

Sten Bergström

The Swedish Meteorological and Hydrological Institute

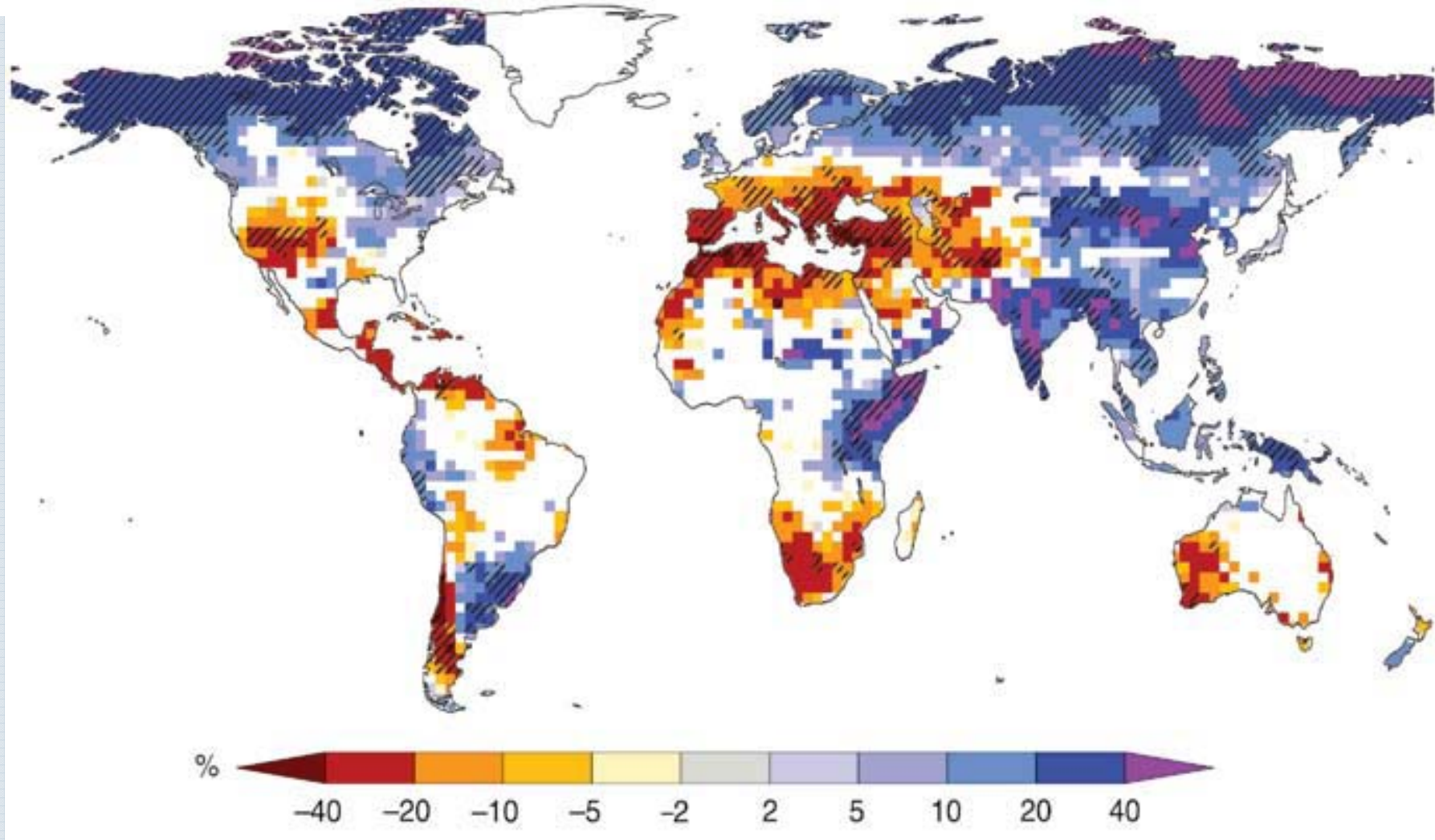
Three main concerns:

Water availability

Sea level rise

Climate and energy

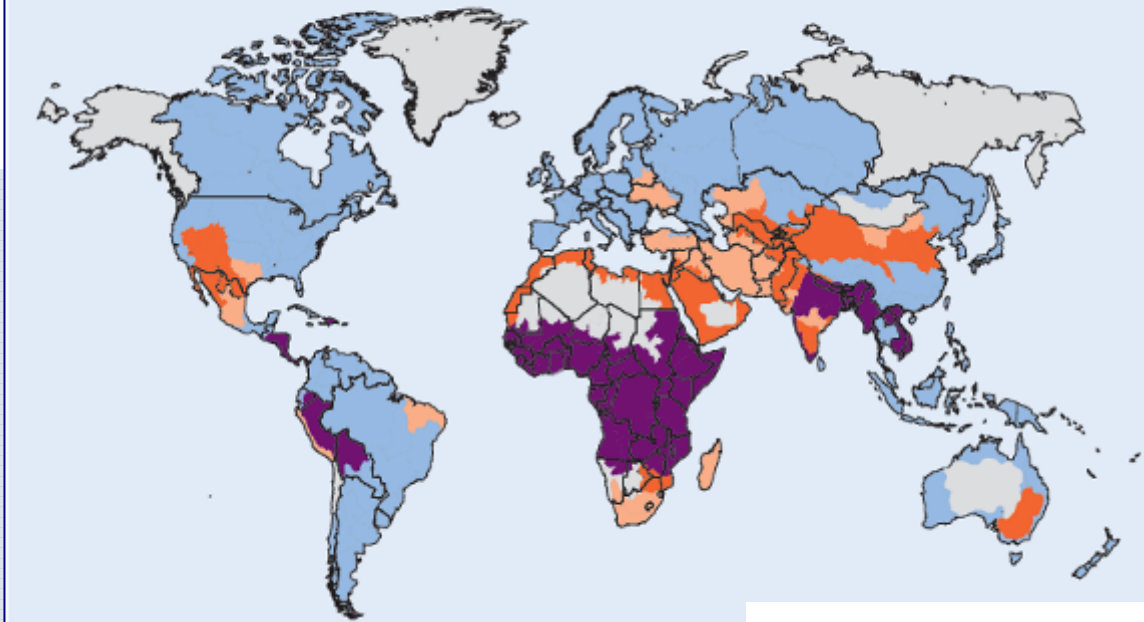
Changed water availability according to 12 climate models



