

#### **HEPEX workshop, SMHI (2023)**





# Forecasting socio-hydrological extremes

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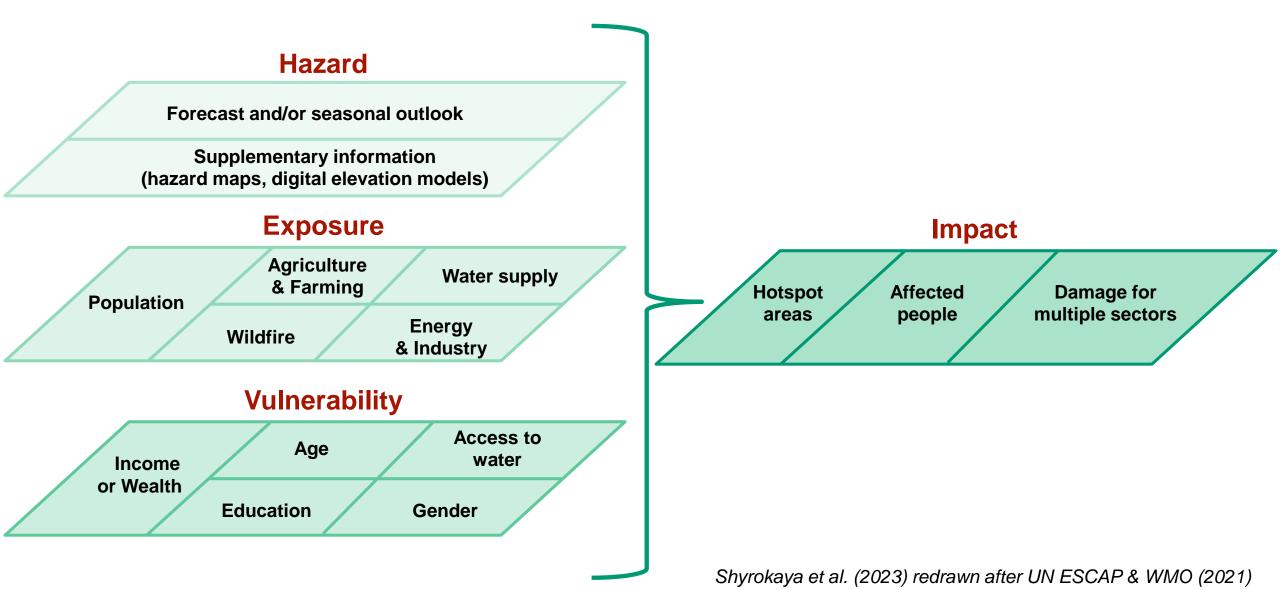
### Giuliano Di Baldassarre

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#### Impact-based forecasting

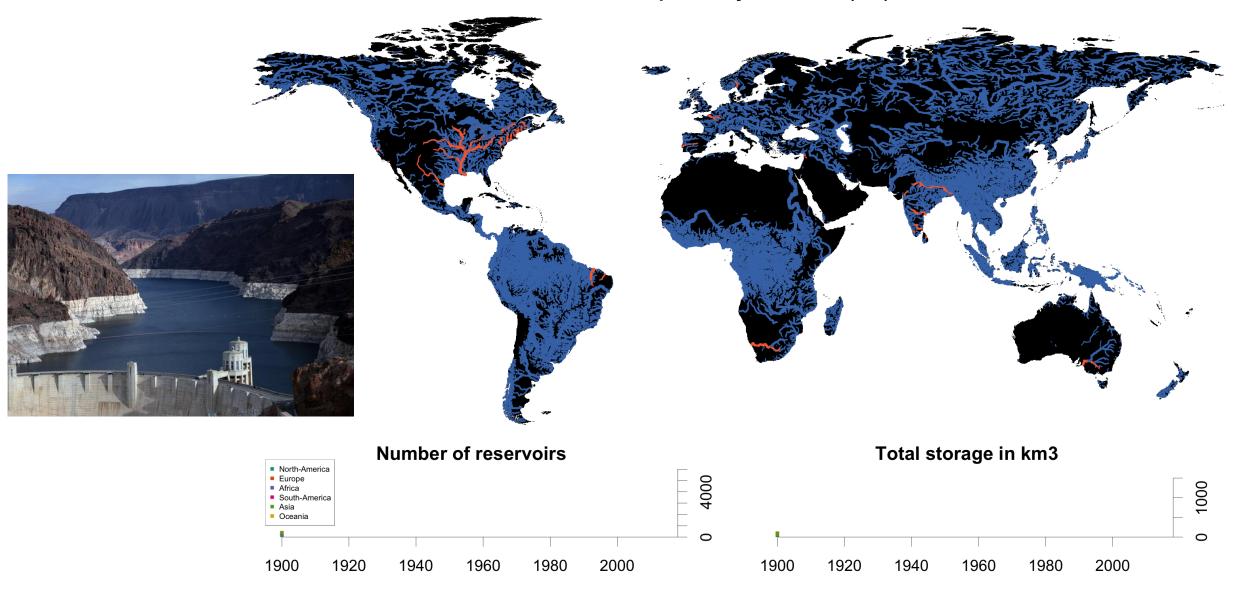
Goal: Identify most affected people/areas/sectors and prioritize response measures



