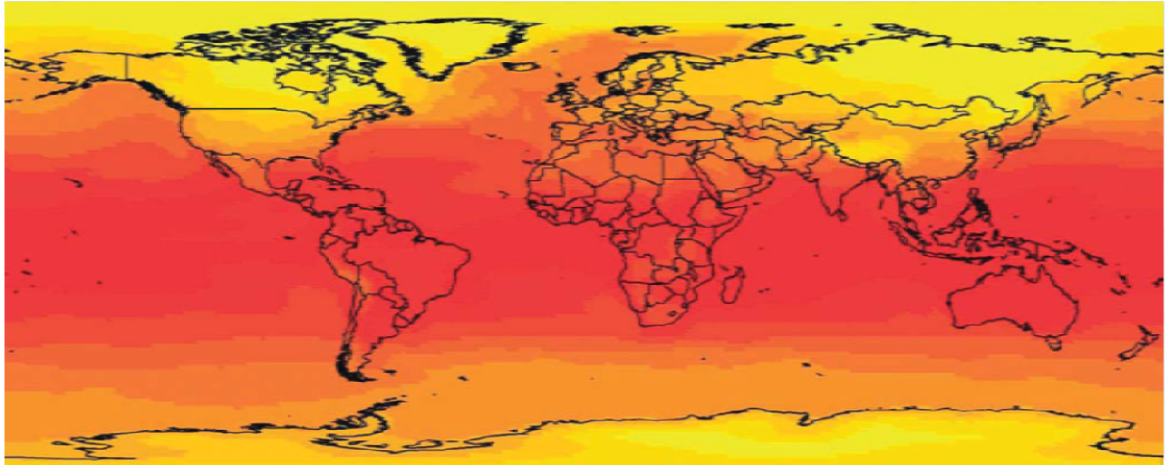


Comparative overview of climate change and ways to an adaptation strategy in the Rhine and Mekong basins

IKSR CIPR ICBR

MEKONG RIVER COMMISSION MRC FOR SUSTAINABLE DEVELOPMENT

CHR KHR

1st Rhine-Mekong Symposium
"Climate change and its influence on water and related sectors"
8-9 May 2014, Koblenz, Germany

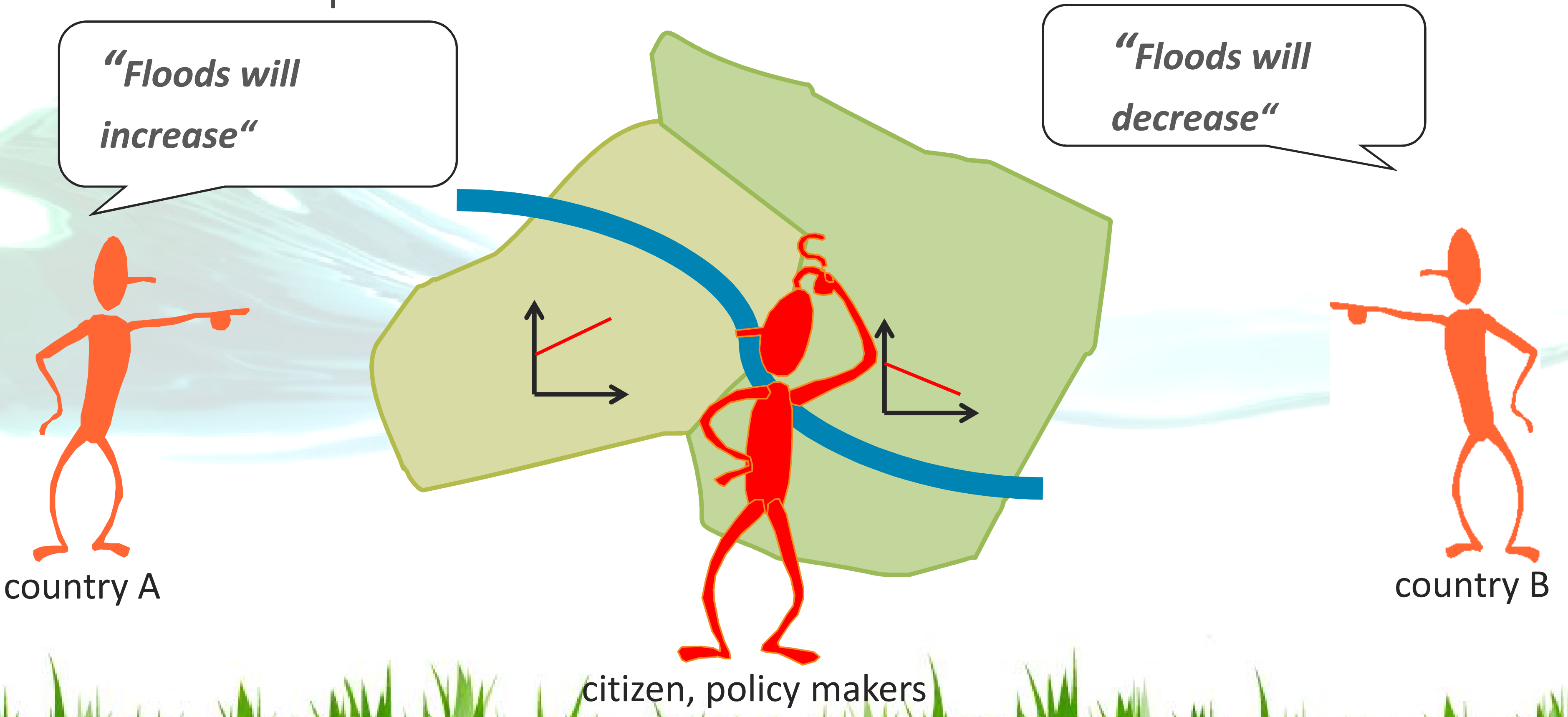
Dr. Kai Gerlinger
HYDRON Consulting Engineers (Germany)

Content

1. Common knowledge base
2. Observed climate changes
3. Climate projections
4. Projections of IPCC AR5
5. Impacts projected in IPCC AR5
6. Uncertainty and complexity
7. Approach to basin-wide adaptation
8. Summary

1. Common knowledge base

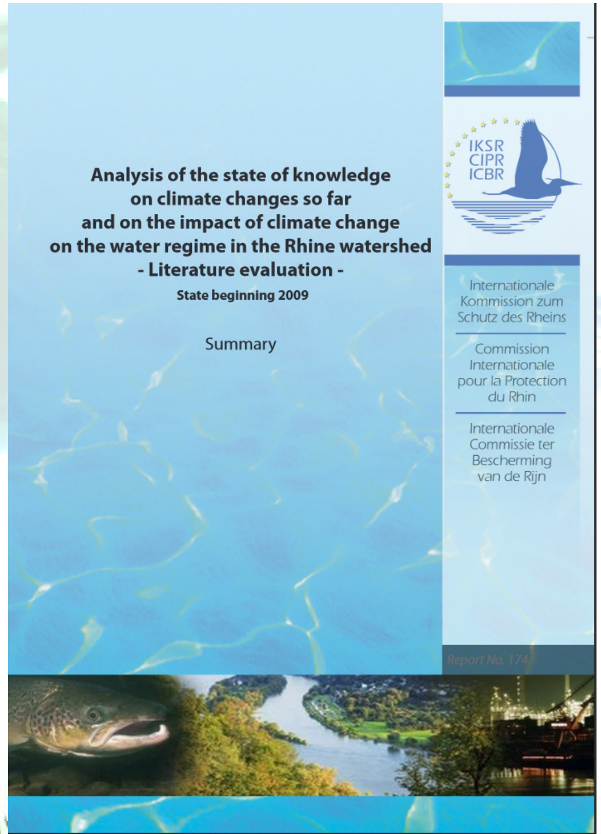
- Hydrology and climate change are both transboundary subjects
- Transboundary cooperation in the assessment of climate change and its impact on water is desirable



1. Common knowledge base

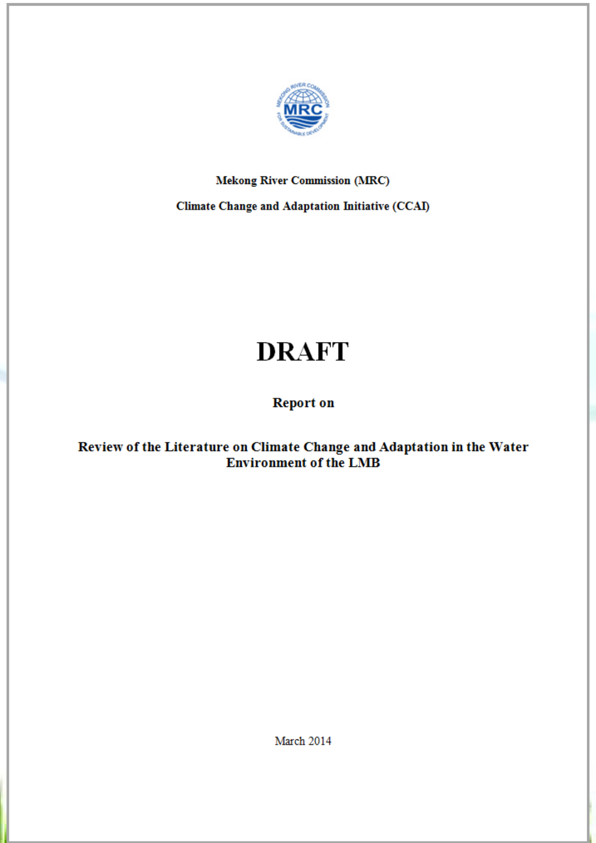
- Initial transboundary review of existing knowledge on climate change and its impacts on hydrology

