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Institute for Integrated Management of Material Fluxes and of Resources

TECHNISCHE UNIVERSITÄT DRESDEN

ADVANCING A **NEXUS APPROACH** TO THE SUSTAINABLE MANAGEMENT OF **WATER, SOIL** AND **WASTE**

INTERNATIONAL KICK-OFF WORKSHOP

11-12 NOVEMBER 2013

DRESDEN, GERMANY

ADVANCING A **NEXUS APPROACH** TO THE SUSTAINABLE MANAGEMENT OF **WATER, SOIL** AND **WASTE**

UNESCO-IHE Institute for Water Education

Global Change and Water – How far can the Nexus Approach help to meet Future Challenges?

Stefan Uhlenbrook

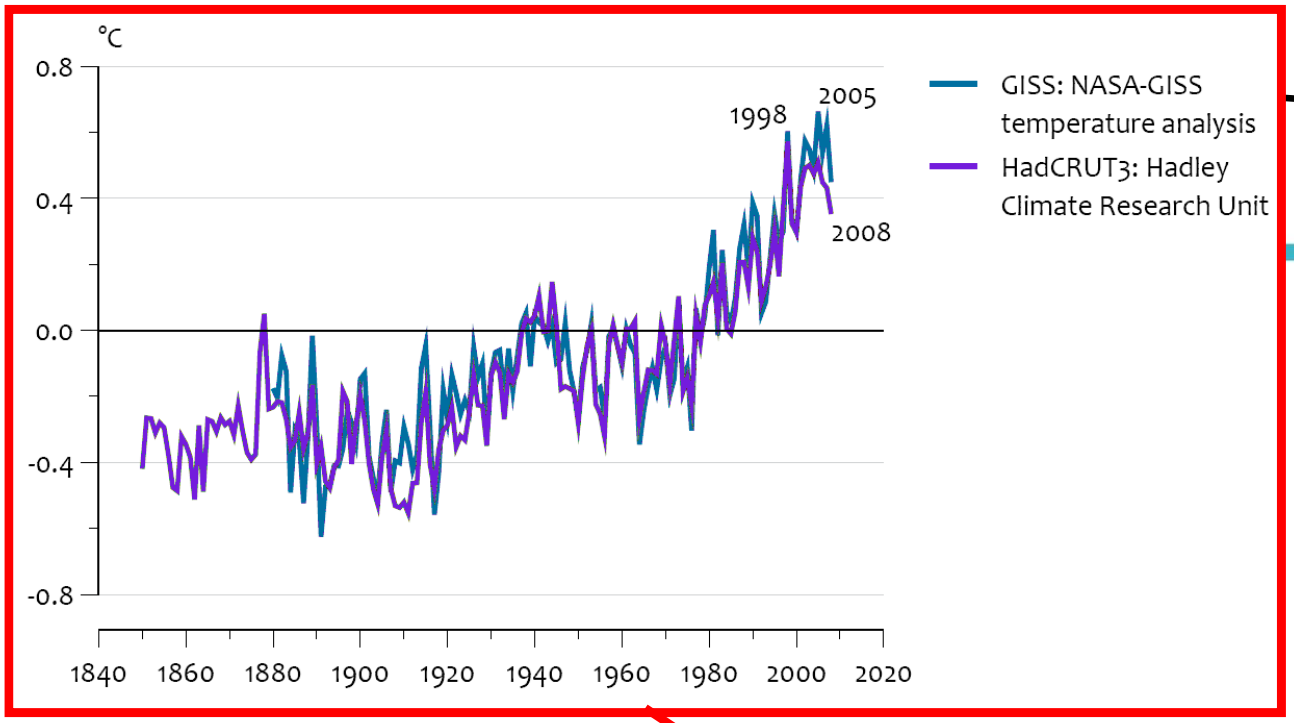
UNESCO-IHE Institute for Water Education

Delft, The Netherlands

ADVANCING A **NEXUS APPROACH** TO THE SUSTAINABLE MANAGEMENT OF **WATER, SOIL** AND **WASTE**

Stefan‘s Questions

1. Do current management approaches adequately address implications of climate change, e.g. frequency, intensity and duration of floods and droughts? **-> No**
2. Will new or improved technologies (and which) be required or at least be helpful to foster integrated management approaches?
3. Data scarcity: how far can remote sensing and satellite data replace or complement data from monitoring programmes? Do we need new approaches in handling data scarcity (e.g. specific modelling tools)?
4. Overall: is there a need for more research on the nexus?


°C
0.8
0.4
0.0
-0.4
-0.8
1998
2005
2008
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020
GISS: NASA-GISS temperature analysis
HadCRUT3: Hadley Climate Research Unit

IPCC Projections
2100 AD
Global Temperature (°C)
6
5
4
3
2
1
0
Lower Risk for Instabilities
N.H. Temperature (°C)
1
0.5
0
-0.5
1000
1200
1400
1600
1800
2000

(NEAA, 2009)