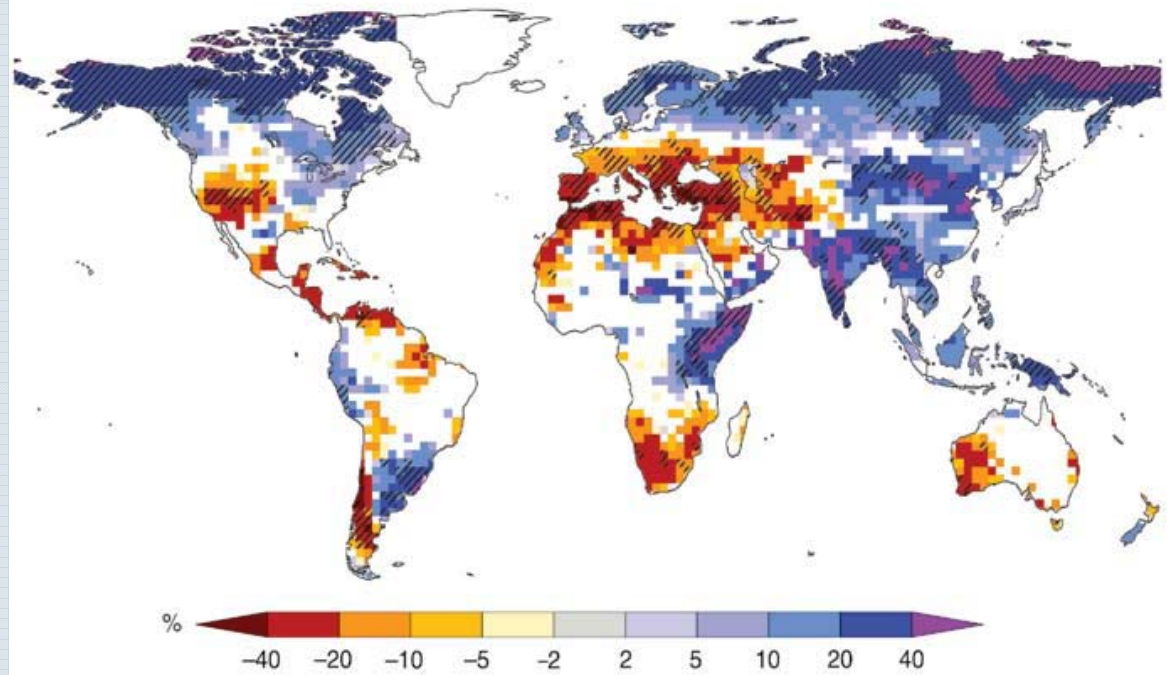
Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.0

- Little or no water scarcity
- Approaching physical water scarcity
- Not estimated
- Physical water scarcity
- Economic water scarcity

Water resources today



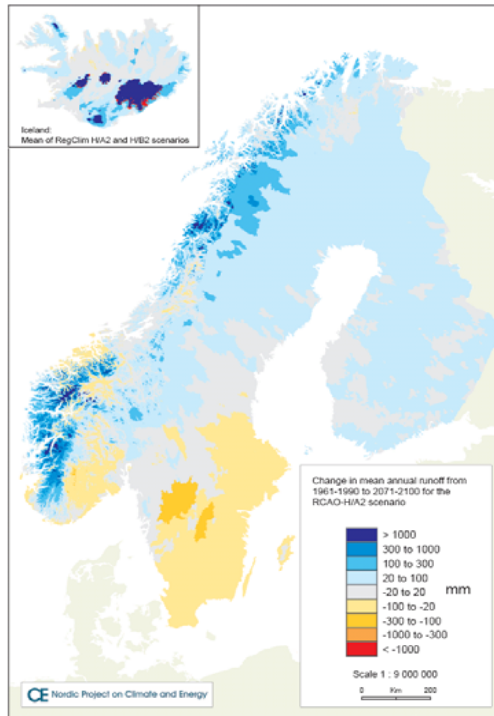
Future change





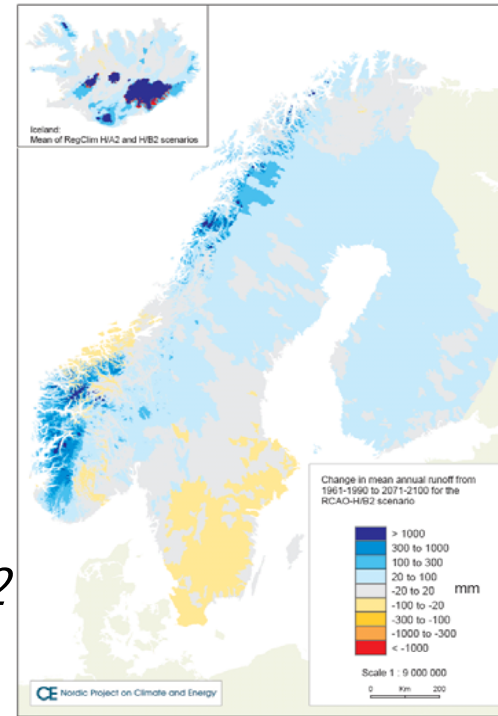
Annual runoff change (mm)

Hadley/A2



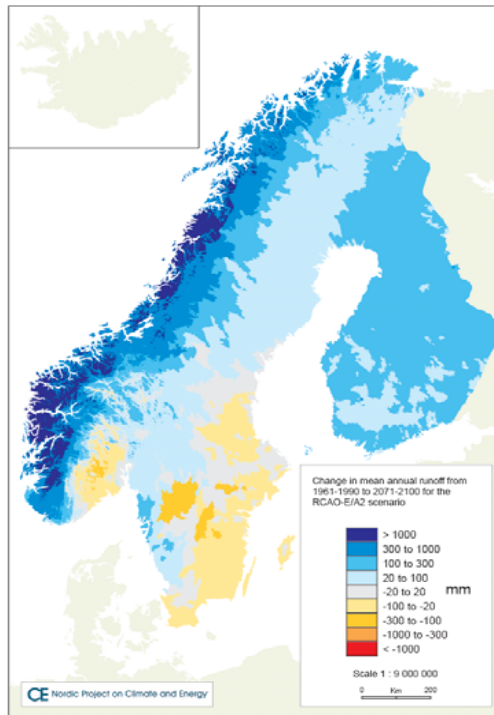
Annual runoff change (mm)

Hadley/B2



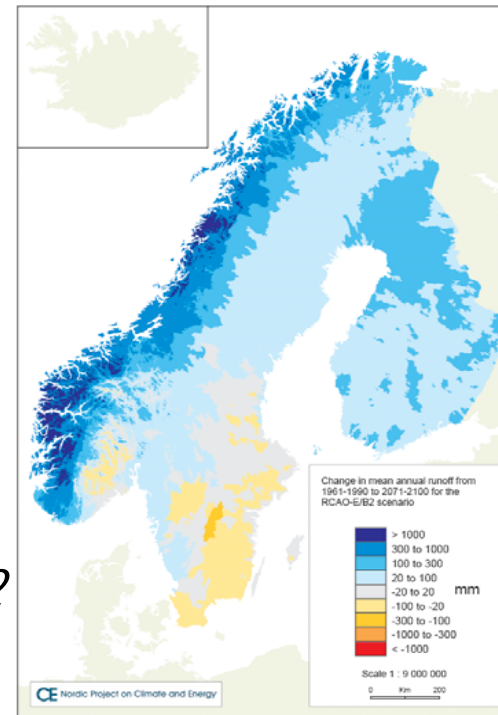
Annual runoff change (mm)

Echam/A2



Annual runoff change (mm)

