

Avoided Risks and Returns Amidst the Landscapes of Science-Based Targets, Sustainable Development Goals, Climate Security Roadmaps, Adaptation Pathways, Co-Benefits, Resource Nexus and anything else?... Where does or can the science support?

XLI MIT Global Change Forum, March 27-28, 2018, Cambridge, Massachusetts

Science-Based Target:

Adopted to reduce greenhouse gas (GHG) emissions according to the level of decarbonization required to keep global temperature increase below 2°C compared to pre-industrial temperatures, as described in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5)

A Brief Poli-Socio-Scientific History of the 2°C Target

- First appearance of objective to limit temperature rise to 2°C shows no clear origin and its adoption neither from compelling scientific evidence nor to the negotiators' informed choice based on scientific data.
- Before the UNFCCC negotiations adopted - 2°C was already used for scientific, economic and political apprehensions about climate change.
- Emergence not a recommendation from scientists consulted by negotiators to identify threshold of "anthropogenic disturbance of the climate system".
- Late 1990s and 2000s, rising concern climate catastrophic and nonlinear changes, a.k.a. "tipping points" (e.g. popularized by M. Gladwell) such as shutdown of ocean overturning or massive permafrost thaw.
- Through Cancun (COP16), Durban (COP17), Doha (COP18), Warsaw (COP19), Lima (COP20), leading up to landmark COP21 Paris agreement – "…work to limit global temperature rise to well below 2 degrees Celsius, and given the grave risks, to strive for 1.5 degrees Celsius…"
- Leading up to and in wake of COP21 – rhetoric and debate to "ditch it" or move to "a suite of vital signs" has ensued…

