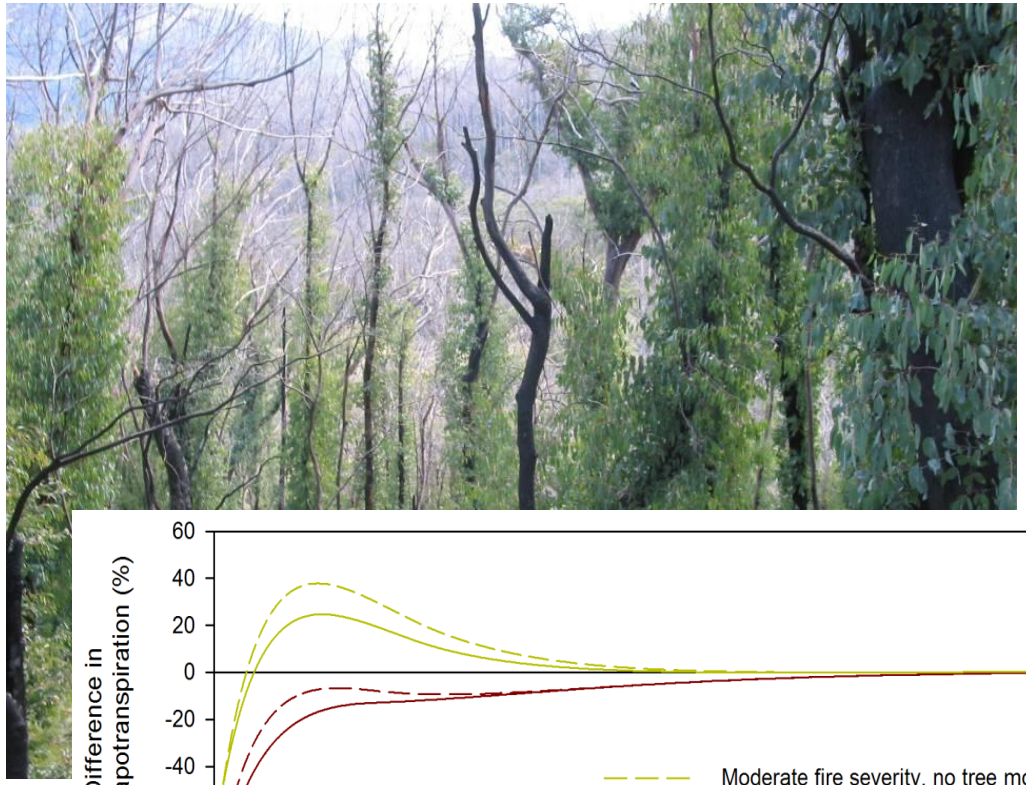
Mass erosion events impacting on infrastructure – again where and why, and how might these link to water quality?