ICPR



ICPR 2009

MRC

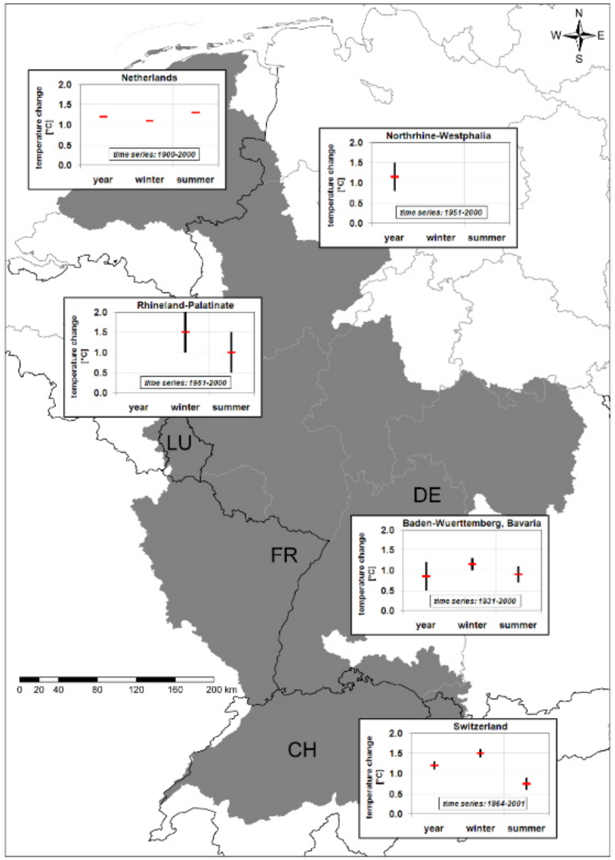


MRC CCAI 2014

3. Observed changes

- Climate change is already observable in temperature records
- Increase ranges are similar in the Rhine and Mekong basin (+0.08 to +0.18°C/decade)

ICPR



ICPR 2009

Changes of air temperature (average, minima and maxima)

MRC

MRC CCAI 2014

Changes of annual air temperature [°C/decade]

3. Observed changes

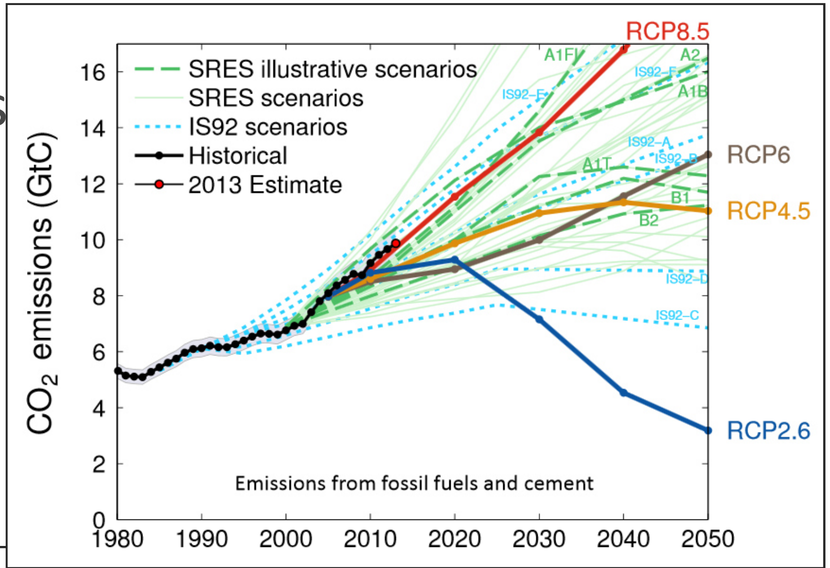
- Also sea level rise is already observable
- Climate change is already observable in temperature records, but trends are heterogeneous in time and space
- Heterogeneity represents inherent spatial variability of climate change
- But there are also differences in underlying data basis (e.g. data quality, density of stations, lengths of time series) and methods of analysis
- Changes in precipitation are much more heterogeneous than in temperature

→ to keep track of current climate change, transboundary harmonization of data analysis is helpful. Measuring network has to be maintained.

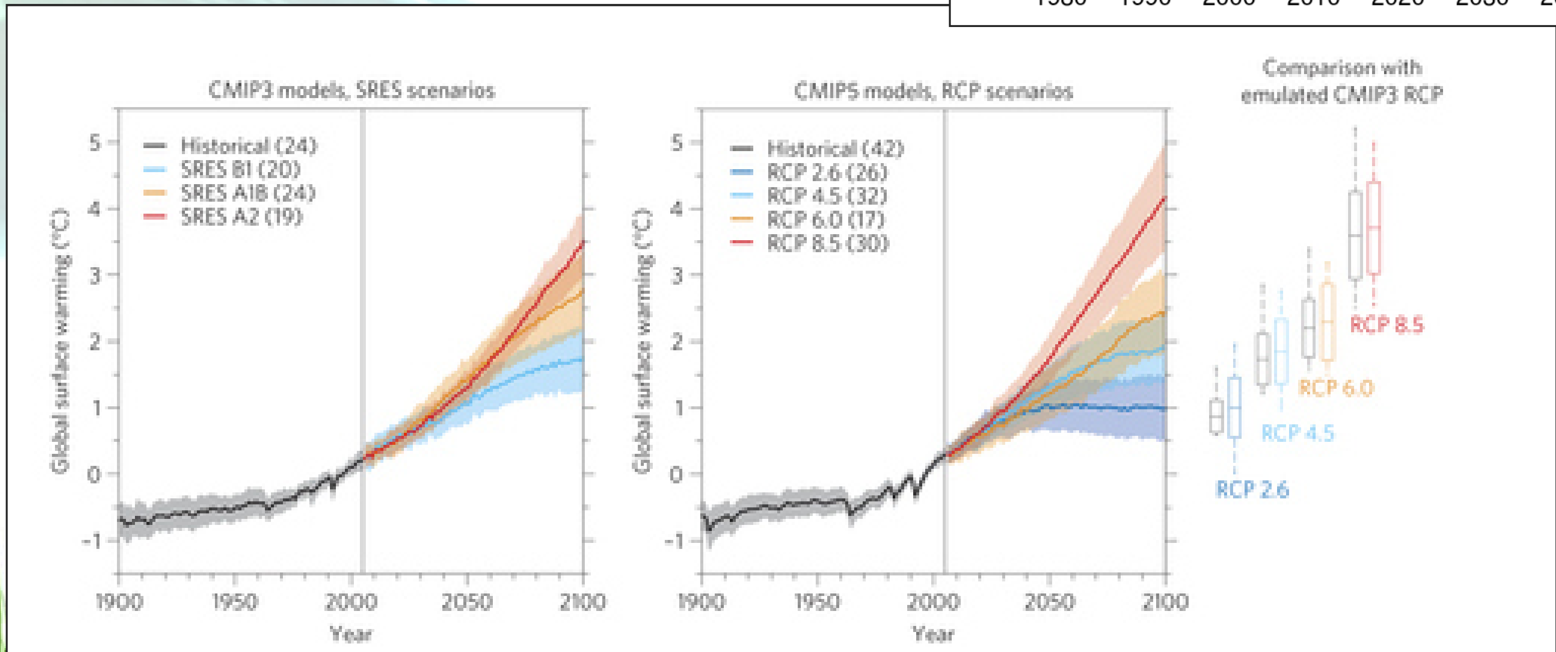
4. Climate projections

- Climate modelling is applied to as

Atmospheric greenhouse gas concentrations
Emission scenario



Le Quéré et al. 2013



Knutti & Sedláček 2013

4. Climate projections

- Climate modelling is applied to assess future climate change

Atmospheric greenhouse gas concentrations
Emission scenario

→

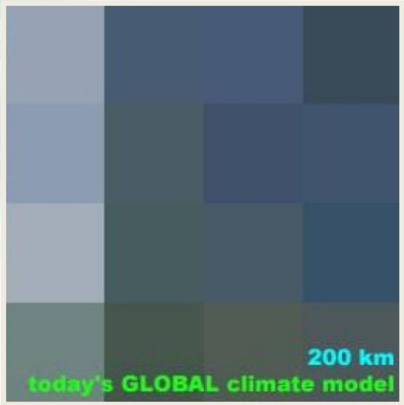
Global climate model (GCM)
(complex, feedback climate system)

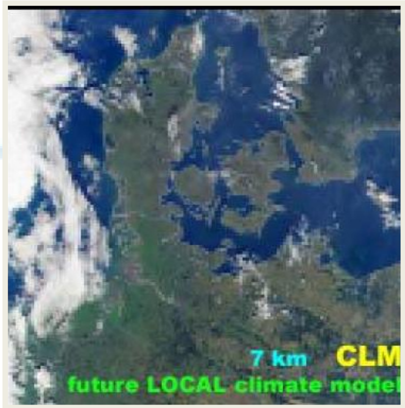
→

Downscaling
(regional processes, consideration of small-scale heterogeneity)
-> time series of climate parameters