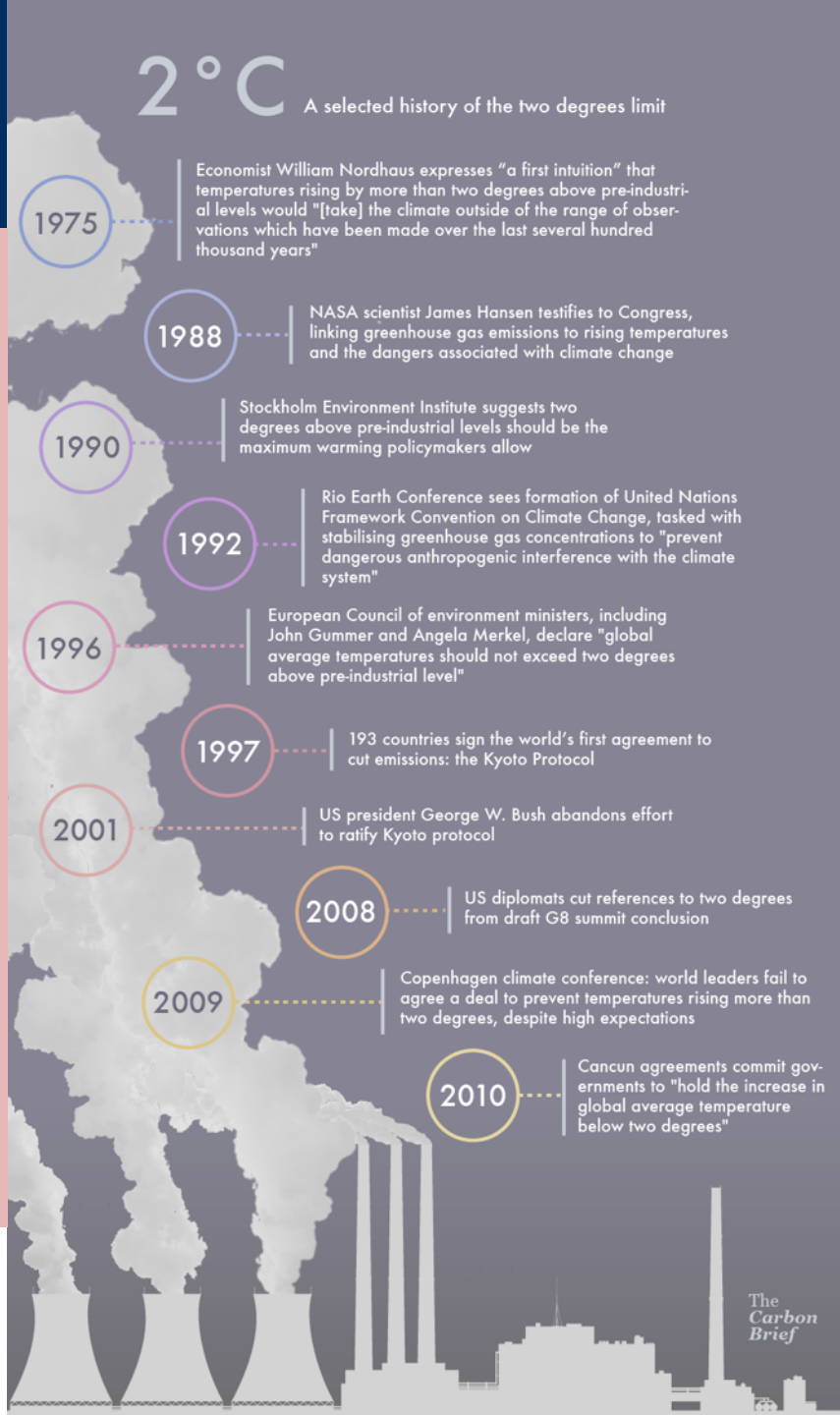


Figure from: Two degrees - A selected history of climate change's speed limit. R. Pearce, Carbon Brief. Other bullet points drawn from: Cointe, B., Ravon, P.-A., Guérin, E., 2011: 2°C: the history of a policy-science nexus, Working Papers N°19/11, IDDRI, Paris, France, 28 p.; http://unfccc.int/timeline/; and "Could the 2C climate target be completely wrong? A. Vaughan, The Guardian, Oct. 2014.