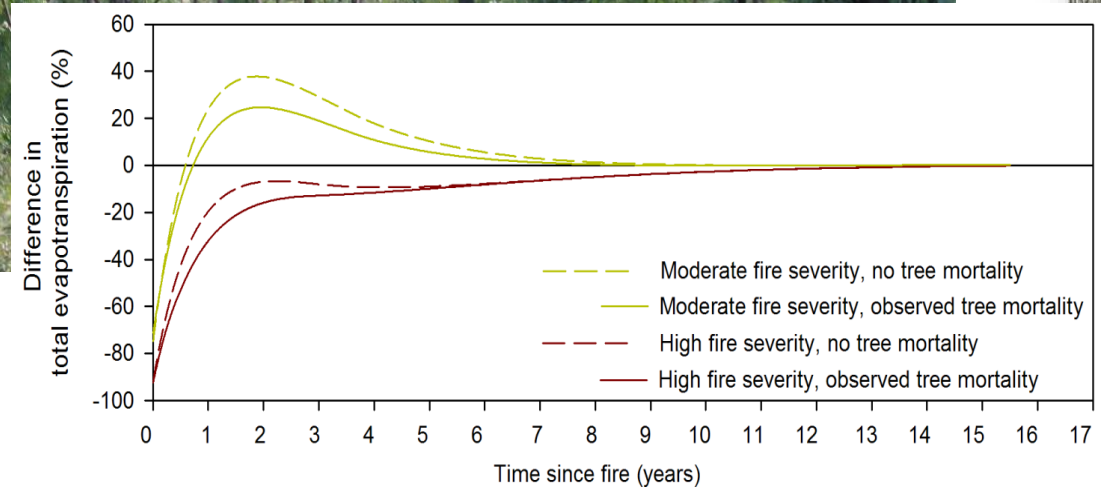
Water balance



What do we know? We know that the ET (and therefore Q) response is largely about stand mortality, recovery rates and pre-and post-fire rainfall

