

Water is the Master Variable

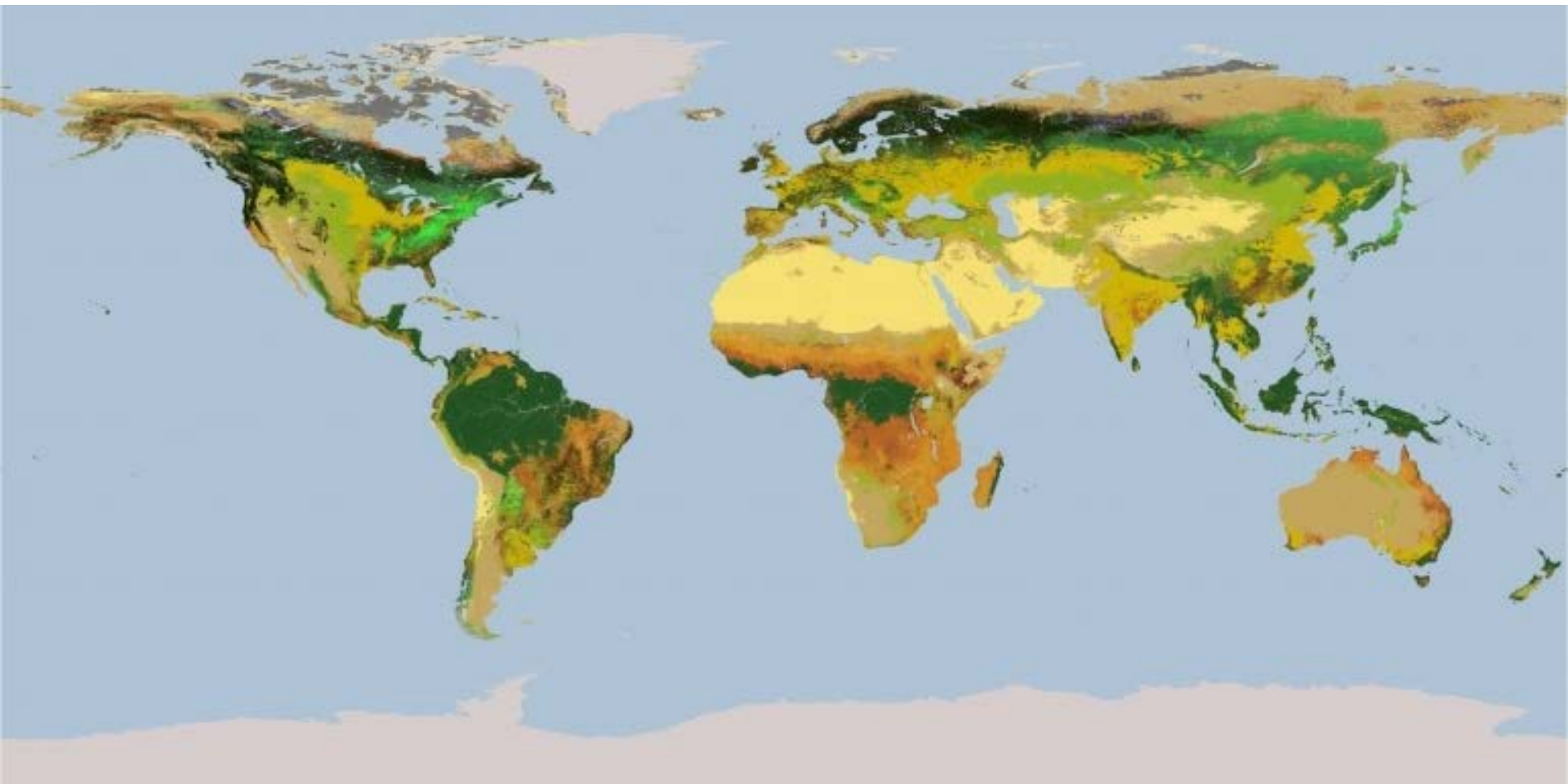
Solving for Resilience in the Modern Era