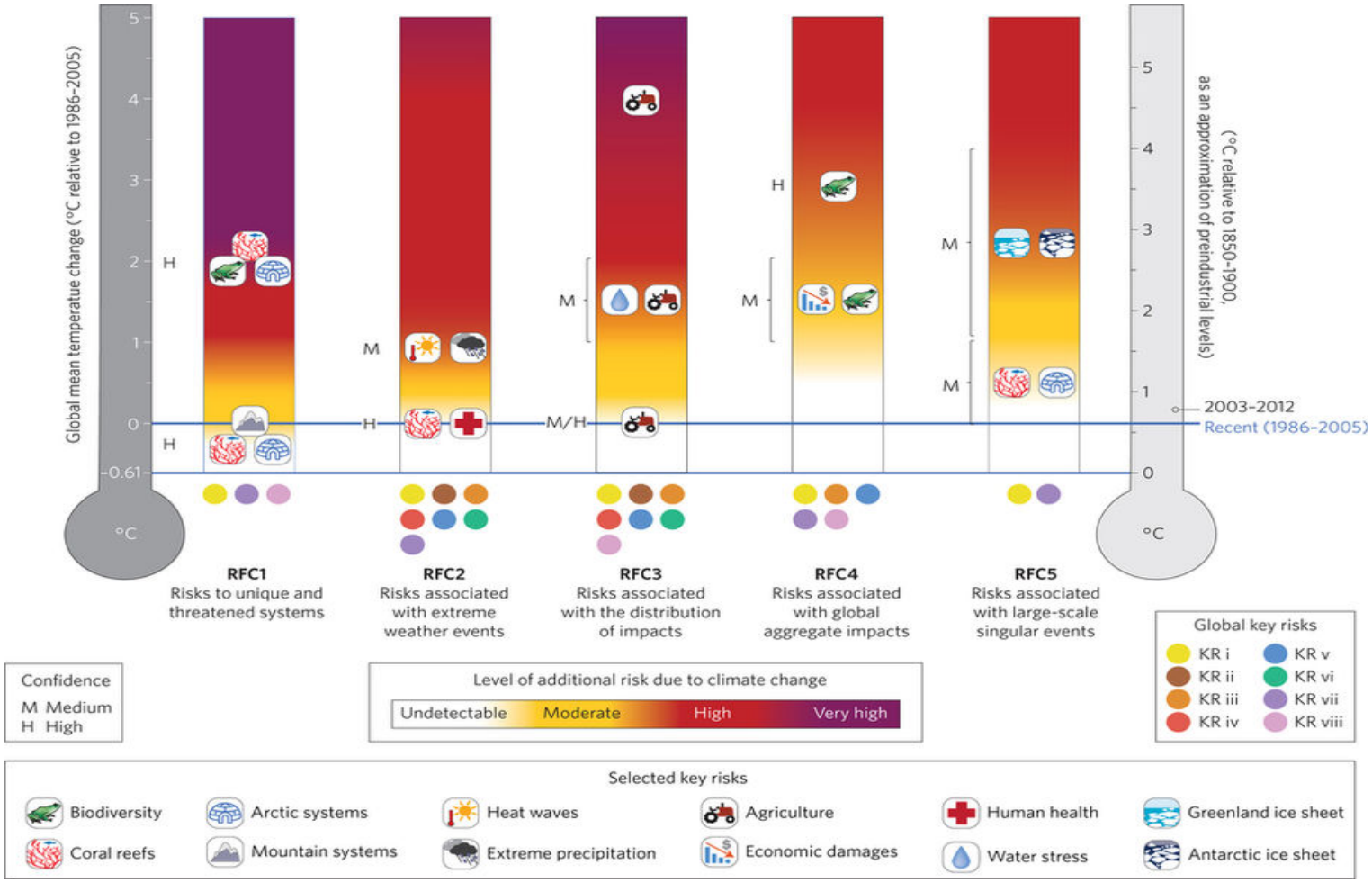
One target not enough?... How about 17 Sustainable Development Goals (SDGs) with 169 targets to chose from?

Replace the Millennium Development Goals (MDG) – which ended Sept., 2015.

Also known as "Transforming our World: the 2030 Agenda for Sustainable Development" or "2030 Agenda" in short.

- Ban Ki-moon, the UN Secretary-General from 2007 to 2016, stated, "We don't have plan B because there is no planet B." This thought has guided the development of the SDGs.
- Targets within each SDG goal may have 1-3 indicators to measure progress. There are 304 indicators in total. Climate action – "regulating emissions and promoting developments in renewable energy"
- Only a very ambitious climate deal [COP21 – i.e. the 2C target] could enable countries to reach the sustainable development goals and targets – and vice versa...

Most Recent IPCC "Reasons for Concern" (RFC) Framework And the (Enhanced) Burning Embers Diagram



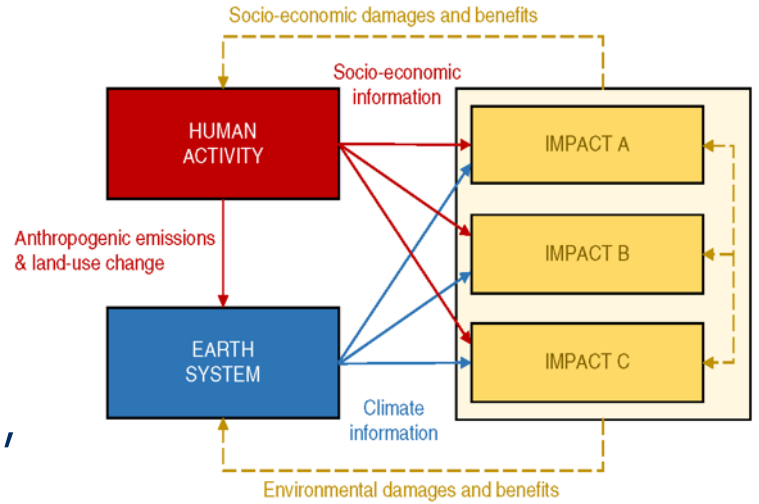
O'Neil et al., 2017, NCC

Risk levels enable integration within each RFC across different but related risks and evidence.