→

Impact modelling
e.g. hydrological modelling
-> time series of discharge





HSG 2012

4. Climate projections

- Different climate projections exist and have been analyzed for both basins

ICPR

Typ	Bezeichnung (Version)	Antrieb *Szenarien*, Modell (Land)	max. hor. Auflösung °	km	max. zeitl. Auflösung	max. Zeit-raum	Ersteller RCM (Land) Datenbank
Dynamisches Downscaling	CLM (2.4.11)	*Szenarien 20C, A1B, B1, A2* MPI-ECHAM5-MPI-OM (D) run 1, 2 und 3	0.165	18	H	1960-2100	CLM-Community (D) CERA
Klimamodell RCM	REMO (UBA)	*Szenarien 20C, A1B, B1, A2* MPI-ECHAM5-MPI-OM run 1 (D)	0.088	10	H	1950-2100	MPI-M (D) CERA
Dynamisches Downscaling	REMO (BFG)	*Szenarien 20C, A1B* MPI-ECHAM5-MPI-OM run 2 (D)	0.088	10	H	1950-2100	BfG, MPI-M (D)
statistisches Downscaling	STAR (2.0)	*Szenario A1B* (MPI-ECHAM5-MPI-OM (D)	Stationen	Stationen	D	2001-2055	PIK (D)
statistisches Downscaling	WETTREG (UBA)	*Szenarien A1B, B1, A2* MPI-ECHAM5-MPI-OM (D)	Stationen	Stationen	D	1961-2100	Meteo Research (D) CERA
Dynamisches Downscaling	HIRHAM	*ERA40, Szenarien 20C, A1B* MPI-ECHAM5-MPI-OM (D) CNRM-CM3 (F)	0.22	25	H	1950-2100	DMI (DK) ENSEMBLES
Dynamisches Downscaling	RCA	*ERA40, Szenarien 20C, A1B* HADGEM1 (GB) HADCM3 (GB) NERSC-BCCR_BCM2 (US)	0.22	25	H	1950-2050	SMHI (S) ENSEMBLES
Dynamisches Downscaling	RACMO	*ERA40, Szenarien 20C, A1B* MPI-ECHAM5-MPI-OM (D)	0.22	25	H	1950-2050	KNMI (NL) ENSEMBLES
Dynamisches Downscaling	RegCM	*ERA40, Szenarien 20C, A1B* MPI-ECHAM5-MPI-OM (D)	0.22	25	H	1950-2050	ICTP (I) ENSEMBLES
Dynamisches Downscaling	HadRM	*ERA40, Szenarien 20C, A1B* HADGEM1 (GB) HADCM3 (GB) MPI-ECHAM5-MPI-OM (D)	0.22	25	H	1950-2100	METO-HC (GB) ENSEMBLES
Dynamisches Downscaling	ARPEGE	*ERA40, Szenarien 20C, A1B* CNRM-CM3 (F)	0.22	25	H	1950-2050	CNRM (F) ENSEMBLES
Dynamisches Downscaling	REMO	*ERA40, Szenarien 20C, A1B* MPI-ECHAM5-MPI-OM run 3 (D) IPSL-CM4 (CH)	0.22	25	H	1950-2100	MPI-M (D) ENSEMBLES
Dynamisches Downscaling	PROMES	*ERA40, Szenarien 20C, A1B* HADGEM1 (GB) HADCM3 (GB)	0.22	25	H	1950-2050	UCLM (E) ENSEMBLES
Dynamisches Downscaling	CHRM	*ERA40, Szenarien 20C, A1B* HADGEM1 (GB) HADCM3 (GB)	0.22	25	H	1950-2050	ETH (CH) ENSEMBLES
Dynamisches Downscaling	CLM	*ERA40, Szenarien 20C, A1B* *????*	0.22	25	H	1950-2100	ETHZ, GKSS ENSEMBLES

ICPR 2009

4. Climate projections

- Different climate projections exist and have been analyzed for both basins

MRC

	Lauri et al. 2012	Laux et al. 2013	Kingston et al. 2011	Thompson et al. 2013	Thompson et al. 2013	Hoanh et al. 2010	TKK & SEA START 2009	Johnston et al. 2009	Eastham et al. 2008	Kiem et al. 2008	Chinvanno et al. 2006	Hoanh et al. 2003	Snidvongs et al. 2003
Region	Mekong Basin	GMS	Mekong Basin	Mekong Basin	Mekong Basin	Mekong Basin	LMB	GMS	Mekong Basin	Mekong Basin	LMB	LMB	LMB
GCM	CCCMA_CGCM3.1 CNRM_CM3 GISS_AOM MIROC3.2Hires MPI_ECHAM5 NCAR_CCSM3	ECHAM5	UKMO HadCM3 CCCMA CGCM31 CSIRO Mk30 IPSL CM4 MPI ECHAM5 NCAR CCSM30 UKMO HadGEM1	UKMO HadCM3 CCCMA CGCM31 CSIRO Mk30 IPSL CM4 MPI ECHAM5 NCAR CCSM30 UKMO HadGEM1	UKMO HadCM3	ECHAM4	ECHAM4	ECHAM4	11 GCMs	JMA AGCM	CCAM (RCM)	HadCM3	CCAM (RCM)
Downscaling method	Statistical downscaling	WRF (dynamical downscaling)	ClimGen (pattern-scaled downscaling)	ClimGen (pattern-scaled downscaling)	ClimGen (pattern-scaled downscaling)	PRECIS	PRECIS	PRECIS	Pattern-scaling	-	-	-	-
Scenario	A1B, B1	A1B, B1	Prescribed global warming of +0.5-+6°C	Prescribed global warming of +2°C	Prescribed global warming of +1.0-+6°C	A2, B2	A2, B2	A2, B2	A1B	A1B	540 ppm and 720 ppm	A2, B2	700 ppm
Baseline period	1982-1992	1971-2000	1961-1990	1961-1990	1961-1990	1985-2000	1995 to 2004		1961 -1990	1979–1998	360 ppm	1961-1990	350 ppm
Scenario period	2032-2042	2001-2030 (I) 2021-2050 (II)	-	-	-	2010-2050	2010-2049	1960-2049	2030	2080-2099	540 ppm (I) 720 ppm (II)	2010-2039 (I) 2070-2099 (II)	700 ppm
Mean temperature	+0.8-+1.4°C (A1B) +0.6-+1.3°C (B1)	+0.17°C (B1 I) +0.38°C (A1B I) +0.6°C (B1 II) +1.39°C (A1B II)	+0.5-+6°C (prescribed)	+2°C (prescribed)	+1.0-+6°C (prescribed)	+0.7°C (A2) +0.8°C (B2)	+2-+3°C (+1-+2°C from Västilä et al. 2010, Scenario A2 only)	+0.023°C/yr to +0.024°C/yr	+0.68-+0.81°C	+2.6°C	Slight decrease (I) and increase (II)	+1.0°C (B2 I) +1.0°C (A2 I) +2.9°C (B2 II) +4.0°C (A2 II)	increase in daily max. temperature by +1-+3°C from Jan. to May, decrease from Oct. to Dec.
Mean precipitation	-2.5-+8.6% (A1B) +1.2-+5.8% (B1)	+90mm (B1 I) -5mm (A1B I) +74mm (B1 II) -20mm (A1B II)	only very slight changes, except for three northern basins, where increases occur, seasonal changes are very heterogeneous	heterogeneous changes reaching from -6.1-+12.3% for different sub-catchments	-2-+5% for different sub-catchments for 1°C-scenario; -6.9-+30.2% for different sub-catchments for 6°C-scenario	annual: +1.2mm/yr (B2) +2.0mm/yr (A2); wet season: +1.2mm/yr (B2) +1.5mm/yr (A2); dry season: +0.06mm/yr (B2) +0.54mm/yr (A2)	+4% (from Västilä et al. 2010, Scenario A2 only)	no significant change in mean annual precipitation, wetter wet season in North Myanmar and Gulf of Thailand, drier dry seasons around Gulf of Thailand	mean: +13.5% range of models: +0.5-+36.0%	+4.2%	mean annual precipitation increases from 0-+25% for different sub-catchments	-0.2% (B2 I) +0.2% (A2 I) +9.4% (B2 II) +9.8% (A2 II)	drier and longer dry seasons

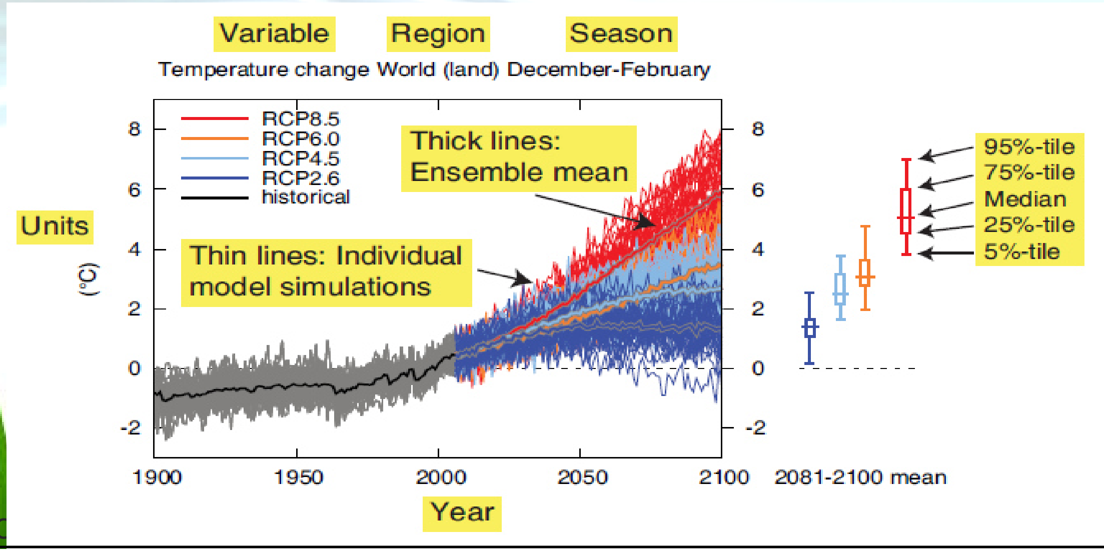
4. Climate projections

- Different climate projections exist and have been analyzed for both basins

➡ to assess future climate change, transboundary cooperation in the selection of an ensemble of suitable climate projections is desirable