Evidence of climate change

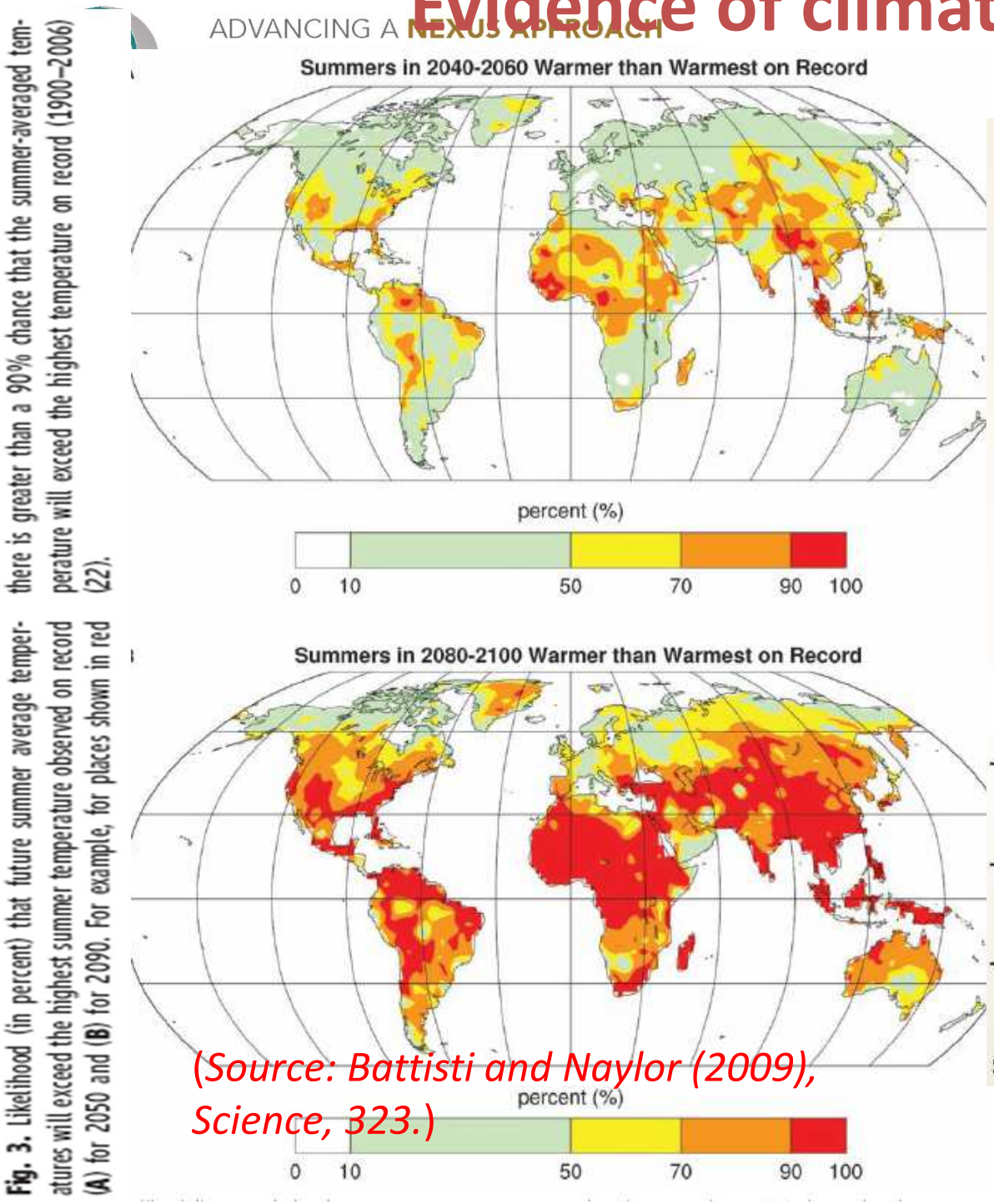
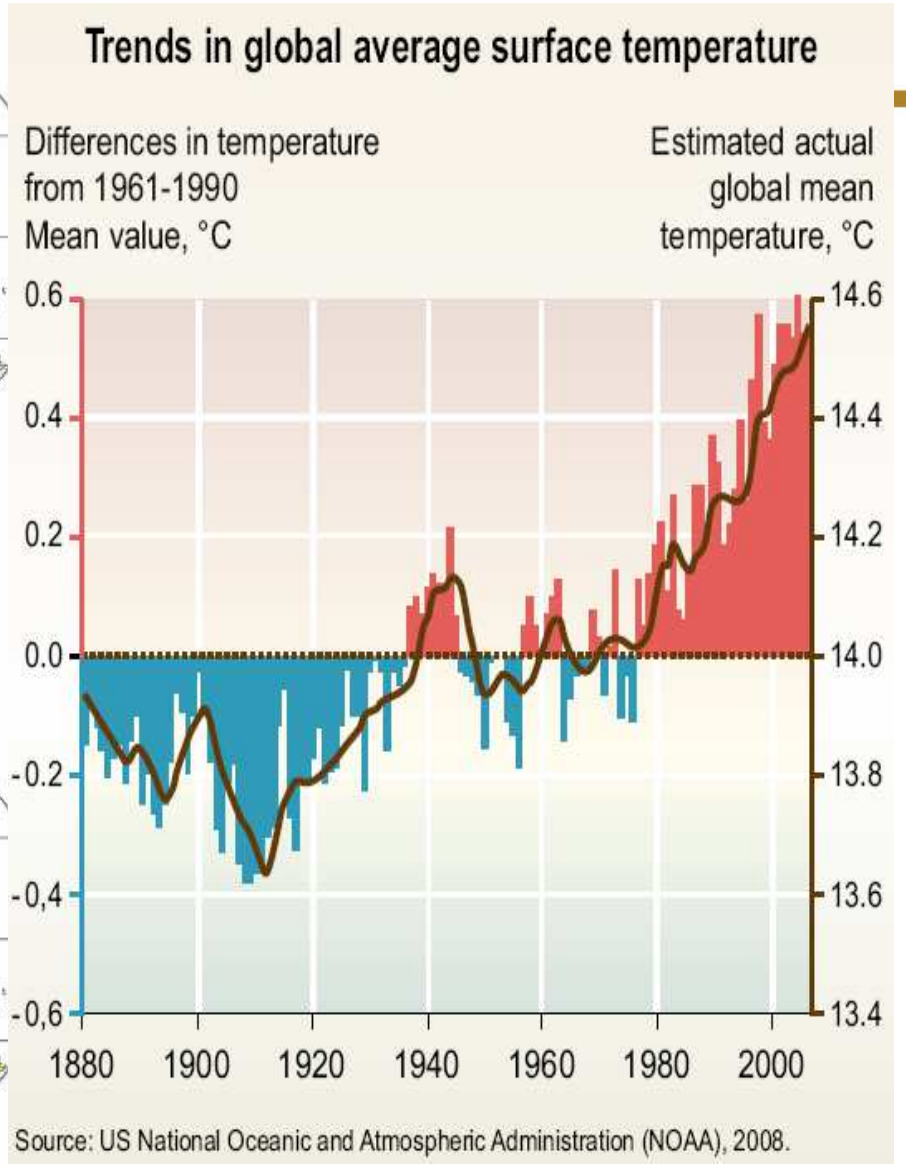


Fig. 3. Likelihood (in percent) that future summer average temperatures will exceed the highest summer temperature observed on record (**A**) for 2050 and (**B**) for 2090. For example, for places shown in red there is greater than a 90% chance that the summer-averaged temperature will exceed the highest temperature on record (1900–2006) (22).



(Source: Battisti and Naylor (2009), Science, 323.)

Slide from S. Maskey (2011)

Global Changes – Connected by Water

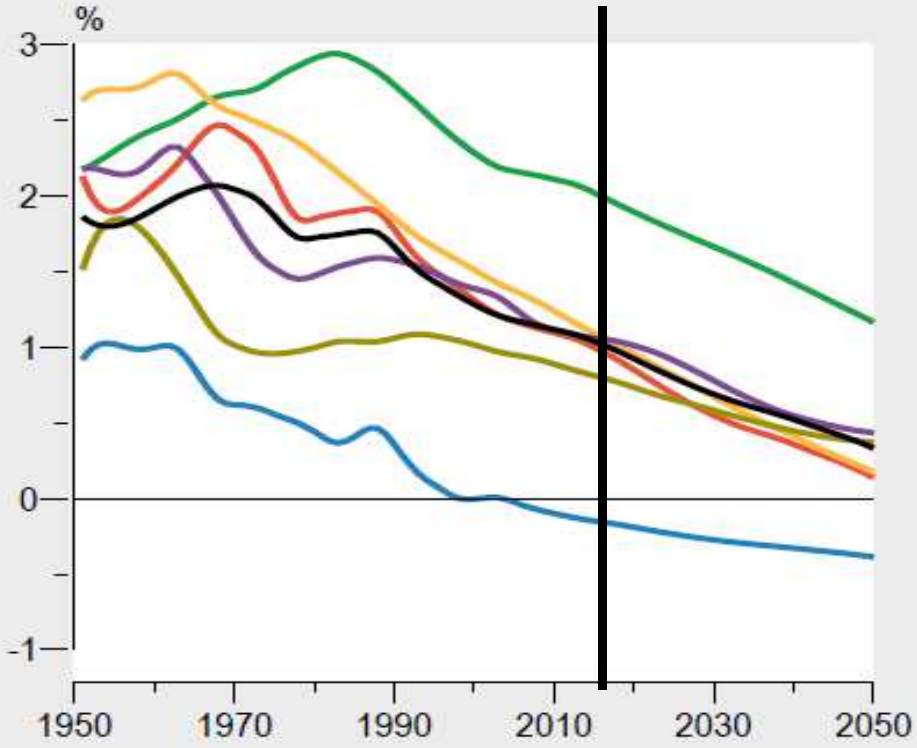
- Population (amount, density, structure, …)
- Climate (temperature, precipitation, radiation …)
- Land use, land cover
  - De-forestation / re-forestation
  - Increase of (irrigated) agriculture
  - Biofuel production
  - Urbanisation
  - Etc.
- Change of energy production
- Hydraulic works
- Technological development
- Water use in space and time
- Economic development
- Change of diet (*more meat => more water*)
- Nutrient fluxes to water bodies
- Pollution (new substances etc.)
- etc. etc. etc.

…. and many interdependencies/feedbacks!