"The scale is inherently nonlinear and qualitative, even if quantified evidence enters the judgments"

With all these in mind – where can the science go to support all these seemingly interwoven and growing mesh of targets?...

- Self-consistent model frameworks to assessing multi-sectoral impacts
- Informative impact metrics and indices
- Improve skill, confidence, detail, and consensus of predictions



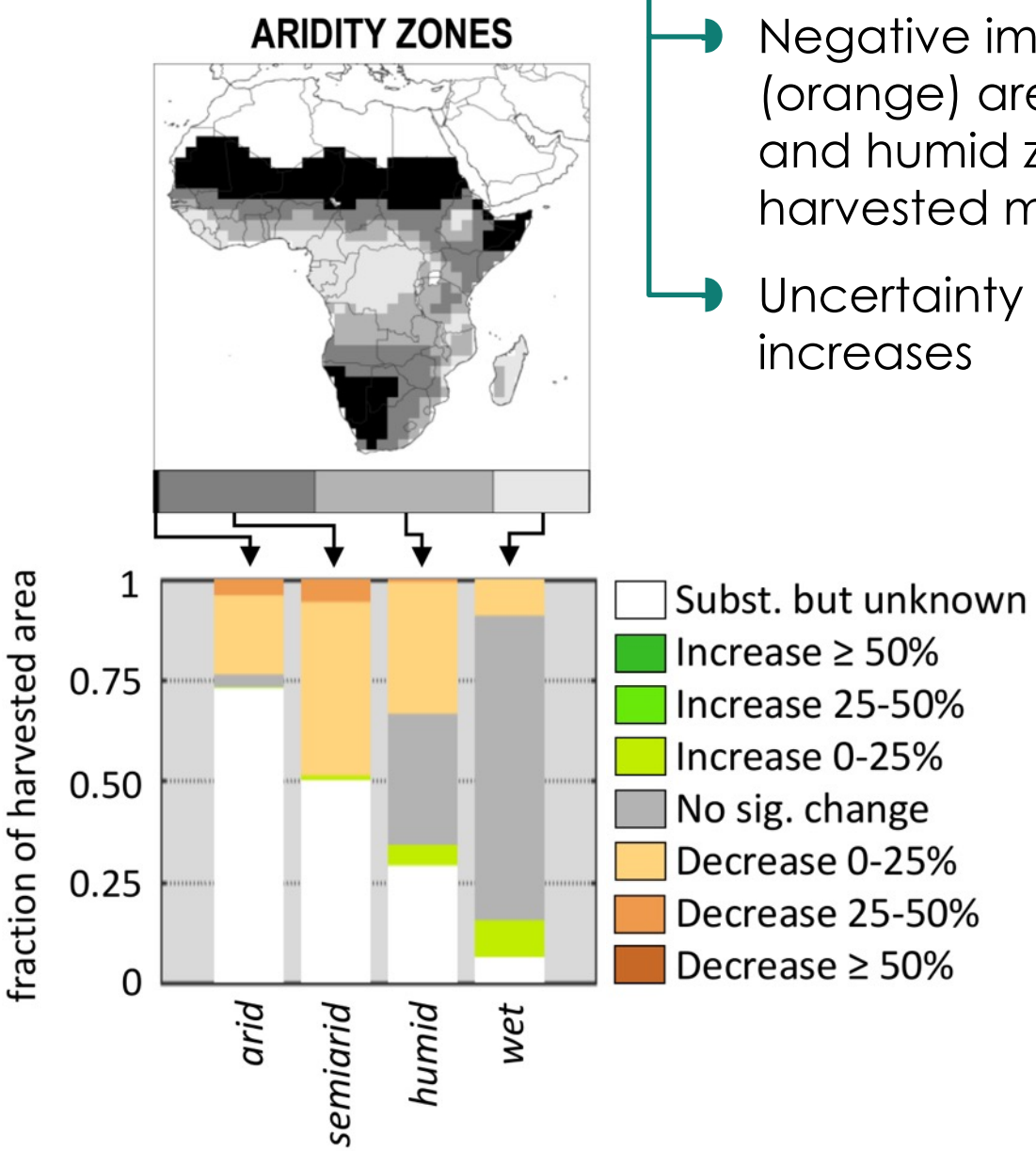
Potential impacts:
- Health
  - Air quality
  - Extreme temperature
  - Water quality
- Infrastructure
  - Roads and bridges
  - Urban drainage
  - Coastal property
- Electricity
  - Grid vulnerability
  - Supply and demand
- Water resources
  - Inland flooding
  - Droughts
  - Supply & demand
- Agriculture
  - Crop yield
  - Forest productivity
  - Land-use change