Echam/B2



IPCC (2007) statement on sea level rise until 2100

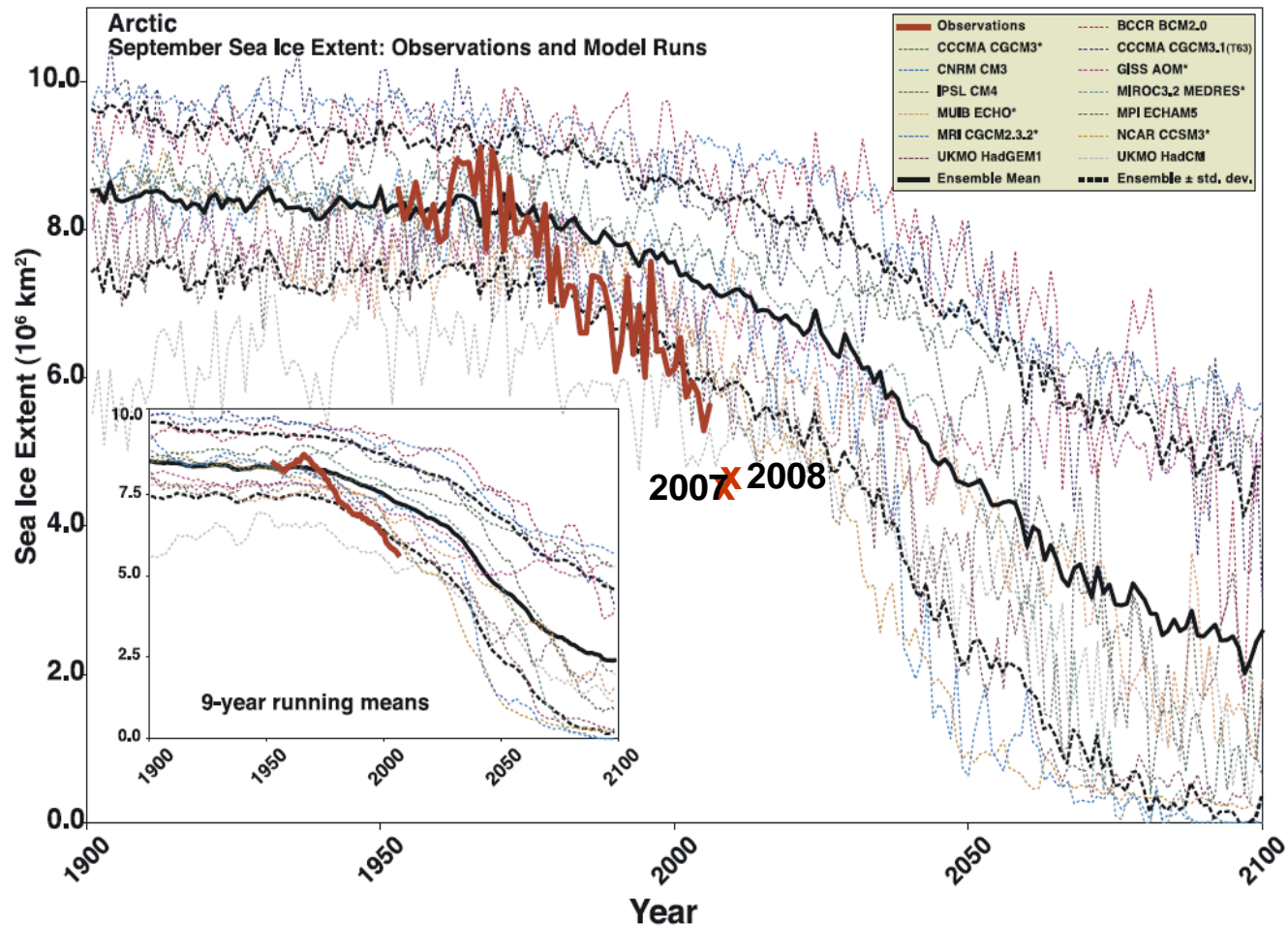
The sea level will rise 18 - 59 cm until 2100

+ some 20 cm for local effects in the North Sea

”Dynamical processes related to ice flow not included in current models but suggested by recent observations could increase the vulnerability of the ice sheets to warming, increasing future sea level rise. Understanding of these processes is limited and there is no consensus on their magnitude.”

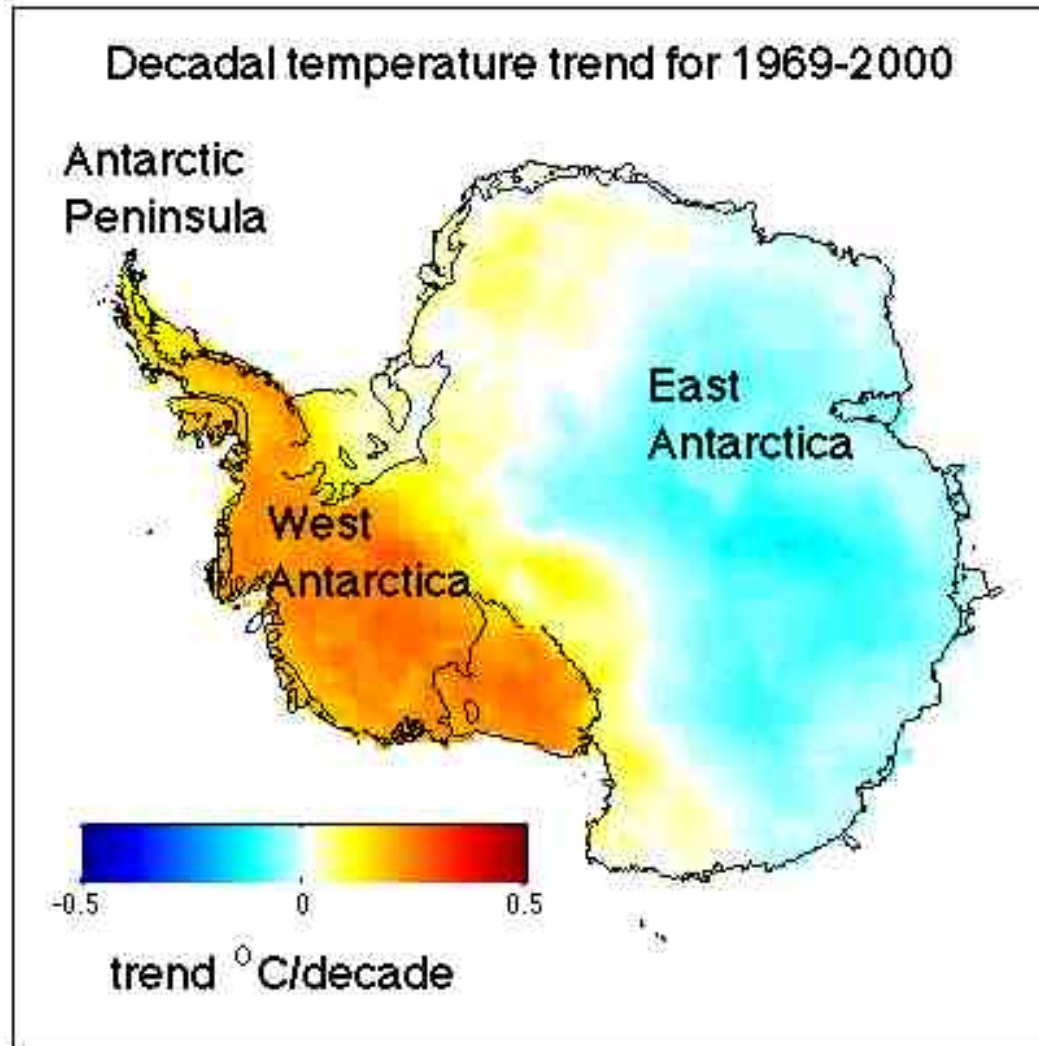
May lead to additional 20 cm

Modelled and observed extension of the Arctic sea ice



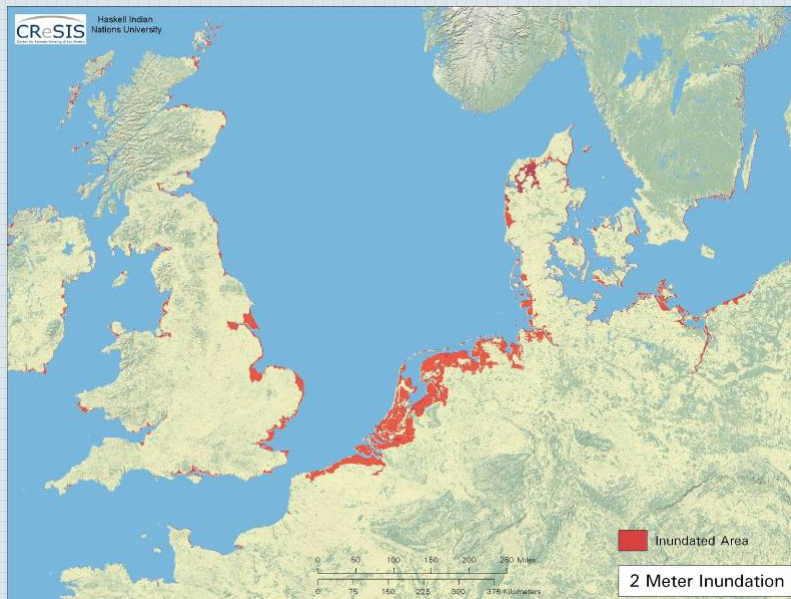
Source: Genomgång av forskning sedan IPCC AR4/WGI 2007
 Markku Rummukainen Erland Källén

