Climate change impact on water resources: a summary of recent findings

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WAT: 4th Workshop on Water and Adaptation to Climate Change in Transboundary Basins, 14 October 2014, United Nations, Geneva, Switzerland

Climate change threats on water supply

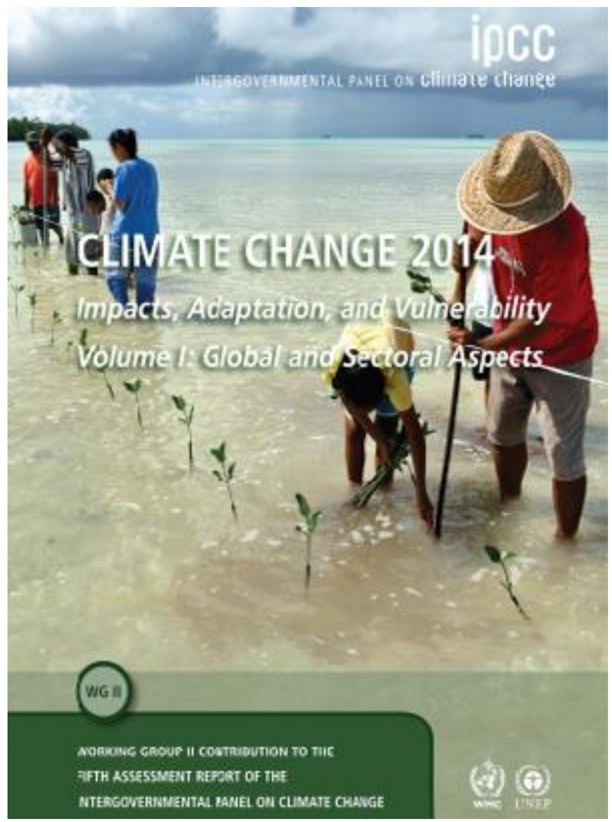
- Change in precipitations
- Glaciers retreats
- Coastal acquifers and SLR
- Change in extremes (disaster risk)
- Change in landcover

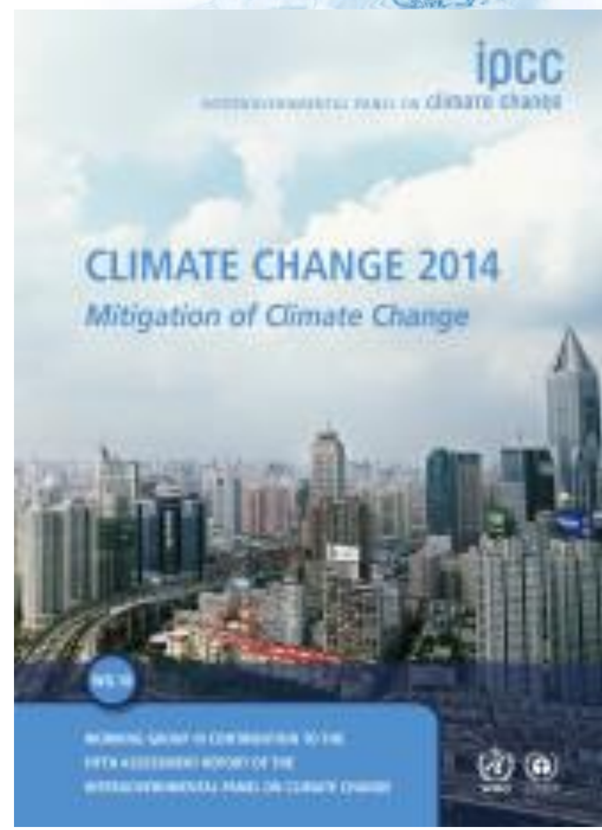
Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5)

WG I

WG II

WG III



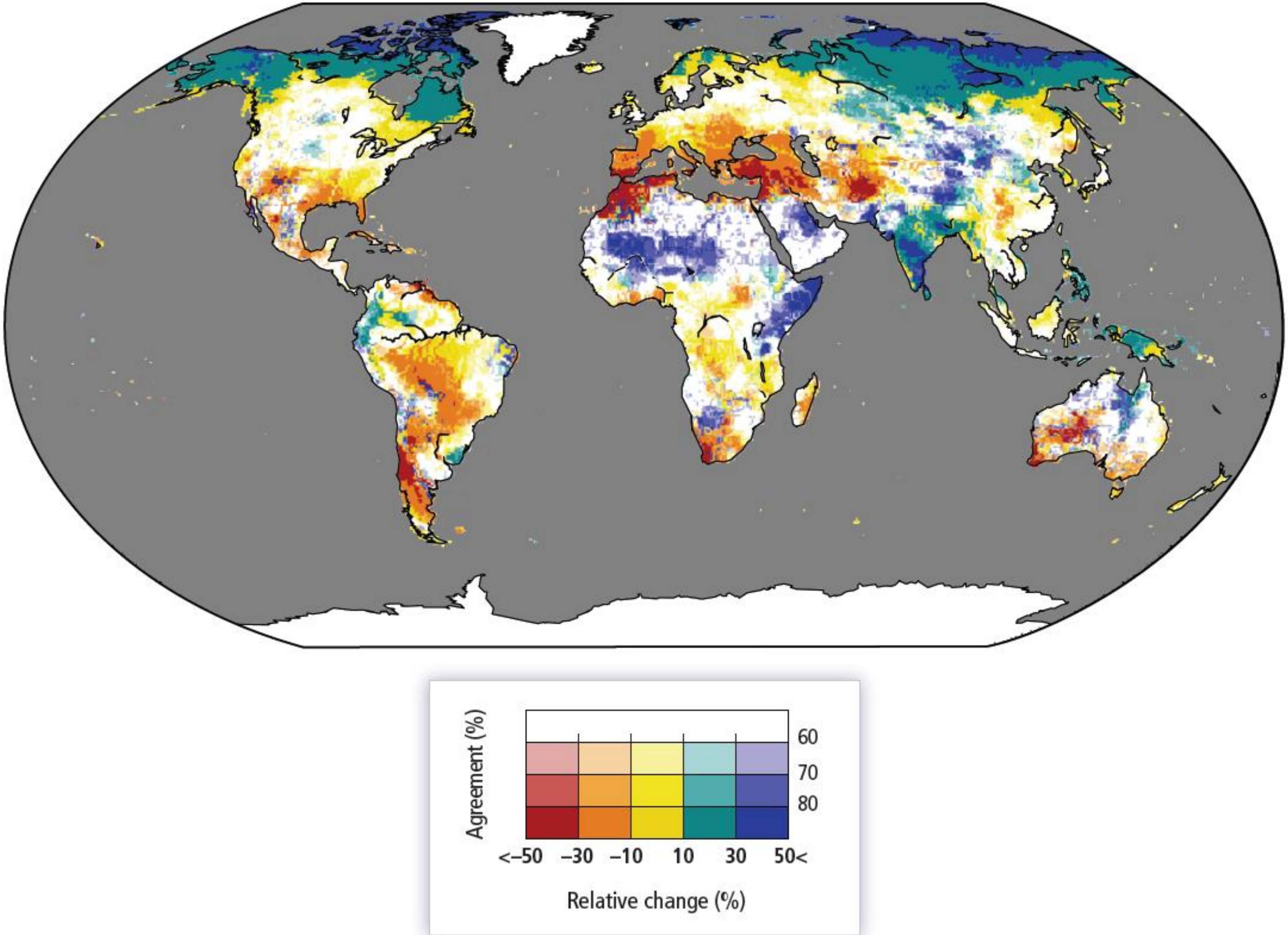


Changes in precipitations

UNEP

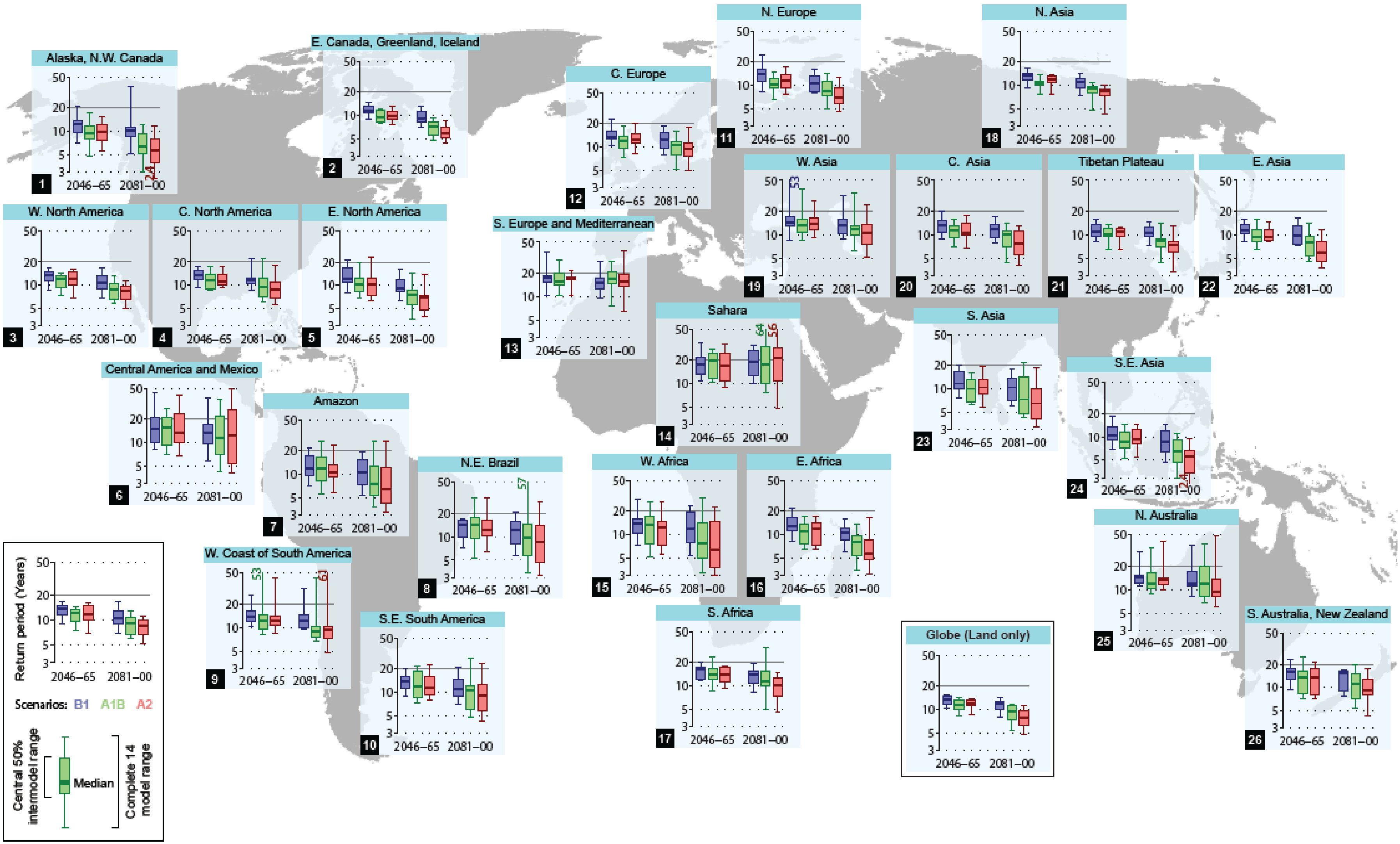
- **Freshwater-related risks of climate change increase significantly with increasing greenhouse gas concentrations (robust evidence, high agreement).**
- **Climate change over the 21st century is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions (robust evidence, high agreement)**
- **In contrast, water resources are projected to increase at high latitudes (robust evidence, high agreement).**
- **Climate change is projected to reduce raw water quality and pose risks to drinking water quality even with conventional treatment, due to interacting factors.**

Increased temperature; increased sediment, nutrient, and pollutant loadings from heavy rainfall; increased concentration of pollutants during droughts; and disruption of treatment facilities during floods (medium evidence, high agreement).



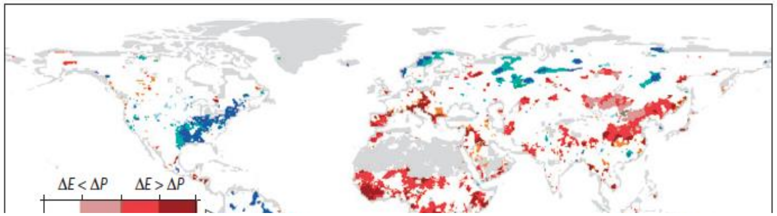
Percentage change of mean annual streamflow for a global mean temperature rise of 2° C above 1980–2010 (2.7° C above pre-industrial). Color hues show the multi-model mean change and saturation shows the agreement on the sign of change (Jiménez *et al*. 2014).