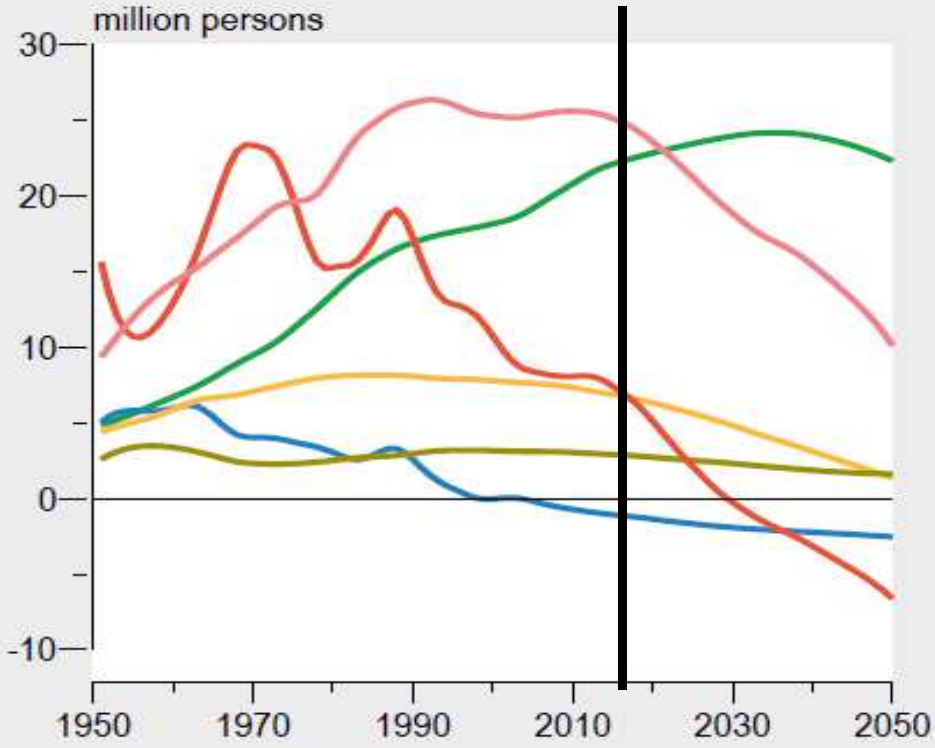
Demographics – *a huge challenge …*

Net annual population change

Relative growth

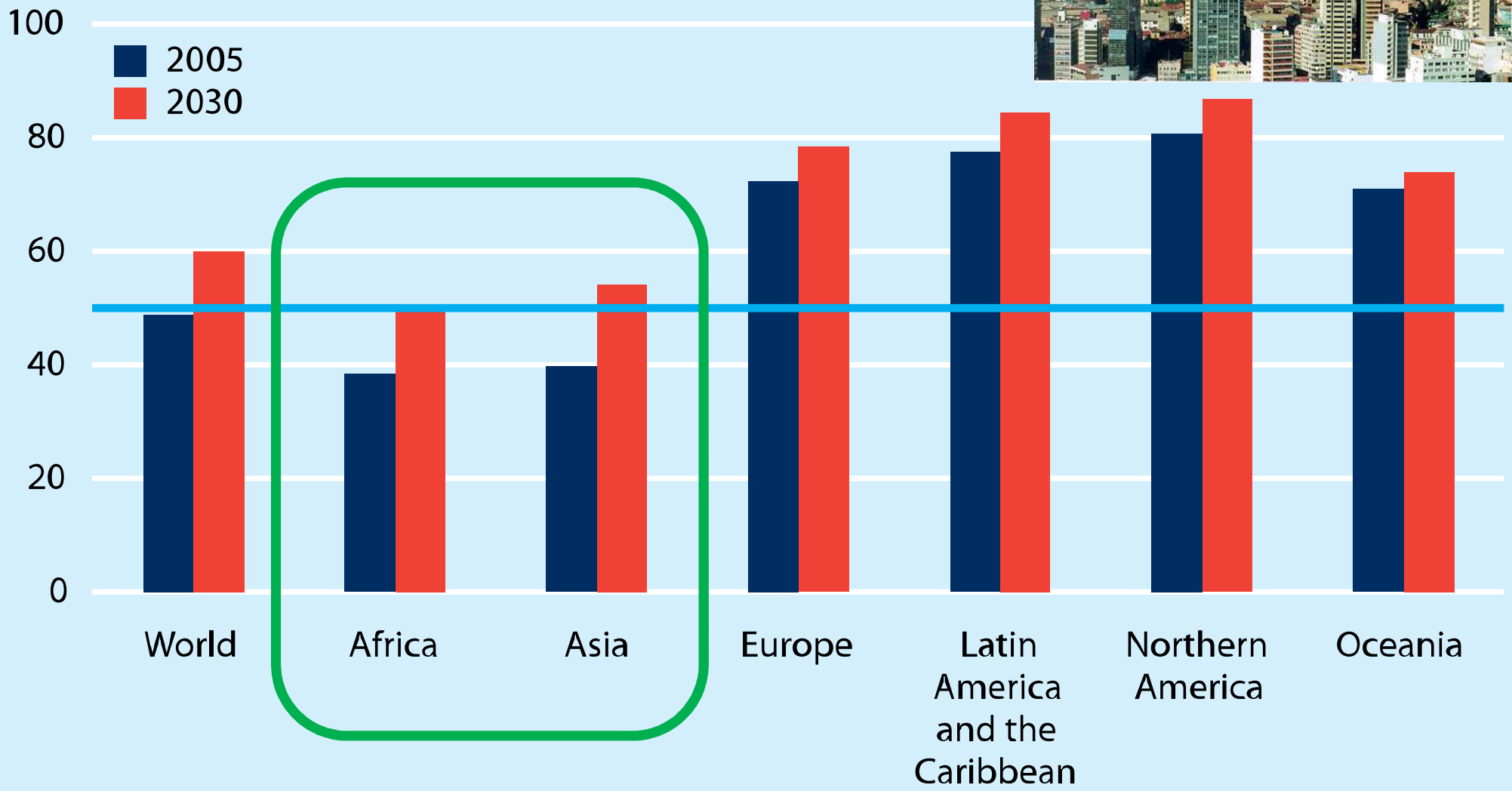


Absolute growth



By 2030 about 60% of the world's p
is expected to live in urban areas

Share of population residing in urban areas, 2005 and 2030 (perc



Note: Regions are official UN regions.

Source: United Nations 2006b.