West Antarctic warming



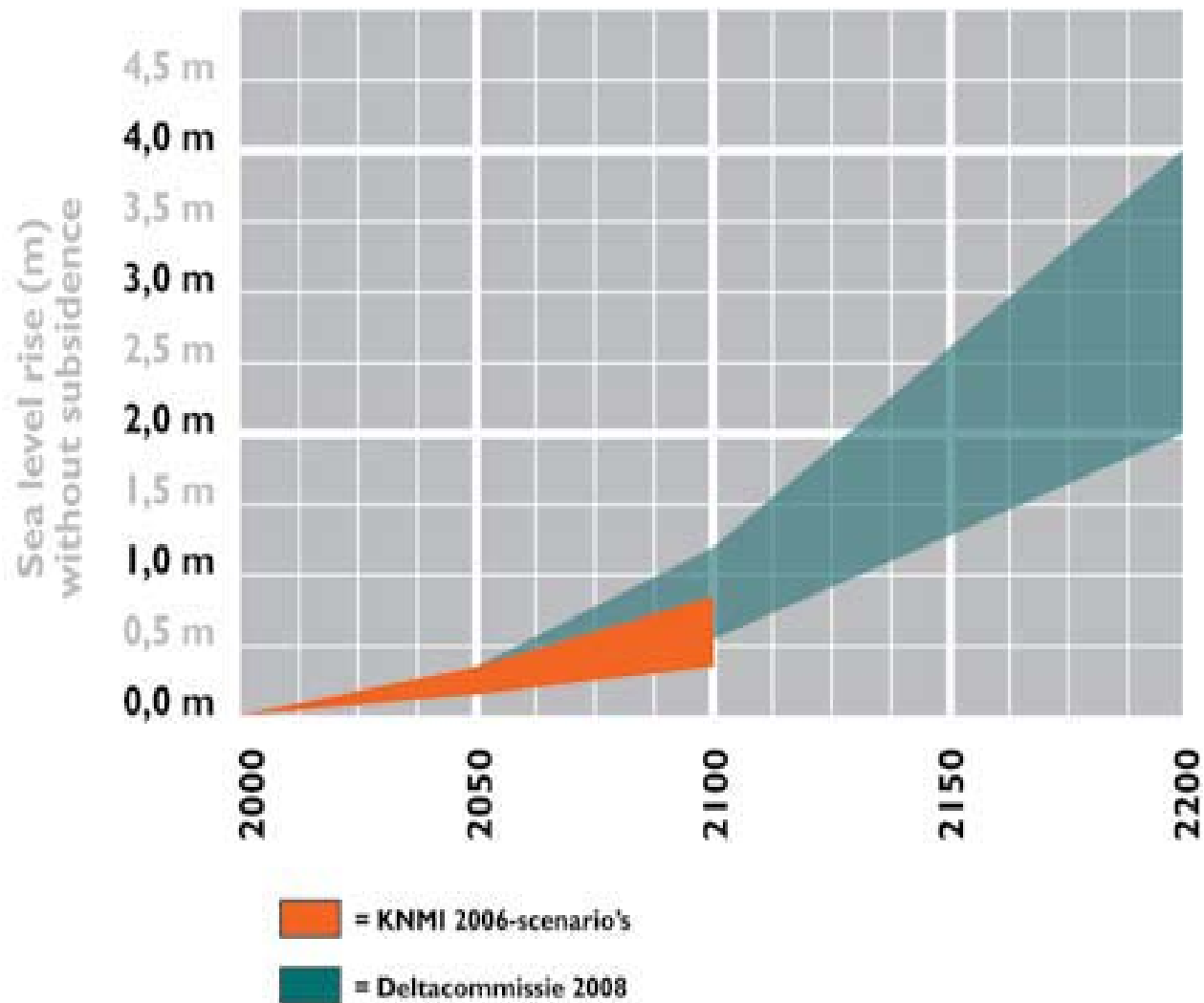
Steig et al. 2008

”It is the Delta Committee’s conclusion that a regional sea level rise of **0.65 to 1.3 meters should be expected for 2100**, and from **2 to 4 meters in 2200**. This includes the effect of land subsidence. These values represent plausible upper limits based on the latest scientific insights. ”