Houston, TX August 2017



water and temperature define and delineate the terrestrial biosphere



NASA GSFC 2016

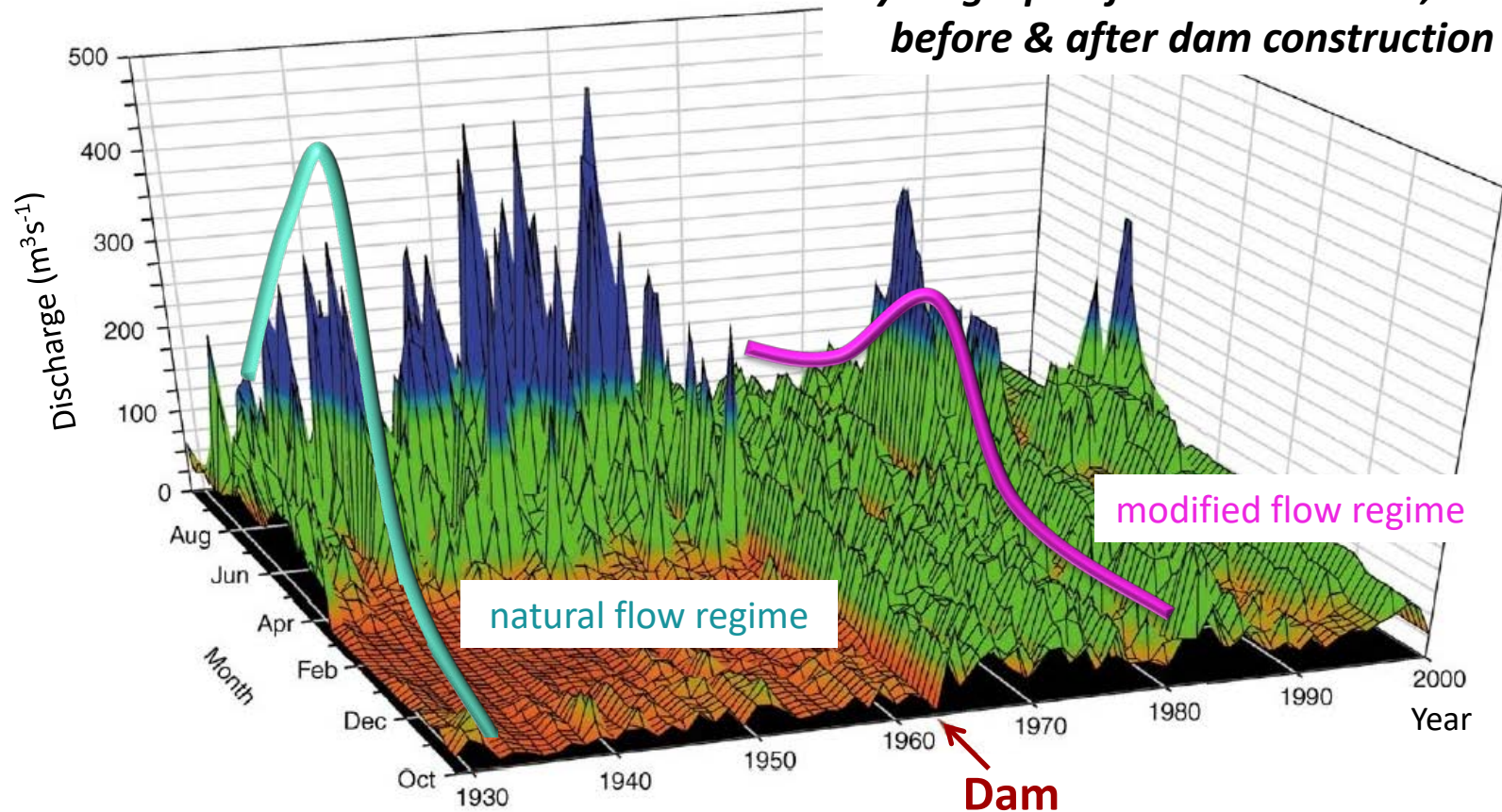


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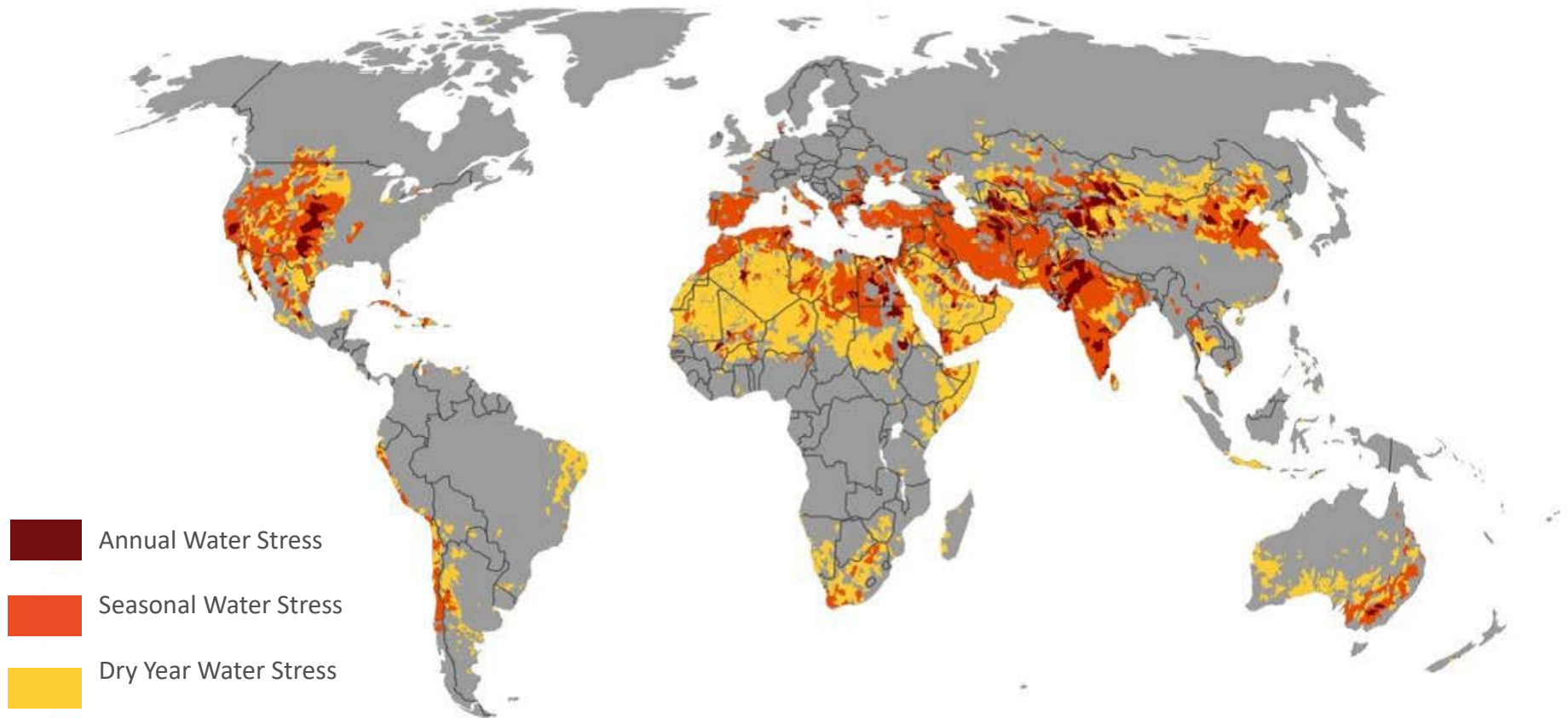
water bounds human growth and inspires innovation