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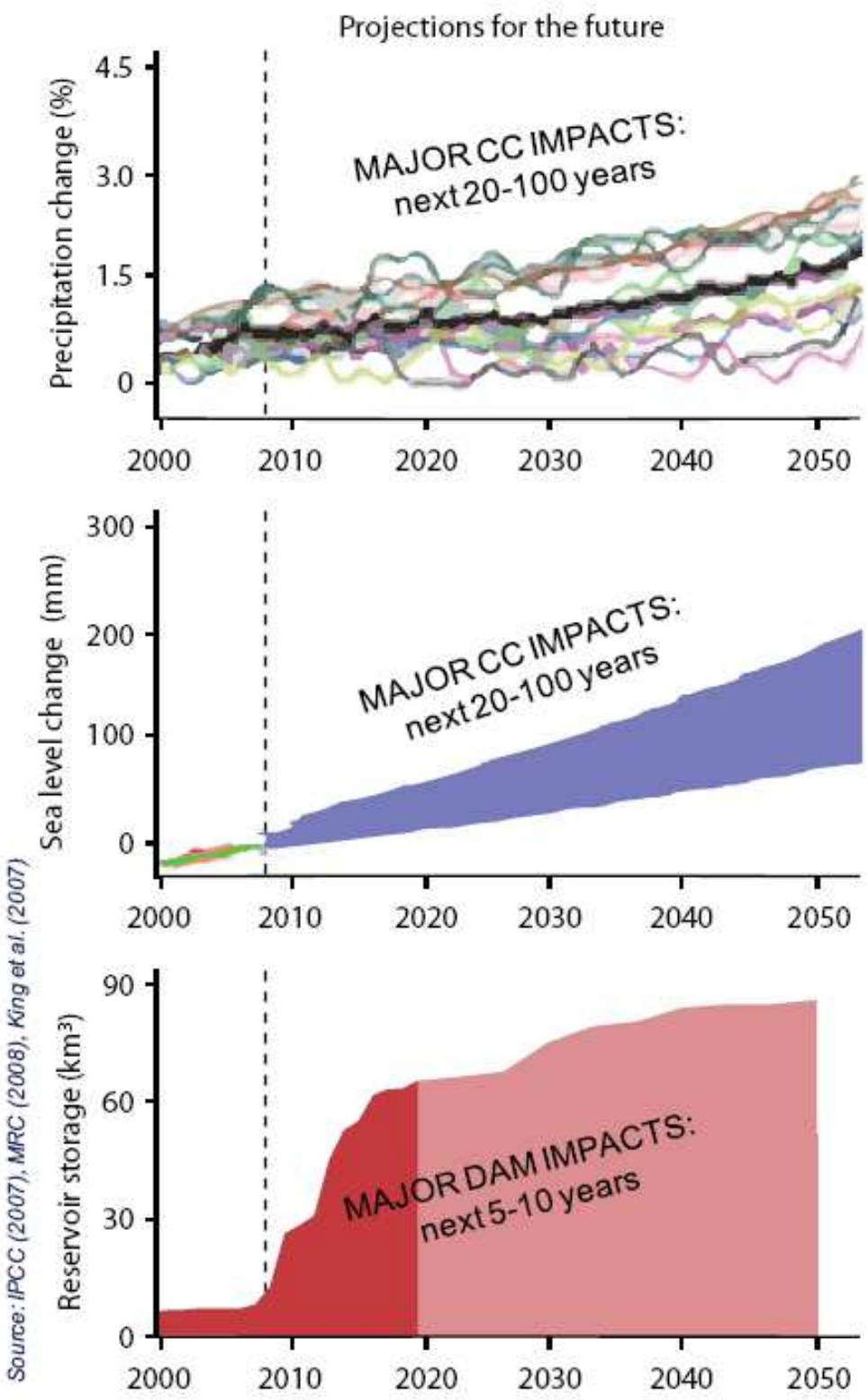
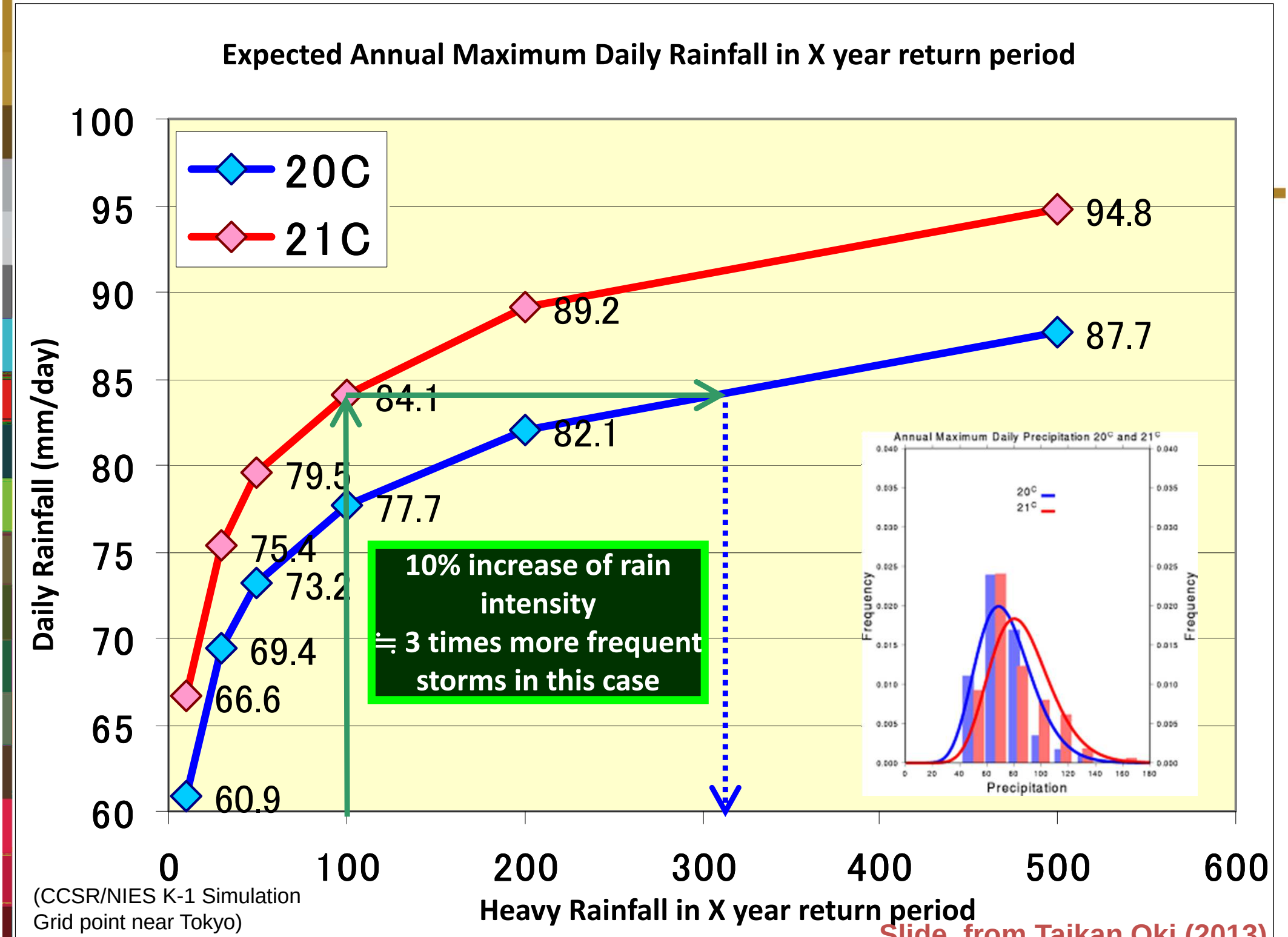
Facts about Mekong River Basin

Prediction of two climate related variables (precipitation and SLR) vs. planned reservoir storage development in the Mekong Basin

(TKK & SEA START RC, 2009)



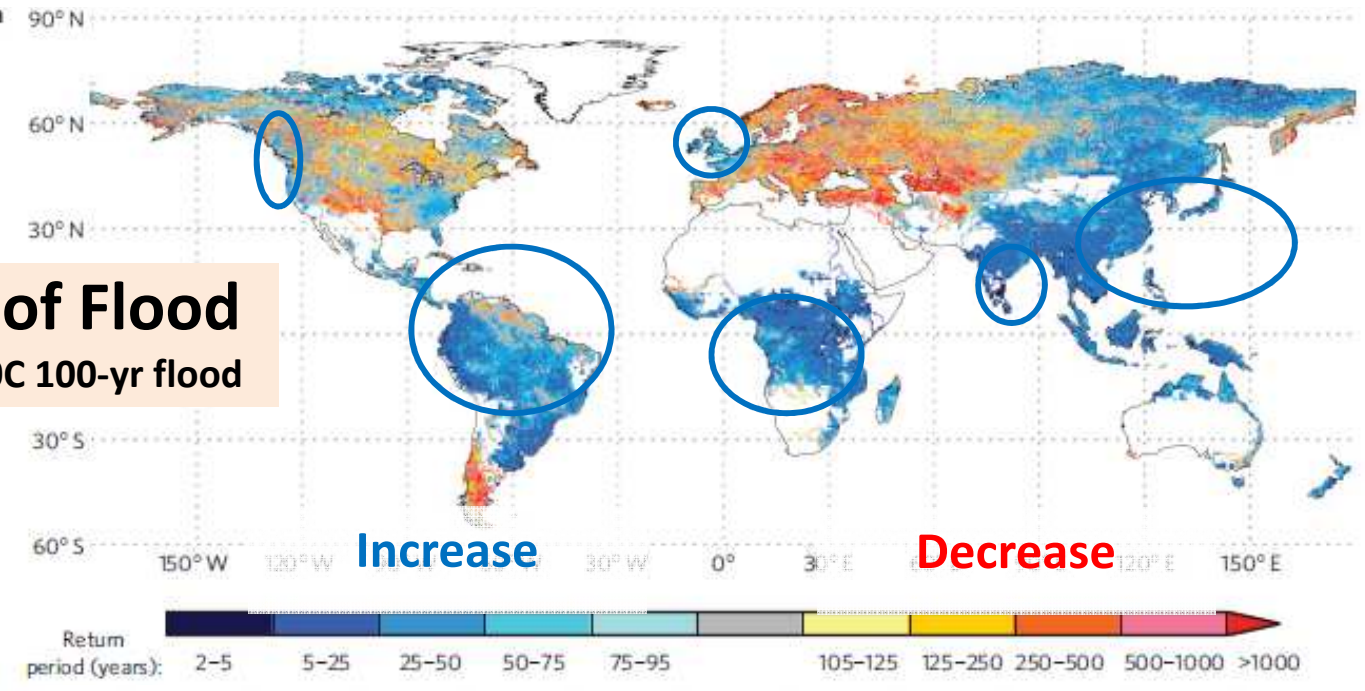

Expected Annual Maximum Daily Rainfall in X year return period
20C
21C
94.8
89.2
87.7
84.1
82.1
79.5
77.7
75.4
73.2
69.4
66.6
60.9
10% increase of rain intensity
≒ 3 times more frequent storms in this case
Annual Maximum Daily Precipitation 20C and 21C
Frequency
Precipitation
Daily Rainfall (mm/day)
Heavy Rainfall in X year return period
100
95
90
85
80
75
70
65
60
0
100
200
300
400
500
600
(CCSR/NIES K-1 Simulation
Grid point near Tokyo)
Slide from Taikan Oki (2013)