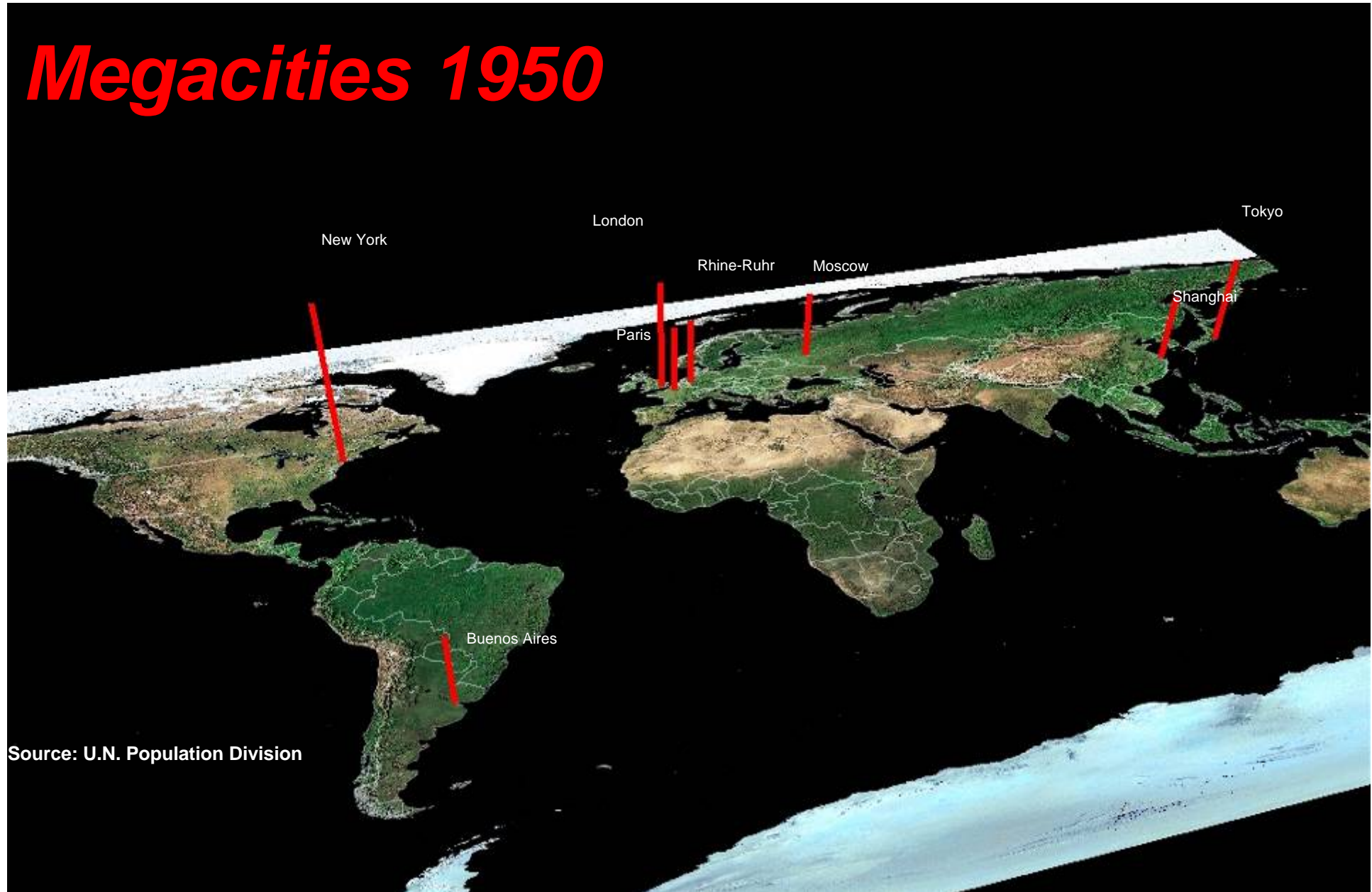
The Dutch Delta Committee, 2008

<http://www.deltacommissie.com/en/advies>



Population Trends

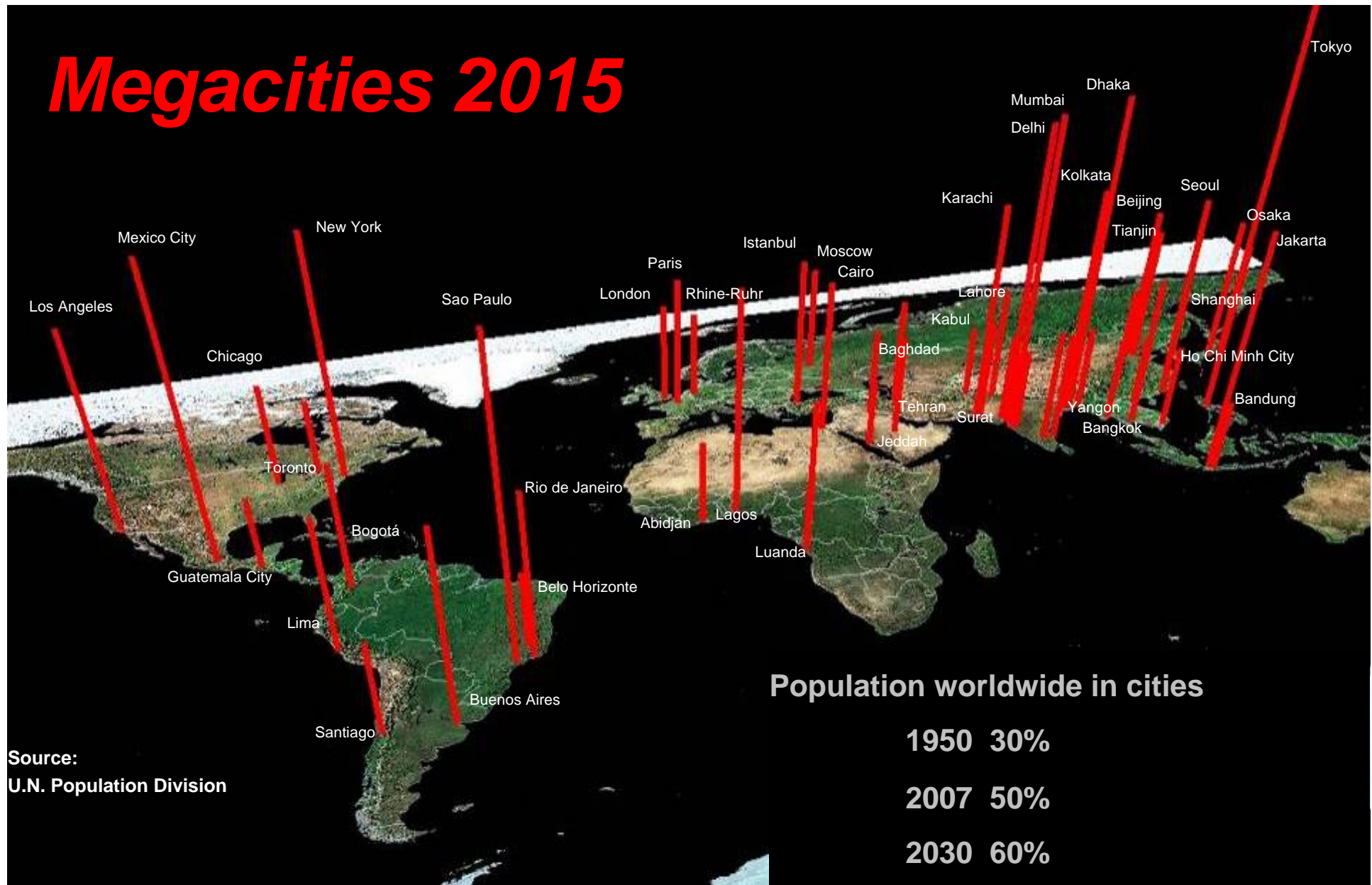
Megacities 1950



Source: U.N. Population Division

Population Trends