>2/3 of major rivers have modified flow regimes

*Hydrograph of the Green River, Utah
before & after dam construction*

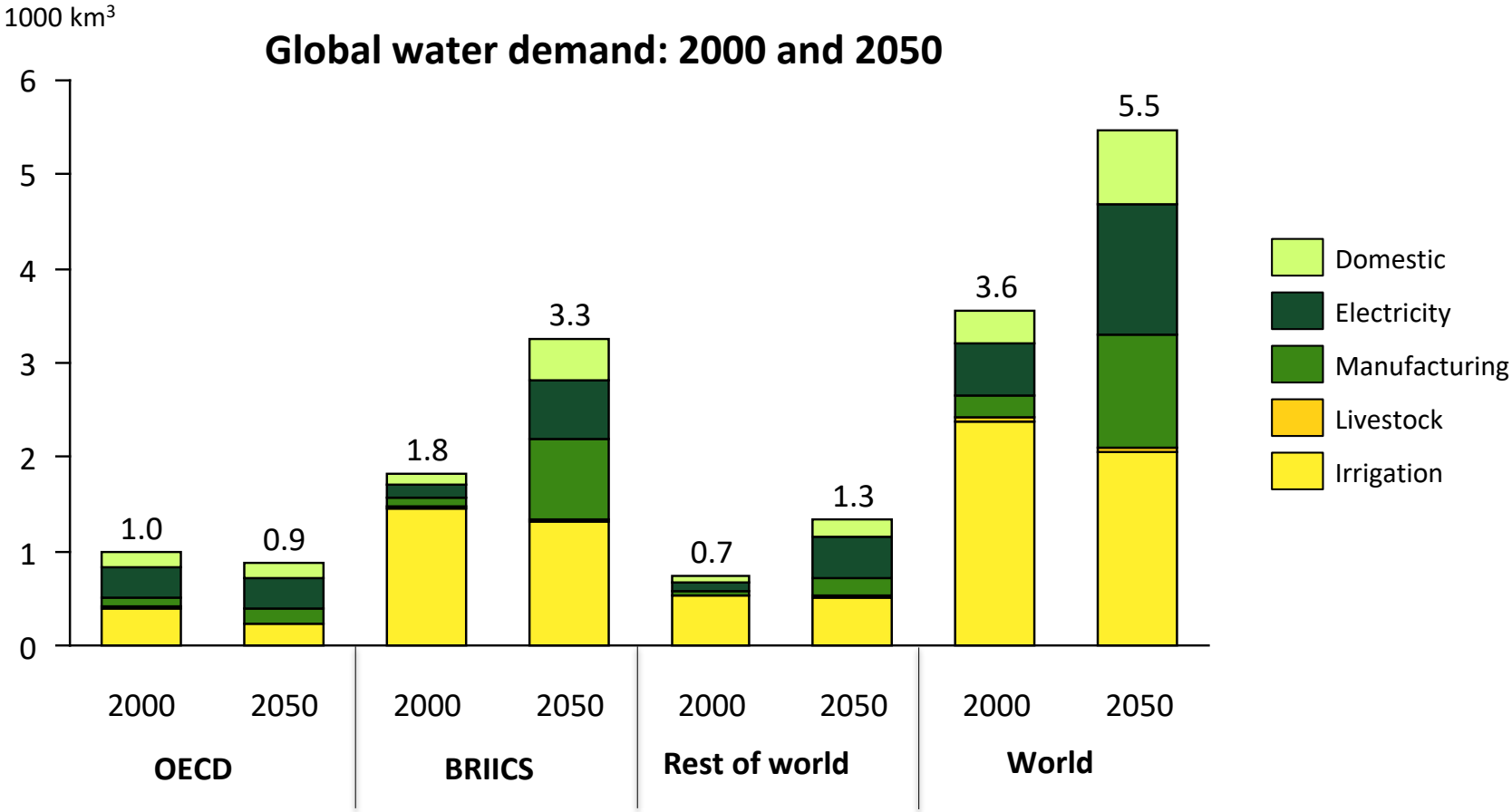


1/3 of humanity lives under water stress



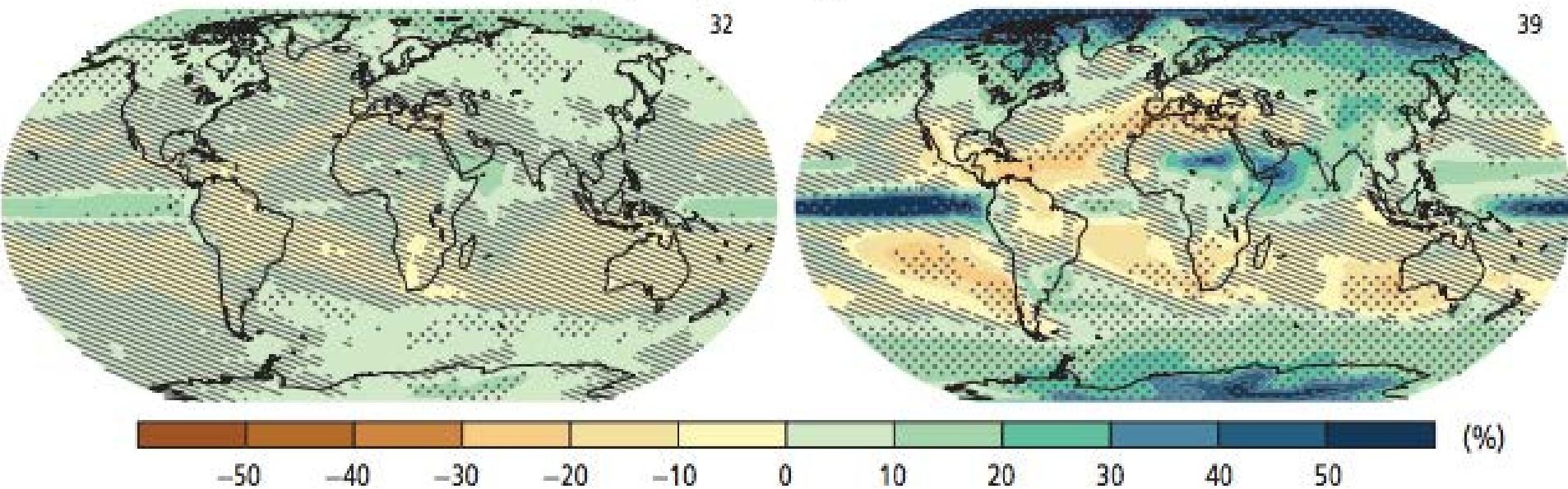