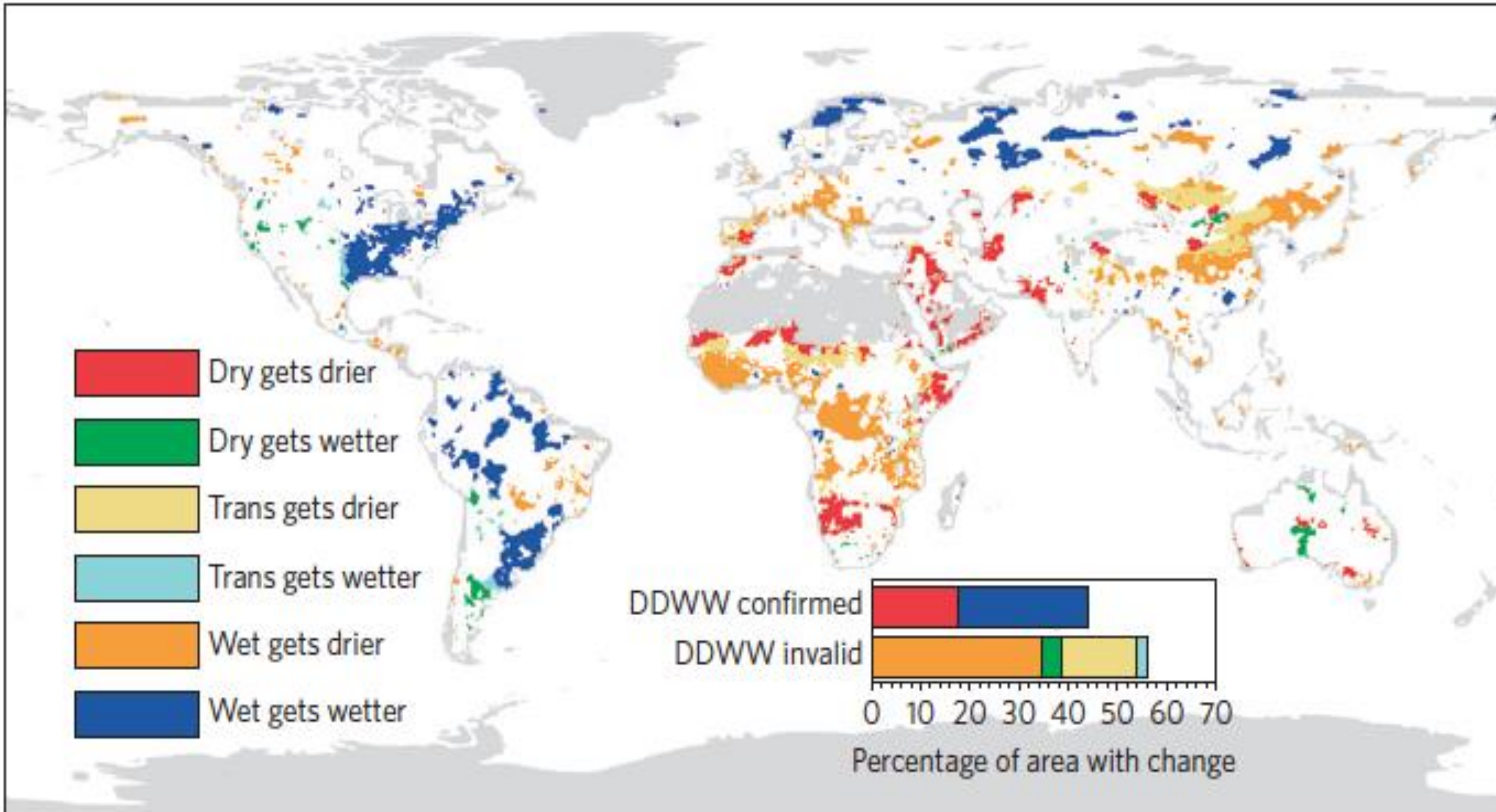
The frequency of heavy precipitation or the proportion of total rainfall from intense events will likely increase over many areas of the globe.



Projected return period (in years) of late 20th-century 20-year return values of annual maximum 24-hour precipitation rates. [Source: Seneviratne et al. (2012), based on Kharin et al. (2007).]

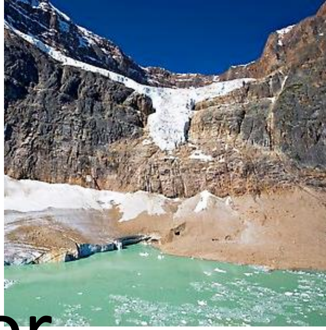
Robust assessment of changes in drought over land (comparison of 1948-1968 and





Glacier retreat

UNEP



Glacier retreat

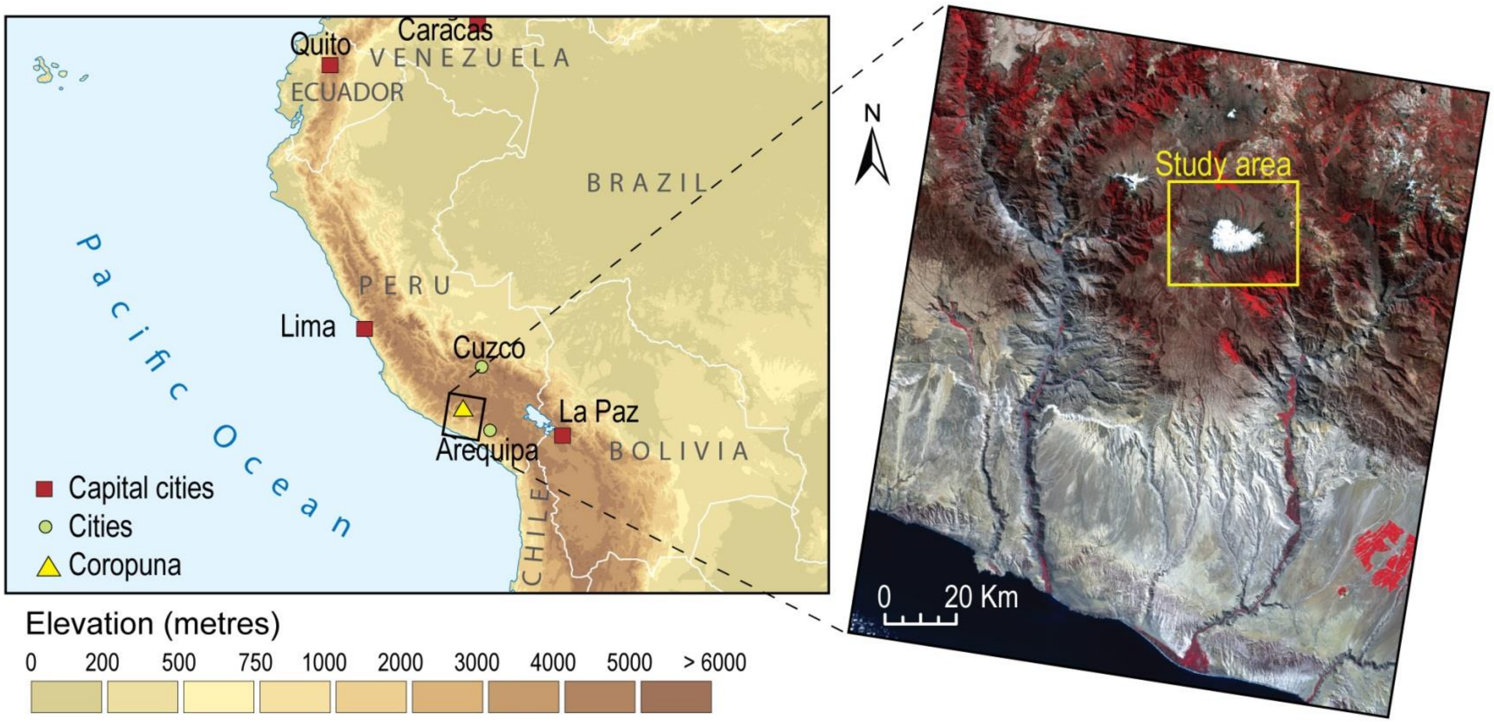
- In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality (medium confidence).
- Glaciers continue to shrink almost worldwide due to climate change (high confidence), affecting runoff and water resources downstream (medium confidence).

IPCC, WG AR5, 2014

Glaciers

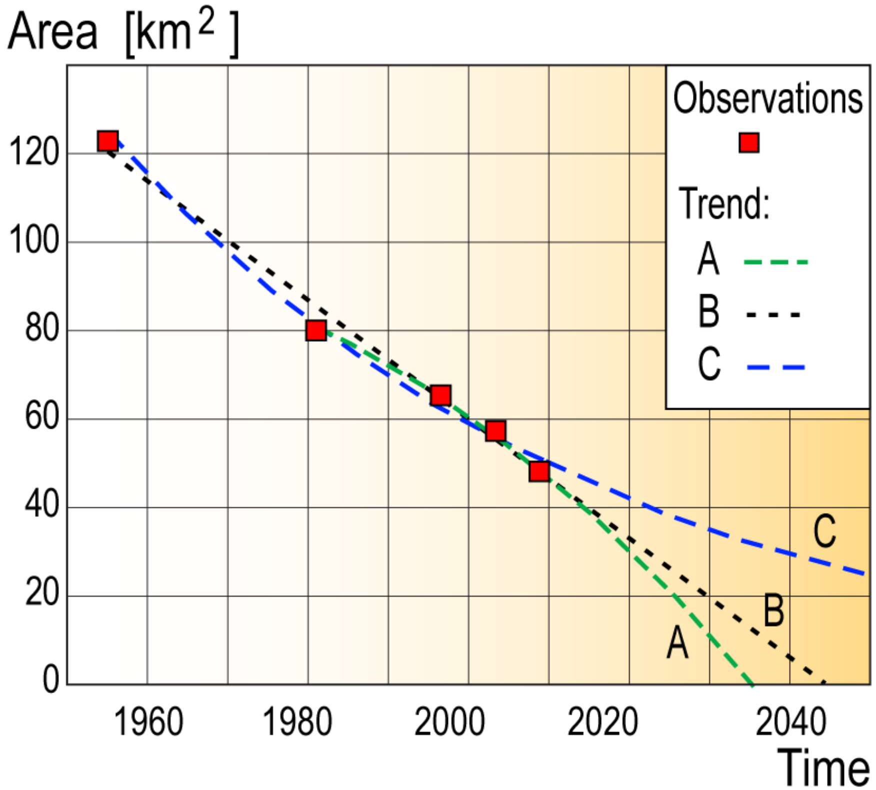
Coropuna Glacier retreat

The Case of Coropuna (Peru)



Peduzzi, P., Herold, C., Silverio, W., Assessing high altitude glacier thickness, volume and area changes using field, GIS and remote sensing techniques: the case of Nevado Coropuna (Peru), *The Cryosphere*, **4**, 313-323, 2010
http://www.the-cryosphere.net/4/313/2010/tc-4-313-2010.html

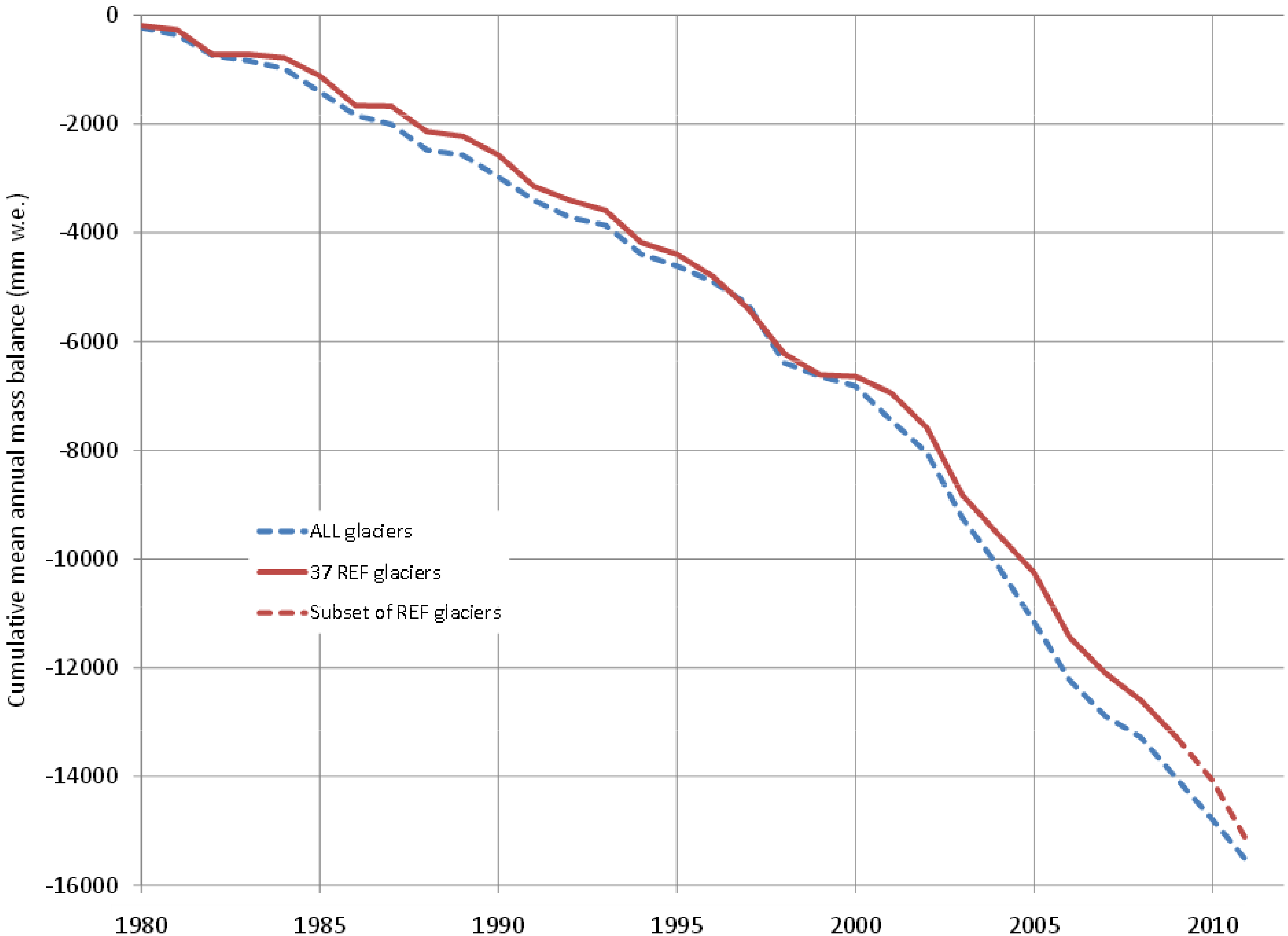
Trend and potential future scenarios



Peduzzi, P., Herold, C., Silverio, W., Assessing high altitude glacier thickness, volume and area changes using field, GIS and remote sensing techniques: the case of Nevado Coropuna (Peru), *The Cryosphere*, **4**, 313-323, 2010
http://www.the-cryosphere.net/4/313/2010/tc-4-313-2010.html

