Humid heatwave events and their socio-economic implications at different warming levels

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Outline

• Risk framing in IPCC AR5

• IPCC Working Group (WGI) dealing with extremes

• Importance of indices and data availability

• Example: Climate extremes and health

• Outlook
Risk framing in IPCC AR5
Risk framing in IPCC AR5

\[
\text{Climate change risk} = \text{Hazard probability} \times \text{Vulnerability} \times \text{Exposure}
\]
IPCC Working Group I – The physical basis in AR5

Long-term Climate Change: Projections, Commitments and Irreversibility

Chapter 12

a) Coldest daily Tmin  
RCP8.5: 2081-2100

b) Coldest daily Tmin (TNn)

ranging from -2 to 8°C

historical  
RCP4.5  
RCP2.6  
RCP8.5

Years: 1960-2100

CMIP3 B1  
CMIP3 A1B  
CMIP3 A2

(c) Warmest daily Tmax  
RCP8.5: 2081-2100

d) Warmest daily Tmax (TXx)

ranging from -2 to 8°C

historical  
RCP4.5  
RCP2.6  
RCP8.5

Years: 1960-2100

CMIP3 B1  
CMIP3 A1B  
CMIP3 A2

based on Sillmann et al. 2013b
Consequences?

Natural loss events worldwide 2015
Geographical overview

- Consequences

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Risk framing in IPCC AR5

Climate change risk = Hazard probability × Vulnerability × Exposure

Land & Ocean Temperature Percentiles Jul 2015
NOAA’s National Centers for Environmental Information
Data Source: GHCN-M version 3.3.3 & ERSSS version 4.0.0

In Bern ist es leichter, kühl zu bleiben
Wer in Bern lebt, sollte nicht zu laut über Hitze klagen. Denn Grünanlagen und ein «Kühlelement» namens Aare sorgen für ein sehr privilegierteres Klima.

Tipps: Luftige Kleidung, Skinny Jeans

• Regenmantel: Wasser aufnehmen und Spülen
Dabei ist es wichtig, nicht in so großen Mengen zu konsumieren, da dies zu Kopf- oder Magenschmerzen führen kann. Ideal ist es, Dusche und kalt zu nehmen, indem man immer wieder Wasser zu sich nimmt, sich auftaucht.

'article' by 'CICERO'
Importance of indices and data availability

Climate change risk = Hazard probability × Vulnerability × Exposure

- Heat
- Air Pollution
- Age
- Gender
- Income
- Population density
Importance of indices and data availability

Heat

- Warmest daily Tmax (TXx)
- Warm Spell Duration Index (WSDI)
- Heat Wave Magnitude Index (HWMId)
- Humid Heat Wave Magnitude Index (AWMI)
- Wet Bulb Global Temperature (WBGT)
- Etc.
Heat wave magnitude index

Russo, Sillmann & Fischer, ERL, 2015

**Heat wave killed 11,000 in France**
As temperatures rose to 40°C (104°F) in parts of the country there were massive backlogs and at hospitals many people died.

**Russians and Their Crops Wilt Under Heat Wave**
The heat has been besting decades-old records here. At 92.5°F, Friday was the hottest July 16 ever in Moscow.
Humid heat wave index

Russo, Sillmann & Sterl, 2017

AHWI → Replacing daily Tmax with Apparent Temperature AT, when AT > T
Humid heat waves in the future

Risk of heat cramps and exhaustion

Extreme risk of heat strokes

Russo, Sillmann & Sterl, 2017

9 CMIP5 models

0 1 10 20 30 40 50 60 70 80 90 100

Probability (%)
Humid heat waves in the future

Under 4°C warming some regions of the world become uninhabitable!
Example: Climate Extremes and Health

Climate change risk = Hazard probability × Vulnerability × Exposure

Heat
HWMId from 50 ensemble members of CanESM2

Age
UN ESA* (<4 and >65 years)

Population
NCAR SSP2 scenario (Jones & O'Neill 2016)

Hazards: Heat waves (HWMId from CanESM2)
Exposure: Population SSP2 scenario (Jones & O’Neill 2016)
Vulnerability: Age distribution from UN ESA
Climate change risk = Heat x Population x Age

Natural events, such as heatwaves, can trigger disasters, which for the most part are socially constructed → however, there are limits to adaptation under climate change
Heatwaves scaled by Population x GDP

For present day conditions (2001-2010) of population and GDP (Harrington et al. 2016, ERL)

Population (2001-2010)

1979-2015

1.5°C

2°C

4°C

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Conclusion

Challenges with following IPCC risk framework to identify social «hot spots»

- Data availability, open-access and compatibility
- Temporal and spatial resolution of datasets
- Empirical data combined with model development
- Up-scaling of case studies → learning from climate services

Close collaboration needed between Climate Change and IRDR community!

→ New WCRP-IRDR-Future Earth initiative on Knowledge-Action-Network (KAN) on Extreme Events and Disaster Risk Reduction / Emergent Risks

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Each SSP has a different population, but climate change does not feedback onto population growth.

Each SSP and IAM has a different GDP, and mitigation leads to reduce GDP growth. The cost of climate impacts is not included (and IPCC has shied from this).

Shades of Climate Risk

Scenarios

- **Emission pledges** (NDCs)
- **Paris target** (2 Degrees)
- **Paris pledges** (3 Degrees)
- **Business as Usual** (4-5 Degrees)

*If climate policies are strengthened over time (as per Paris Agreement design), distribution will shift left.*

*If climate policies are weakened over time, distribution will shift right.*

**Data:** CDIAC/GCP/IPCC/Fuss et al 2014
Humid heat waves in the future

Russo, Sillmann & Sterl, 2017, submitted
Example: Climate Extremes and Wealth

Climate change risk = Hazard probability × Vulnerability × Exposure

Heat
HWMId from 50 ensemble members of CanESM2

GDP

Population
NCAR SSP2 scenario (Jones & O’Neill 2016)
Example: Climate Extremes and Wealth

Source: Centre for Global Development, www.cgdev.org/blog/global-map-subnational-gdp
“… during the European summer heat wave of 2003 [...] possibly 50% of the deaths could have been associated with ozone exposure rather than the heat itself.” IPCC AR5 WGII (2014)

“… particle air pollution [is] among the largest risk factors globally, far higher than any other environmental risk [...]. IPCC AR5 WGII (2014)

“The economic impact of this burden is difficult to assess as evaluation methods vary dramatically in the literature.” IPCC AR5 WGII (2014)
Hazards: Ozone and PM2.5 from ECLIPSE
Example: Climate Extremes, Air Pollution and Health

Climate change risk = Hazard probability \times Vulnerability \times Exposure

Heat
- HWMId from 50 ensemble members of CanESM2

Air Pollution
- ECLIPSE (Stohl et al. 2015)
  - O₃ and PM2.5

Age
- UN ESA*
  - (<4 and >65 years)

Population
- NCAR SSP2 scenario
  (Jones & O’Neill 2016)