Brauman et al. 2016

rapidly growing demand and scarcity

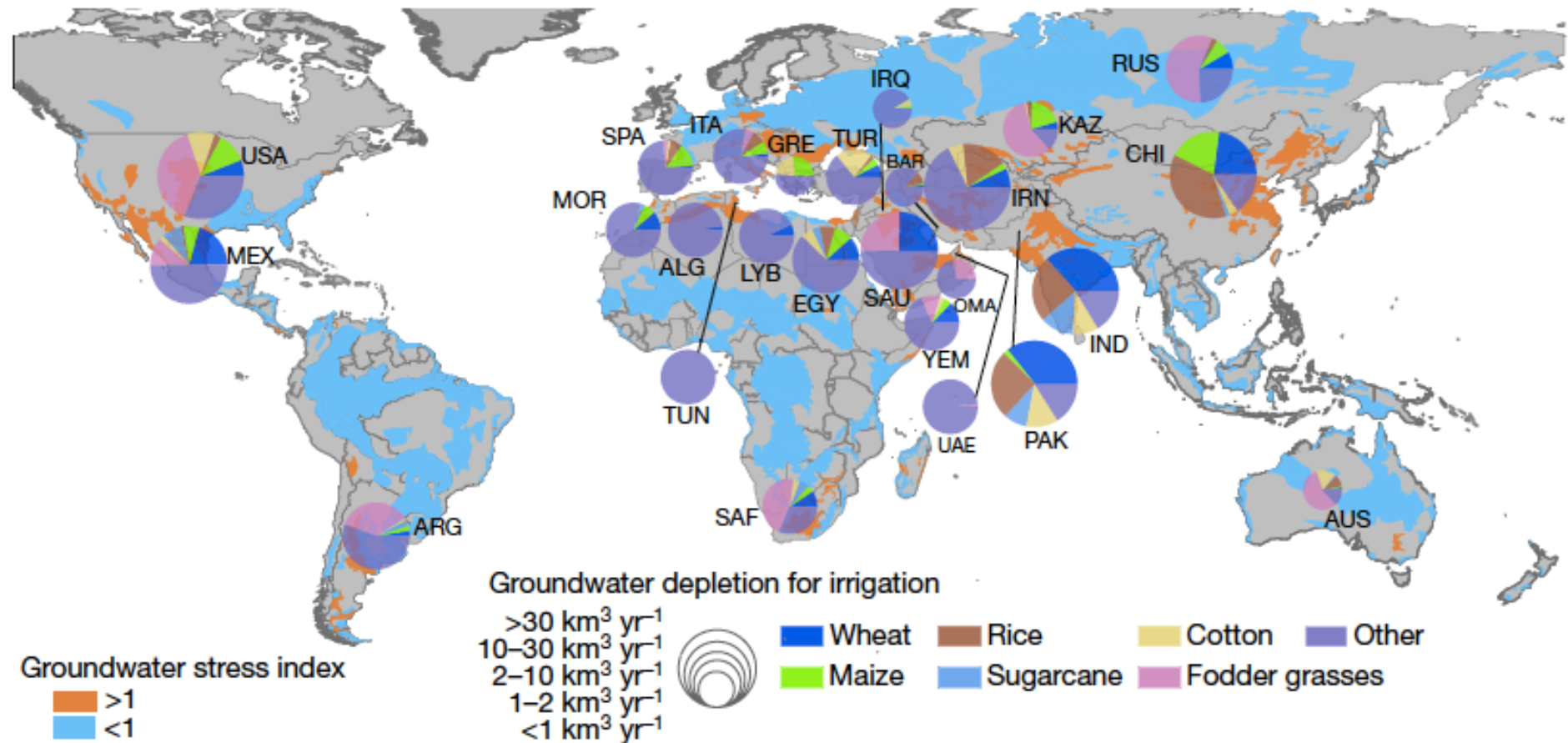


climate change may dramatically alter water availability and variability

Change in average precipitation (1986–2005 to 2081–2100)