Monier et al., 2017, Nature Comm.

- To the extent possible – simulation frameworks that support risk-based assessments.

- "...the practical question is how wrong do [models] have to be in order to not be useful?" (Box and Draper)
- Can "somewhat useful" models that are linked become useless?
- "Garbage in – Garbage out" or "Garbage in – Gospel out" (GIGO)

MEDIAN PERCENT CHANGE IN CROP YIELD, 2010-2050



- Negative impacts on maize yields (orange) are highest in the semiarid and humid zones (~80% of current harvested maize area)
- Uncertainty (white) increases as aridity increases

MOTIVATION

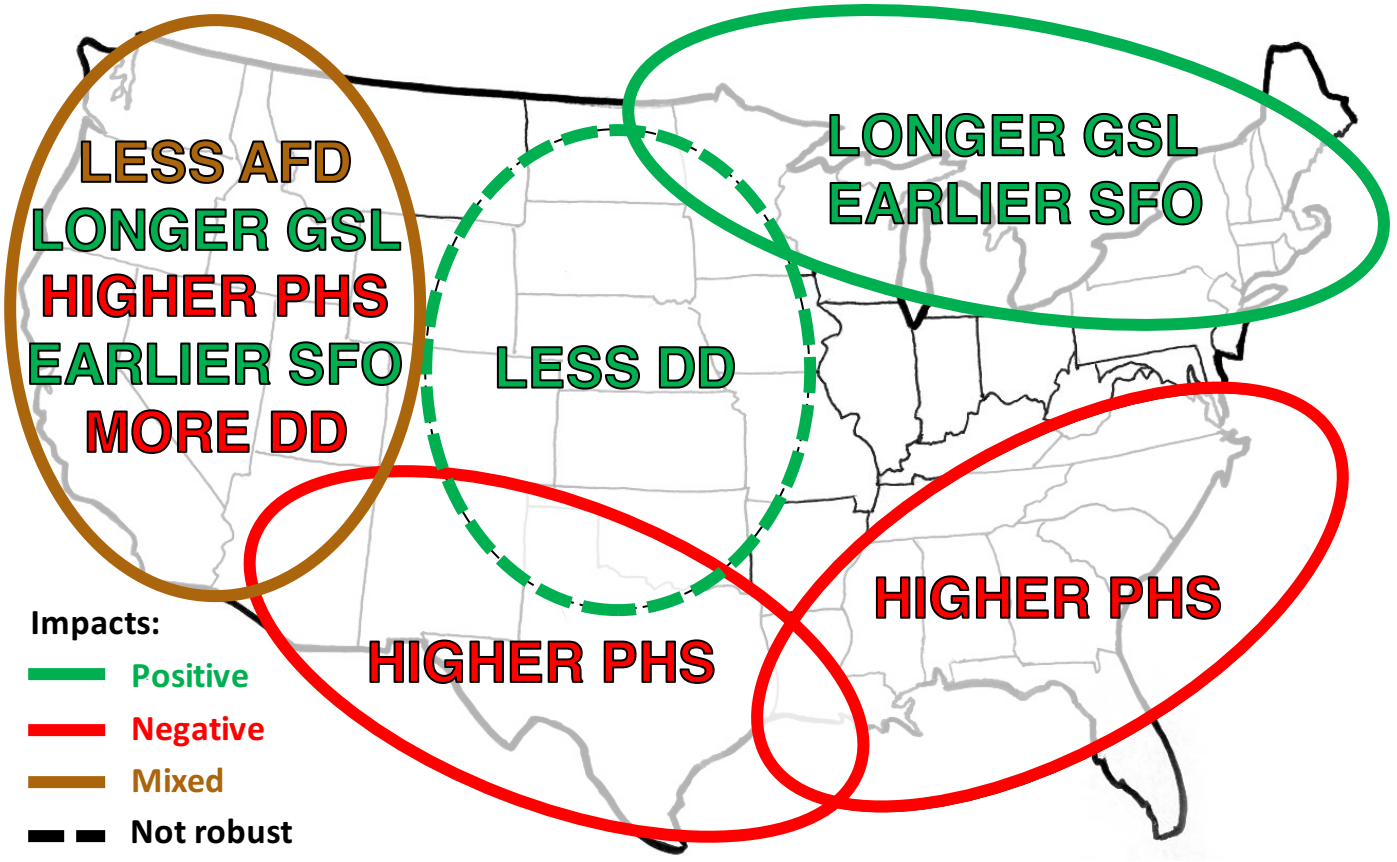