Glaciers Mean cumulative mass balance

all reported glaciers (blue line) and the reference glaciers (red line)

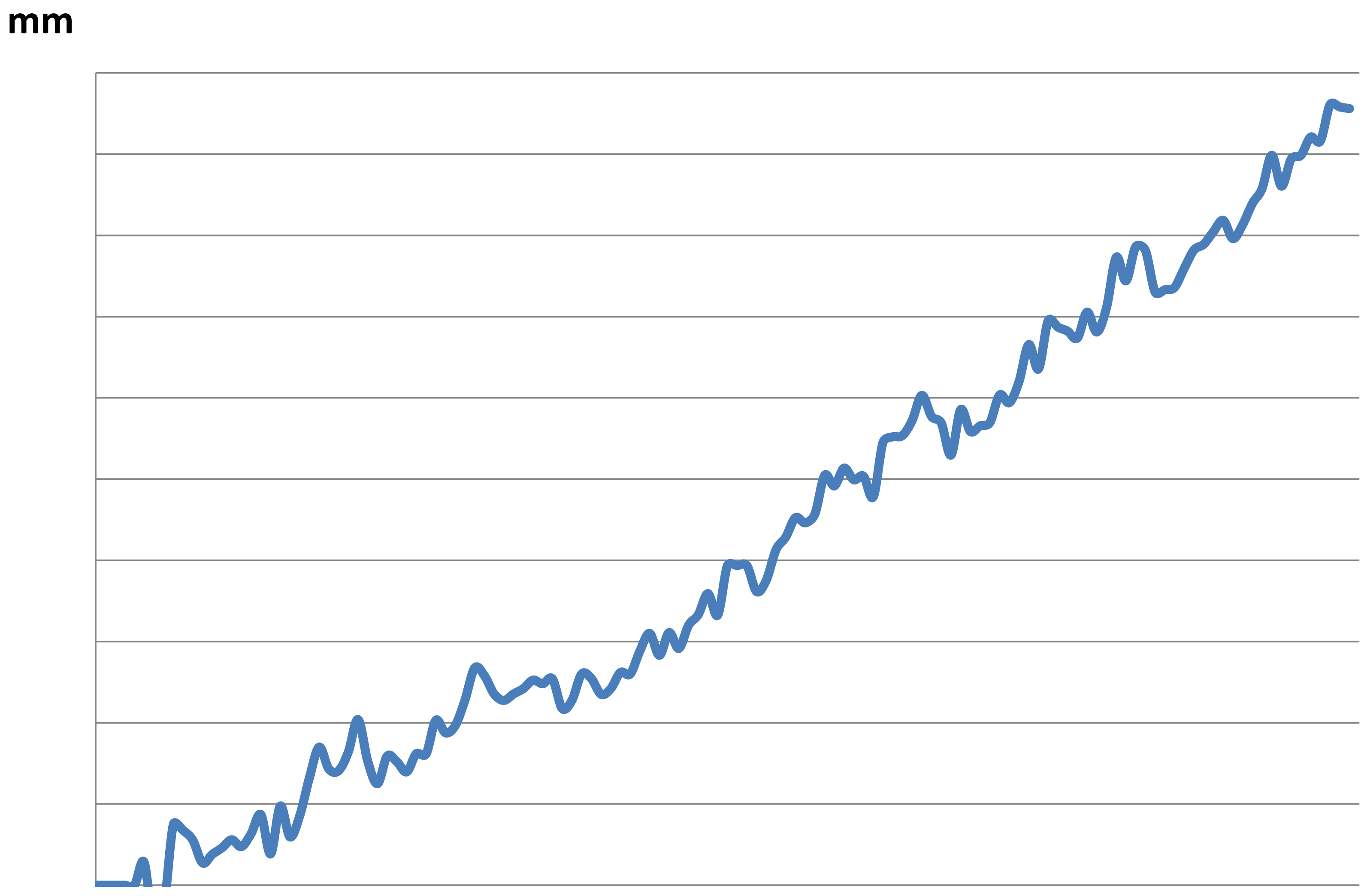


Sources: WGMS

http://www.wgms.ch/mbb/mbb12/Fig2_2011.pdf

Coastal aquifers and Sea level rise

Global Sea Level Rise



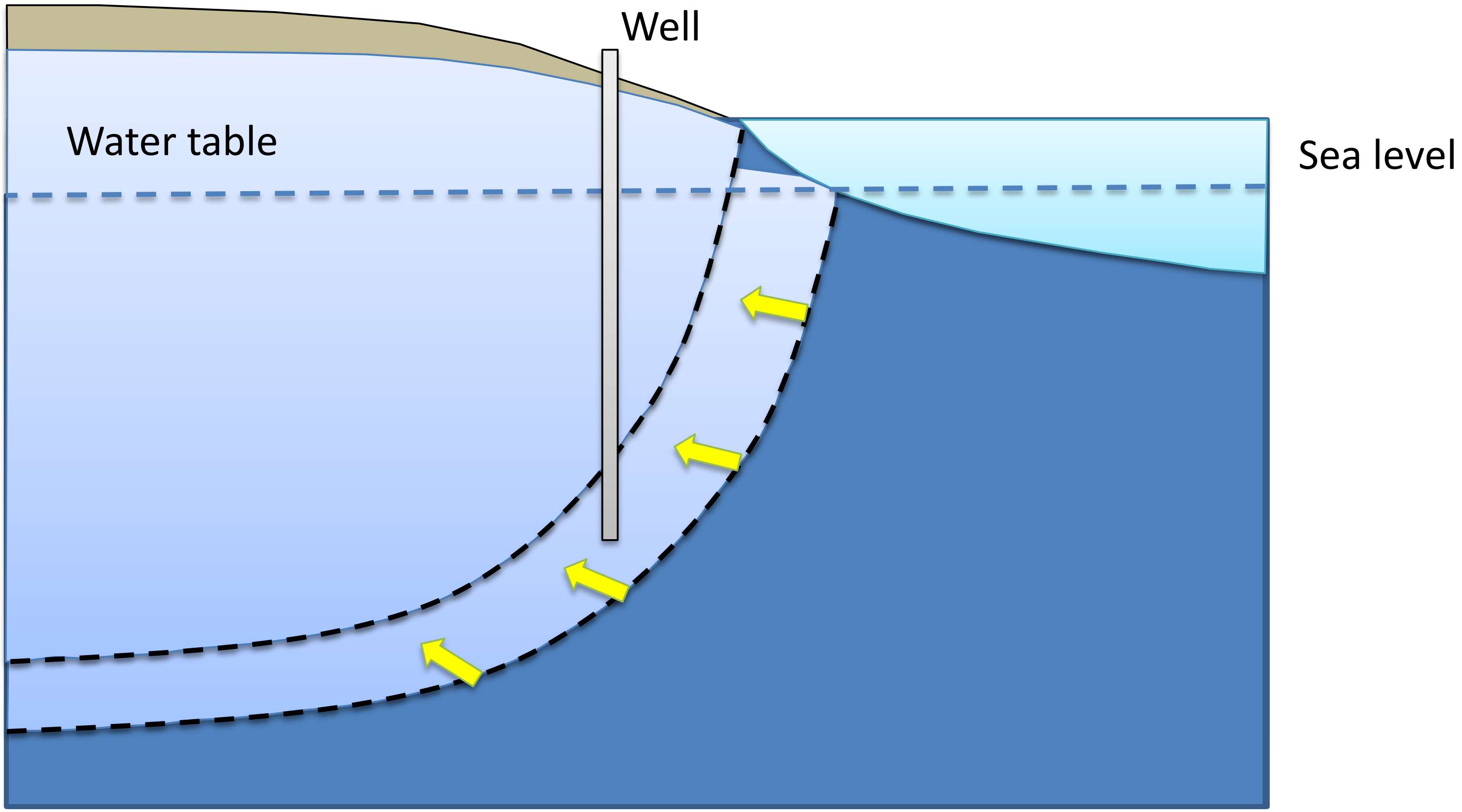
Data sources: CSIRO

Sea Level Rise (0.26 – 0.82 m)

Table SPM.2 | Projected change in global mean surface air temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986–2005. {12.4; Table 12.2, Table 13.5}

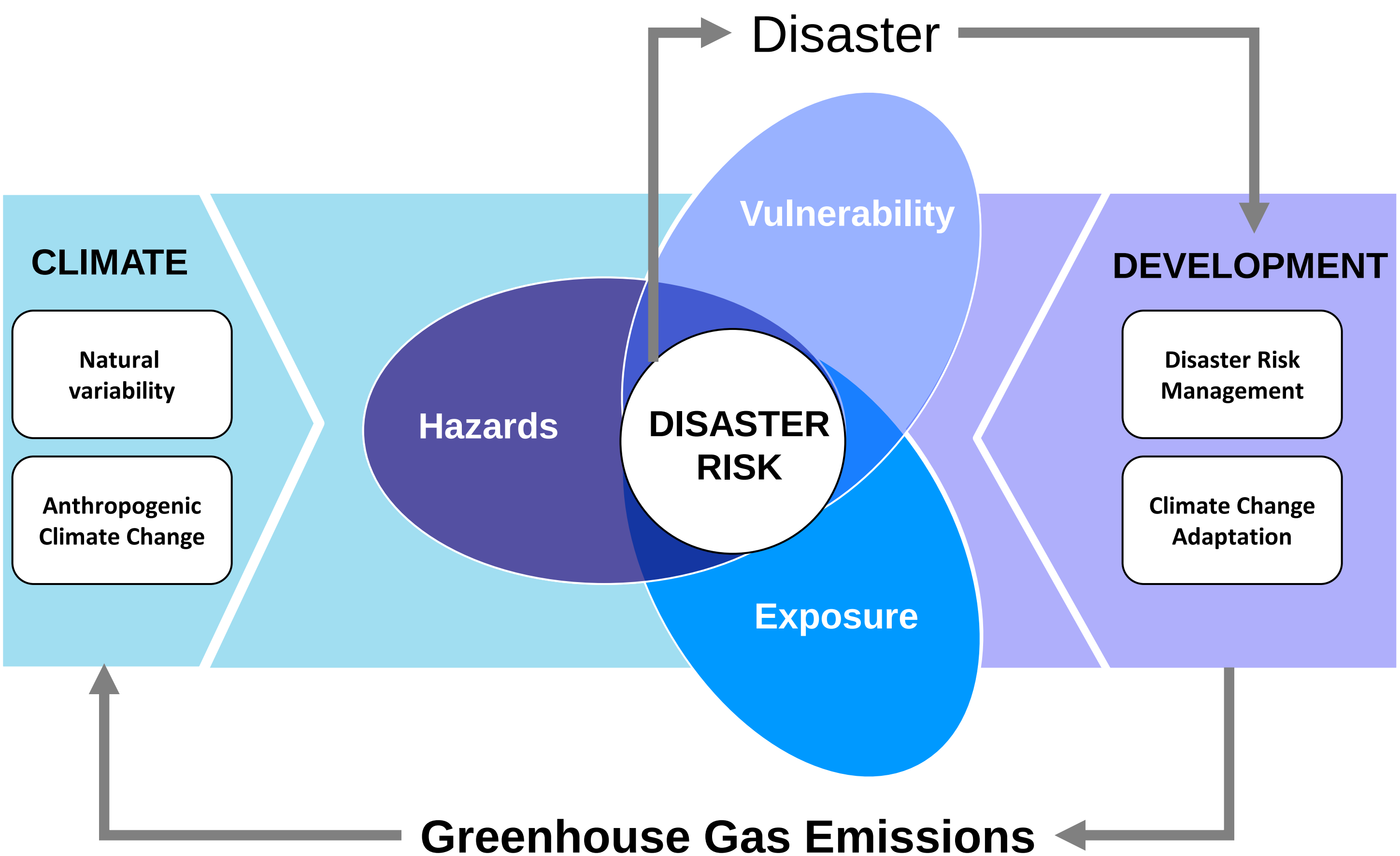
		2046–2065		2081–2100	
	Scenario	**Mean**	***Likely* range[c]**	**Mean**	***Likely* range[c]**
Global Mean Surface Temperature Change (°C)[a]	RCP2.6	1.0	0.4 to 1.6	1.0	0.3 to 1.7
	RCP4.5	1.4	0.9 to 2.0	1.8	1.1 to 2.6
	RCP6.0	1.3	0.8 to 1.8	2.2	1.4 to 3.1
	RCP8.5	2.0	1.4 to 2.6	3.7	2.6 to 4.8
	Scenario	**Mean**	***Likely* range[d]**	**Mean**	***Likely* range[d]**
Global Mean Sea Level Rise (m)[b]	RCP2.6	0.24	0.17 to 0.32	0.40	0.26 to 0.55
	RCP4.5	0.26	0.19 to 0.33	0.47	0.32 to 0.63
	RCP6.0	0.25	0.18 to 0.32	0.48	0.33 to 0.63
	RCP8.5	0.30	0.22 to 0.38	0.63	0.45 to 0.82