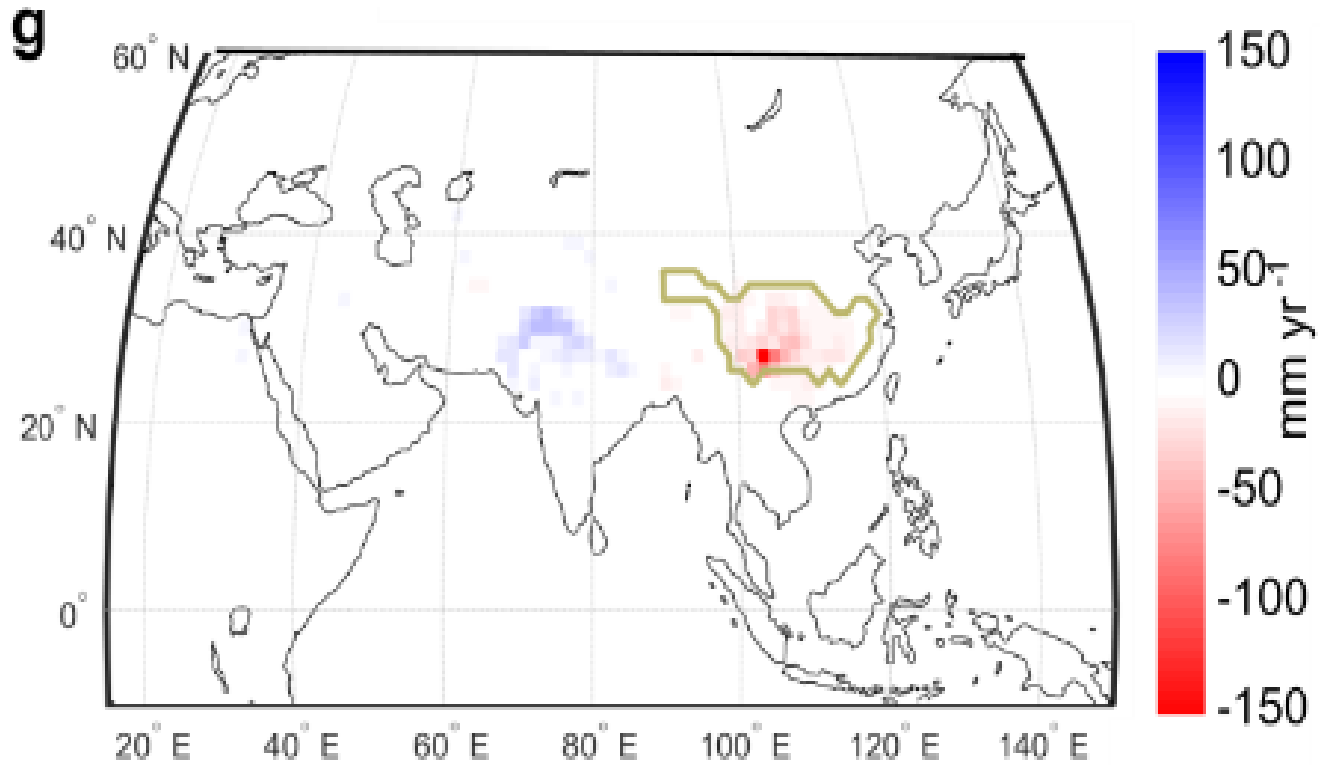


nested vulnerabilities, globalized risks

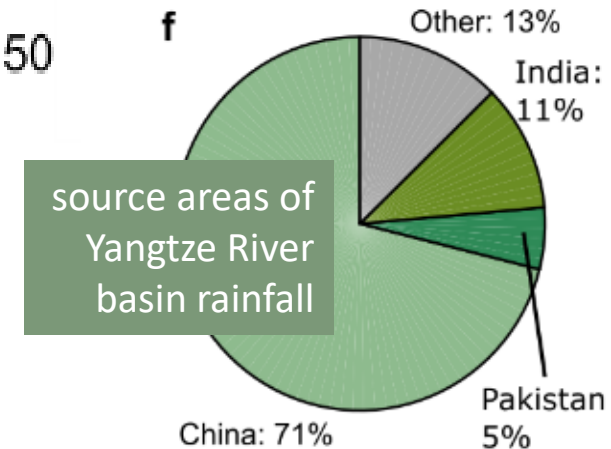


country and crop-specific contributions to groundwater depletion in 2010 (Dalin et al. 2017)

global water cycle interdependencies



land use change and groundwater
extraction disrupt natural water cycle at
regional and global scales