MAIZE & WATER IN SUB-SAHARAN AFRICA (SSA) UNDER CLIMATE CHANGE

Almost a quarter of the world's malnourished population lives in SSA

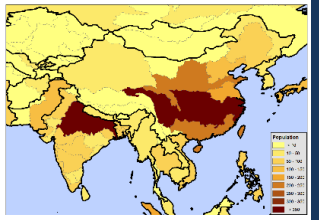
Maize (corn) is the most calorically important crop in SSA and the most widely produced crop by harvested area. It is also drought-sensitive.

high reliance on rainfall rather than irrigation → high sensitivity to future changes in precipitation

Dale et al., Earth's Future, 2017

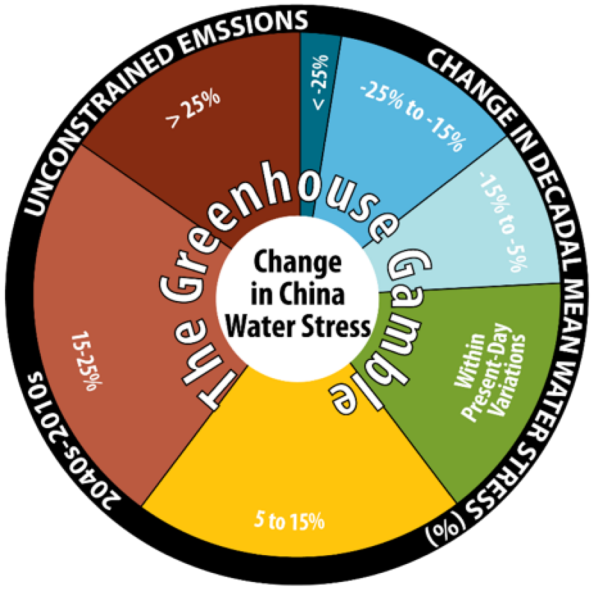


AFD: Accumulated Frost Days
GSL: Growing season length
PHS: Plant Heat Stress
SFO: Start of Field Operations
DD: Dry Days