Sea leve rise and impacts on coastal aquifers



Disaster Risk

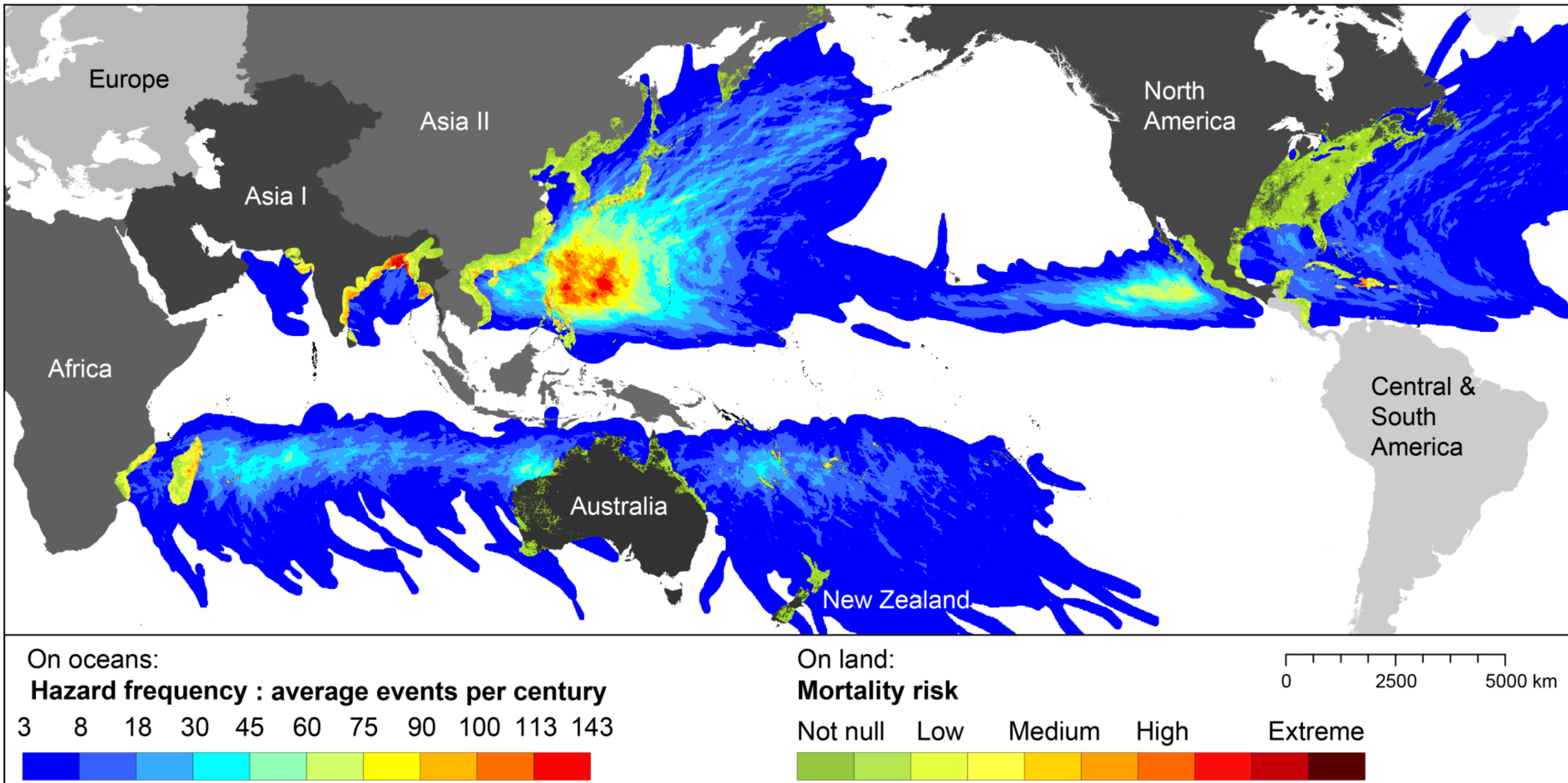
IPCC schematic description of disaster risk

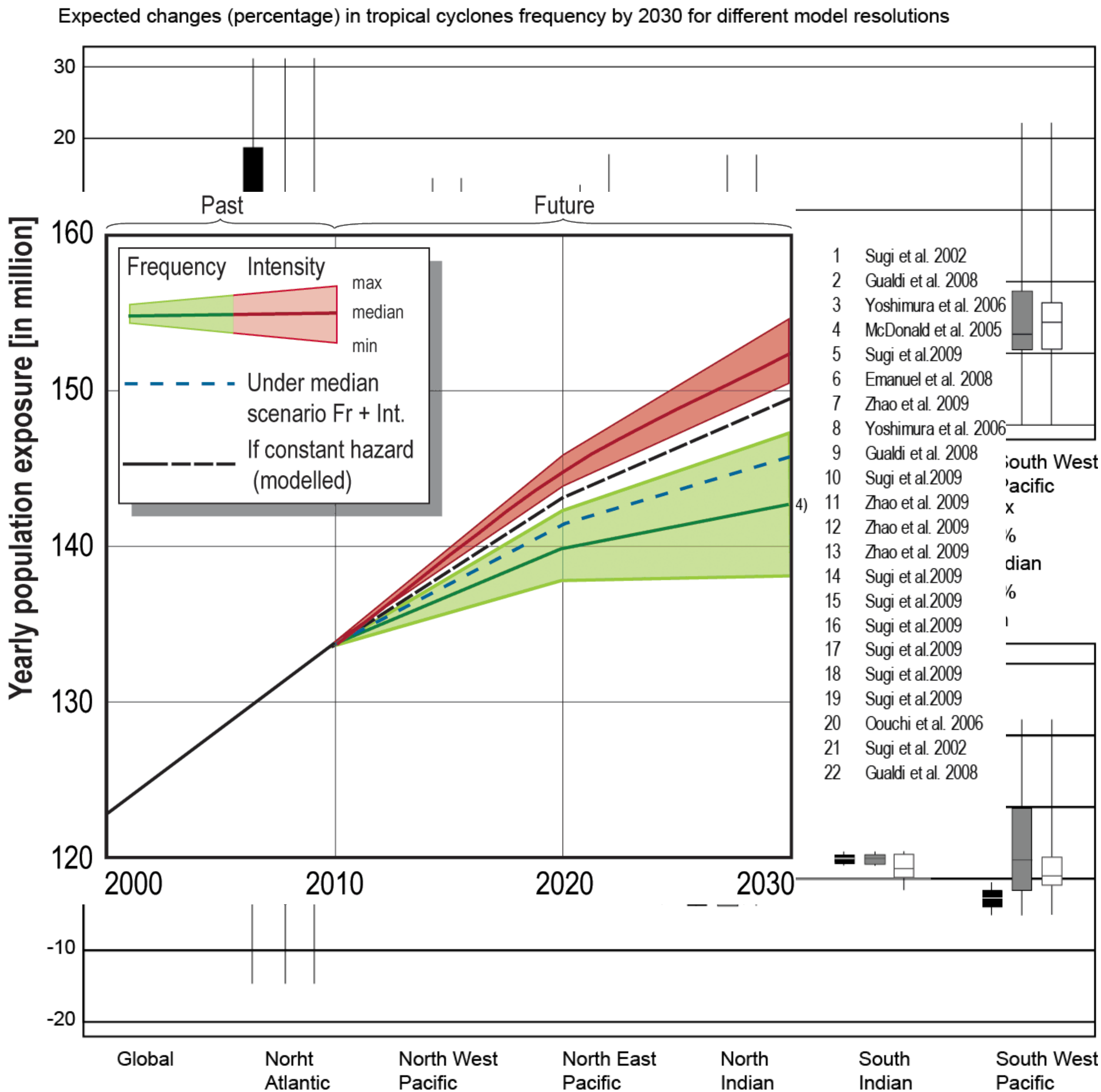


- In presently dry regions, drought frequency will likely increase by the end of the 21st century under RCP8.5 (medium confidence).

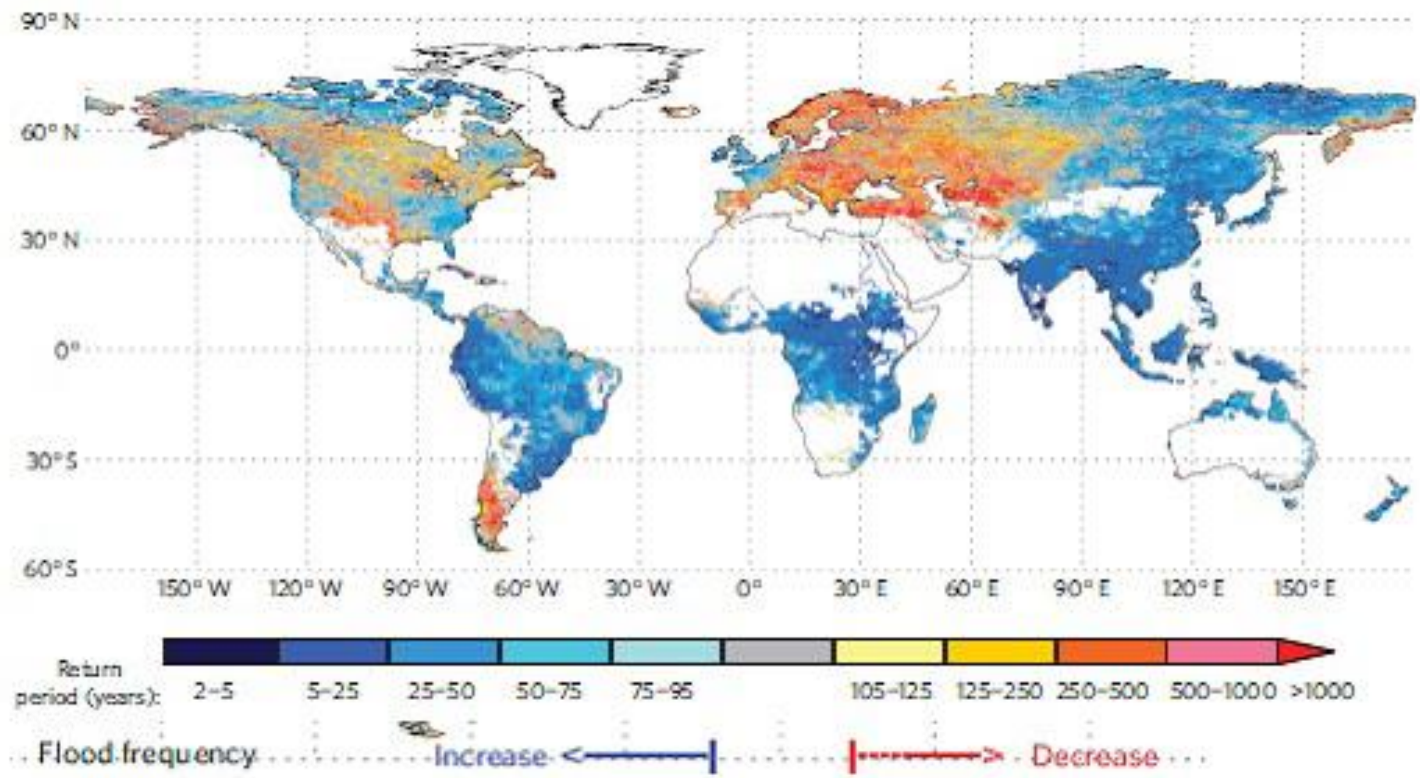
2.4 Tropical cyclones global trends

Peduzzi, P., Chatenoux, B., Dao, H., De Bono, A., Herold, C., Kossin, J., Mouton, F., Nordbeck, O., Tropical cyclones: global trends in human exposure, vulnerability and risk, *Nature Climate Change*, (in press).