5. Projections of IPCC AR5

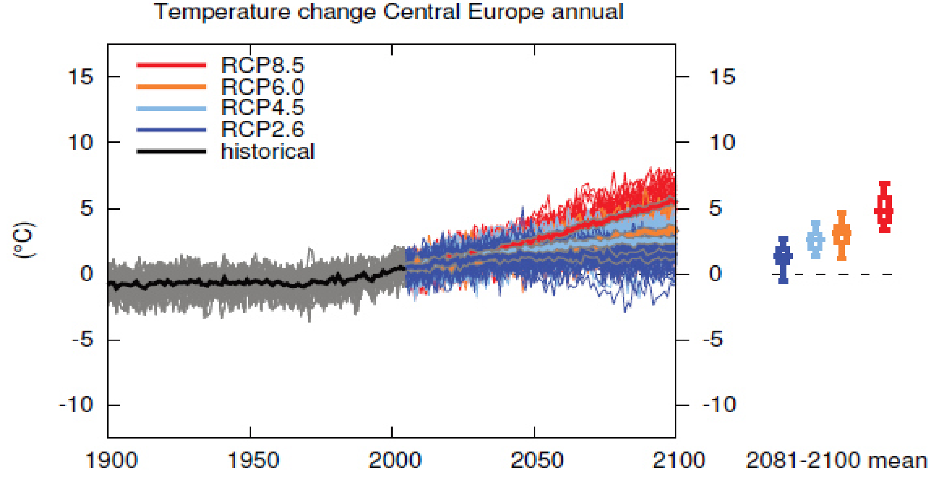
- IPCC’s Fifth Assessment Report provides results of most recent and comprehensive global climate modelling