Megacities 2015



Population worldwide in cities

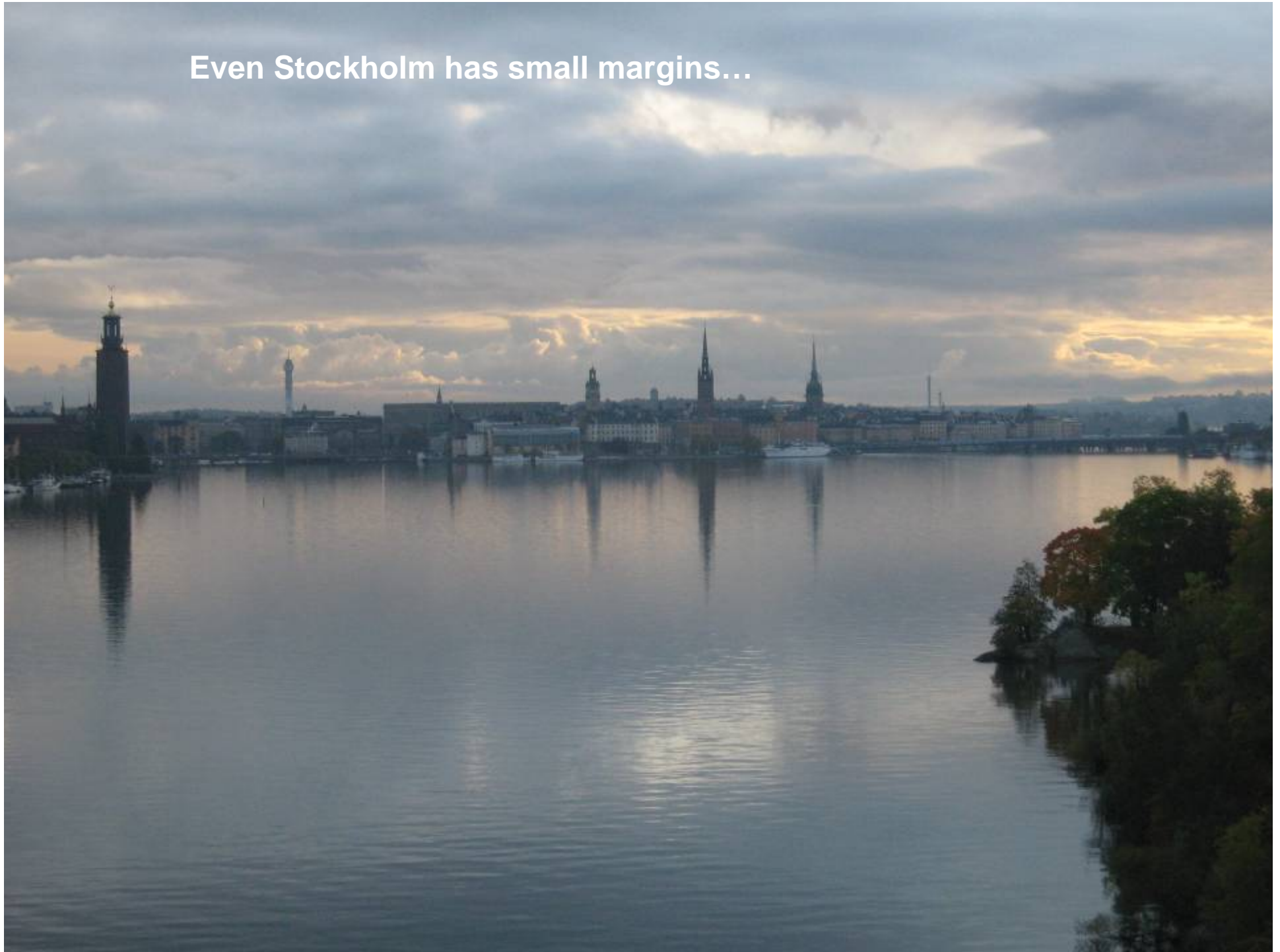
1950 30%

2007 50%

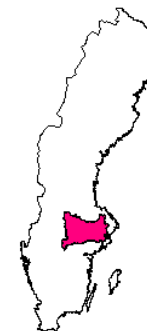
2030 60%

Source:
U.N. Population Division

Even Stockholm has small margins...



