Quantifying lifetime water scarcity with ISIMIP 3b

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Opening new horizons

1 The idea

How much water does a person need during his life and to what extent will this demand be met?

How does this differ for a newborn compared to a 60-year-old?

How much does this differ across the world?

Integration of **blue water scarcity** during a person's lifetime

Application of lifetime exposure framework of Thiery et al. (2021):

- Global-scale analysis
- Exposure (frequency), but also intensity, duration and hotspots
- Both climate change and socio-economic drivers (SSP and RCPs)
- Based on ISIMIP3b simulations

2 Lifetime exposure explained

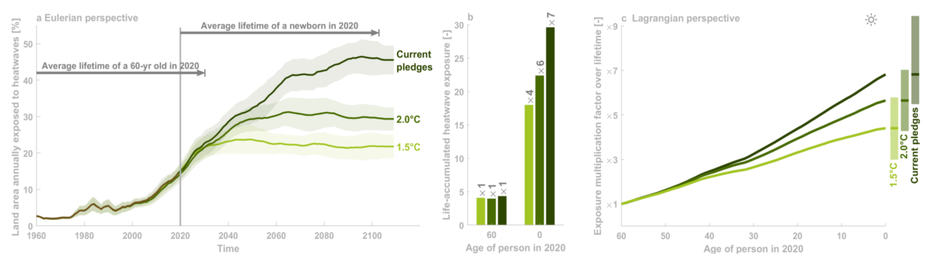

Fig. 1 Global land area annually exposed to heatwaves under three scenarios (a). Lifetime heatwave exposure for the 1960 and 2020 birth cohorts under the three scenarios (b). Multiplication factors for lifetime heatwave exposure across birth cohorts relative to the 1960 cohort. Adapted from Thiery et al. 2021

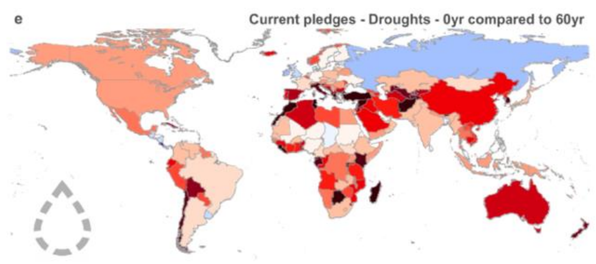

Fig. 2 Country-scale exposure multiplication factors for droughts under current pledges. The multiplication factors aggregate within-country variability in population density and land fraction affected by extreme events. Adapted form Thiery et al., 2021

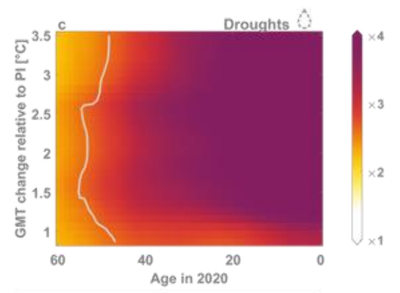

Fig. 3 Exposure multiplication factors for global drought exposure across birth cohorts under a range of global warming trajectories. Adapted form Thiery et al., 2021

3 Water scarcity indices

Falkenmark index
water shortage

Liu et al., 2017

Per capita water availability

$$WS_{i,m} = \frac{Q_{i,m}}{pop_{i,m}}$$

- $WS_{i,m}$ Per capita water availability (m³/cap month)
- $Q_{i,m}$ Total water availability in cell i, month m (m³/month)
- $pop_{i,m}$ Number of people in cell i, and corr. year (#/month)

Absolute water scarcity: $WS_{i,m} < 500$ m³/cap year

Criticality ratio
water stress

According to Veldkamp et al., 2017

$$\mathrm{WSI}_{i,m} = \frac{\mathrm{WW}_{i,m}}{\mathrm{Q}_{i,m} - \mathrm{EF}_{i,m}}$$

- $WSI_{i,m}$ Water Scarcity Index in cell i, month m
- $WW_{i,m}$ Total Water Withdrawal in cell i, month m (m³/month)
- $Q_{i,m}$ Total water availability in cell i, month m (m³/month)
- $EF_{i,m}$ Environmental flow requirement (m³/month)

Water scarcity threshold: $WSI_{i,m} > 1$

Grid cell water availability accounts for water from upstream, correted with upstream water use:

$$Q_{i,m} = qtot_{i,m} + \Sigma(qtot_{upstream,i,m} - atotuse_{upstream,i,m})$$

4 Data requirements

Simulations required from the ISIMIP 3b global water sector:

- monthly timescales
- picontrol, historical and SSP1-2.6, SSP3-7.0 and SSP5-8.5
- total runoff, actual total water use, potential total water withdrawal
- sectoral water withdrawals, if possible

not available / *available* / *can be calculated* / *critical for analysis*

Table 1. Variables and GHMs available within ISIMIP3b on 9/05/2022

	CWatM	H08	WaterGAP2-2e	
qtot	available	available	available	Total (surface + subsurface) runoff
adomuse	not available	available	not available	Actual Domestic Water Consumption
aelecuse	not available	not available	not available	Actual Electricity Water Consumption
ainduse	not available	not available	not available	Actual Industrial Water Consumption
aliveuse	not available	not available	not available	Actual livestock Water Consumption
amanuse	not available	available	not available	Actual Manufacturing Water Consumption
atotuse	not available	can be calculated	available	Total Actual Water Consumption (all sectors)
pdomww	available	not available	available	Potential Domestic Water Withdrawal
pelecww	not available	not available	available	Potential electricity Water Withdrawal
pindww	available	not available	not available	Potential Industrial Water Withdrawal
pirrww	available	not available	available	Potential Irrigation Water Withdrawal
pliveww	available	not available	available	Potential livestock Water Withdrawal
pmanww	not available	not available	available	Potential Manufacturing Water Withdrawal
ptotww	available	not available	available	Total Potential Water Withdrawal (all sectors)

5 Open questions

- Water footprints to account for local versus non-local demand and availability?
- Account for age-dependent water requirements during lifetime?
- Adaptation to water scarcity? Framing to how much adaptation is needed

6 References

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