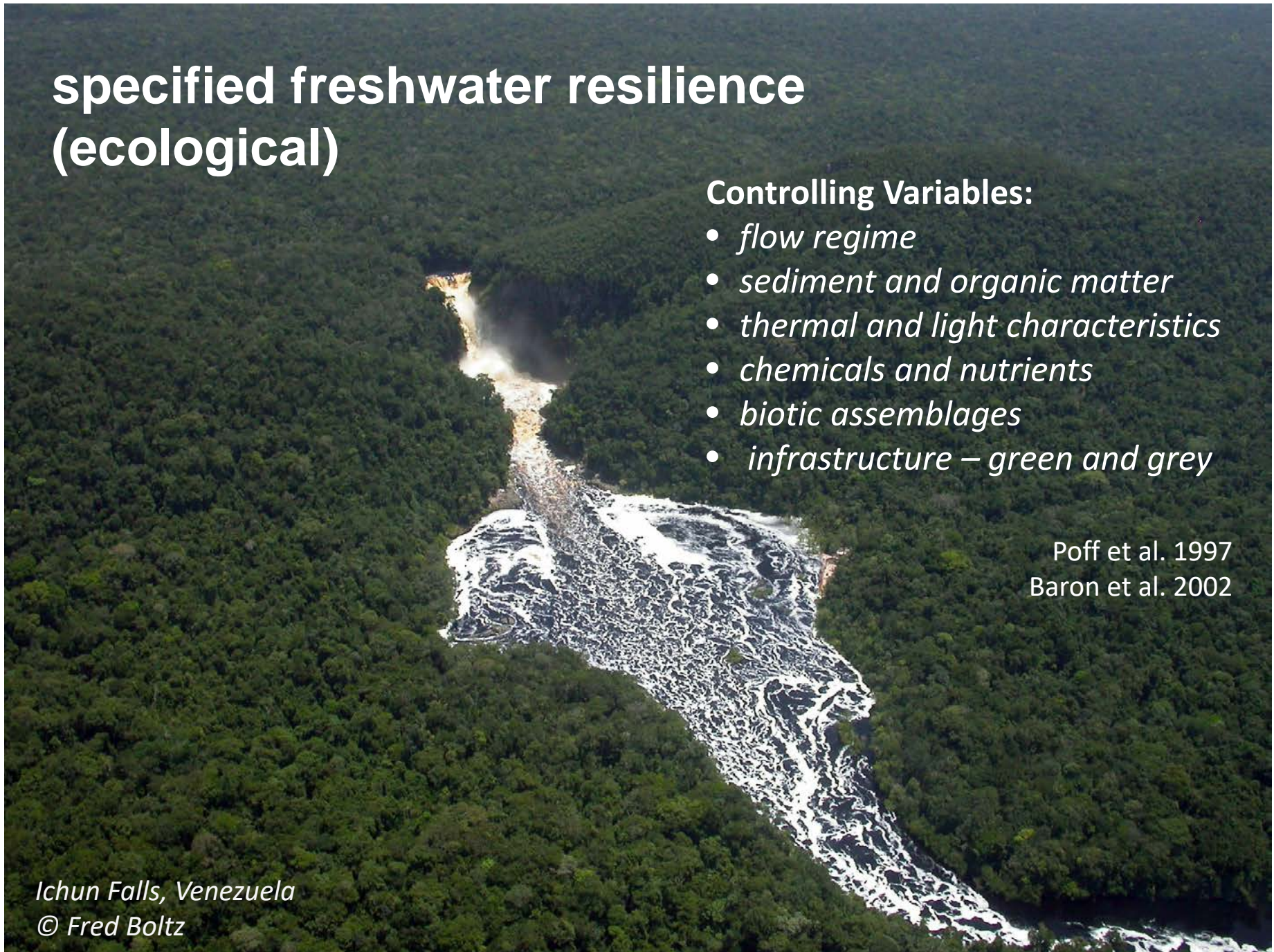
specified freshwater resilience (ecological)

Controlling Variables:

- *flow regime*
- *sediment and organic matter*
- *thermal and light characteristics*
- *chemicals and nutrients*
- *biotic assemblages*
- *infrastructure – green and grey*