Expected changes (percentage) in tropical cyclones frequency by 2030 for different model resolutions
30
20
-10
-20
Global
Norht Atlantic
North West Pacific
North East Pacific
North Indian
South Indian
South West Pacific
Past
Future
Yearly population exposure [in million]
160
150
140
130
120
2000
2010
2020
2030
Frequency
Intensity
max
median
min
Under median scenario Fr + Int.
If constant hazard (modelled)
1 Sugi et al. 2002
2 Gualdi et al. 2008
3 Yoshimura et al. 2006
4 McDonald et al. 2005
5 Sugi et al.2009
6 Emanuel et al. 2008
7 Zhao et al. 2009
8 Yoshimura et al. 2006
9 Gualdi et al. 2008
10 Sugi et al.2009
11 Zhao et al. 2009
12 Zhao et al. 2009
13 Zhao et al. 2009
14 Sugi et al.2009
15 Sugi et al.2009
16 Sugi et al.2009
17 Sugi et al.2009
18 Sugi et al.2009
19 Sugi et al.2009
20 Oouchi et al. 2006
21 Sugi et al. 2002
22 Gualdi et al. 2008

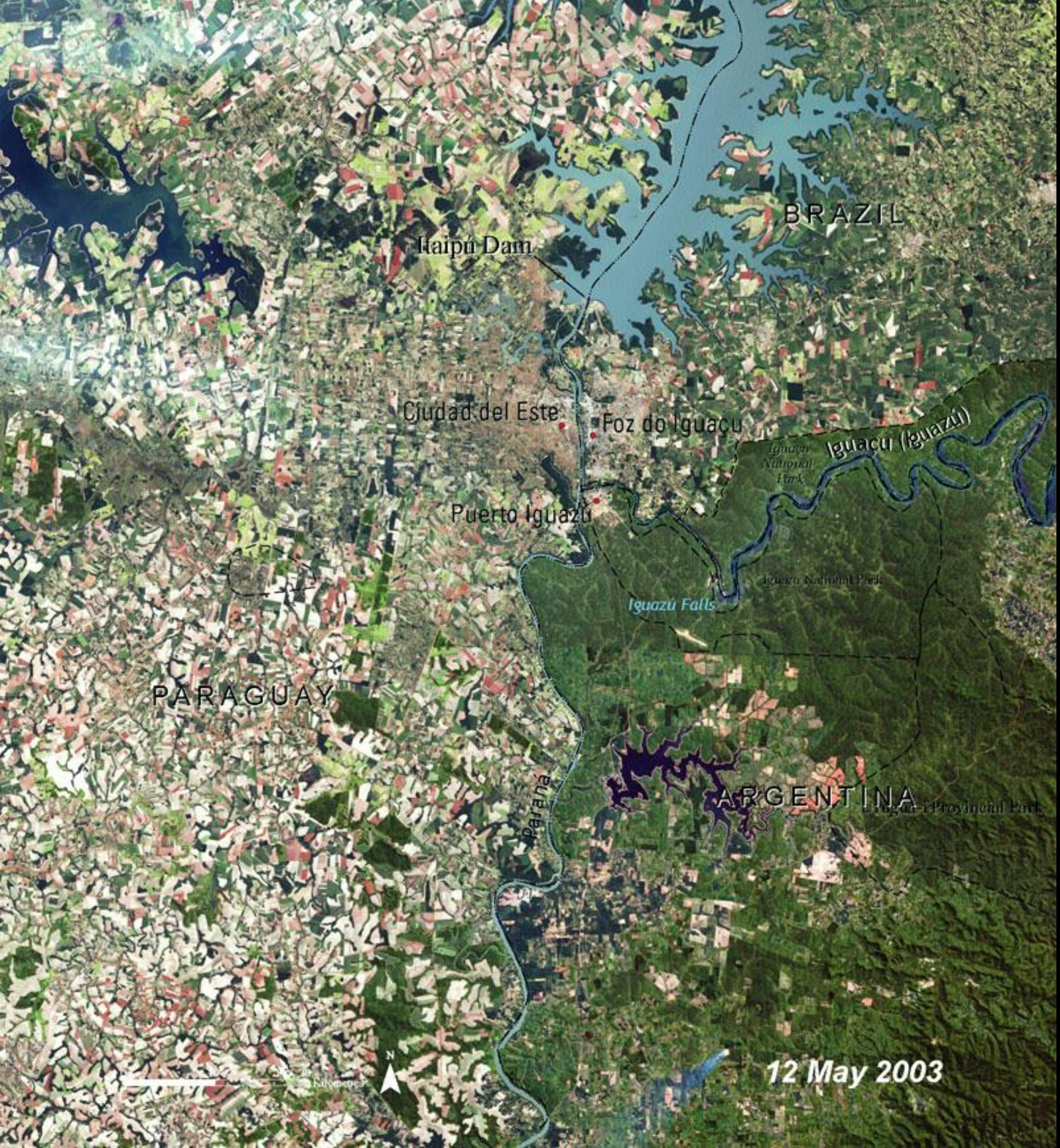


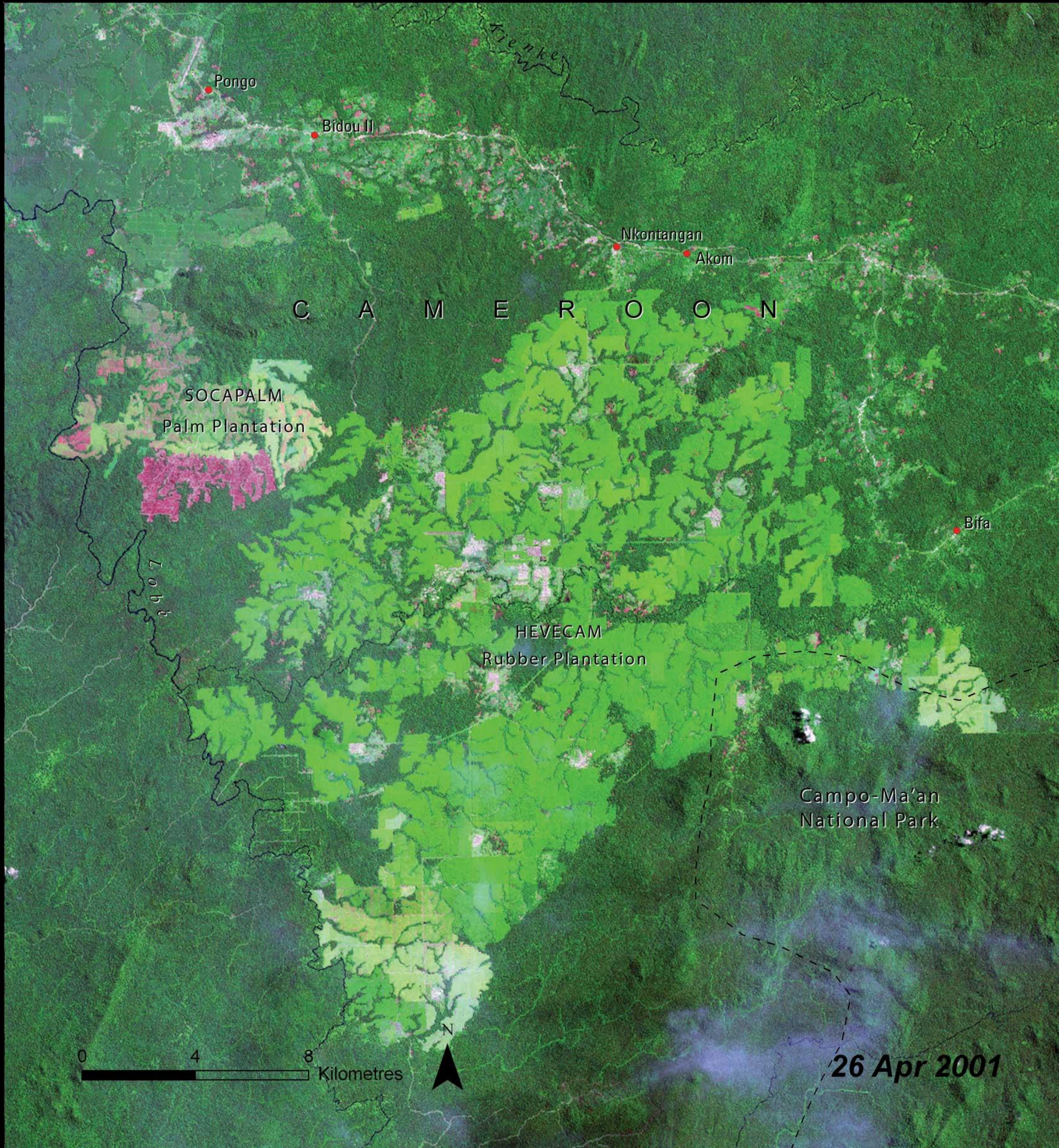
Changes in frequency of 100-year river discharge (Hirabayashi et al., 2014)

Land cover changes

Deforestation
13 million ha / year globally

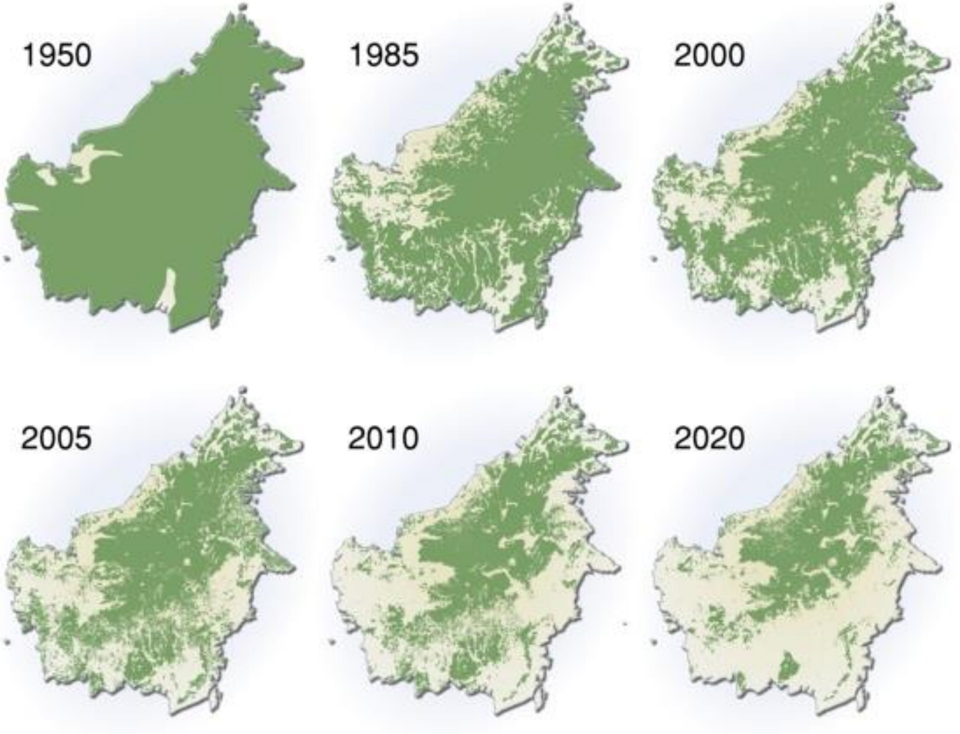
Deforestation
13 million ha / year globally





Kienke
Pongo
Bidou II
Nkontangan
Akom
C A M E R O O N
SOCAPALM
Palm Plantation
Bifa
HEVECAM
Rubber Plantation
Campo-Ma'an
National Park
0
4
8
Kilometres
N
26 Apr 2001