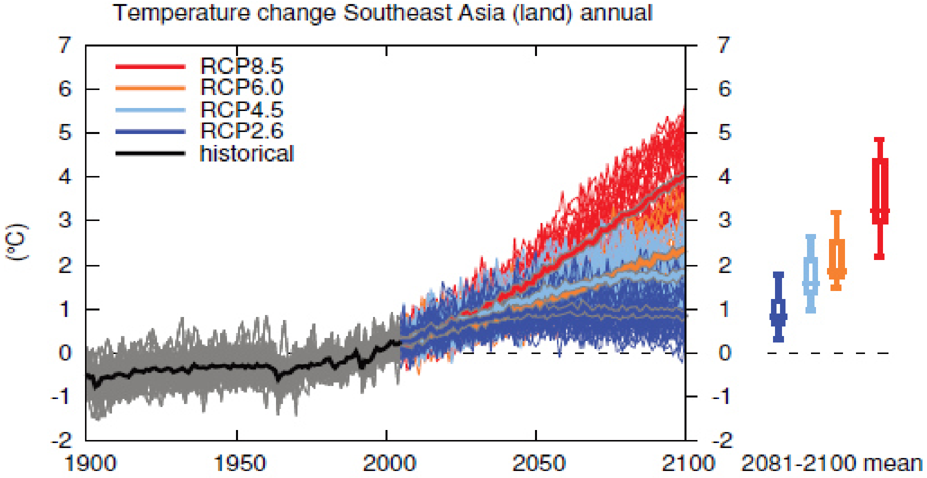
IPCC 2013

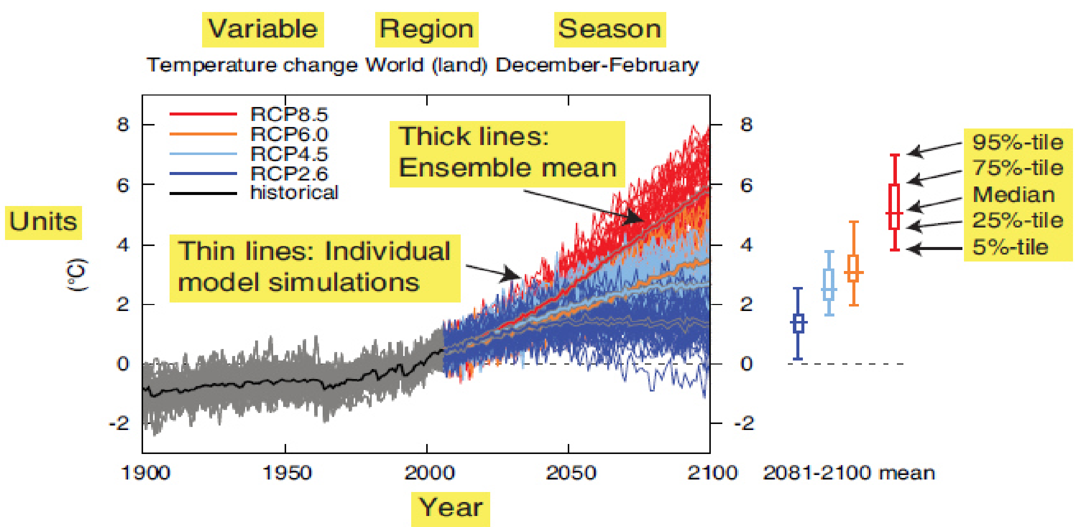
5. Projections of IPCC AR5

Central Europe



South East Asia

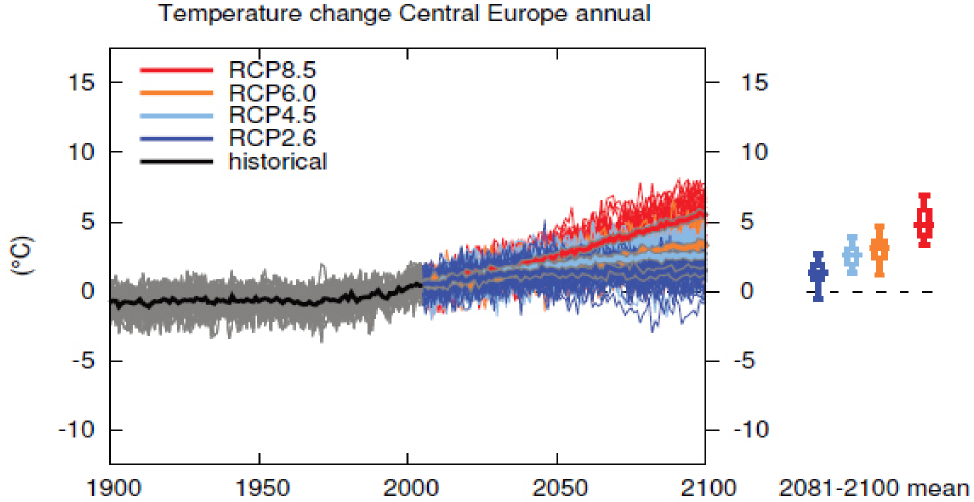


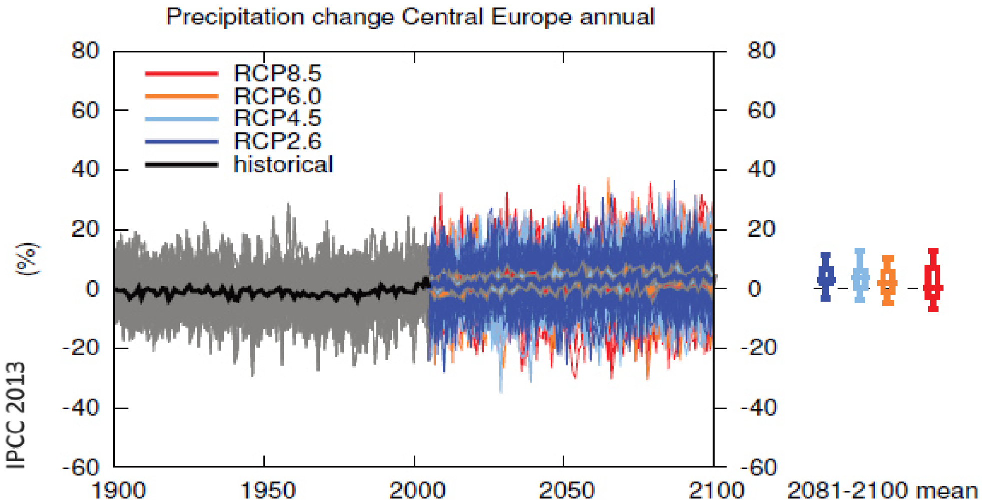


IPCC 2013

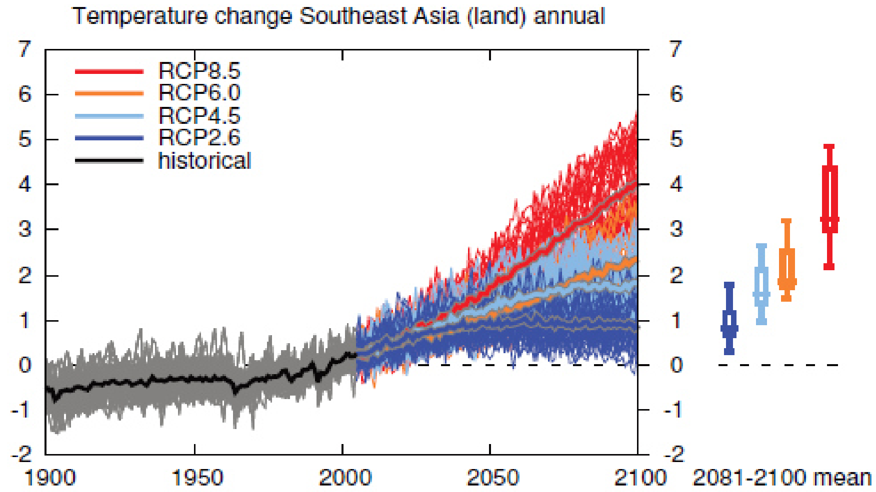
5. Projections of IPCC AR5

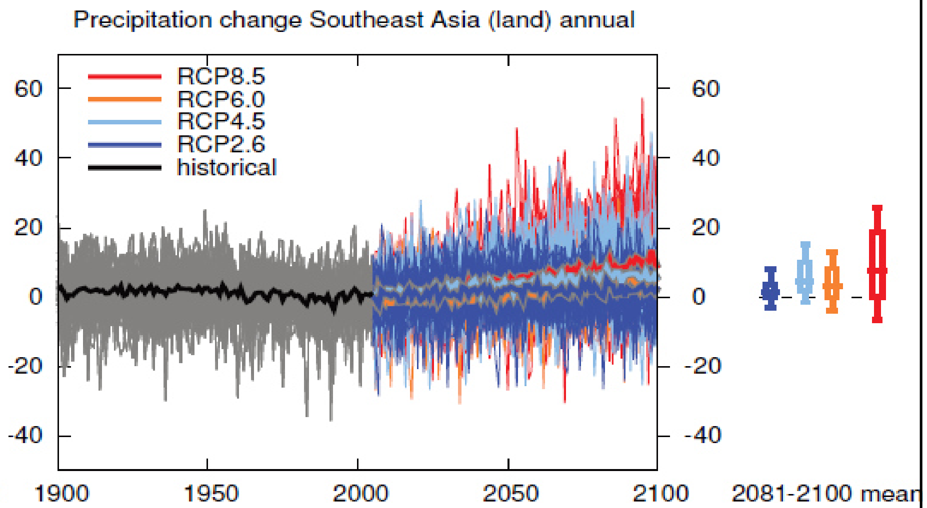
Central Europe





South East Asia

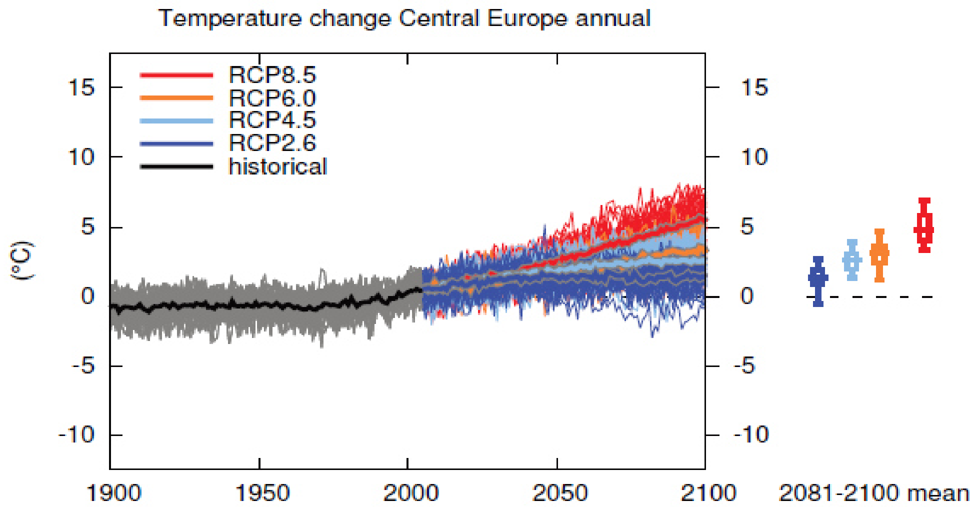


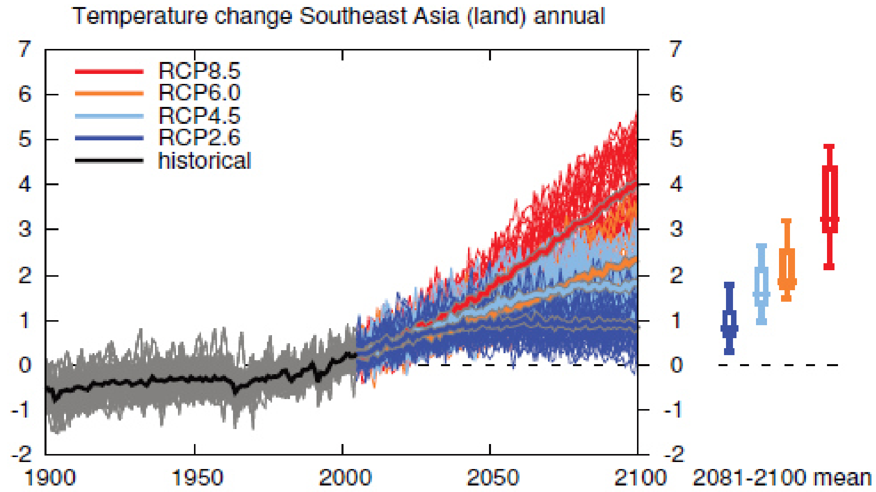


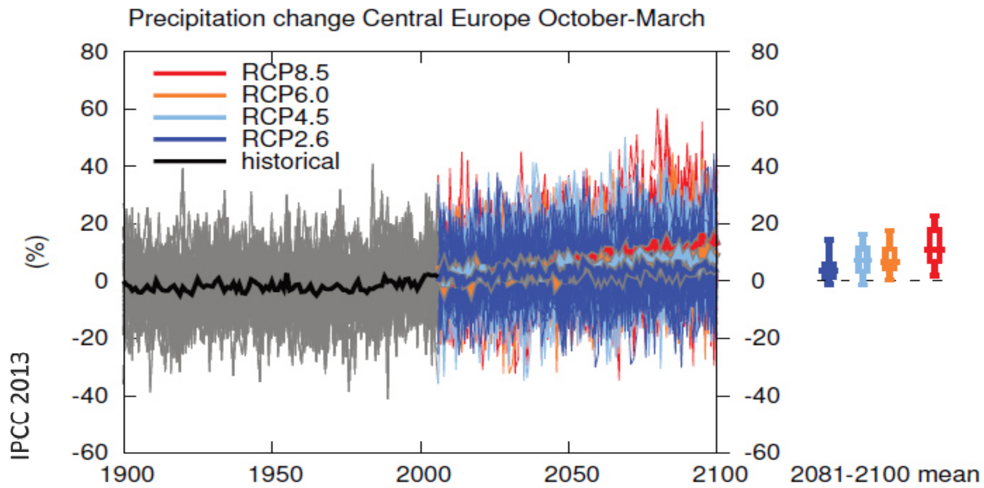
5. Projections of IPCC AR5

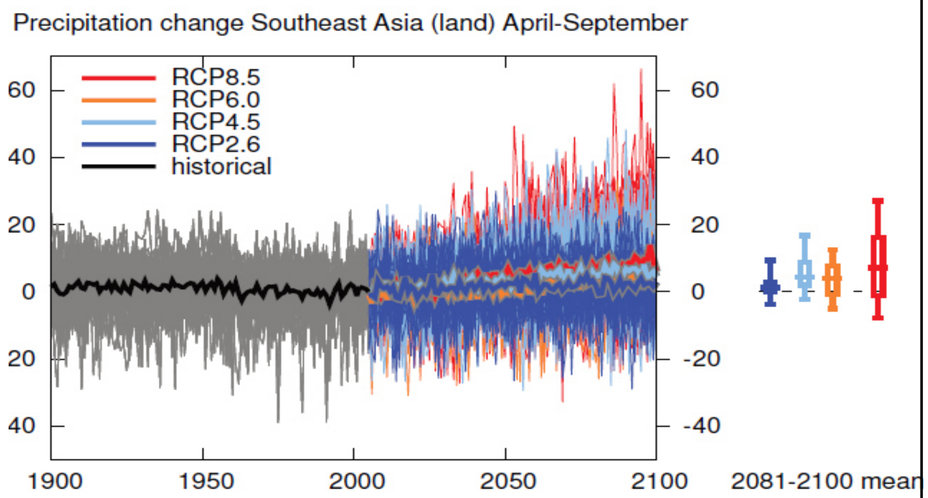
Central Europe

South East Asia





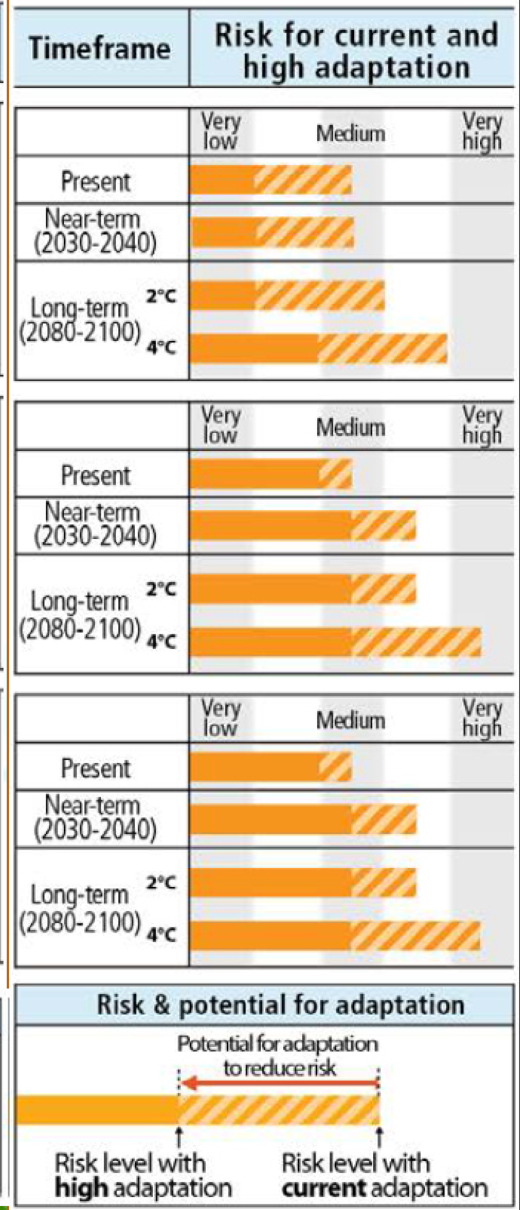




6. Impacts projected in IPCC AR5

Europe

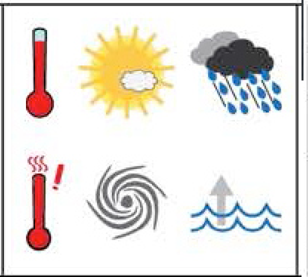
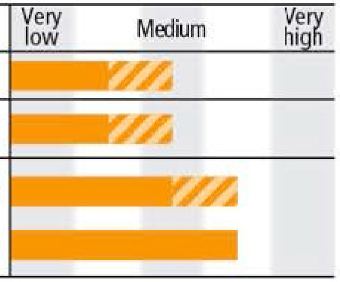
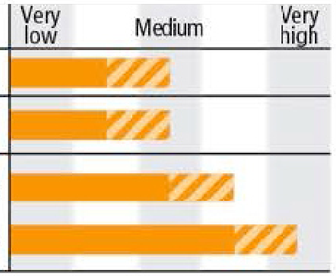
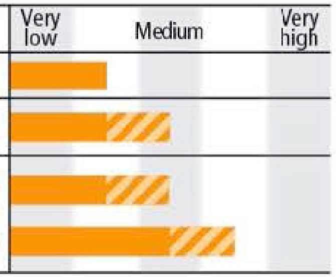
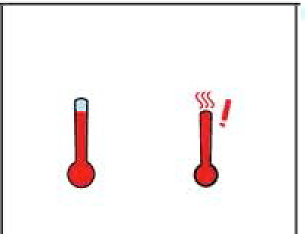
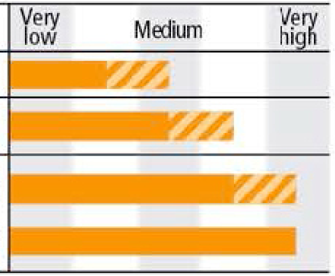
Key risk	Adaptation issues and prospects	Climatic drivers
Increased economic losses and people affected by flooding in river basins and coasts, driven by increasing urbanisation and by increasing sea-levels and increasing peak river discharges (*high confidence*)	Adaptation can prevent most of the projected damages (high confidence). The experience in hard flood protection technologies is significant. Main issues include the high costs for increasing flood protection demand for land in Europe, and environmental and landscape concerns.	Extreme precipitation, Damaging cyclone, Sea level
Increased water restrictions. Significant reduction in water availability from river abstraction and from groundwater resources, combined to increased demands from a range of sectors (irrigation, energy and industry, domestic use) and to reduced water drainage and run-off (as a result of increased evaporative demand) (*high confidence*)	Proven adaptation potential from changes in technologies and adoption of more water efficient technologies and of water saving strategies (irrigation, crop species, land cover, industries, domestic use). Further adaptation possible through solar desalinization (to limit fossil fuel demand).	Extreme temperature, Extreme precipitation
Increased economic losses and people affected by extreme heat events: impacts on health, welfare (overheating in buildings), labour productivity, crop production, reduced air quality (*medium confidence*)	Implementation of warning systems, adaptation of dwellings and work places, and transport and energy infratructure. Reductions in emissions to improve air quality. Improved wild fire management.	Extreme temperature



