Fired up!

How can water utilities and catchment managers be ready for water quality and yield impacts resulting from bushfires?

Australian Water School Presentation

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Water Research Australia

Acknowledgement of Country

WaterRA would like to respectfully acknowledge the Traditional Owners, Custodians and Carers of the lands and waters on which we all live, work and meet.

We pay our respect to their elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples today.

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Bushfires and the Risks to Drinking Water Quality

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Introduction

Bushfires in drinking water catchments can directly compromise water quality in the short term and more broadly in the long term. For months and years afterwards, it changes the water balance and catchment landscape. During active fires, forest litter is replaced by an ash and a charcoal layer with ash settling on lakes and reservoirs. Rainfall events post-fire can have a significant effect on water quality; from increased rates of erosion, increased sediments and turbidity and the introduction of a range of chemicals and precursors into the water supply.

The degree in which a bushfire has negative impacts on water quality depends on multiple factors; such as intensity of the fire, post-fire precipitation, catchment topology and local ecology.

This factsheet highlights the priority issues for concern, along with secondary issues that have been seen to arise across Australia and internationally.

Burn Intensity

The intensity of a bushfire is a key determinant of the severity of the water quality consequences. Low intensity fires that do not burn the crown of the forest lead to increased leaf litter. Therefore, during post-fire rainfall, leads to increased dissolved organic carbon (DOC) concentrations in water storages. If the leaf litter ends up in streams, this can result in an increase in microbial activity, reduced dissolved oxygen levels and release of metals from the sediments - particularly manganese.

High intensity fires, which burn the above ground matter and soils, can result in a different range of issues. Due to the high heat generated by these fires, most of the organic matter is volatilised resulting in the inorganic nutrients in the leaves leaching out and passing into the soil. As a result, following rainfall, there will be an increase in phosphorus and nitrogen entering waterways and reservoirs. The increase in phosphorous can lead to future algal blooms. High intensity fires can also lead to leaching of trace elements, such as copper, lead and chromium. In particular, the volatilisation of mercury, which can reabsorb and be released as methyl-mercury.

High intensity fires can result in the loss of riparian vegetation that support the banks of rivers and streams. With the loss of these trees and their root systems. Over time this can result in land disturbance and erosion causing an influx of sediments, nutrients, ash and burnt organic material into raw water supplies.

High intensity burns not only have a water quality impact but can have a water quantity impact; leading to an increase in water yields from the catchment by a combination of hydrologic processes. This can include dramatic decreases of evaporative losses (interception of precipitation and transpiration) from the forest canopy, increases in soil moisture and runoff generation from hillslopes. These in turn, can produce greater storm runoff. Including large peak flows and increase overall water production from fire affected landscapes.

Suggested Priorities

Depending on the severity of the fires, there can be different water quality risks. For low intensity fires water quality managers should be particularly concerned with:

- increases in DOC; and
- increases in dissolved metals from sediments such as iron and manganese.

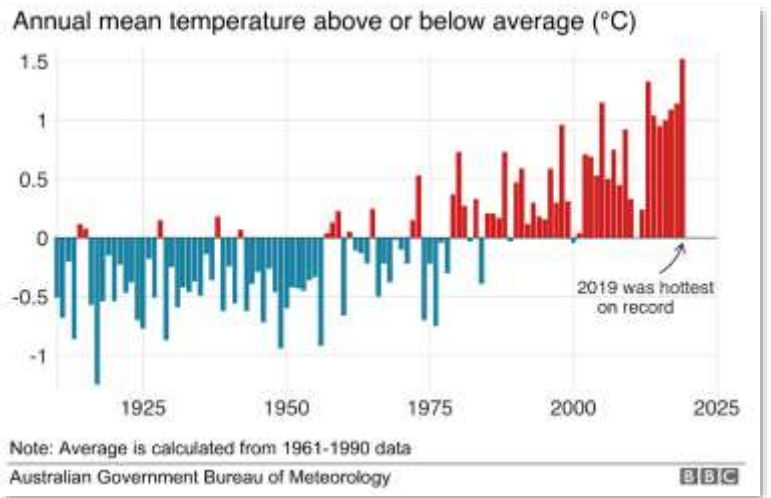
For high intensity burns water quality managers should be particularly concerned with:

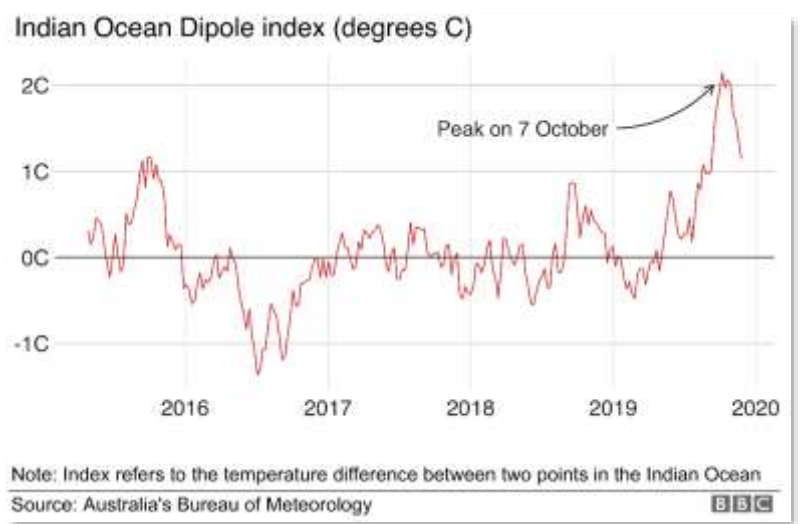
- increases in suspended solids and turbidity from ash and soil;
- increase in inorganic nutrients, particularly phosphorous, leading to cyanobacteria; and
- potential increase in trace metals.