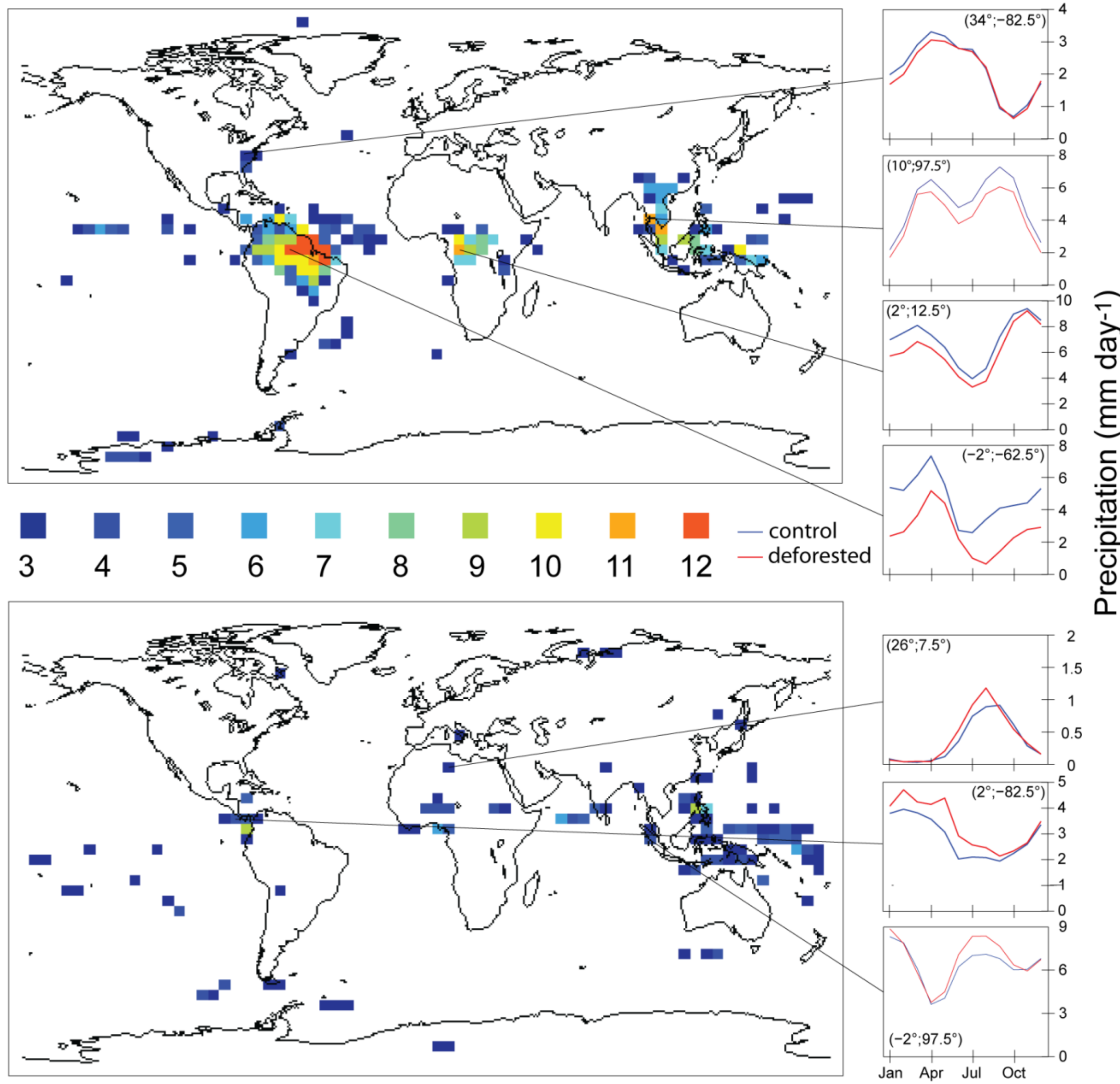
Monitoring deforestation (Bolivia)


1950
1985
2000
2005
2010
2020

Deforestation: less rain.

Most models show that deforestation will decrease precipitation in tropical areas.

(e.g Hasler N., Werth D. and Avissar R., 2009).



Pascal Peduzzi, UNEP, 2011

Forest: less biomass produced

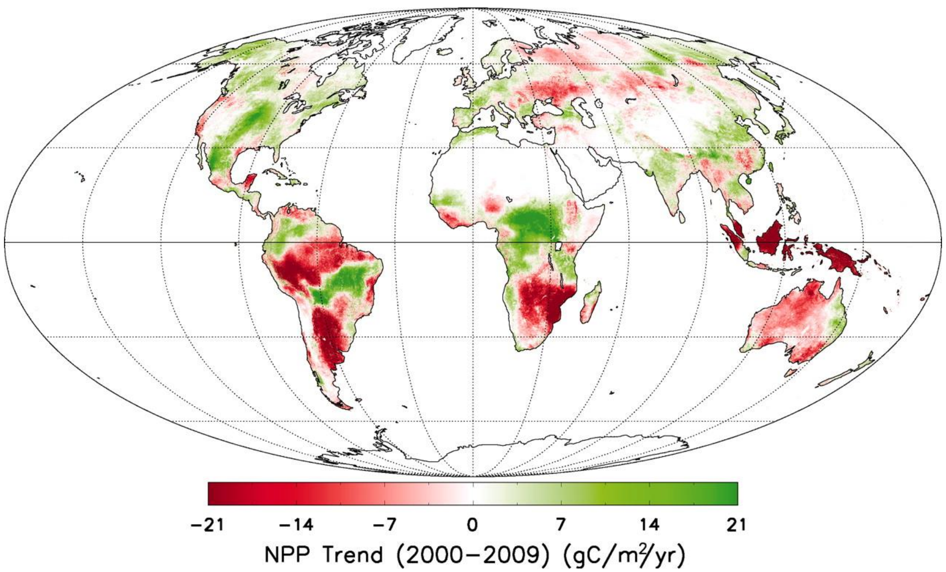


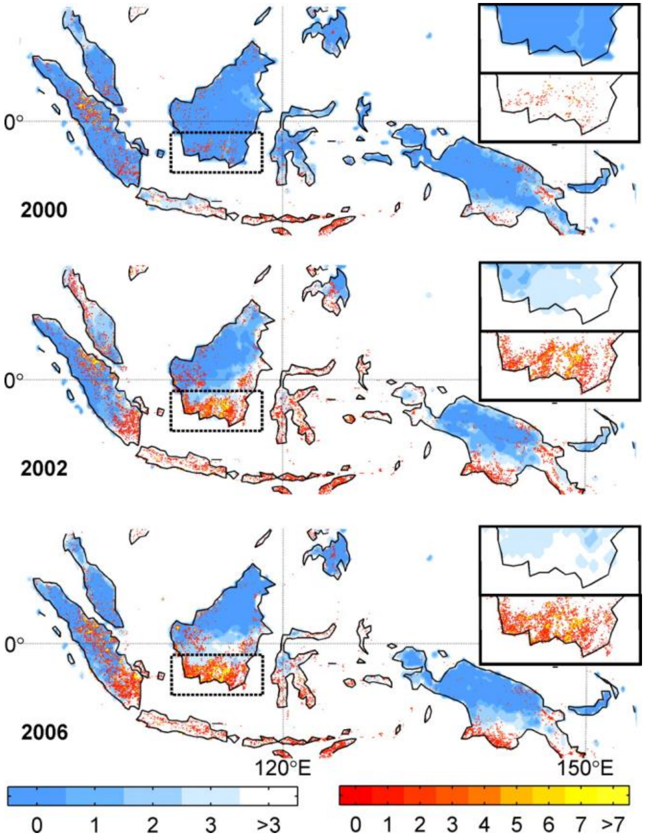
Figure 2 Spatial pattern of terrestrial NPP linear trends from 2000 through 2009
sources: with kind permission of Zhao and Running, 2010.

We thought that with more CO_2, there would be more photosynthesis, thus more biomass (Nemani et al. 2003). But it is not the case. Water might be the limitation factor (Zao & Runnin, 2010), nitrogene is another limitation.

More CO_2 was supposed to increase photosynthesis (Nemani et al., 2003). But recent measurements on the warmest decades (2000-2009) show that the creation of biomass is slower. (Zao & Running, 2010)

Photosynthesis also request H_2O, which may be the limiting factors

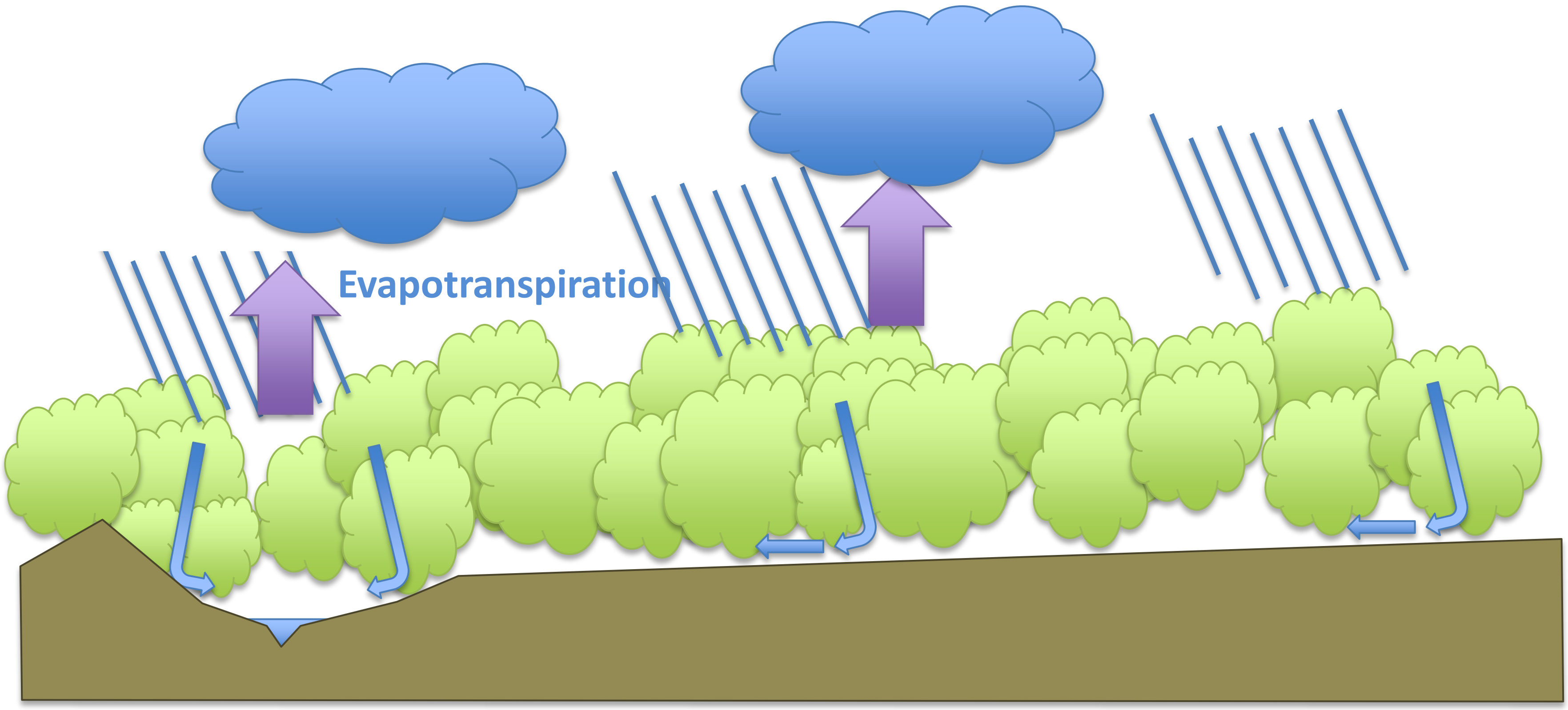
Forest: drought, more fires



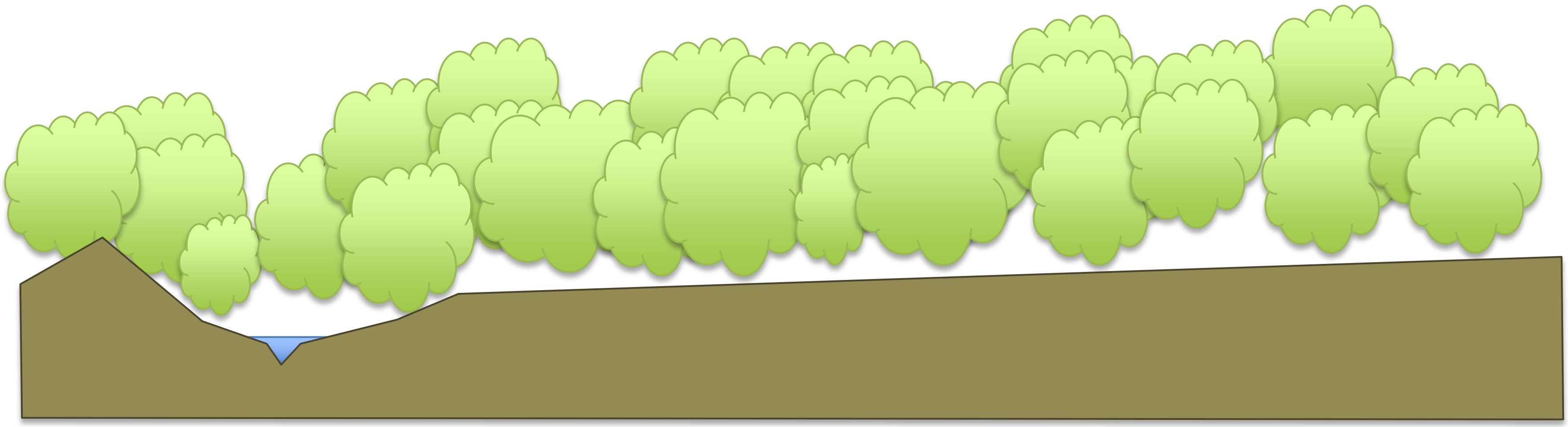
More drought, more forest fires (Van der Werf et al. 2008)

More drought more forest fires.
From Van der Werf et al., (2008), reproduced with kind permission from the authors and courtesy of National Academy of Science.