Future change in flood frequency and low flow

(Median of 11 GCMs under the extreme future scenario, RCP 8.5
difference between 2071-2100 and 1971-2000)

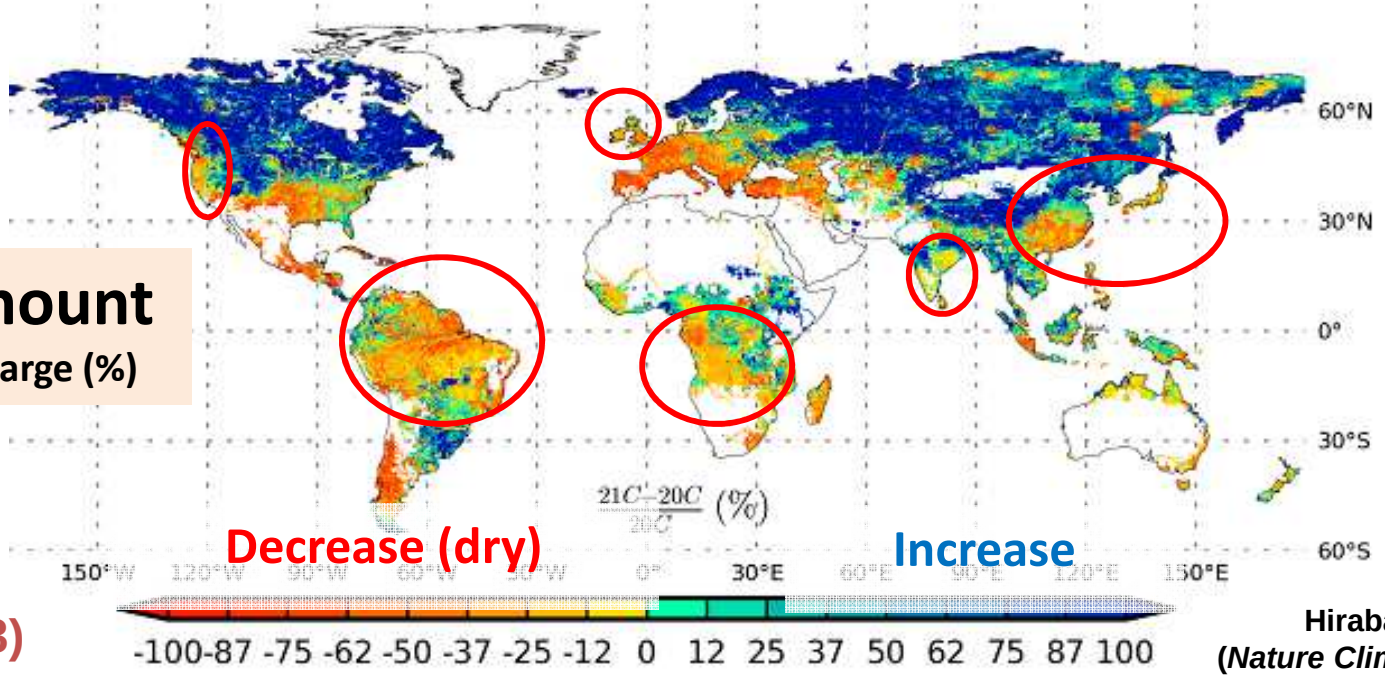
Frequency of Flood

return period of 20C 100-yr flood



Low flow amount

change in Q95 discharge (%)



Slide from Taikan Oki (2013)

Hirabayashi et al.,
(*Nature Climate Change*, 2013)

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Stefan‘s Questions

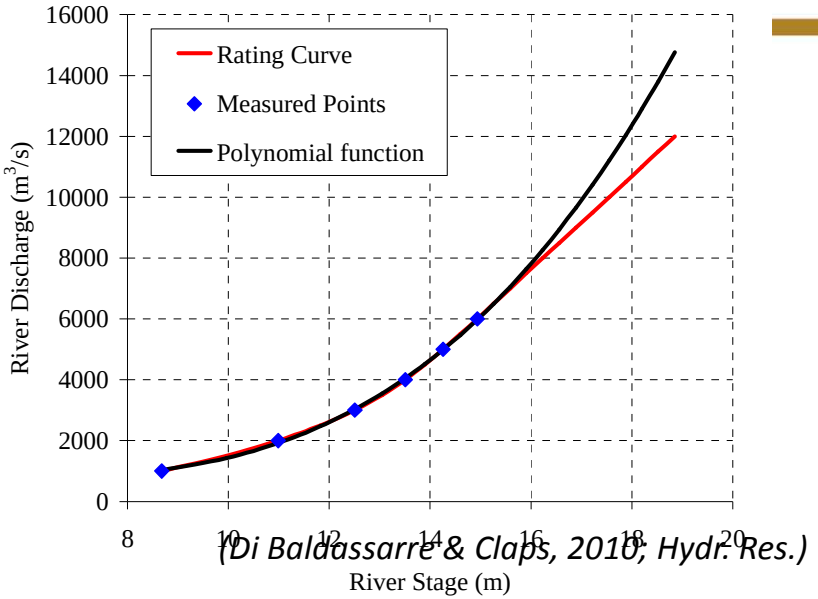
Innovations?!

1. Do current management approaches adequa… implications of climate change, e.g. fre…ency, intensity and duration of floods and droughts?
2. Will new or improved technologies (and which) be required or at least be helpful to foster integrated management approaches? **-> probably**
3. Data scarcity: how far can remote sensing and satellite data replace or complement data from monitoring programmes? Do we need new approaches in handling data scarcity (e.g. specific modelling tools)?
4. Overall: is there a need for more research on the nexus?

Example:
Uncertainty in flood modelling

Main sources of uncertainty:

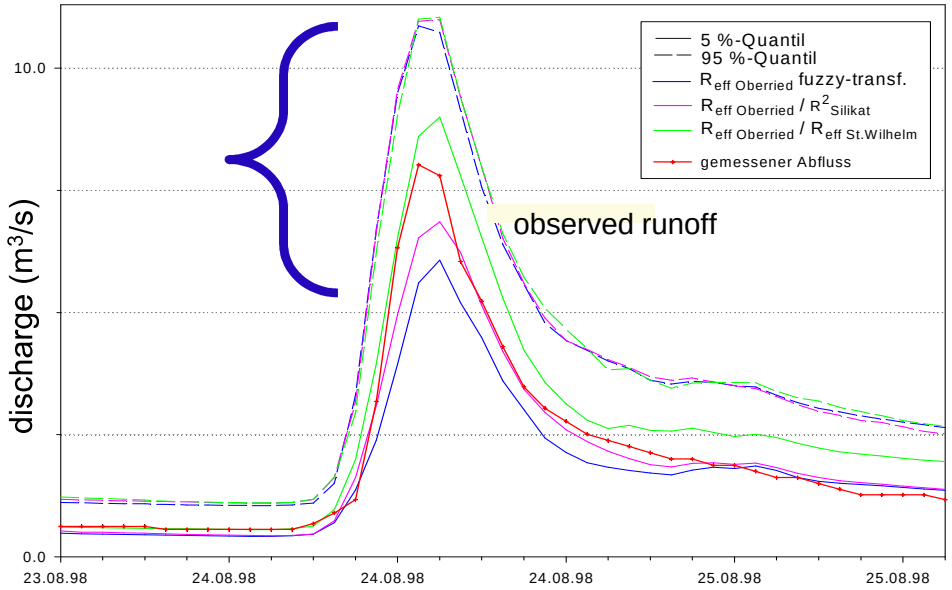
- input data
- calibration data
- model parameters
- model structure



(Di Baldassarre & Claps, 2010; Hydr. Res.)

Uncertain predictions:

- Design floods
- forecasting
- inundated areas
- Risk maps/risk assessment
- Etc.



