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Multi-scale sectoral water use responses to droughts and heatwaves

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1. Introduction

Sectoral use of water plays a **major role** in the water scarcity problem.

This situation is **worsened** by the occurrence of droughts and heatwaves.

Up-to-date efforts assess global water scarcity **only in average conditions**

There is a **lack of understanding** on the interaction sectoral water use – extreme events.

2. Objective

Estimate the response of sectoral water use under past drought – heatwave events across the world.

3. Methodology

1 Sectoral water use data collection

Sectors:

Dimensions:
Withdrawal and consumption

Scales:
Global, national and local

Sources:
Huang, et al. (2018)[1] (Fig 1a), governmental institutions, local water suppliers

2 Extreme events identification

Events:
Heatwaves, Droughts* and Compound events

Input data:
W5E5, GRDC, GSIM, ESA CCI SM, GLEAM SM Root

Method:
Combination of two threshold-based methods[2,3] (Fig 1b)

* Both hydrological and agricultural droughts

3 Analysis of responses

Analysis:
Change in water use:
< periods with **vs** without occurrence of extreme events >
using their percentiles scores

Aspects:
Sectoral responses, competition and potential water use drivers

Scales:
Global and local

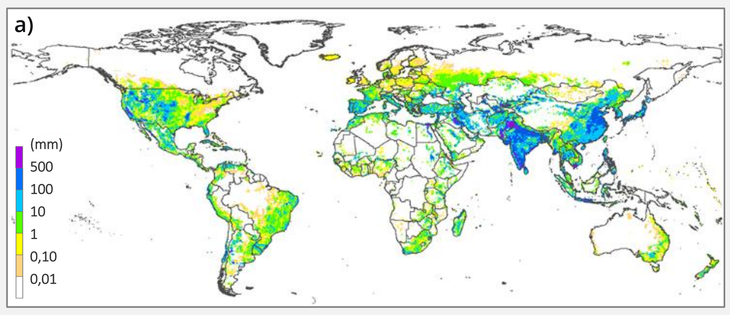

Figure 1
(a) Annual mean irrigation water withdrawal during 1971-2010 (Huang, et al. 2018).
(b) Droughts, heatwaves and compound events identified globally for the period 1990 – 2019.