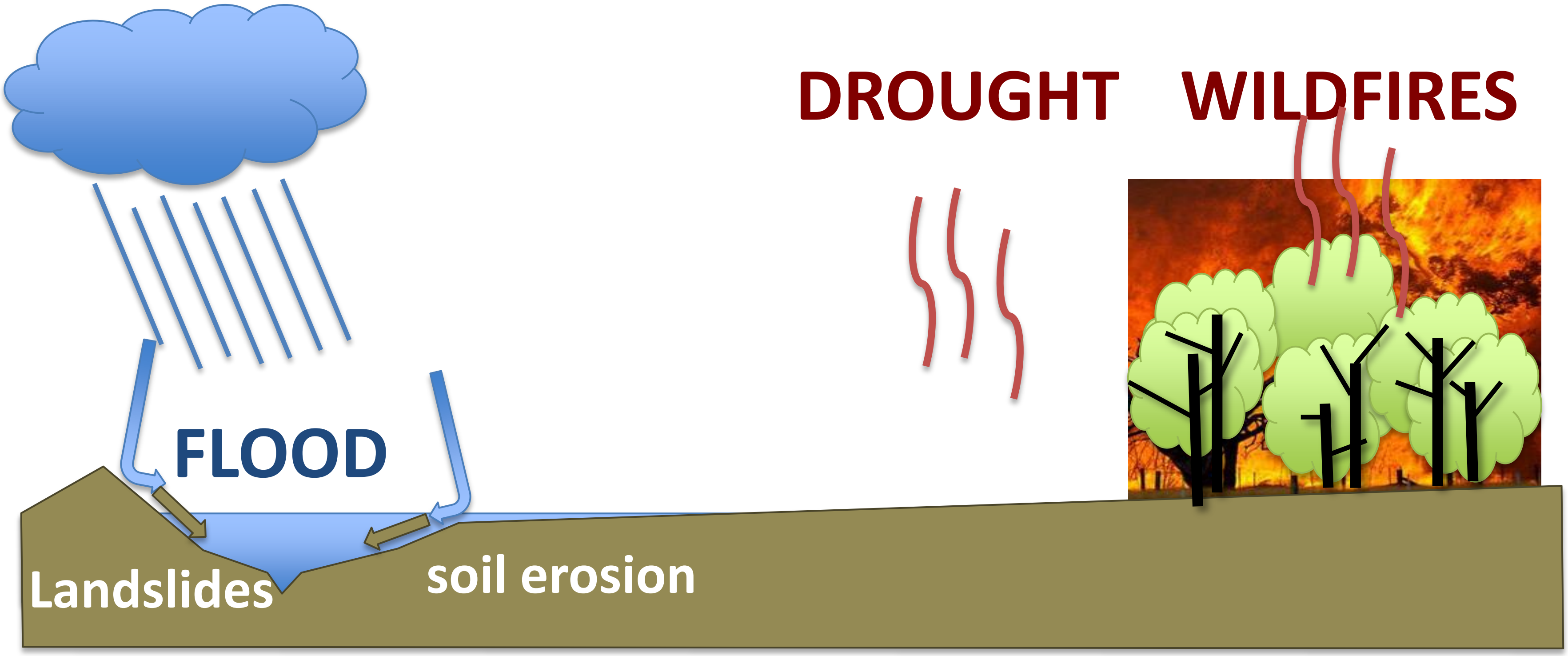
Forest helps the rain to go further inland,…



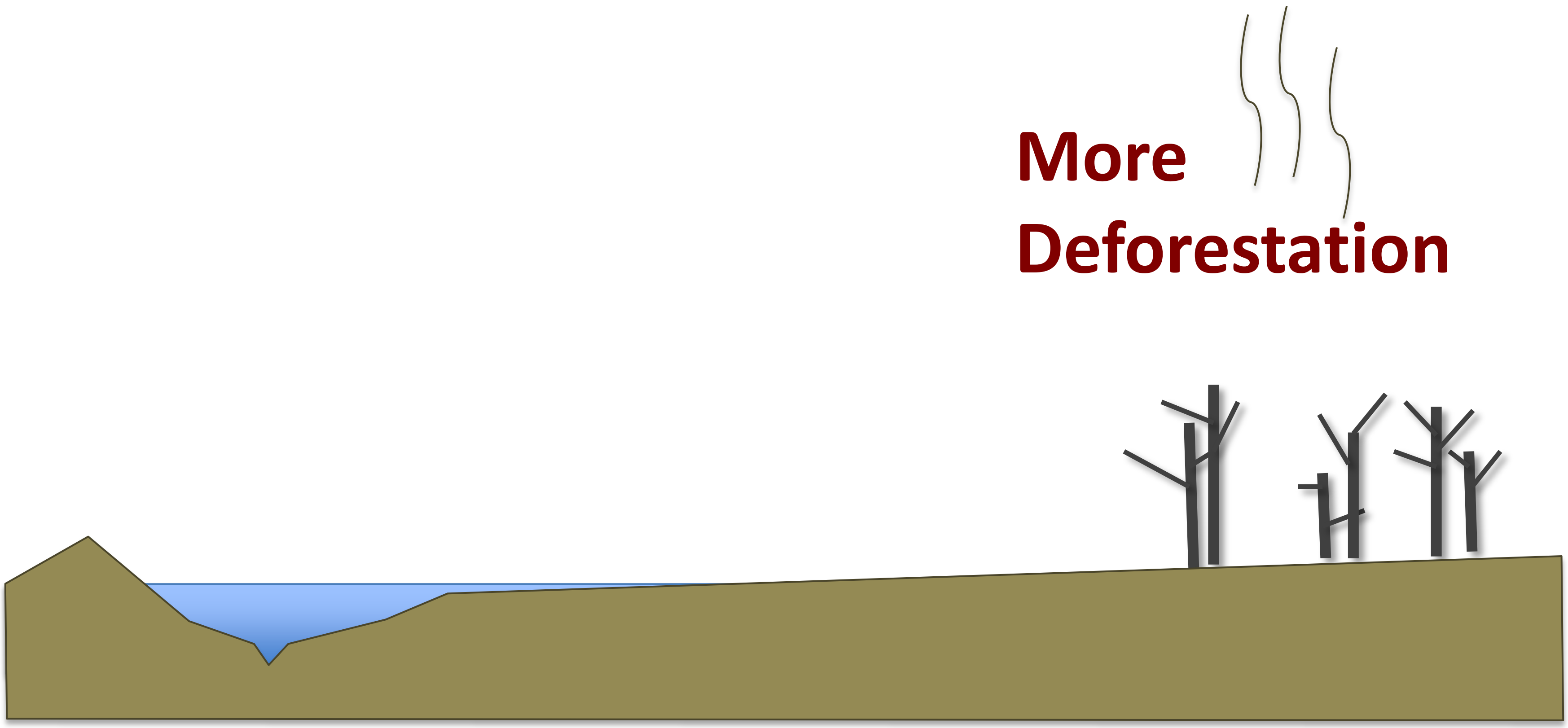
… but with deforestation,…



… extremes events are more frequent & intense



this process enters a loop, expending it further



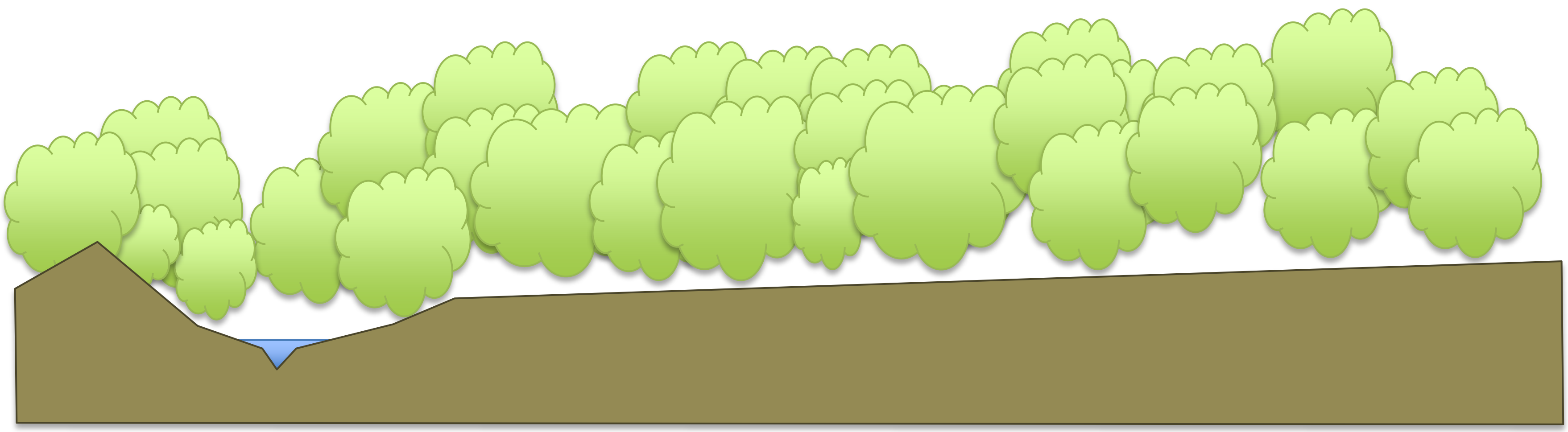
Drought can be a factor contributing to human-ignited forest fires, which can lead to widespread deforestation and carbon emissions (IPCC, SREX p.252)

Deforestation

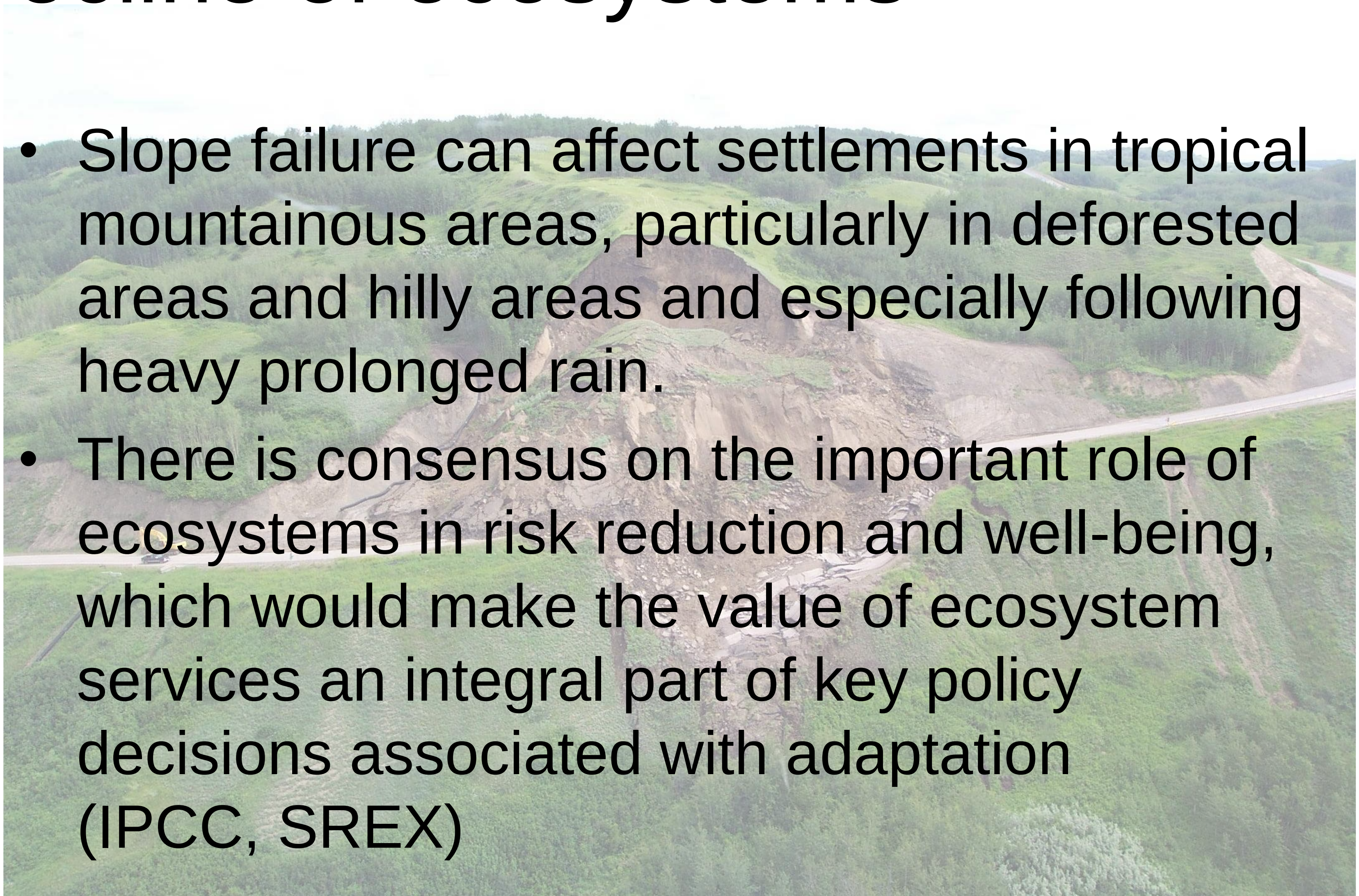
Due to the interrelated nature of forest fires, deforestation, drought, and climate change, isolating one of the processes fails to describe the complexity of the interconnected whole.