(Uhlenbrook and Sieber, 2005; ESM)

We begin to understand the connections, but …

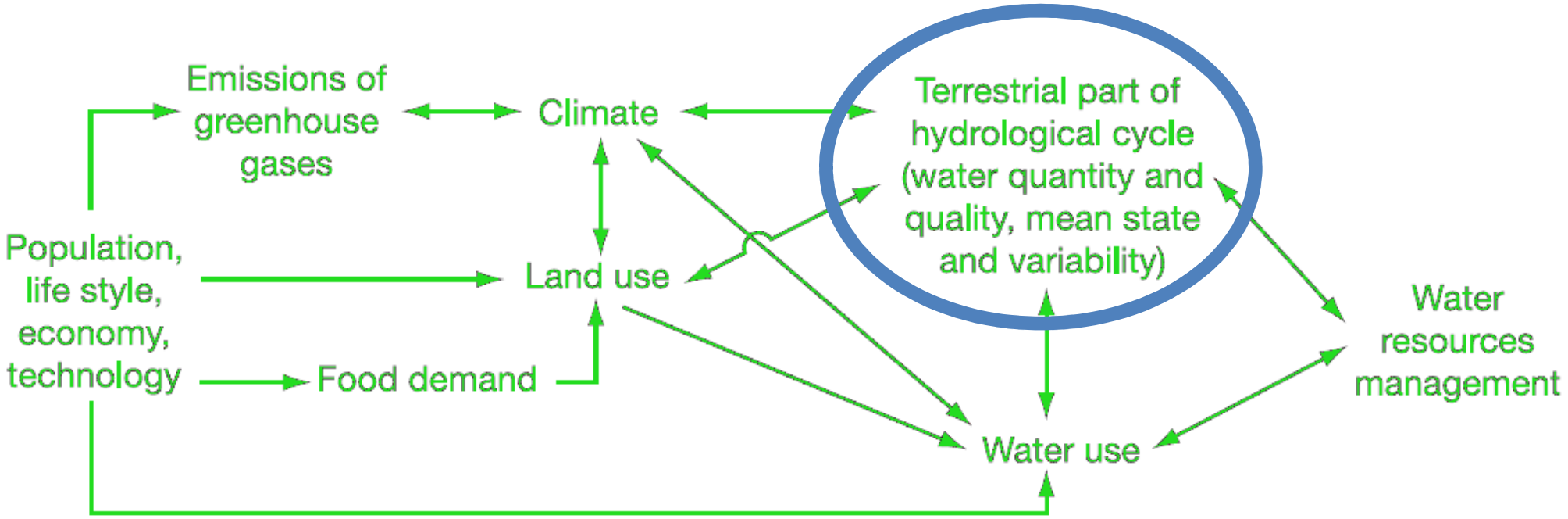
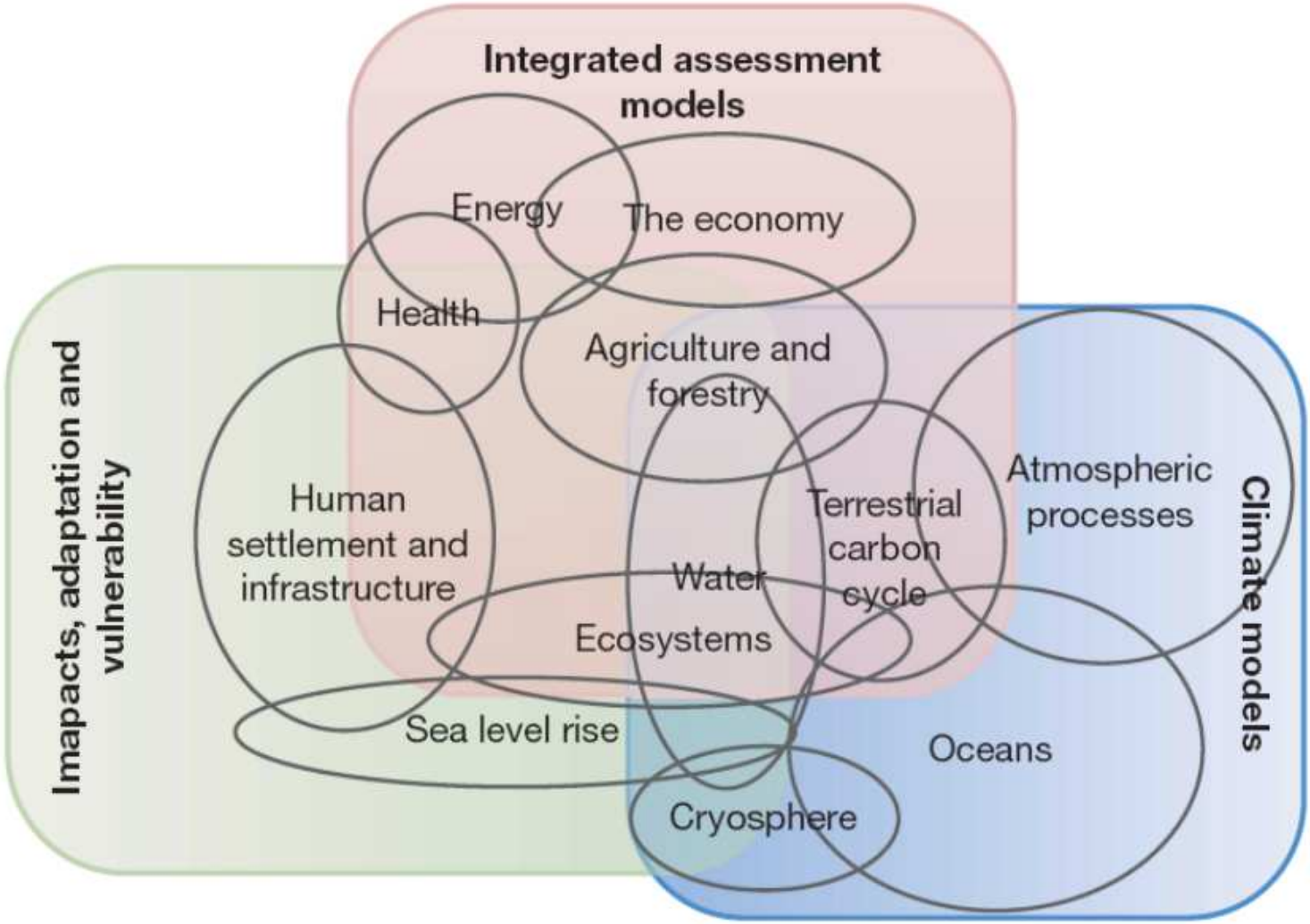


Figure 3.1. *Impact of human activities on freshwater resources and their management, with climate change being only one of multiple pressures (modified after Oki, 2005).*

Source: Kundzewicz et al. (2007); chapter in IPCC (2007)

Towards integrated models, but still along way to integrated management …



Moss et al. Nature 2010

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4. Overall: is there a need for more research on the nexus?

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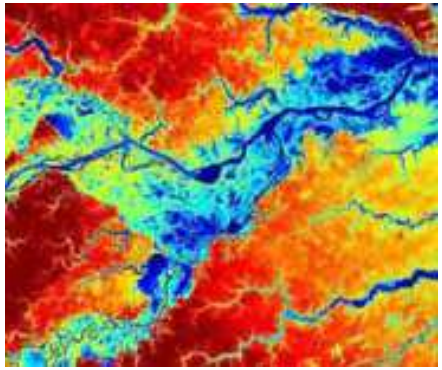
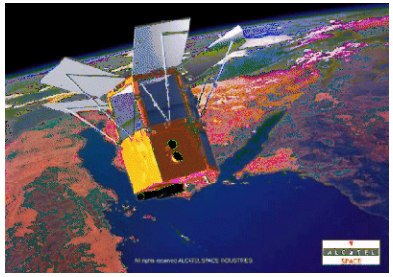
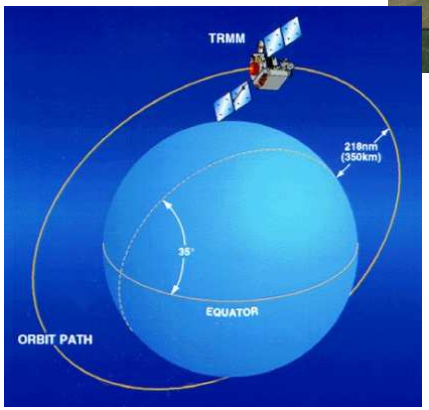
But, isn't there a '*flood of data*' ?