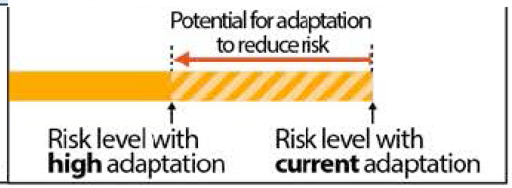
Climatic drivers of impacts

Warming trend	Extreme temperature	Extreme precipitation	Damaging cyclone	Sea level

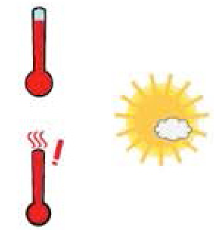
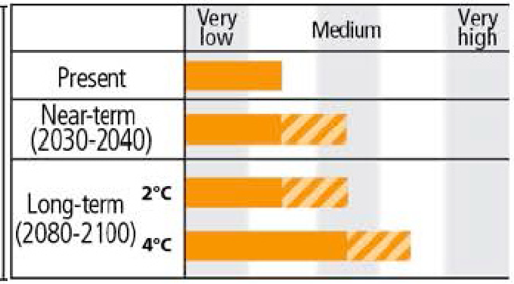
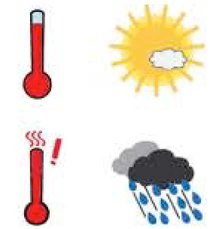
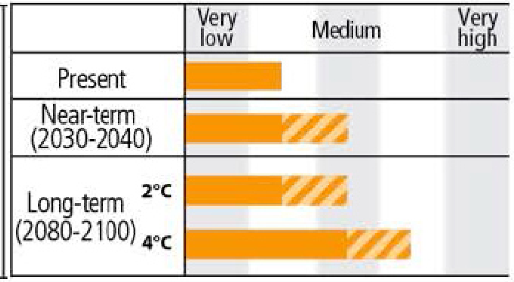
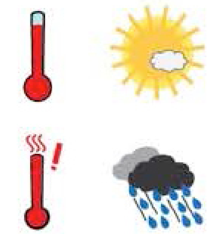
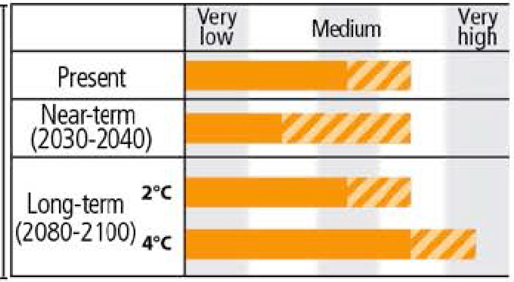
Modified from IPCC 2014

Asia Key risk	Adaptation issues and prospects	Climatic drivers	Timeframe	Risk for current and high adaptation
Increased risk of crop failure and lower crop production could lead to food insecurity in Asia (*medium confidence*)	Autonomous adaptation of farmers on-going in many parts of Asia.		Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	
Increased flooding leading to widespread damage to infrastructure and settlements in Asia (*medium confidence*)	Adaptation measures include extreme weather exposure reduction via effective land-use planning, selective relocation and structural measures; reduction in the vulnerability of lifeline infrastructure and services (water, energy, waste management, food, biomass, mobility, local ecosystems and telecommunications) and measures to assist vulnerable sectors and households.		Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	
Increased risk of flood-related deaths, injuries, infectious diseases and mental disorders (*medium confidence*)	Disaster preparedness including early-warning systems and local coping strategies.		Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	
Increased risk of heat-related mortality (*high confidence*) Modified from IPCC 2014	Heat health-warning systems, urban planning to reduce heat islands and improvement of built environment.		Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	

Climatic drivers of impacts



6. Impacts projected in IPCC AR5

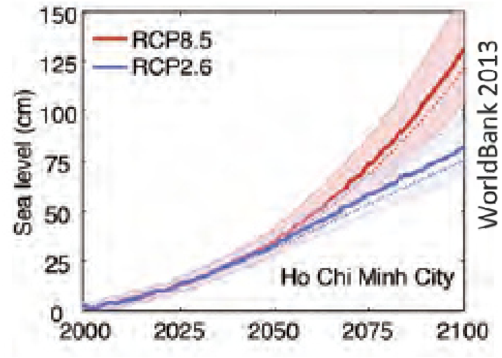
Asia Key risk	Adaptation issues and prospects	Climatic drivers	Timeframe / Risk for current and high adaptation
Increased risk of drought-related water and food shortage causing malnutrition (*high confidence*)	Disaster preparedness including early-warning systems and local coping strategies.		
Increased risk of water and vector-borne diseases (*medium confidence*)	Early-warning systems, vector control programs, water management and sanitation programs.		
Exacerbated poverty, inequalities and new vulnerabilities (*high confidence*)	Insufficient emphasis and limited understanding on urban poverty, interaction between livelihoods, poverty and climate change.		