(IPCC, SREX)

Reforestation can solve this problem

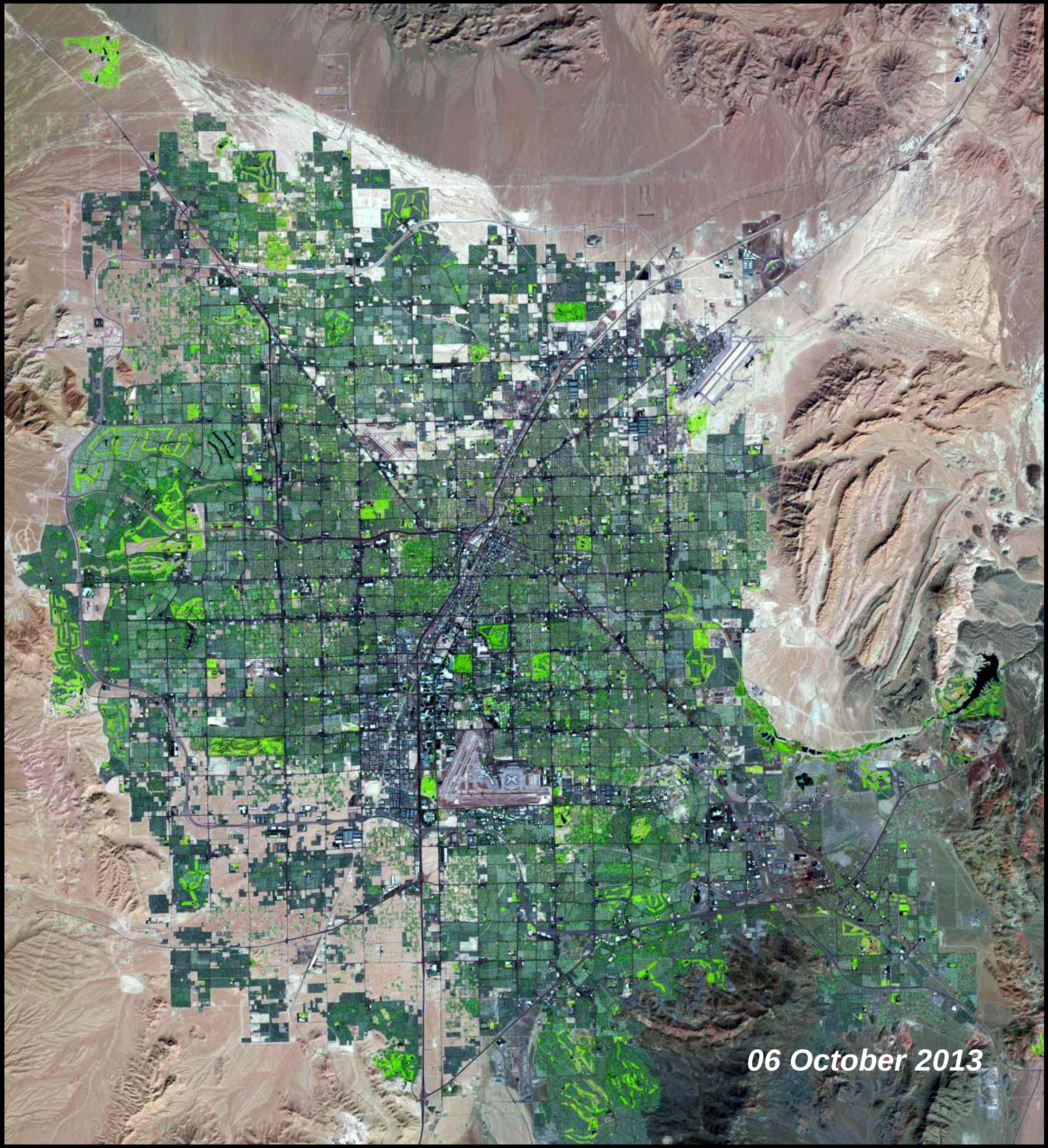


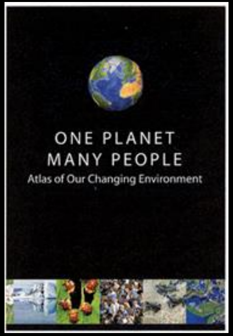
Decline of ecosystems



- Slope failure can affect settlements in tropical mountainous areas, particularly in deforested areas and hilly areas and especially following heavy prolonged rain.
- There is consensus on the important role of ecosystems in risk reduction and well-being, which would make the value of ecosystem services an integral part of key policy decisions associated with adaptation (IPCC, SREX)

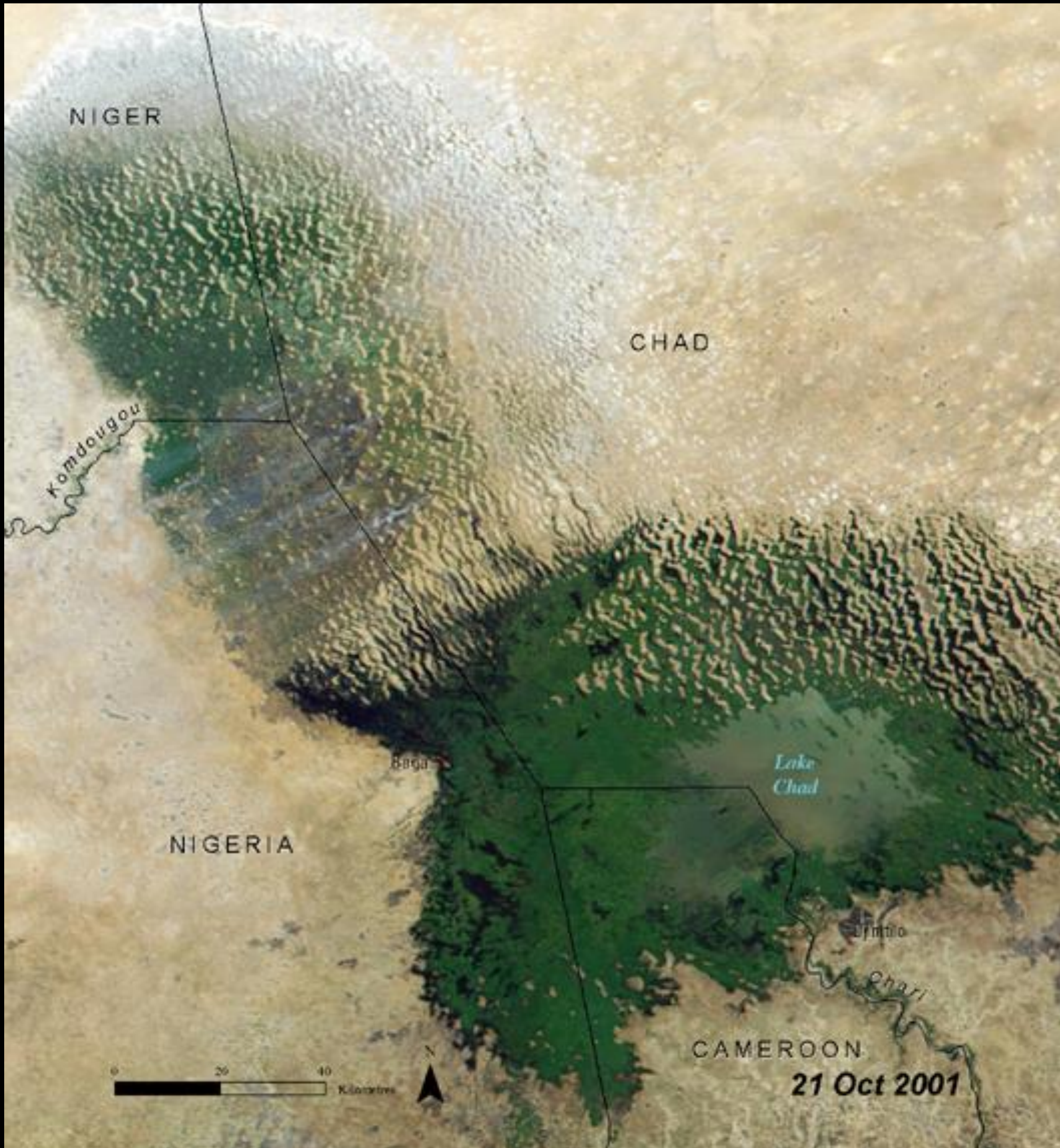
Las Vegas


06 October 2013


ONE PLANET
MANY PEOPLE
Atlas of Our Changing Environment

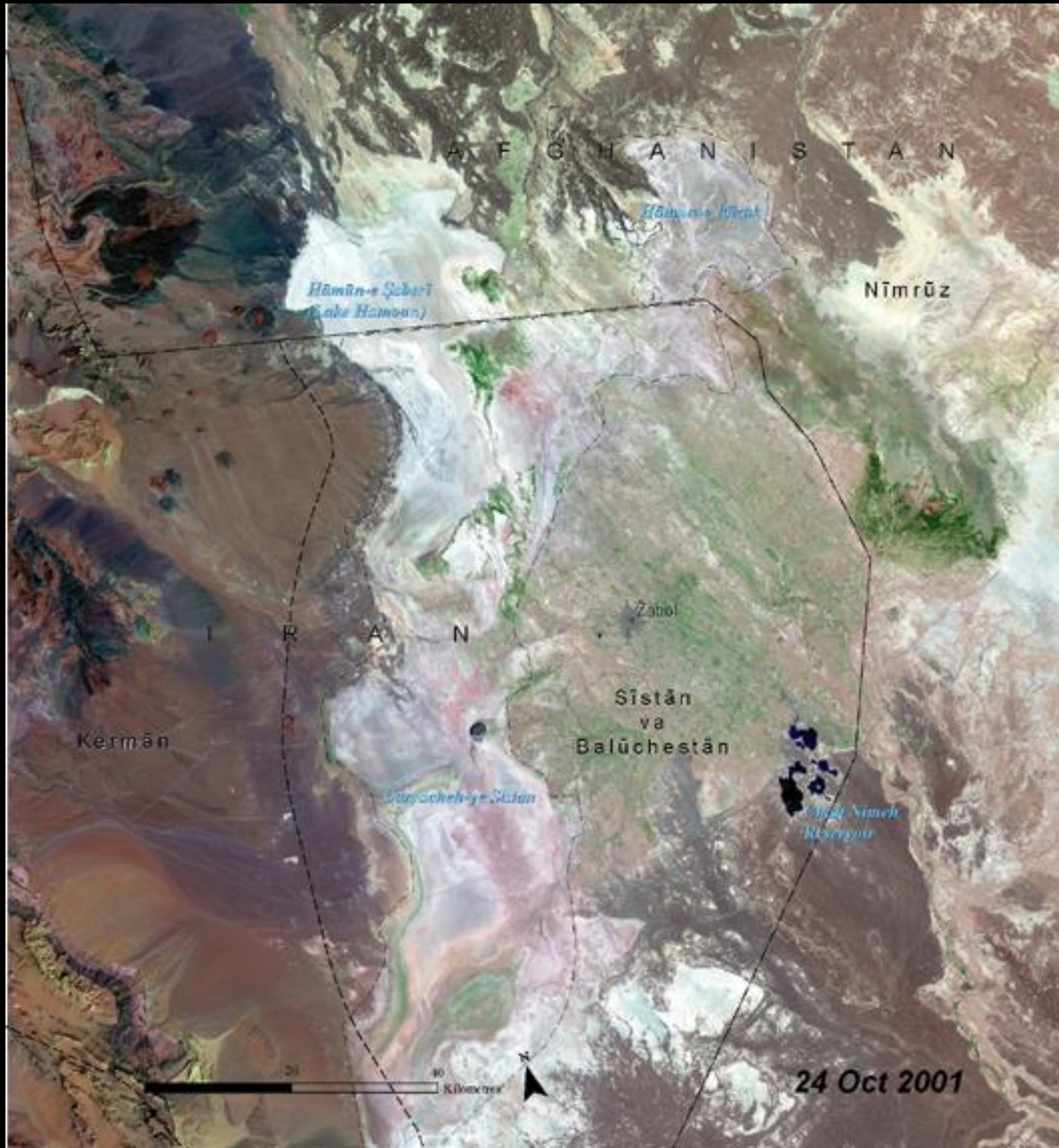



Monitoring the Decline of water ressources (Lake Chad)



Aral sea (when cotton absorbs a sea)

Lac Hamoun, Iran / Afghanistan: Mort d'un lac



1976-2001: assèchement du lac

THANK YOU