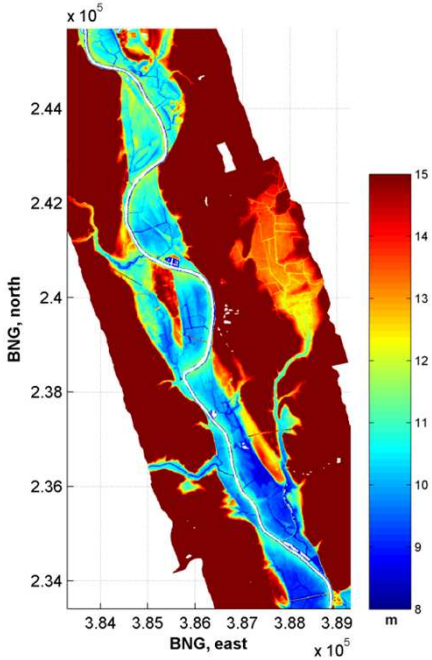
Globally and freely available space-borne data (e.g. SRTM, ENVISAT, SAR images etc.)

<u>Space-borne data</u>







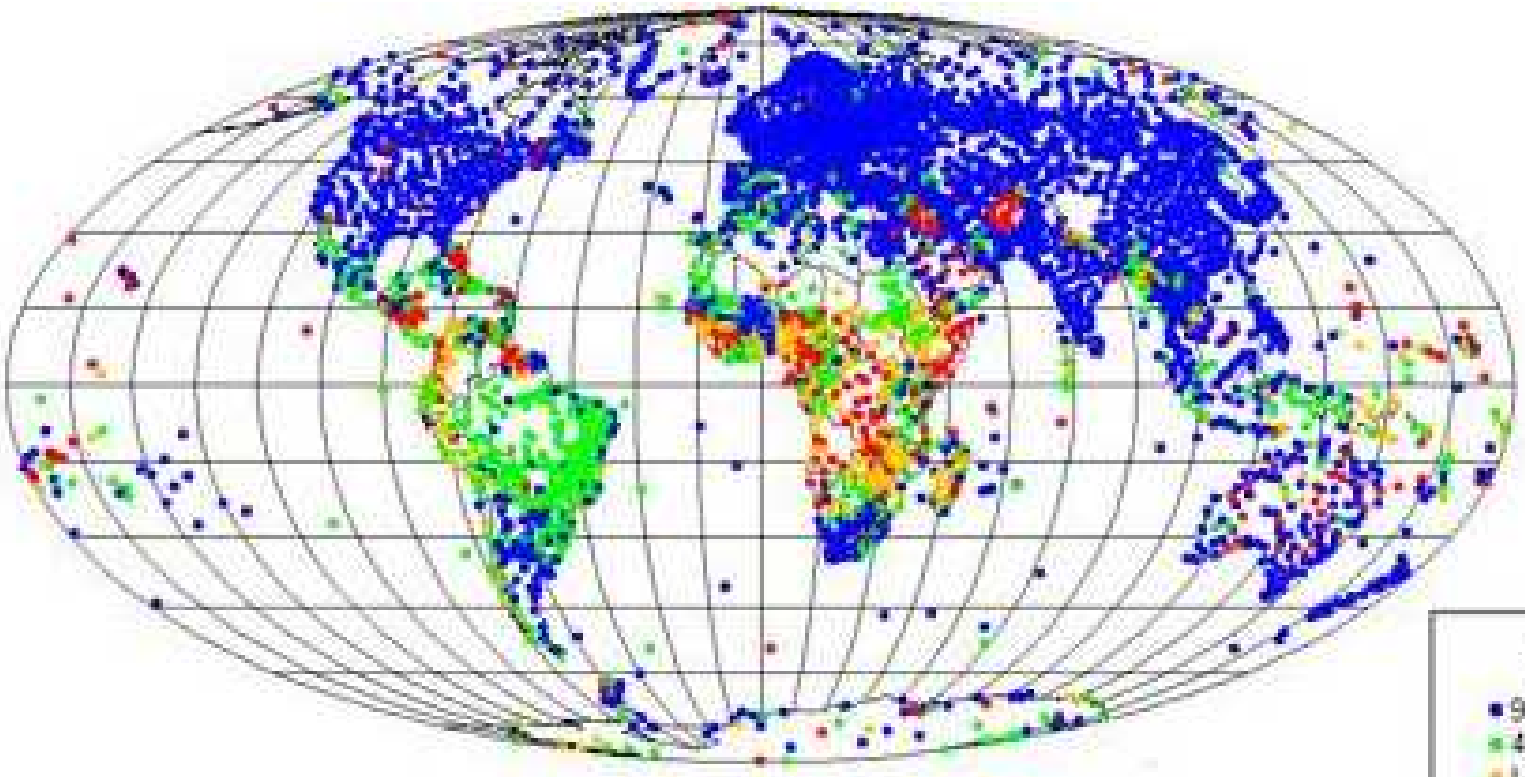


<u>Airborne laser altimetry</u> (LiDAR):
High resolution topography (1m DTM; 10 cm accuracy)

<u>Model output:</u> GCMs, regional models etc.

(Castellarin & Di Baldassarre, 2009)

WMO Stations



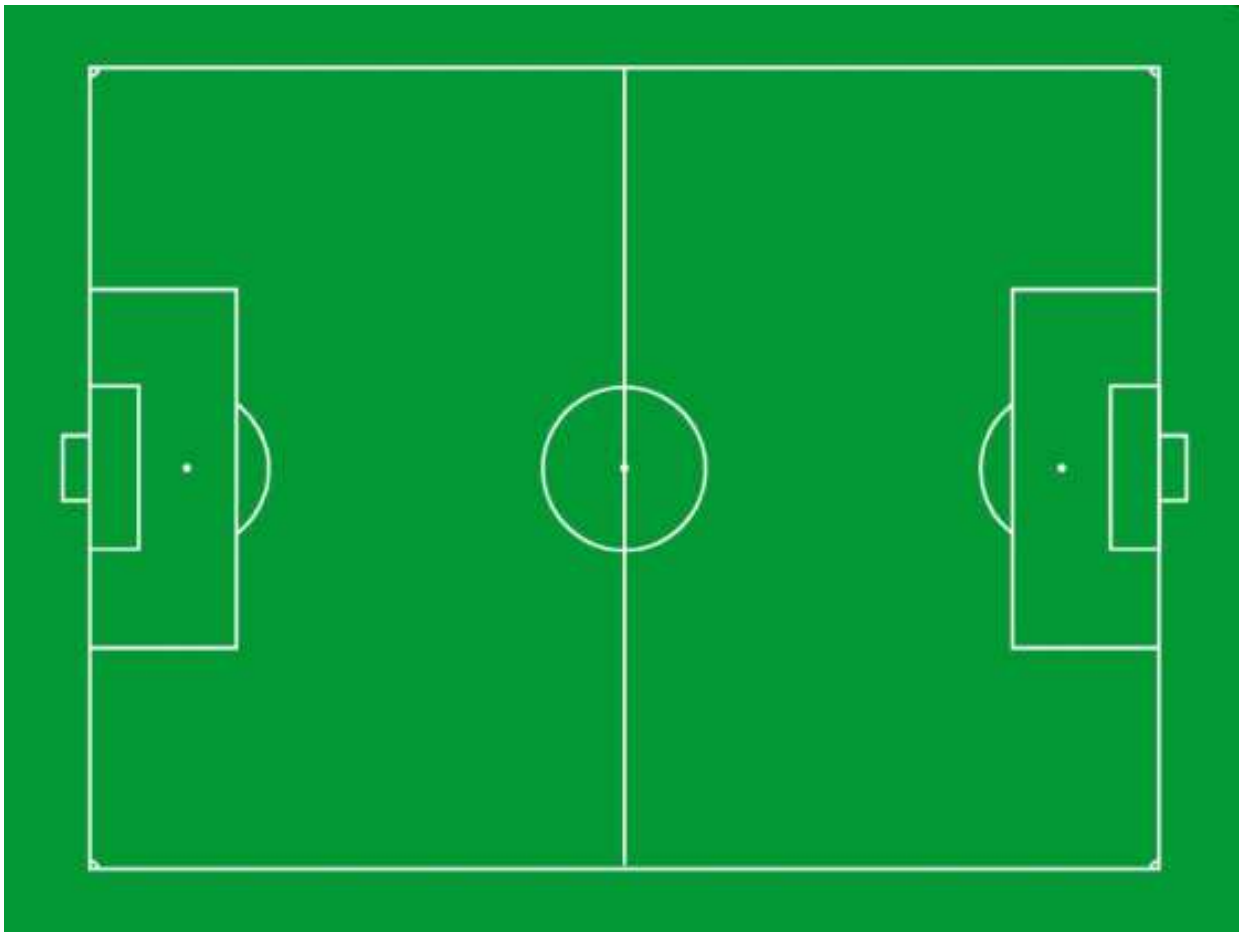
Percentage of reports received
- 90 to 100 per cent (2912 stations)
- 45 to 90 per cent (697 stations)
- Less than 45 per cent (325 stations)
- Silent stations (350 stations)