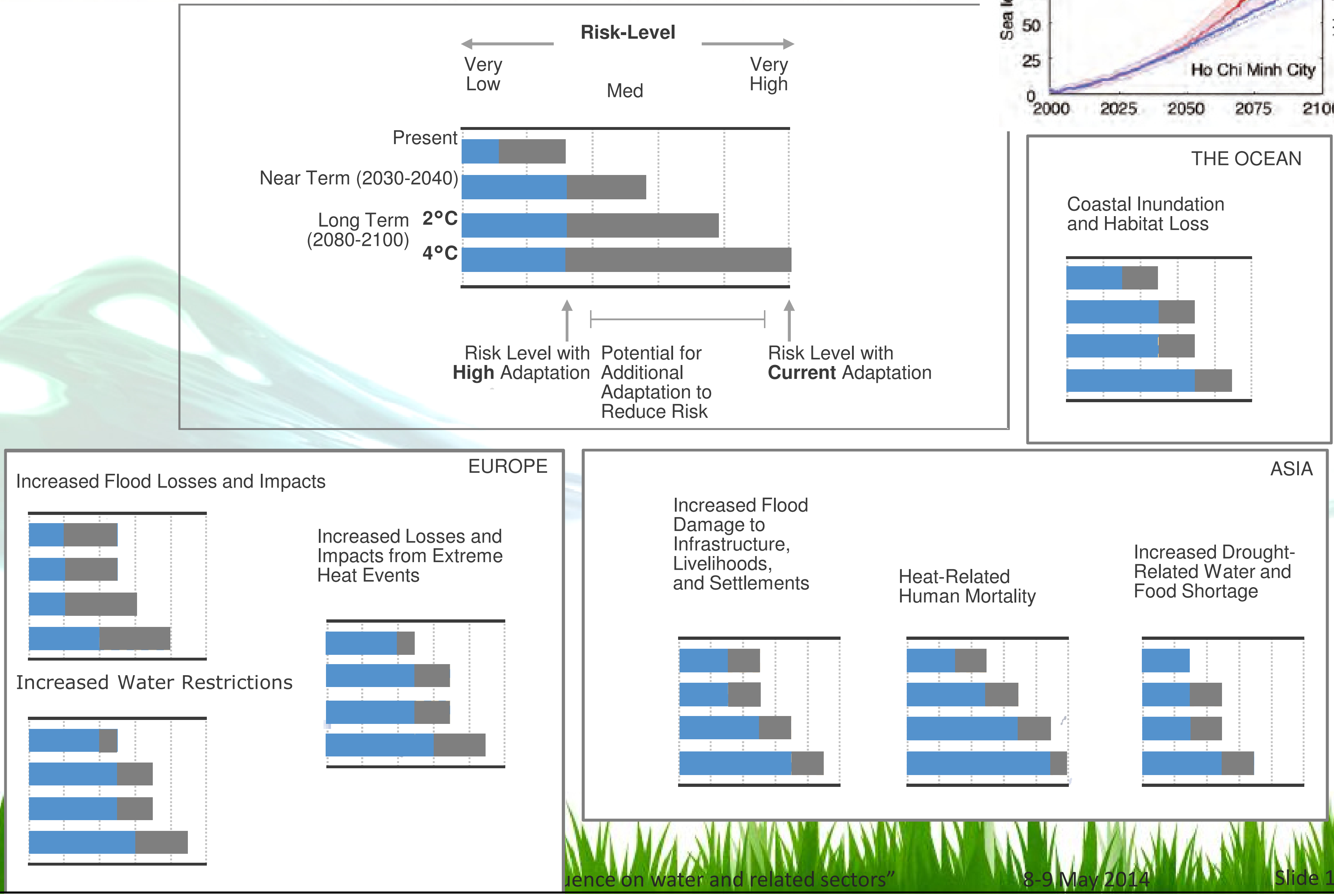
Modified from IPCC 2014

Climatic drivers of impacts

Risk & potential for adaptation

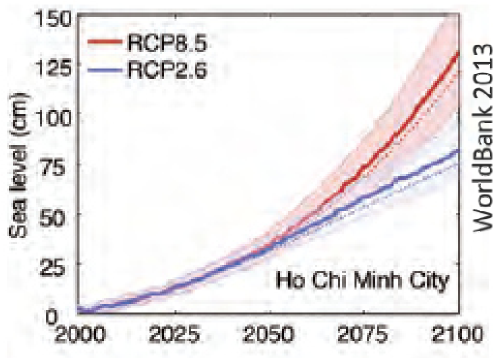
6. Impacts projected in IPCC AR5

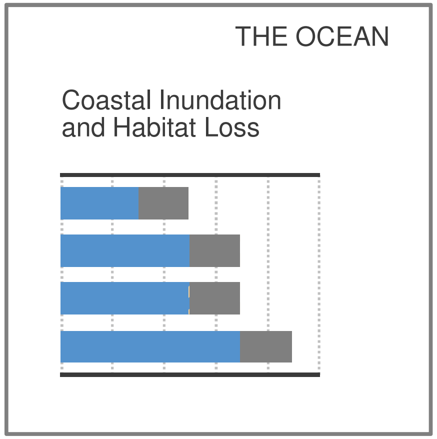


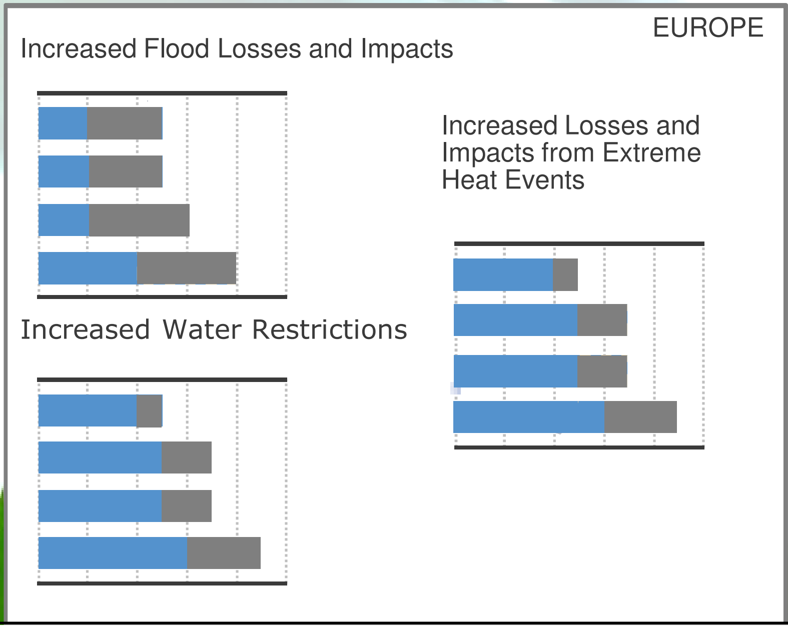


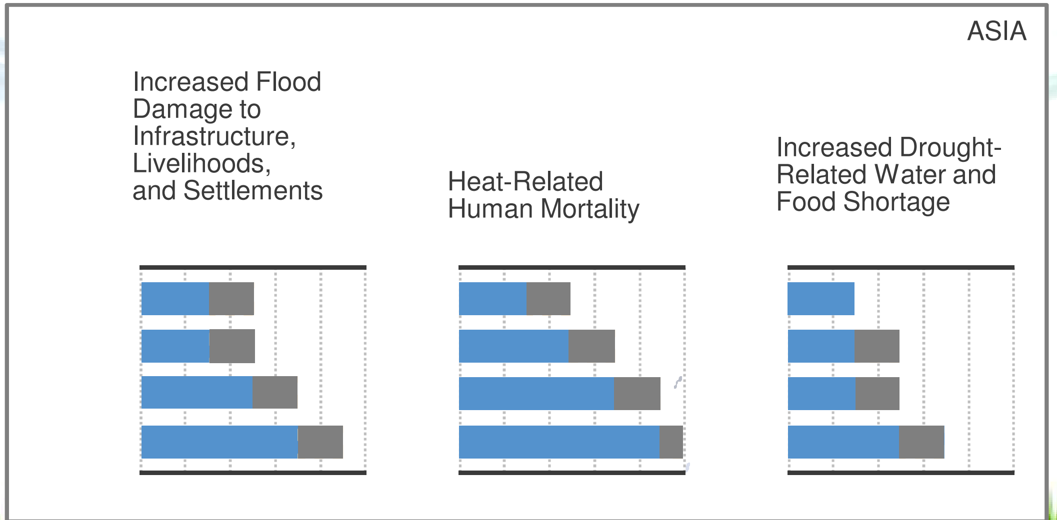
6. Impacts projected in IPCC AR5

- Hazards are similar, but risks in Europe are of more economic nature, while in South East Asia risks of more substantial nature (life, health) are a major concern