Poff et al. 1997
Baron et al. 2002

Ichun Falls, Venezuela
© Fred Boltz



general (social-ecological) resilience

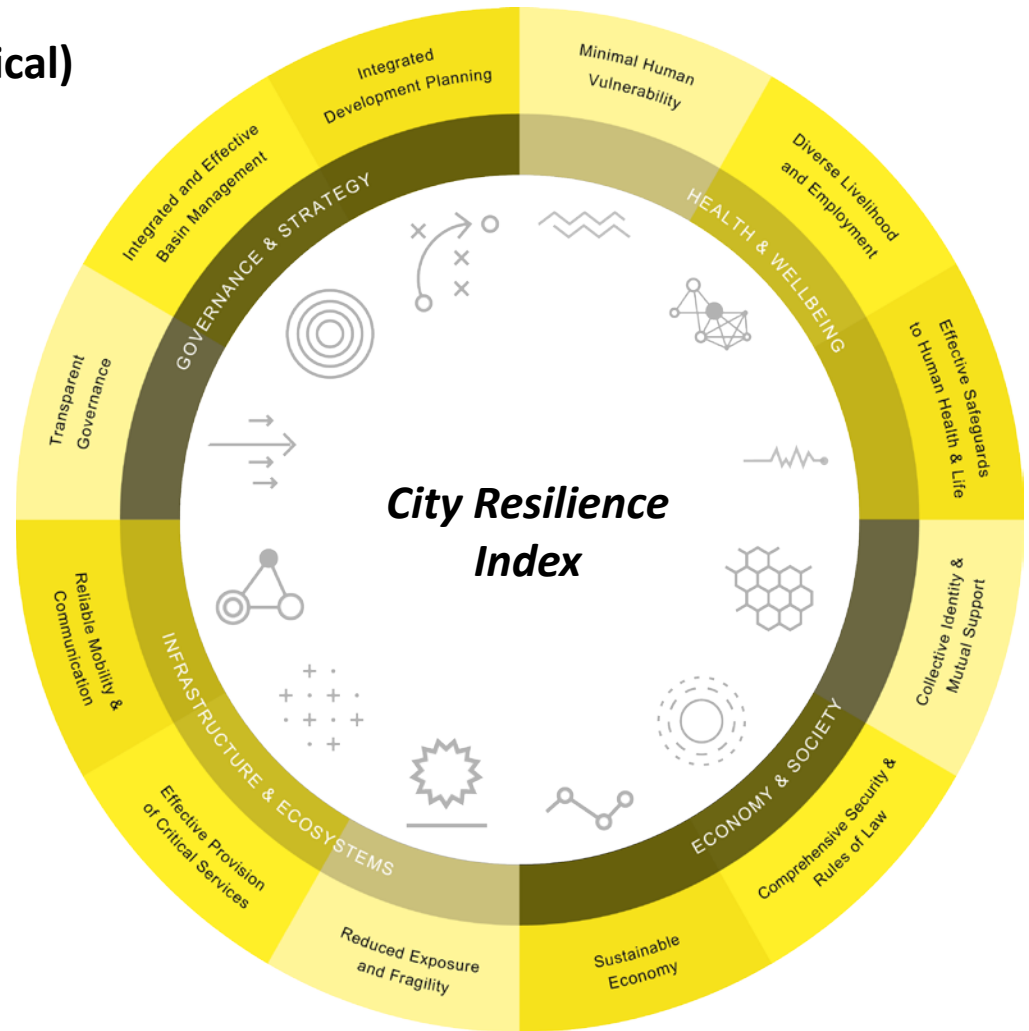
Specified resilience variables (ecological)

+ Social variables:

- Governance
- Institutions (rules, norms)
- Human capital
- Networks & relationships
- Social services & safety net

+ Economic variables:

- Water valuation
- Markets & trading
- Financial capital & investment
- Industry
- Agriculture
- Transport & infrastructure





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ICSU 2017



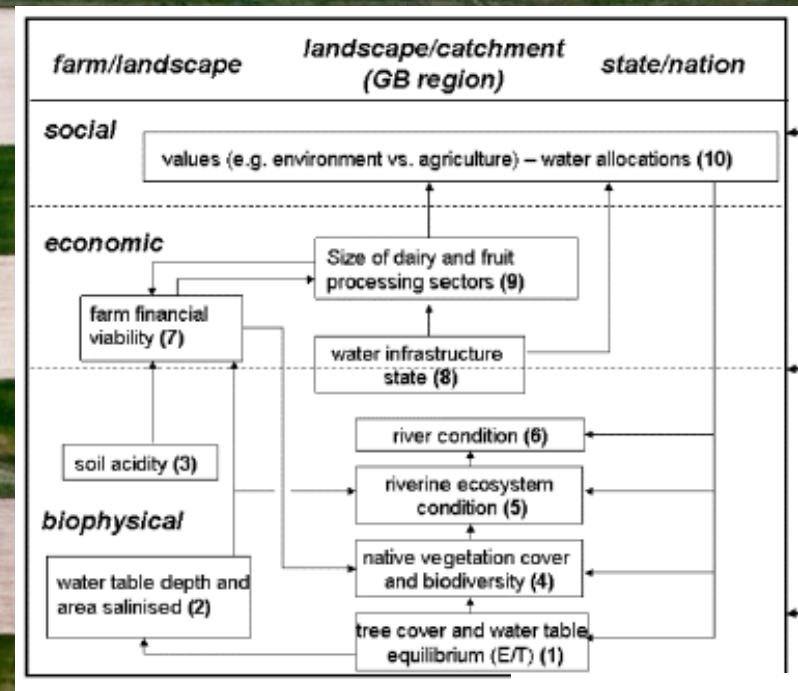
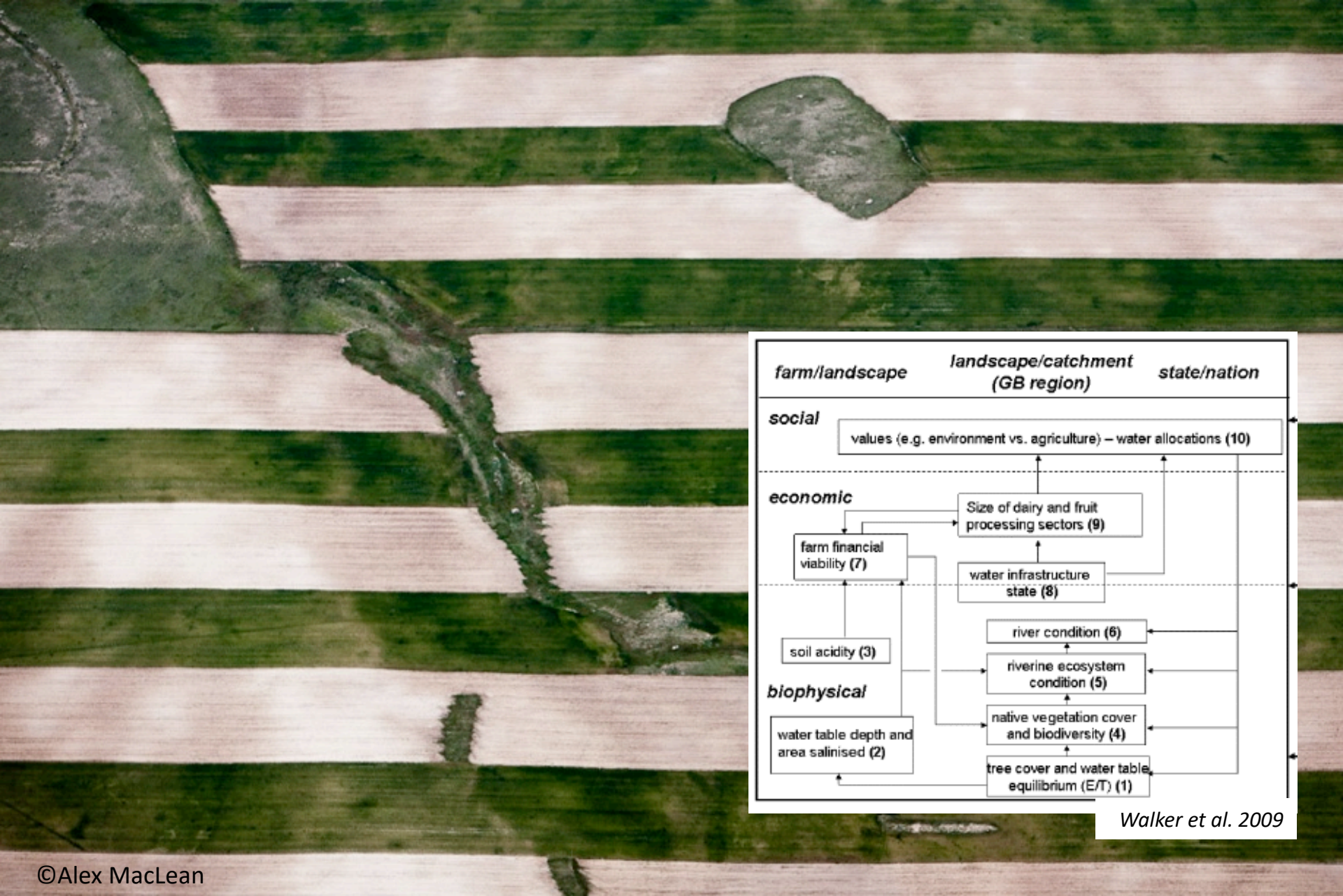
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applicable to multiple sectors, complex systems and scales