#### **Challenge #1: Human influence**

#### Human influence (e.g. dams and reservoirs)

Global rivers impacted by reservoirs (red) in 1900



(Di Baldassarre et al., Nature Sustainability, 2018; video by Niko Wanders)

#### Socio-hydrological extremes

#### **Direct influence**

Deliberate (reservoirs, levees)
Not (urbanization, deforestation)

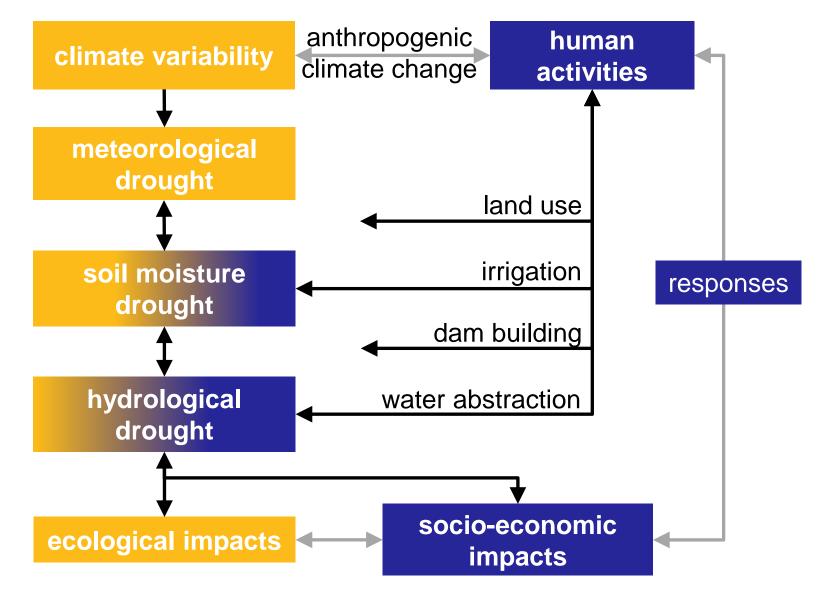
#### **Indirect influence**

- Global warming
- Sea level rise

# Human response Displacement & migration Infrastructure (feedback)

### **Challenge #2: Socio-hydrological feedbacks**

## **Drought propagation**



(Van Loon et al., Nature Geoscience, 2016)

#### **Challenge #3: Impacts are complex**

- Loss of lifes - Injuries - Loss of memorabilia - Psychological distress - Damage to cultural heritage - Negative effects on provisioning ecosystem services

Damage to private buildings and contents

Damage to Vehicles and private assets.

Destruction of infrastructure such as roads, etc

Evacuation and rescure missions

Business interruption inside the flooded area

Erosion of agricultural soil
Damage to livestocks
clean up costs
Health costs

- (Reconstruction of defense measures)

🗲 Intangible ·

Trauma
 Mental illness
 Bereavement
 Loss of trust in authorities
 Loss of jobs (societal disruption)
 Negative effects on regulating and cultural ecosystem services

 Disruption of public services outside the flooded area
 Cost of traffic/transport disruption
 Induced production losses to companies outside the flooded area (suppliers of flooded companies)
 Loss of tax revenue due to migration of companies in the aftermath of flood
 Temporary housing of evacuees