Bushfires in Australia

Statistics:

- More than 20% of Australia's forests burnt during the summer bushfires of 2019-2020 (unprecedented 'globally'): ~13 mill ha (size of Greece, Alabama)
- Unusual combination of factors, including Positive Indian Ocean Dipole (IOP)
    - Warmer waters in the west and cooler waters in the east of the Indian ocean
    - Cooler sea surface temperatures results in reduced rainfall





A resilience framework

Prevention

- **Asset protection**
- **Fit for purpose preventative measures**
- **Prescribed burn approaches (incl. Aboriginal knowledge in cool burns)**

Preparedness / Planning

- **Forecast water quality treatment challenges and yield changes** from burnt catchments
- **Risk assessment** approaches (spatial, water quality and yield)
- Pre-design of fit for purpose design of erosion prevention measures at scale
- Science of contingency and recovery planning (built and natural infrastructure, water supply alternatives, human capital)

Response

- Sentinel (remote) surveillance techniques (fire spread/spotting, intensity, crown cover, ash, etc.) – **validate models for future incidents**
- Fit-for-purpose water supply contingencies
- Fire restardants and water quality

Recovery

- Recovery (built and natural assets)
- Monitor yield and water quality changes over time – **validate models for future incident recoveries**

The role of modelling for water utilities

Prevention

- Fit for purpose preventative measures

Preparedness / Planning

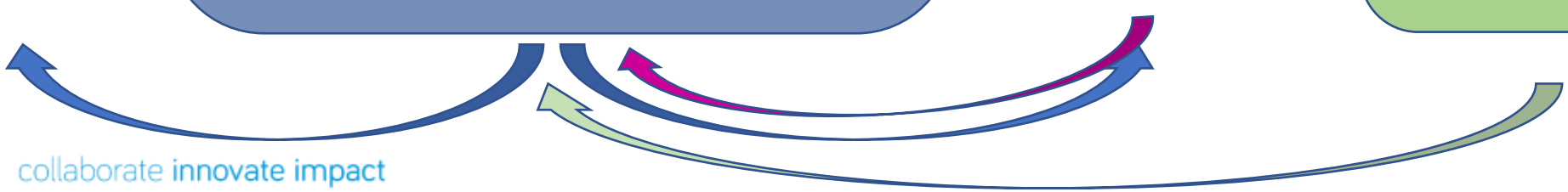
- **Choice of model** (process; 1D, 2D, 3D; SWAT, SOURCE, MIKE, WEPP, BASINS, WASP, QUAL, QUASAR, EFDC,….)
- **Parameterisation** of models through catchment data (soils, slope, vegetation cover; changes in soil structure post fire, meteorological data, etc.)
- **Scenario modelling** (forecasting) ::::: Risk assessment

Response

- **Validation / check of model performance**

Recovery

- Monitor yield and water quality changes over time – **validate models for future incident recoveries**



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WaterRA's approach – a roadmap

Prevention

Prescribed burns

Infusing indigenous knowlege. Indigenous land and fire management practices science underpinning effects on WQ and ecology/ecosystems; landscape recovery post fire; cultural aspects and sensitivities

Preparedness / Planning

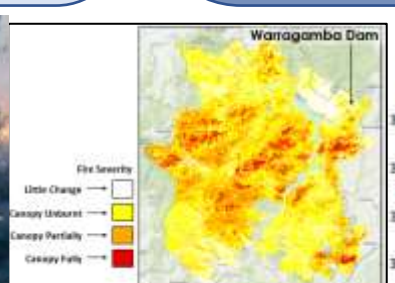
- **Capture and share learnings from bushfires (incl. modelling)**
- **Deep Dive catchment knowledge).** Translate knowledge of catchment characteristics geology, soils, vegetation, slope) into model forecasting to predict WQ and landscape impacts; rate risks and prepare for treatment challenges
- **Modelling for WQ:** Sediment 'slugs' [oxygen depletion, fish kills]; Ash and debris flows; nutrient and carbon inputs (N, P & C) [algal blooms]. metals (Mn, Fe, Pb etc.); pathogens; pyrolysis products (Pyrene, Fluoranthene, PAHs etc.).

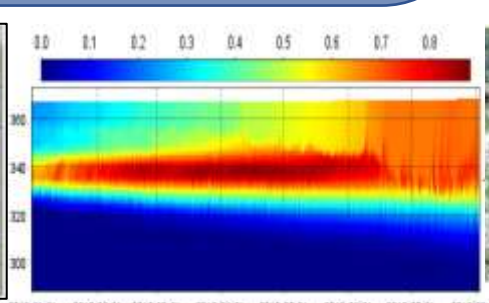
Response

- **Fire Retardants and wq impacts** (fire fighting chemicals and water quality)
- **Preventing Erosion** (design of sediment control structures and other fit-for-purpose mitigation measures)
- **WQ (pre-) treatment** options

Recovery

Build Back Better for Recovery. A GPG (playbook) for bushfire recovery (pre-risk assessments included to determine objectives (WQ, biodiversity/ ecology))





Thank you

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