Mixed species eucalypts

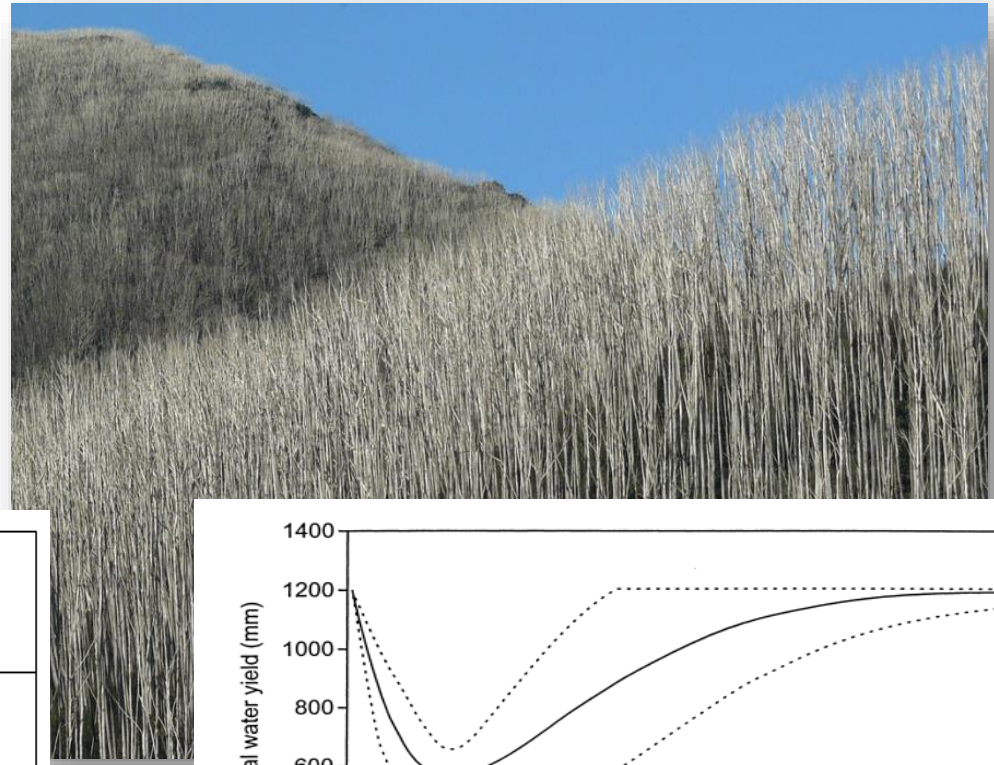


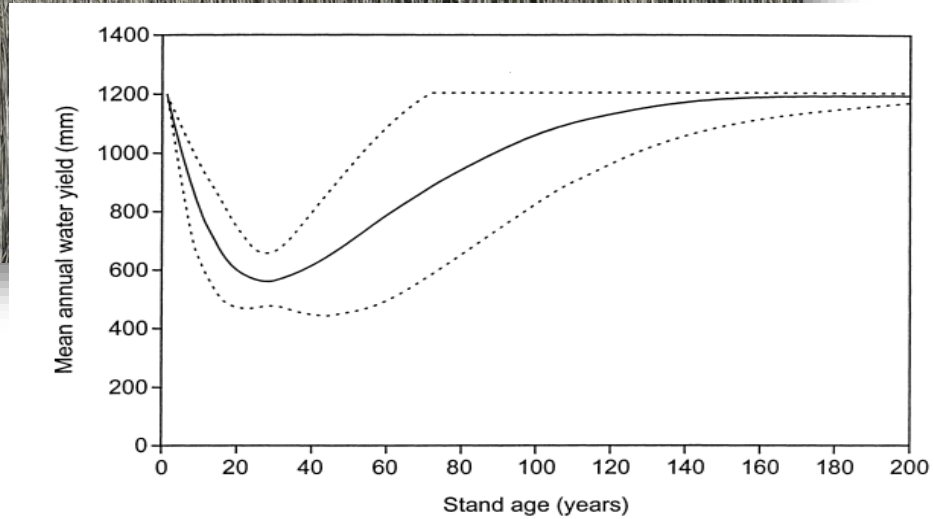


Note the fire severity

Nolan et al., JH 2015

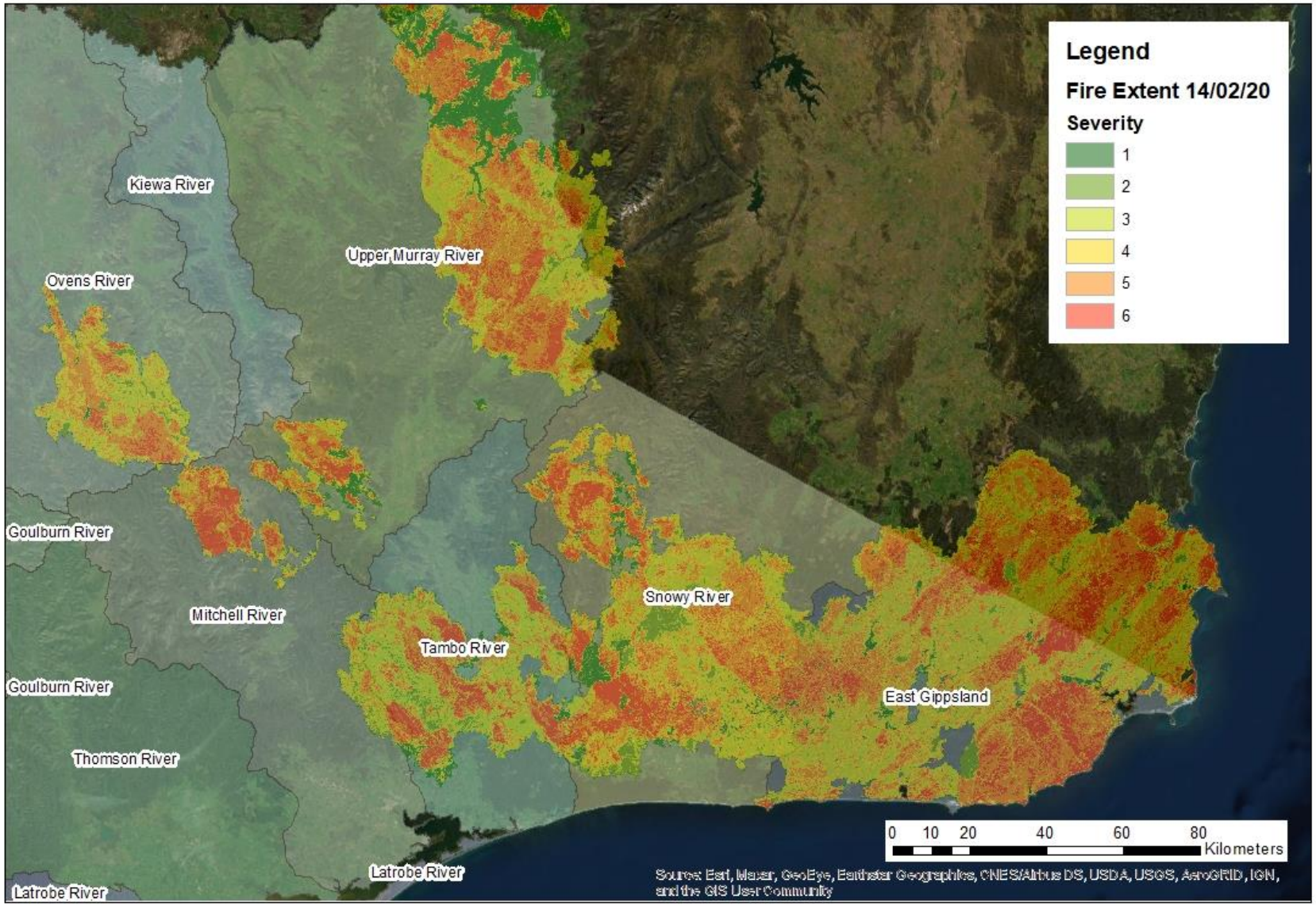
Ash species





May not always occur

Black Summer fire severities in Victorian catchments



If we look at the areal % of species and severity, we see little ash burnt at stand replacing severities, and a balancing out of Moderate and Severe categories for Mixed Species = little impact

				Percent of Basin Area Burnt											
Basin Name	Total Basin Area (ha)	Vegetated Area (ha)		Burnt (Severity 1)		Burnt (Severity 2)		Burnt (Severity 3)		Burnt (Severity 4)		Burnt (Severity 5)		Burnt (Severity 6)	
		Ash	Mixed	Ash	Mixed	Ash	Mixed	Ash	Mixed	Ash	Mixed	Ash	Mixed	Ash	Mixed
East Gippsland	470414	1473.0	448709.0	0.00643 %	0.28%	0.03%	4.53%	0.02%	26.58%	0.01%	12.34%	0.01%	31.77%	0.00%	10.46 %
Mitchell River	522742	47015.3	369082.7	0.00000 %	0.02%	0.08%	1.18%	0.31%	2.62%	0.21%	0.71%	1.09%	3.69%	0.66%	2.19%