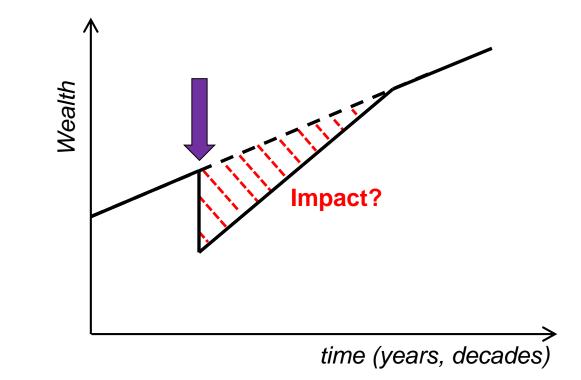
Indirect

Direct

Tangible 🔶

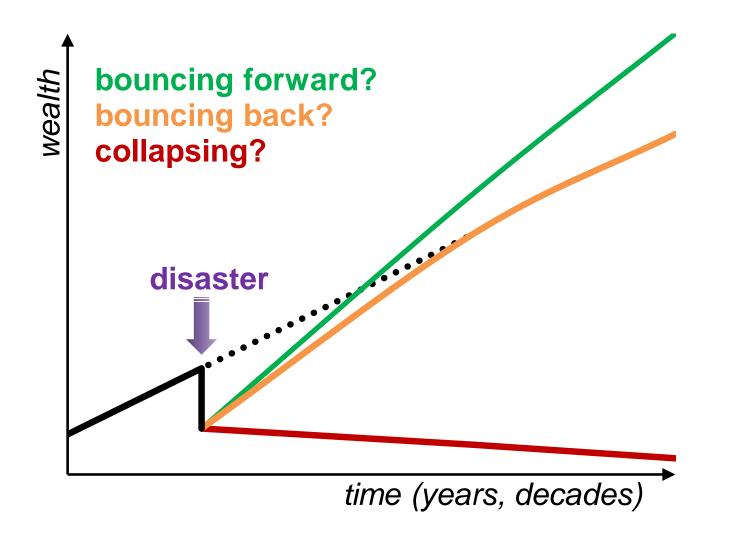
#### **Challenge #4: Impacts are dynamic**

#### **Dynamics (recovery trajectories)**



(Green et al., CONHAZ, 2011)

### **Dynamics (recovery trajectories)**



#### **Challenge #5: Impacts are unevenly distributed**

### Flood fatalities & economic inequalities



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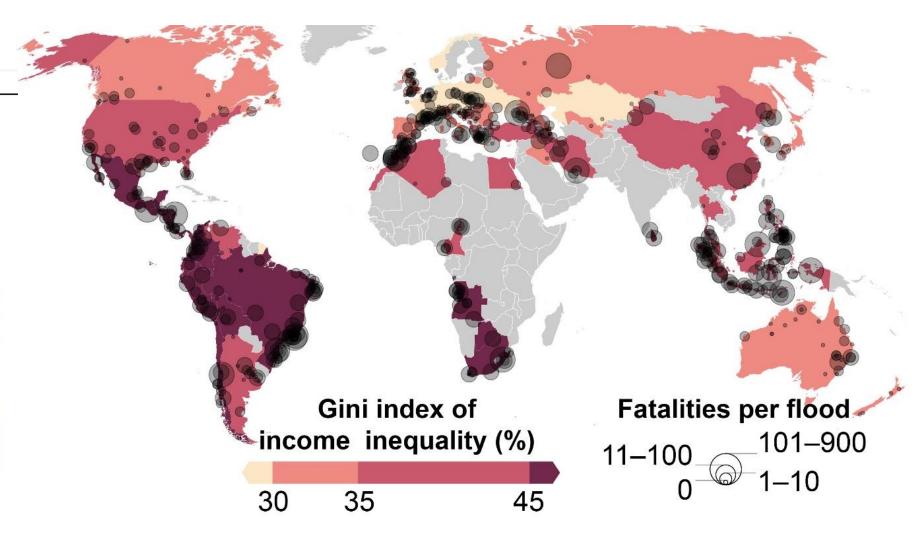
### Floods claim more lives where inequality reigns

Flood mortality rates are far higher in countries with larger income disparities.