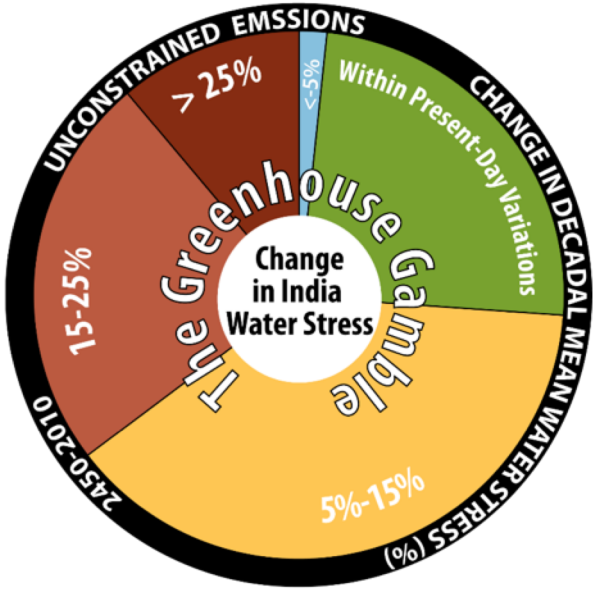


What are the risks/likelihoods we face? What should we try to avoid?

Change in decadal water stress (2040s-2010s) Unconstrained Emissions

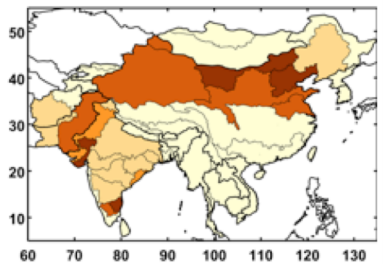


CHINA (Baseline WSI = 0.88)



INDIA (Baseline WSI = 0.73)

Water Stress Index (WSI) Baseline

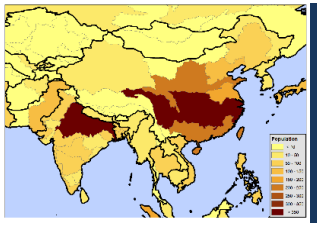


- Population-weighted
- Red shades are changes into "heavier stressed" category(ies)
- Green shade within climate variability

Fant et al., 2016

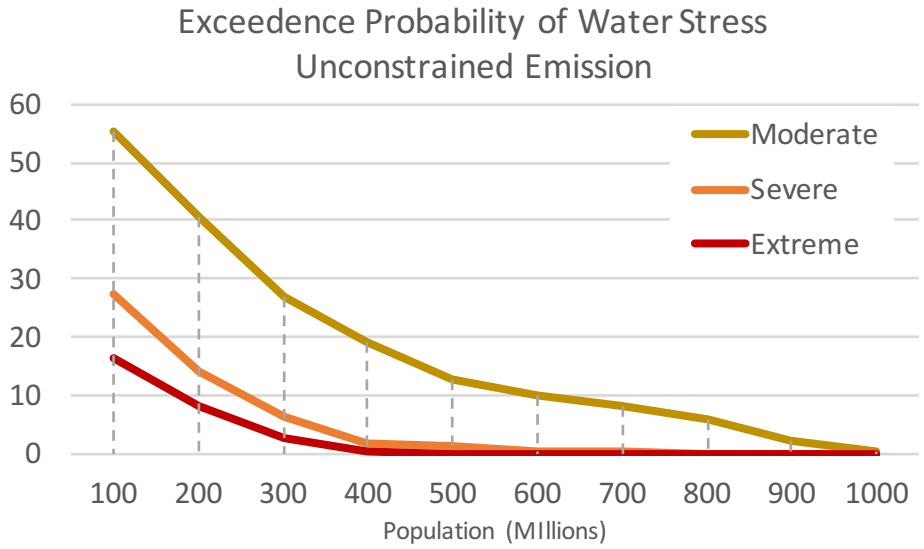
India shows a far greater risk of increased water stress (33% of outcomes) than any decrease