Ovens River	778871	23584.9	410143.9	0.00022 %	0.05%	0.09%	0.92%	0.18%	3.70%	0.11%	2.61%	0.22%	4.29%	0.09%	0.62%
Snowy River	668390	19860.8	571620.9	0.00001 %	0.24%	0.16%	4.98%	0.51%	15.36%	0.10%	4.43%	0.45%	17.32%	0.07%	6.89%
Tambo River	420955	17138.2	318494.8	0.00007 %	0.15%	0.12%	4.42%	0.68%	16.58%	0.06%	1.54%	0.46%	12.54%	0.03%	5.90%
Upper Murray River	1013999	80714.2	666562.0	0.00078 %	0.20%	0.16%	0.94%	0.79%	5.89%	0.45%	3.26%	1.50%	9.87%	0.60%	3.83%
Total	**2861372**	**189786.3**	**2784613.2**	**0.0014%**	**0.21%**	**0.16%**	**3.36%**	**0.61%**	**13.97%**	**0.26%**	**5.29%**	**0.97%**	**16.45%**	**0.38%**	**6.12%**

Basin Name	Burn severity 3&4 Moderate	Burn severity 5&6 Severe	Difference (5&6 - 4&5)
East Gippsland	38.9	42.2	3.3
Mitchell River	3.3	5.9	2.6
Ovens River	6.3	4.9	-1.4
Snowy River	19.8	24.2	4.4
Tambo River	18.1	18.4	0.3
Upper Murray River	9.2	13.7	4.5

Streamflow

The other factor (rather obviously..) is rainfall, both pre- and post-fire. As large fires usually occur after extended dry periods, often the extra water from interrupted ET fills the “soil bucket” and doesn’t go to streamflow.

Early flows following the Black Summer fires were not high (similar to post Black Saturday), but the subsequent wet period is most likely to dominate the flow dynamics (again similar to post Black Saturday)

Examples of post-fire or ET analyses from non-ash dominated catchments include:

- No change (Heath et al. 2015)
- 70% increase for 2 years (Lane et al. 2006)
- Marked increases (Brown et al. 1972)
- A decrease from both drought and **moderate** fire (Nolan et al. 2015)*
- No change in ET (Gharun et al. 2013)

There are some unpublished analyses that also show an increase after Black Saturday, and another broadscale analysis that suggests overall, fire accounts for < 10% of variability in streamflow after fire, with rainfall dominating.