WMO Secretariat

(courtesy Van der Giesen and Hut, 2013)

WMO Stations

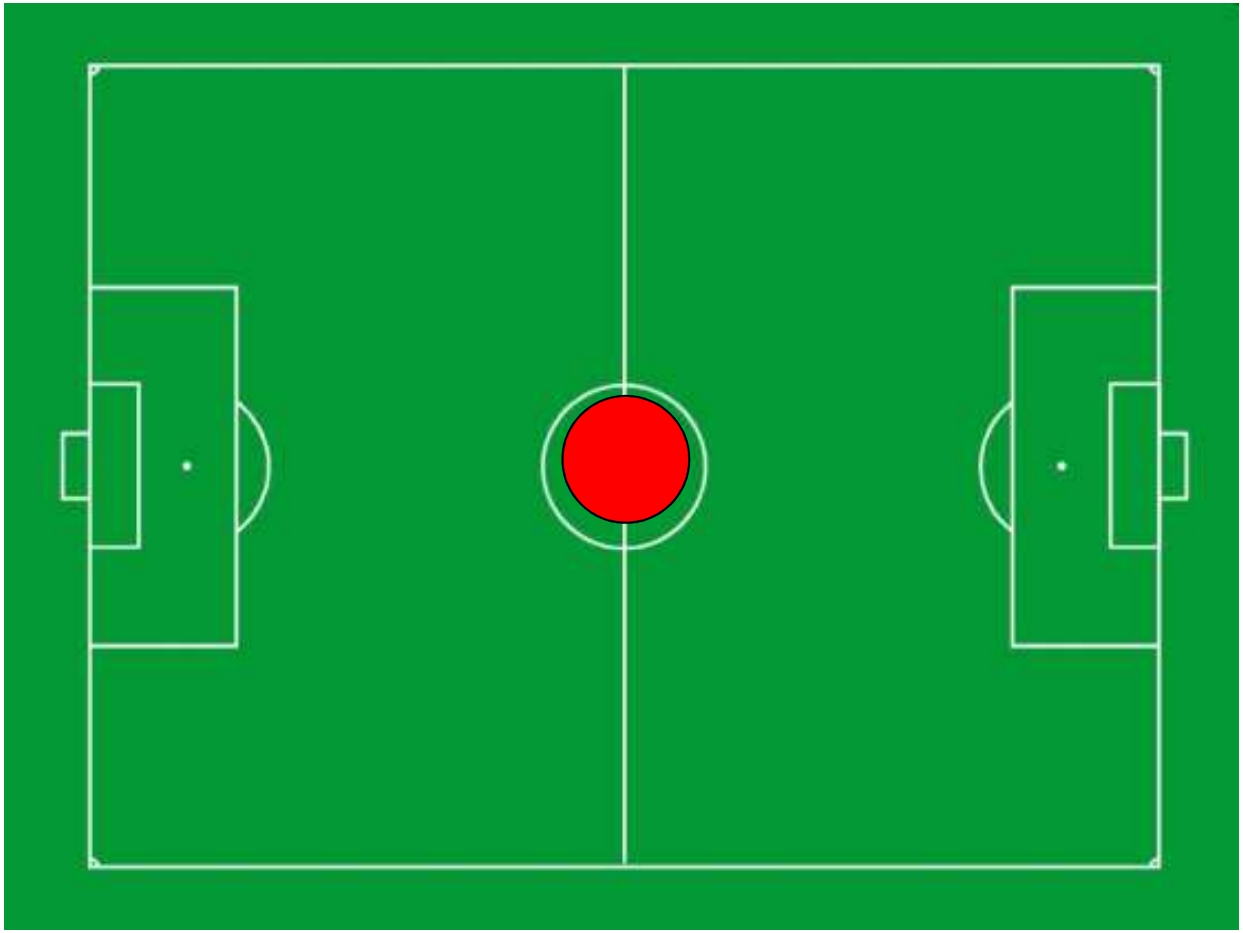
5,000



(courtesy Van der Giesen and Hut, 2013)

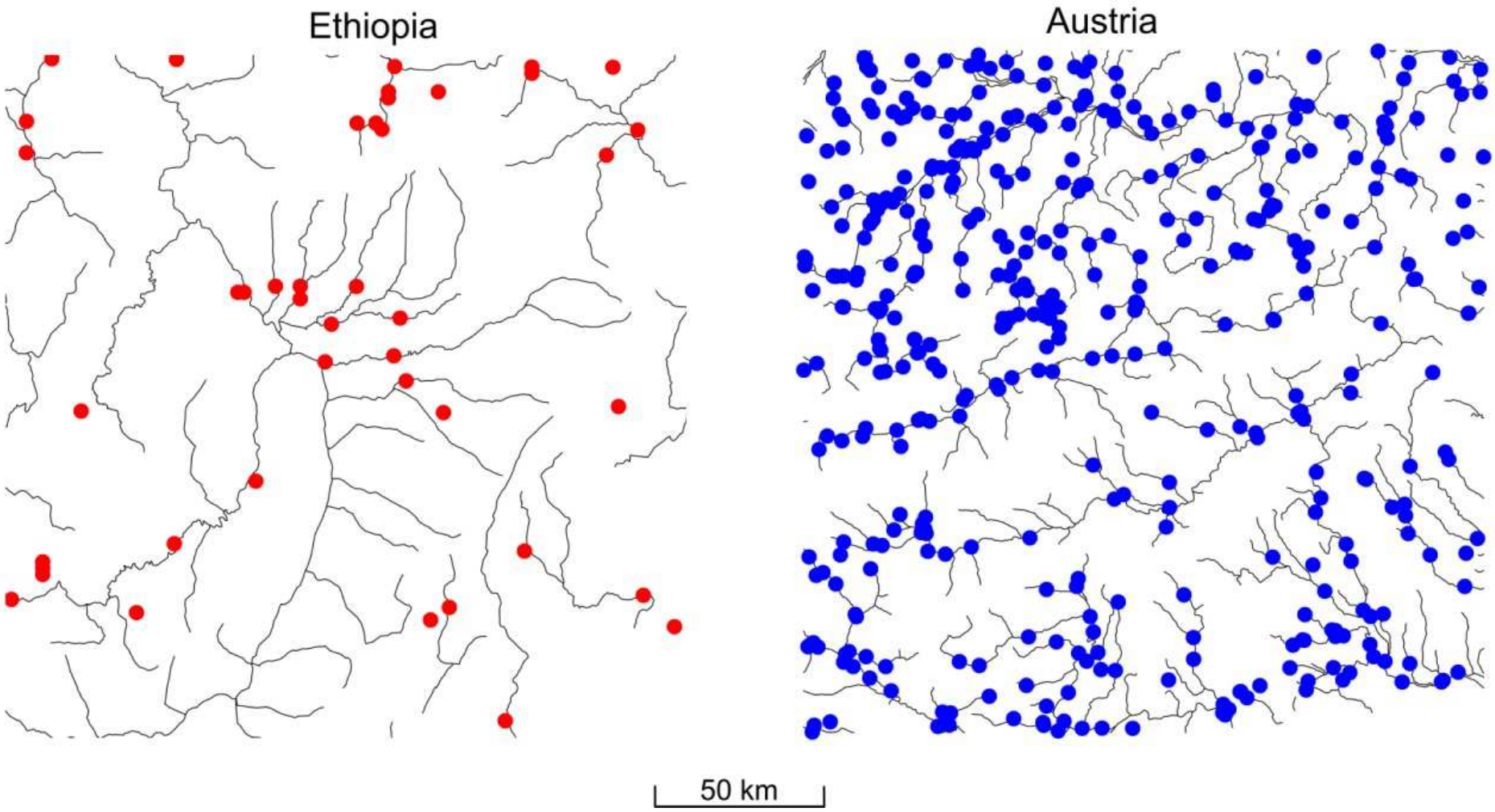
WMO Stations

5,000



(courtesy Van der Giesen and Hut, 2013)

Density of gauging station network – 'ground truthing'?!



(Bloeschl et al. 2013)

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-> of course!