qualities of resilient systems



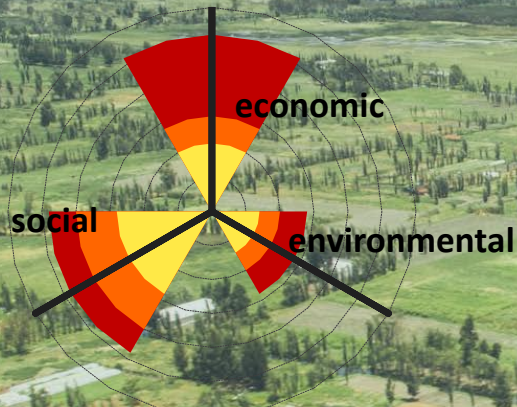


Walker et al. 2009

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agricultural economy – Walker et al., Murray-Darling

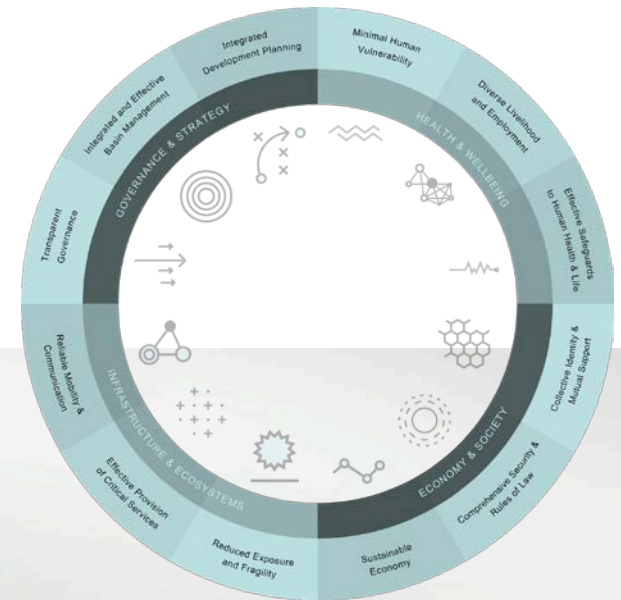
basin scale : food-water-energy-urban nexus



■ Services ■ Robustness ■ Recovery


I'm not going to cancel on them this late.

the city water resilience framework





we prefer the
Poisson
distribution



John Matthews, Alliance for Global Water Adaptation
Casey Brown, U. Massachusetts-Amherst
Diego Rodriguez, The World Bank Group
Olivia Armenta, 100 Resilient Cities
Arnoldo Kramer, Mexico City
Mark Fletcher, ARUP
Alexa Bruce, ARUP