Studies from elsewhere in the world found flow increases in the order of 5-15%

Erosion and Water Quality

What are the potential issues?

- Poor water quality that cannot be supplied
- Deterioration in in-stream habitat
- Infrastructure damage from Debris Flows (mass erosion events)

Glenmaggie Dam, 2007

Ovens River, 2003

Debris Flow in Upper Murray catchment post 2019-20 fire

Erosion and Water Quality

Water quality impacts can range from very low to “off the scale” – highly dependent on:

- fire intensity (ie. degree of loss of ground cover and root strength loss)
- post-fire rainfall **intensity**
- degree of soil water repellency
- soil hydraulic properties such as porosity distribution (can linked to forest type in some envs.)
- Slope

Although poor water quality can result from “traditional” erosion processes (rill, interrill), it is usually fairly transient – maybe a boil water notice for a few days, or turbid stream water, it is mass erosion via Debris Flows that are the big issue

Why focus on debris flows?

Non-debris-flow erosion

Debris-flow erosion

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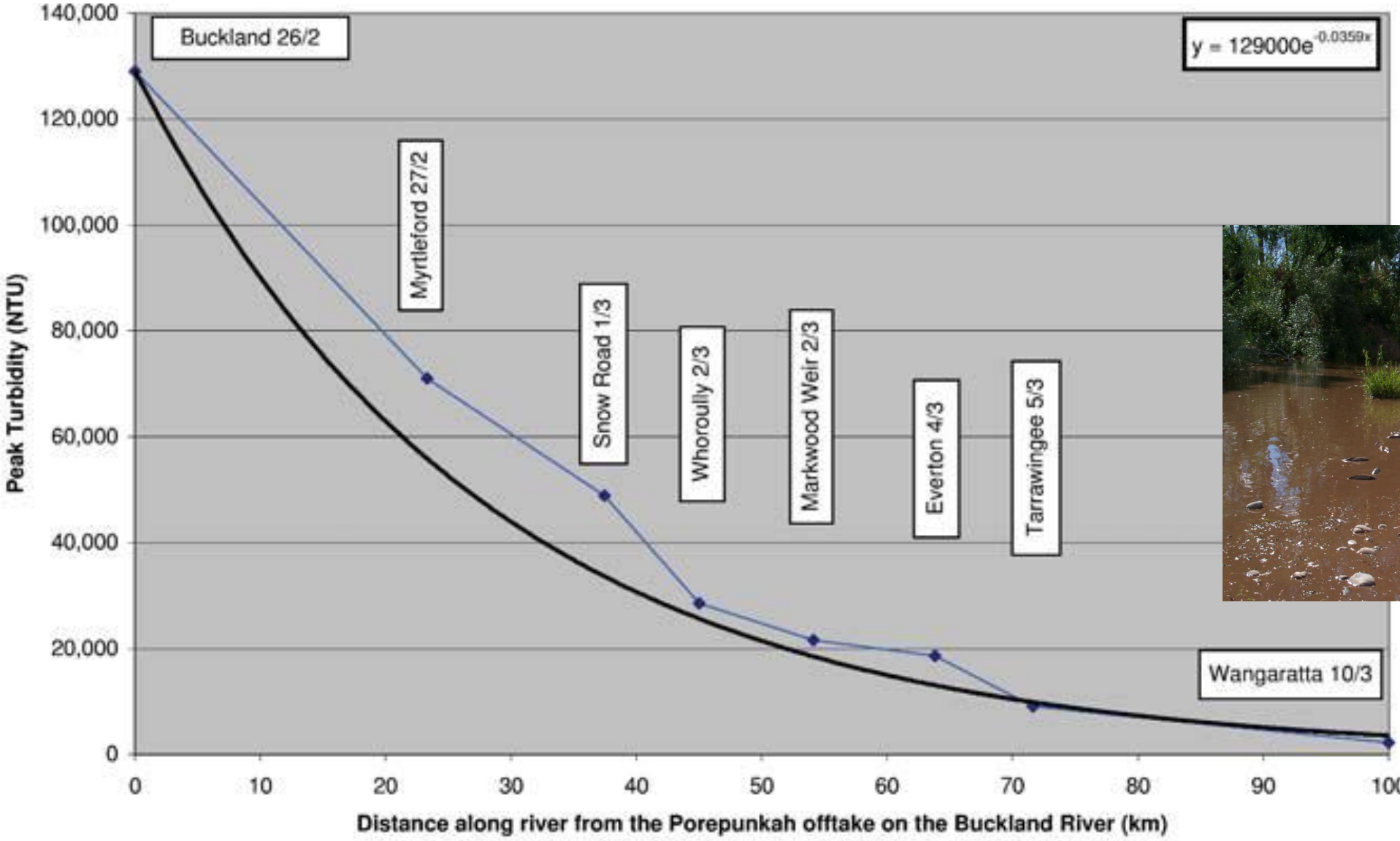
Debris flow, Feb 07, Macalister catchment