The catchment of Lake Mälaren



A flood in Stockholm in 1924

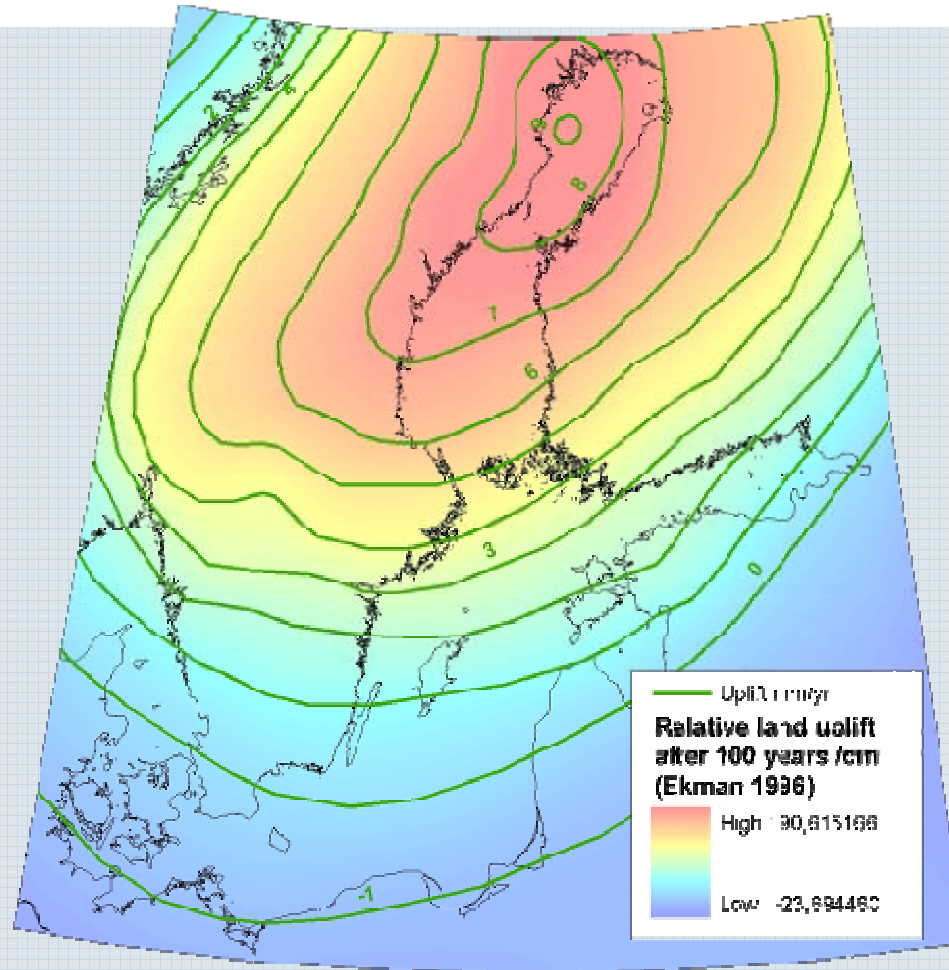


Stockholm today

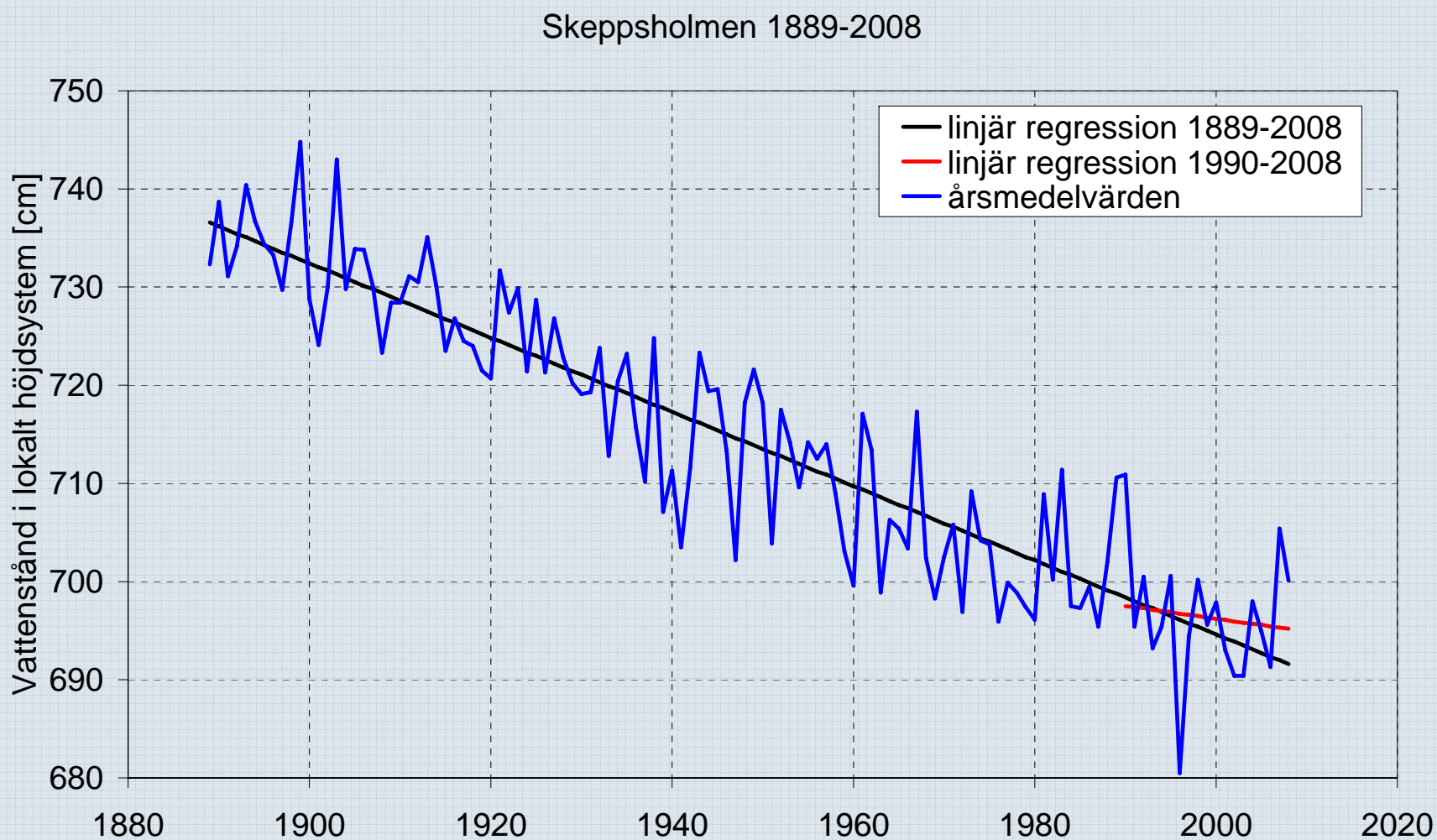


Foto: Sten Bergström, SMHI

Uplift of land in Scandinavia



Sea levels in Stockholm since 1889



Hydropower-
a part of the solution?



Nordic hydropower in % of total electricity production

Norway	100%	123 TWh
Sweden	45%	66 TWh
Finland	12%	8 TWh

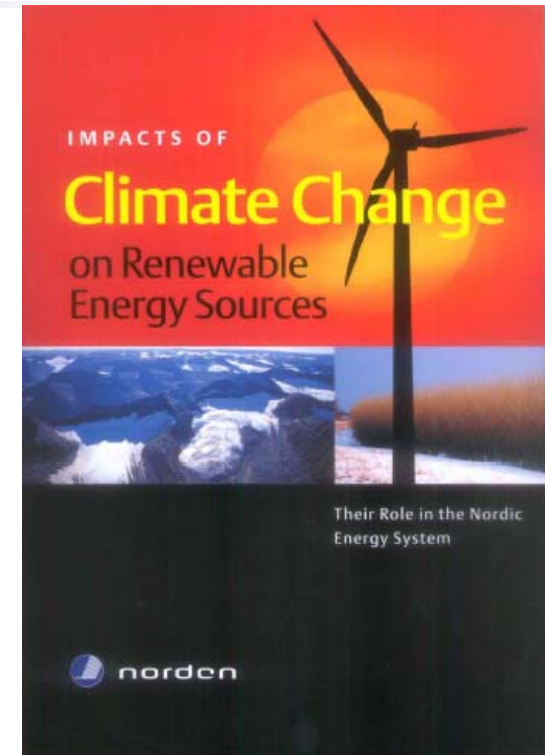
(approximate figures)

Nordic-Baltic projects on the impact of climate change on renewable energy

Climate Water and
Energy 2001-2002

Climate and Energy
2003-2006

Climate and Energy
Systems 2007-2010




To order <http://www.norden.org/pub/sk/showpub.asp?pubnr=2007:003>



Conclusions from the CE-project

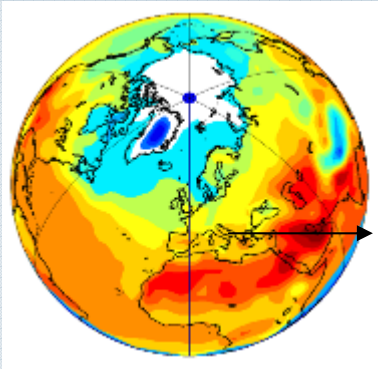
- Hydropower production is expected to increase in the Nordic area (But this is not the case for the rest of Europe!)
- The annual rhythm in river flow will be more favourable for production
- Impact on dam safety is not self-evident and has to be analysed carefully
- The development of the future European energy market will have strong impact on the Nordic hydropower industry

A photograph of an offshore wind farm. A long, straight line of white wind turbines extends from the foreground into the distance across a dark blue sea. The sky is a clear, bright blue with a few small, wispy clouds. The turbines are three-bladed and mounted on tall, slender towers. The perspective is from a low angle, looking down the length of the farm.

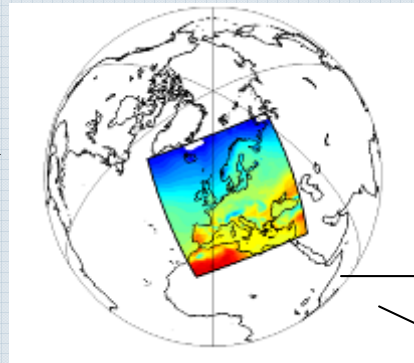
Wind power is on the
move – it requires
hydropower for
regulation!