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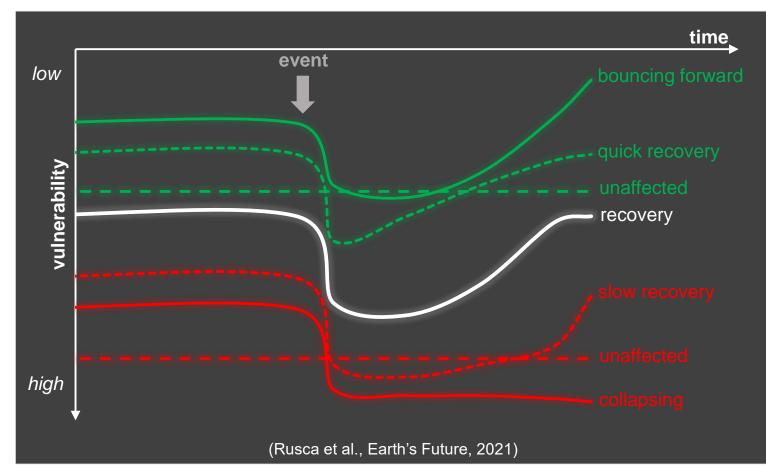


Lower-income areas of New Orleans, Louisiana, were affected most by the flooding caused by Hurricane Katrina in 2005. Credit: Mario Tama/Getty



#### **Uneven impact of socio-hydrological extremes**

- Prioritization of measures are often based on cost/benefit analysis
- Capacity to cope and recover (e.g. insurance) from different social groups
- Low-income groups and minorities often struggle to recover







# Cape Town (SA)

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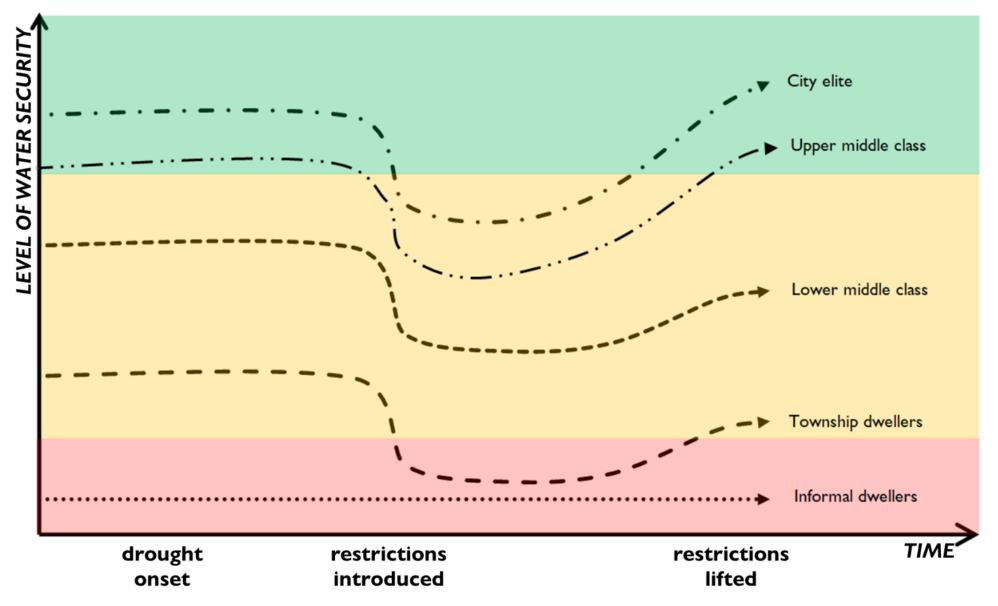
Photo by Johnny Miller (Unequal Scenes)

#### 2015-18 drought: "Day Zero" water crisis



Cape Town during the Day Zero water crisis (source: Wikimedia Commons)

#### Impacts (and recoveries) across social groups



<sup>(</sup>Savelli et al., Journal of Hydrology, 2021)

# Conclusions

#### **Challenges in Impact-based Forecasting**

Floods and droughts as socio-hydrological extremes

New models to inform the forecast of droughts and floods

Impacts are complex, dynamic and unequal

- Social groups with high direct/tangible impacts might recover well (while others don't)
- Impact-based forecasting may unintendedly increase inequality (similar to cost/benefit optimization of risk)
- Need to account for the heterogeneity of impacts



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