Photo: A. Murphy



Source: Leak et al., 2003 Waterworks

Mapping debris flows in the 2020 burn area to improve the risk model HydroFire

Mitigation?

High severity bushfire

↓

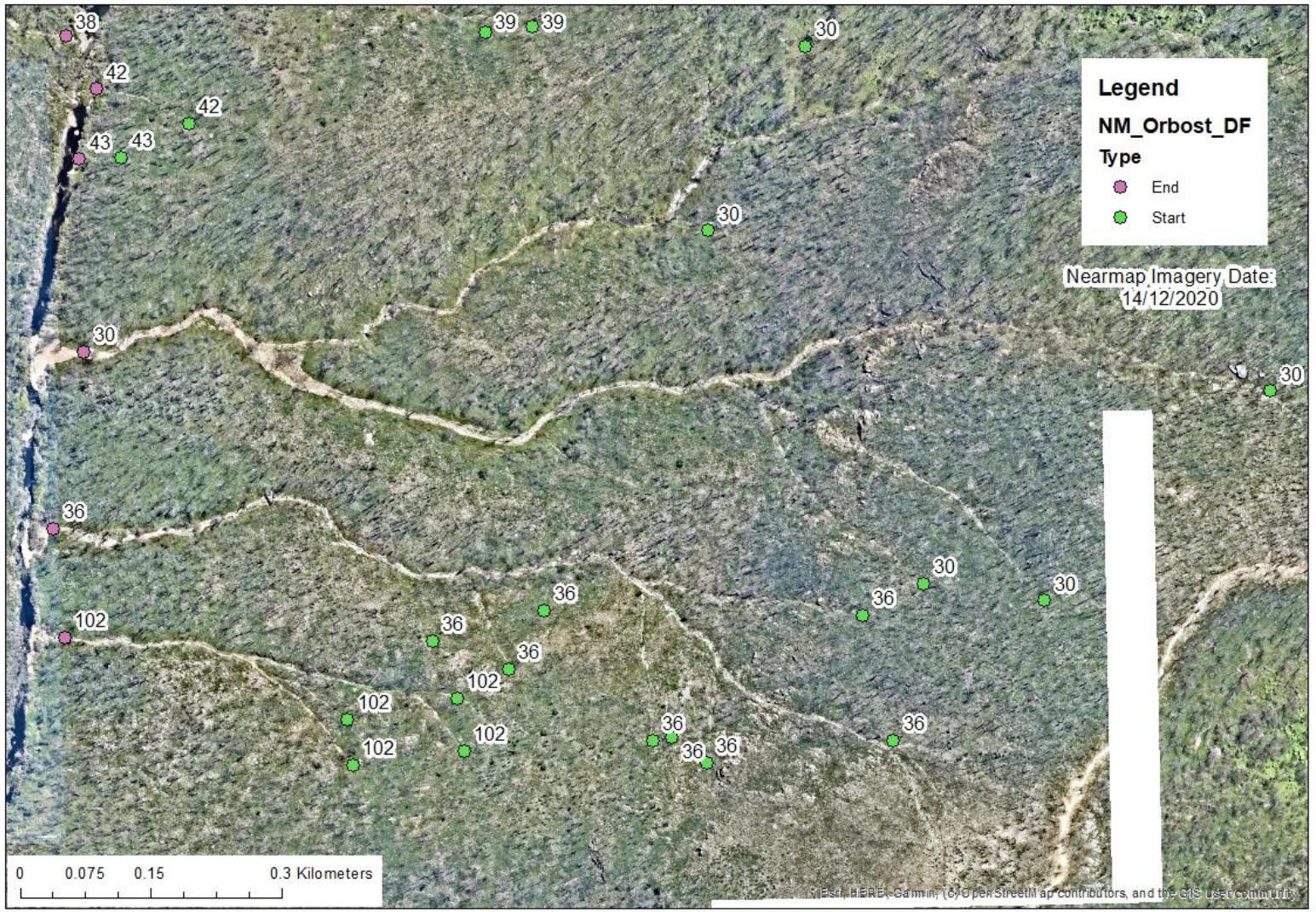
Vulnerable landscape

↓

Intense thunderstorm

↓

Assets downslope /downstream



RISK FACTORS

- Fire severity?
- Rainfall intensity?
- Soils?
- Slope?
- Geology?
- Recovery?