Downscaling and uncertainty

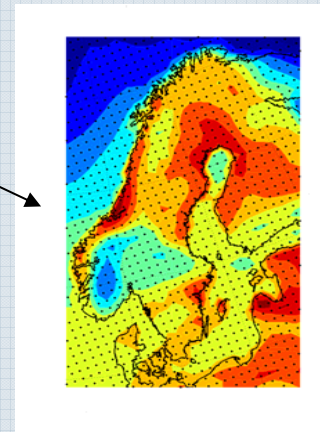
Global modelling



Regional modelling



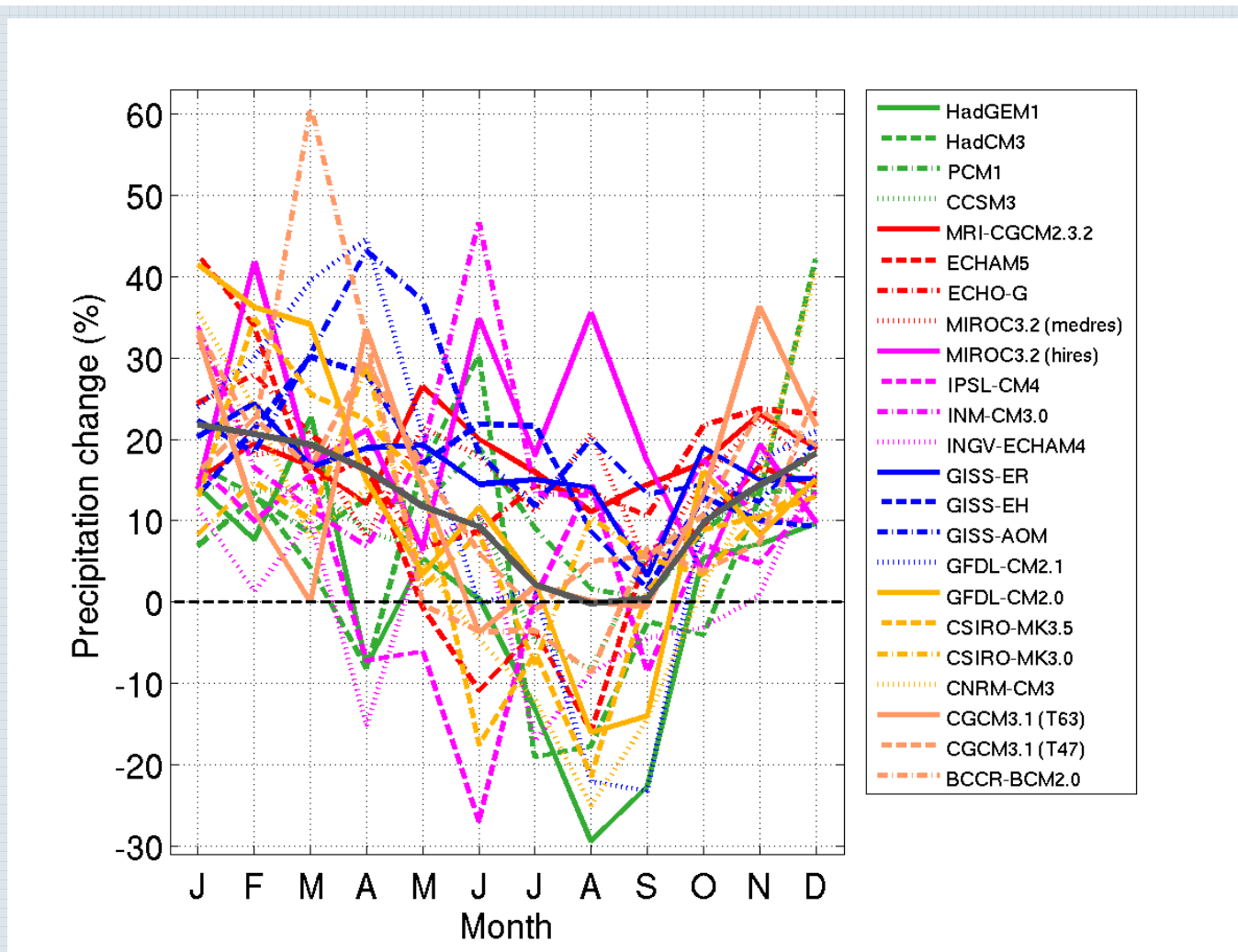
Local-regional studies



New regional climate scenarios from ENSEMBLES

	Institute	Scenario	Forcing GCM	Regional model	Resolution	Timeperiod
	SMHI	A1B	ECHAM5 (1)	RCA3	50km	1961-2100
	SMHI	A1B	ECHAM5 (3)	RCA3	50km	1961-2100
	CNRM	A1B	ARPEGE	Aladin	25km	1961-2050
	KNMI	A1B	ECHAM5 (3)	RACMO	25km	1961-2100
	OURANOS	A1B	CGCM3	CRCM	25km	1961-2050
	MPI	A1B	ECHAM5 (3)	REMO	25km	1961-2100
	C4I	A2	ECHAM5 (3)	C4I-RCA3	25km	1961-2050
	C4I	A1B	HadCM3	C4I-RCA3	25km	1961-2099
	METNO	A1B	BCM	HIRHAM	25km	1961-2050
	UCLM	A1B	HadCM3	PROMES	25km	1961-2050
	ETHZ	A1B	HadCM3	CLM	25km	1961-2050
	DMI	A1B	ARPEGE	HIRHAM	25km	1961-2050
	HC	A1B	HadCM3Q0	HadCM3Q0	25km	1961-2050

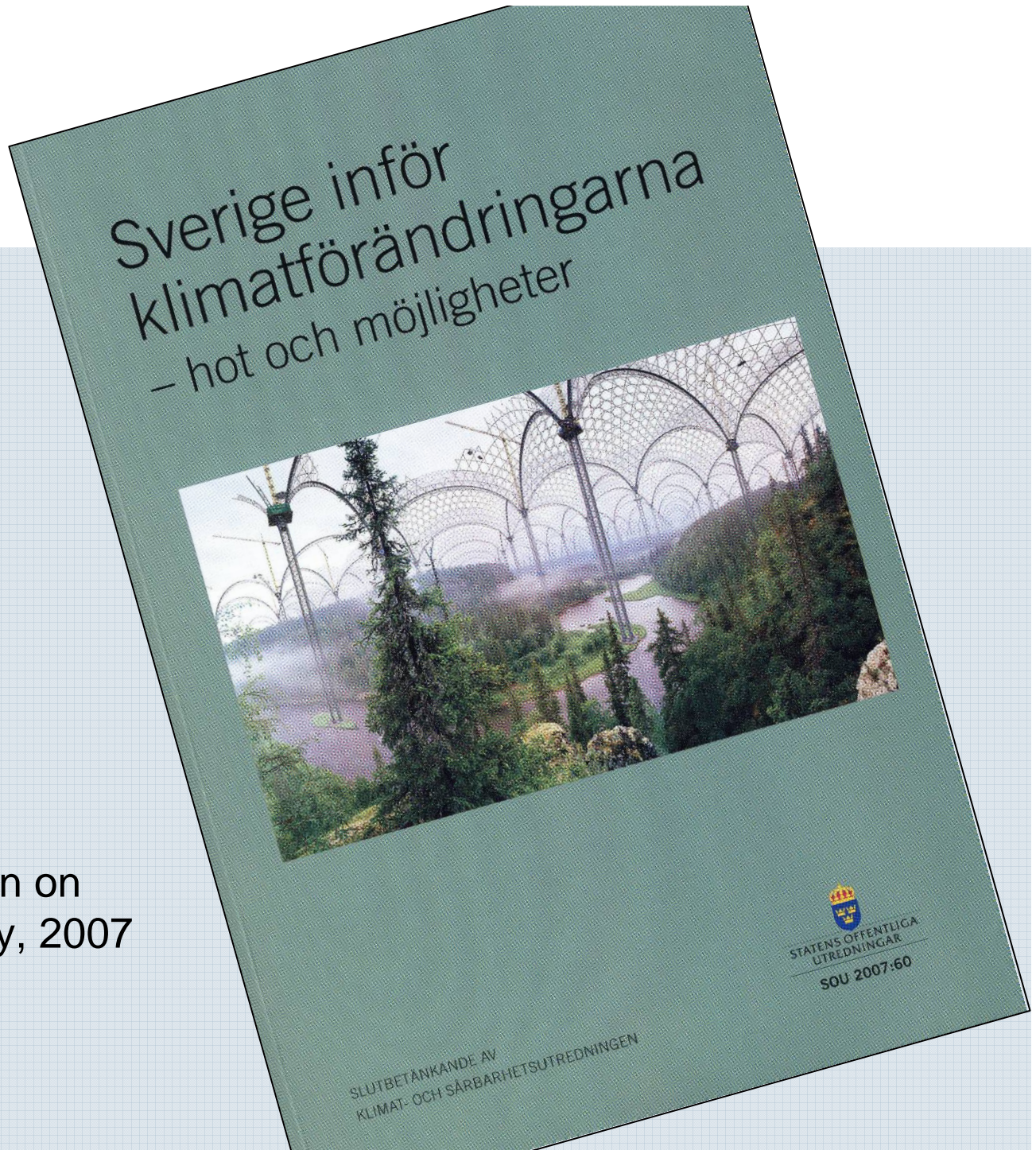
Seasonal cycle of monthly mean changes in precipitation under the A1B emission scenario by the end of the 21st century (2071-2100) in southern Sweden. (Global climate models)



Source: Lind och Kjellström. Report RMK 113, SMHI, 2009

One last question:

How can we develop a strategy for risk assessment and climate adaptation that, in a reasonable way, accounts for all the inherent uncertainties in the climate projections?



the Swedish Commission on Climate and Vulnerability, 2007