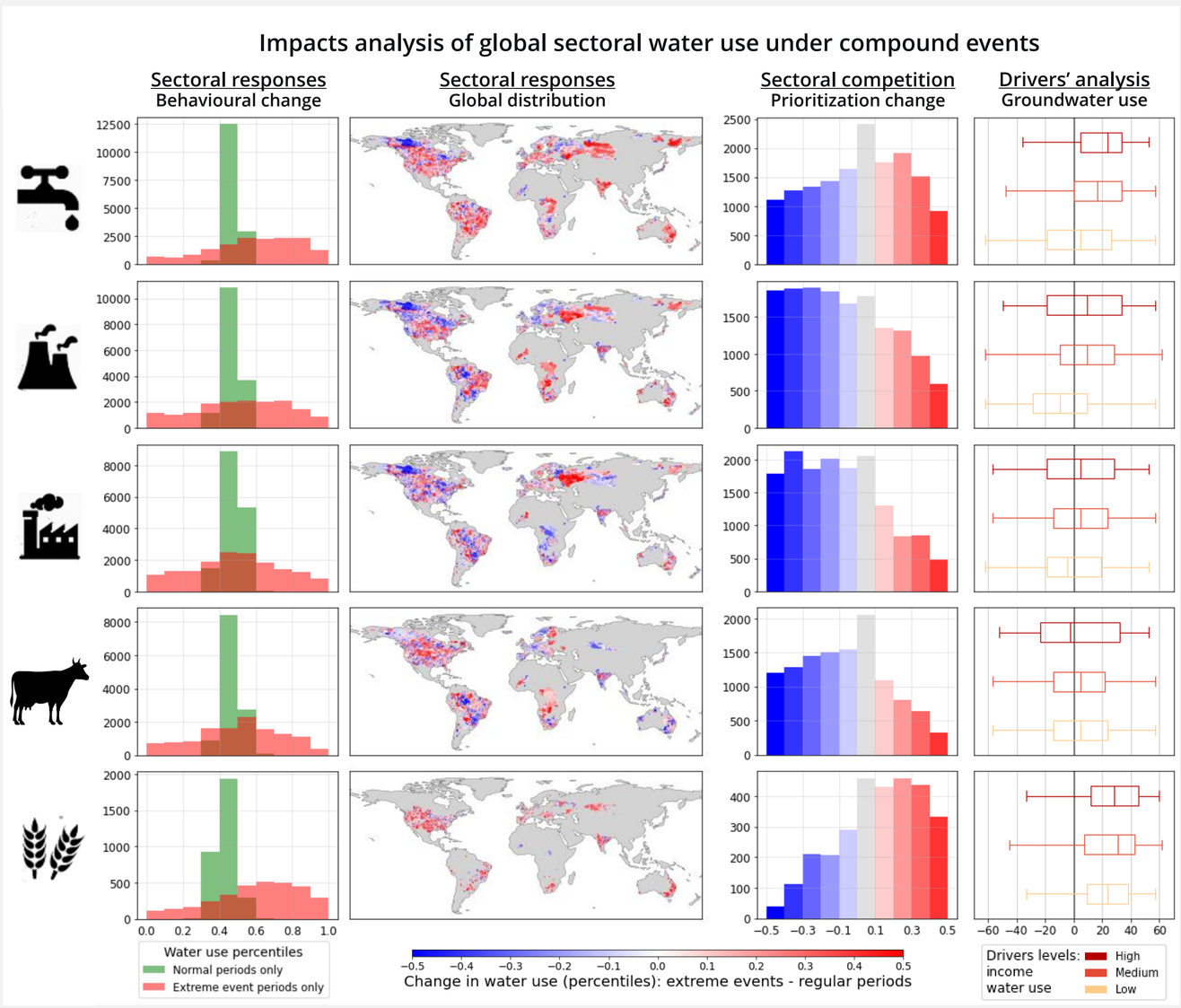

Figure 2
Global scale responses of sectoral water use under compound events for period 1990-2010 at monthly scale for domestic, thermoelectric (cooling), manufacturing, livestock and irrigation sectors.

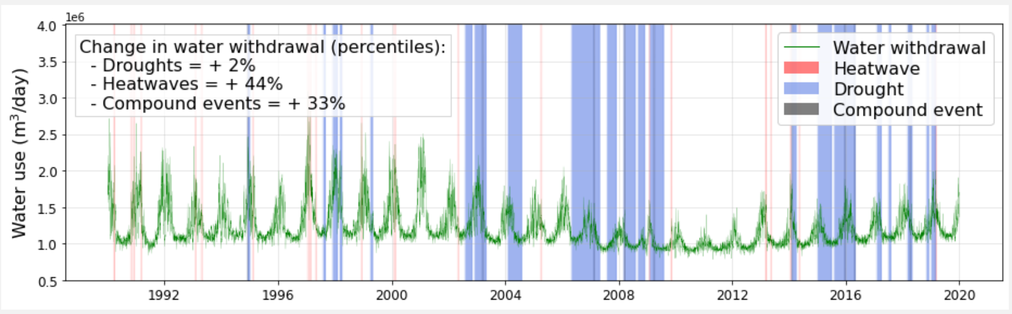

Figure 3
Domestic and manufacturing water withdrawal (m^3/d) versus drought-heatwave events occurred during 1990 – 2019 at daily scale.
Case: Melbourne, Australia.

4. Results

4.1. Global scale (Fig 2)

- **Sectoral responses:**
  During heatwaves and compound events → mainly ↑ water withdrawal worldwide
- **Sectoral competition**:
  During compound events → are given lower priority — are prioritized
- **Drivers' analysis**:
  Level of affordability and use of alternative water sources are water use drivers during extreme events:
  ↓ GDP, ↑ Groundwater use, ↑ Desalinated water production
  ↑ Water use

4.2. Local scale (Fig 3)

- In Melbourne, Sydney, Saskatchewan and California, during heatwaves → ↑ water withdrawal
- In California, during droughts →
  ↑ — ↓ water withdrawal

5. Conclusions

- Drought-heatwave events affect water use patterns differently per sector and region.
- Water use responses patterns show that sectors are prioritized over on a global level.
- Stronger impacts were found for heatwaves and compound events compared to droughts.
- Socio-economic conditions impact both the direction and magnitude of change in sectoral water use under these extreme events.
- The results are useful to improve understanding of the drivers of water scarcity under droughts and heatwaves in different regions.

References

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3. Van Huijgevoort, M. H. J., Hazenberg, P., Van Lanen, H. A. J., & Uijlenhoet, R. (2012). A generic method for hydrological drought identification across different climate regions. Hydrology and Earth System Sciences, 16(8), 2437–2451. https://doi.org/10.5194/hess-16-2437-2012

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