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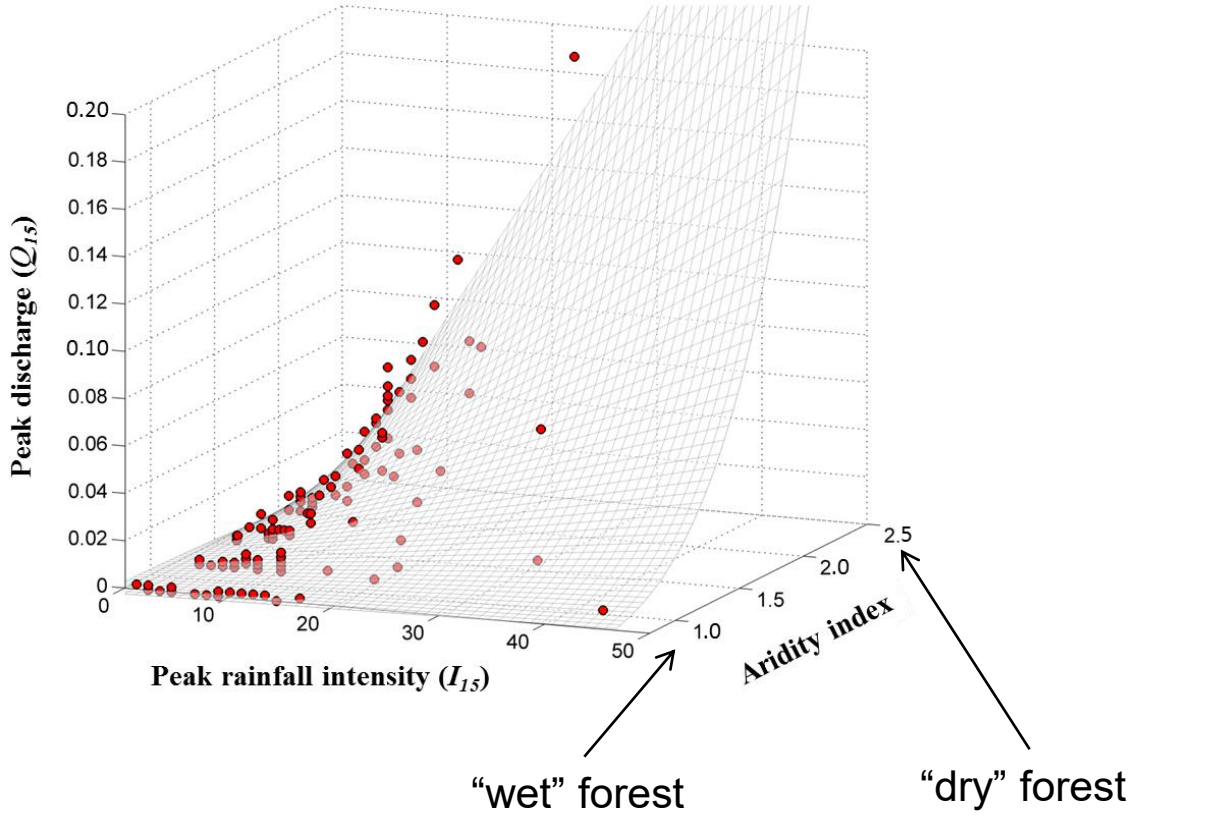
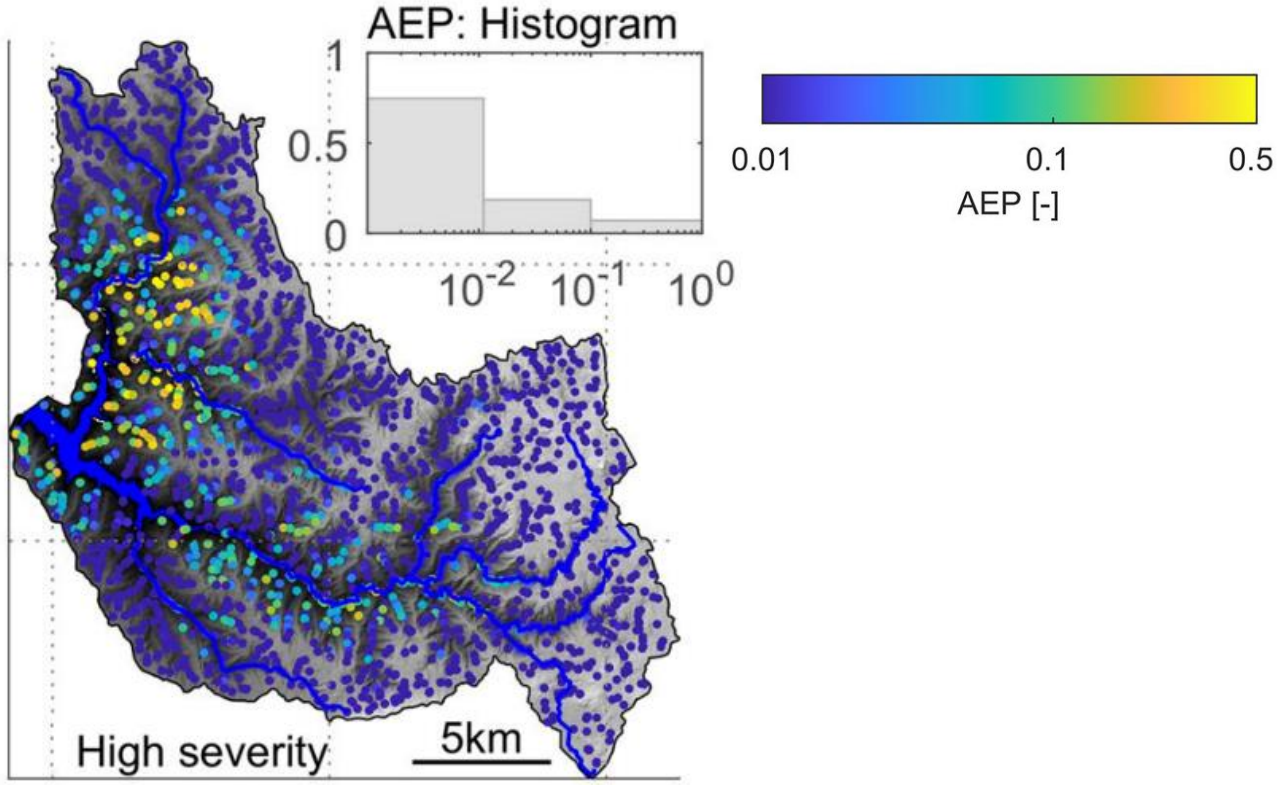
Runoff plots across a forest aridity gradient

40 runoff plots across a forest aridity gradient



Van der Sant et al., 2018, ESPL

Debris Flow Probability in the Upper Yarra (Nyman et al., WRR 2021)



Hydrodynamic modelling found water would be undeliverable for > 12 months. The issue is that much of the sediment load are fines

Flash flood at Licola, February 2007 (Great Divide fire Dec 2006-Jan 2007)

These are driven largely by the same processes, and in the same landscape units, as Debris Flows. Small areas impacted by convective storm cells.