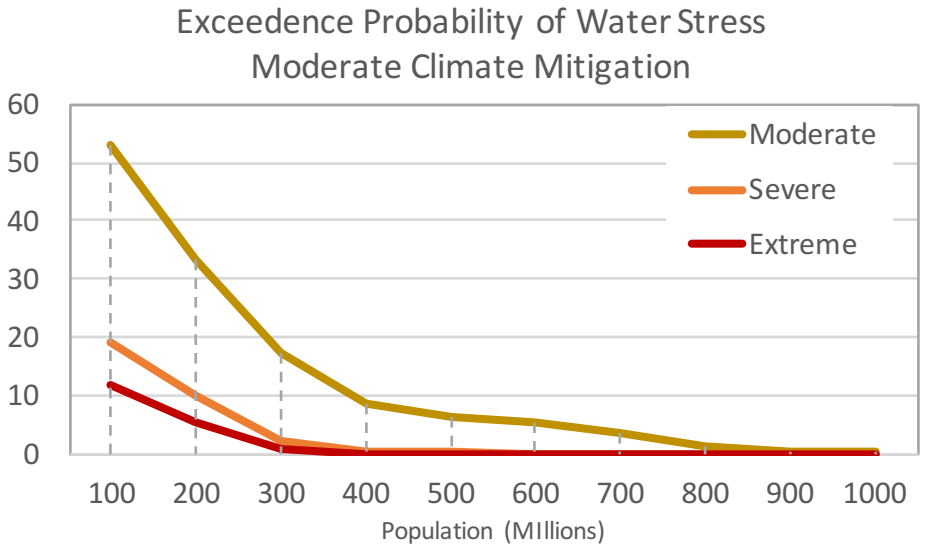
While China's risk for increase stress is commensurate to India – it also shows a considerable chance of seeing decreased stress (about 25% of the simulated outcomes).



What are the risks/likelihoods we face? Mitigation Can Reduce the Risk

Risk of Water Stress over China and India 2040s





Under a mitigation pathways commensurate to 50% chance of meeting 2˚C target

- 400 million people see odds of moderate water stress go from about 1-in-5 to 1-in-10.
- 100 million fewer people see odds of experiencing extreme water stress.
- 100-200 million people's odds of moderate water stress remains at least 1-in-3… adapt!

Improve Consensus and Skill in Climate Predictions that Target Trends in the Frequency of Damaging/Extreme Events

Case Study: "Critical" Large Power Transformers (LPTs)

Novel Approach ("NEW") Compare to conventional method ("OLD")

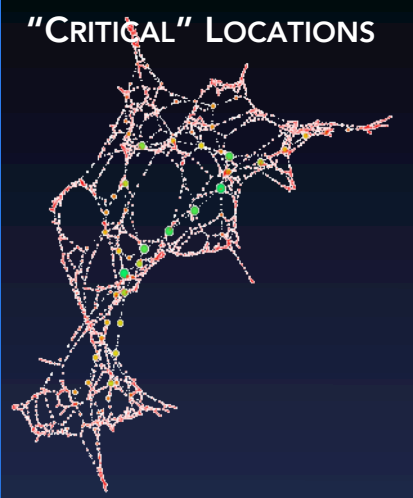
Gao et al., 2018, Climatic Change

<u>Case Study on Extreme Summer Heat</u>

Mitigation – underlying risk is likely to be doubled.

No actions – Underlying risk could be quadrupled.

"Critical" Locations



New Technology

Other Infrastructure & Extremes

Closing Remarks

- History aside – global target impetus for science-backed assessments
- Any sustainable goals mutually exclusive to climate target?
- Models, methods, analyses must evolve to match the complexity and detail of targets
- Careful of the gospel

We gratefully acknowledge all our federal and industrial sponsors

Thank You

http://globalchange.mit.edu/