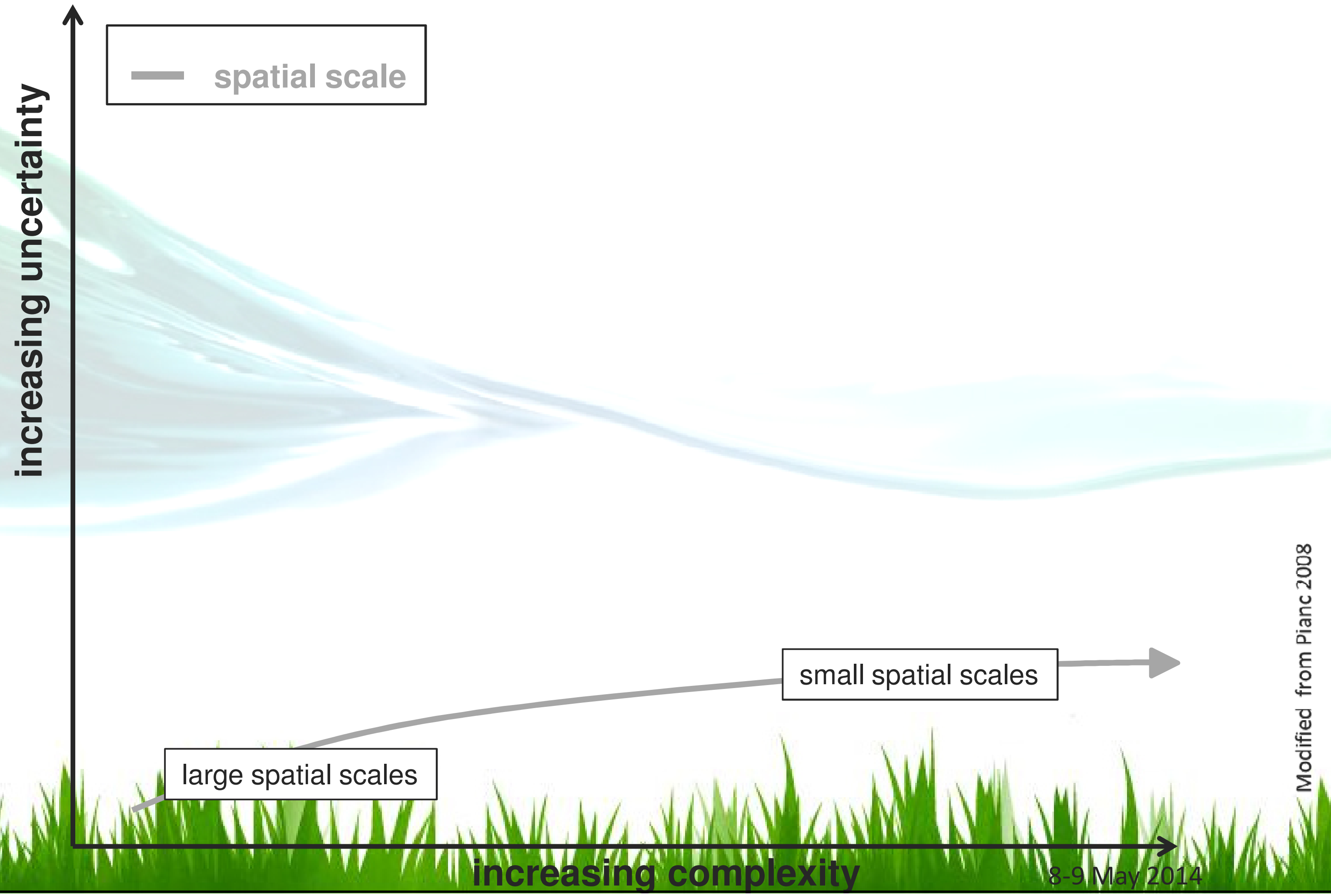






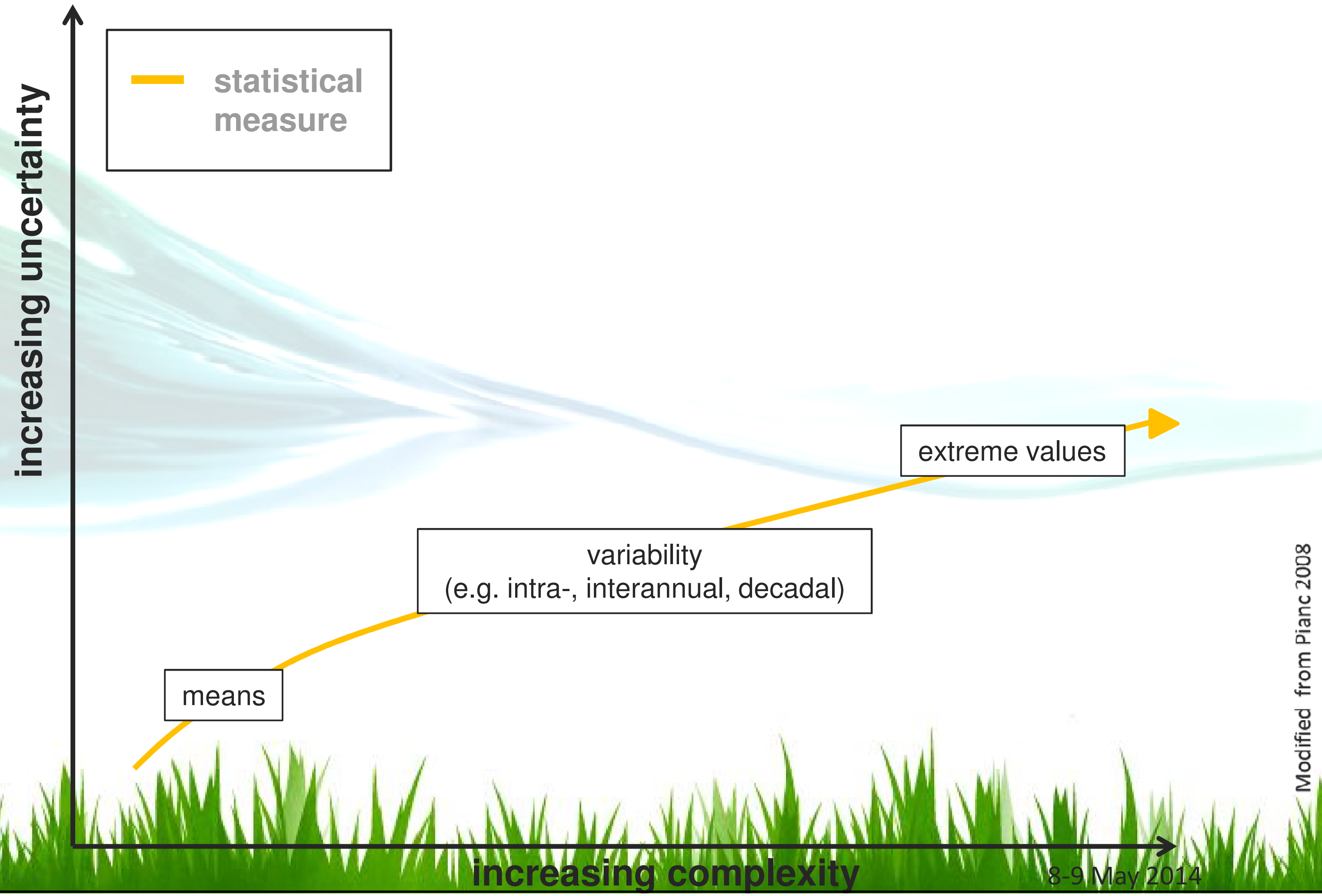
7. Uncertainty and complexity

- To obtain regional climate projections is more complex ("downscaling") and regional assessment of climate change contains larger uncertainties



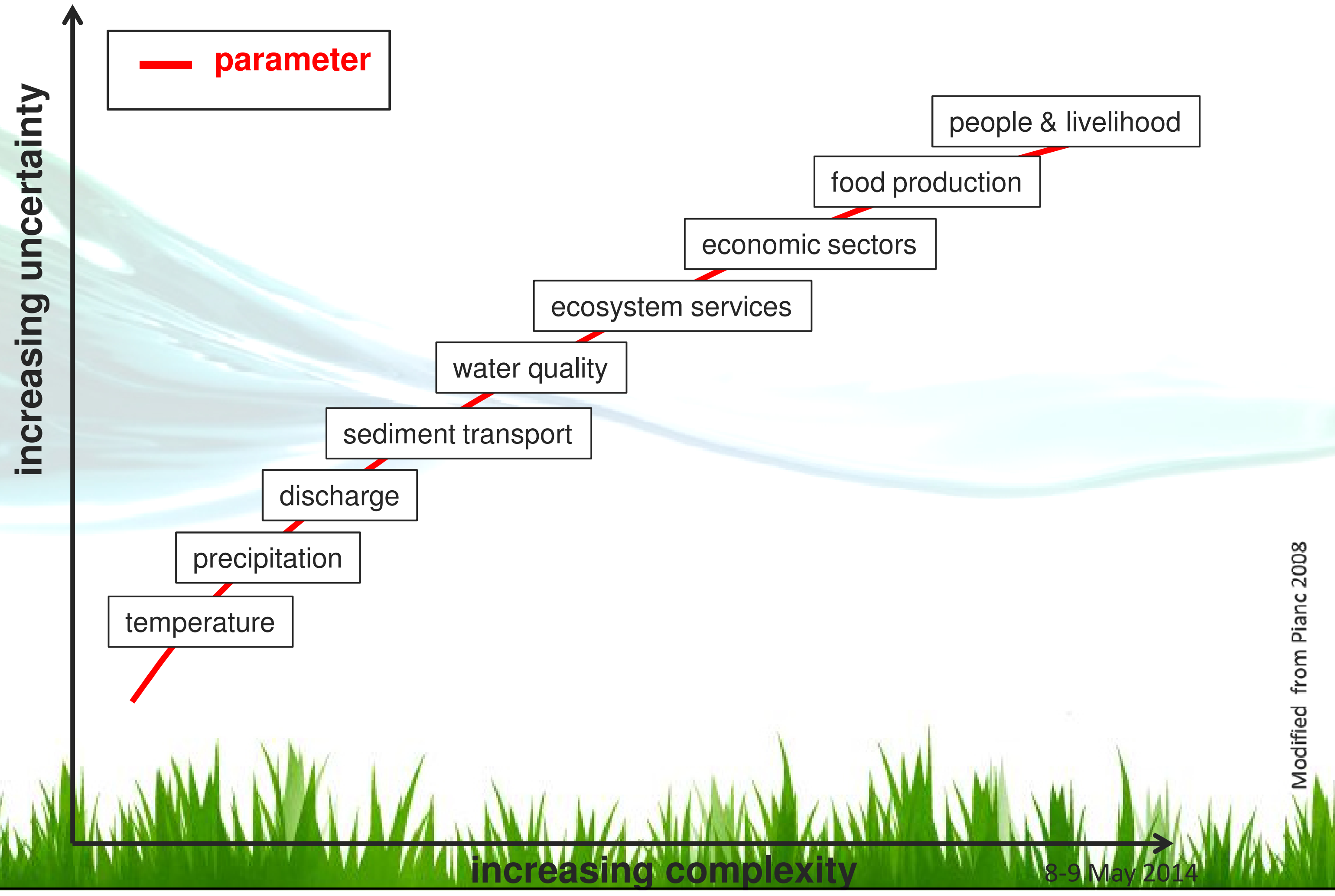
7. Uncertainty and complexity

- For effective adaptation, projections of extremes are sought for; related uncertainty has to be borne in mind

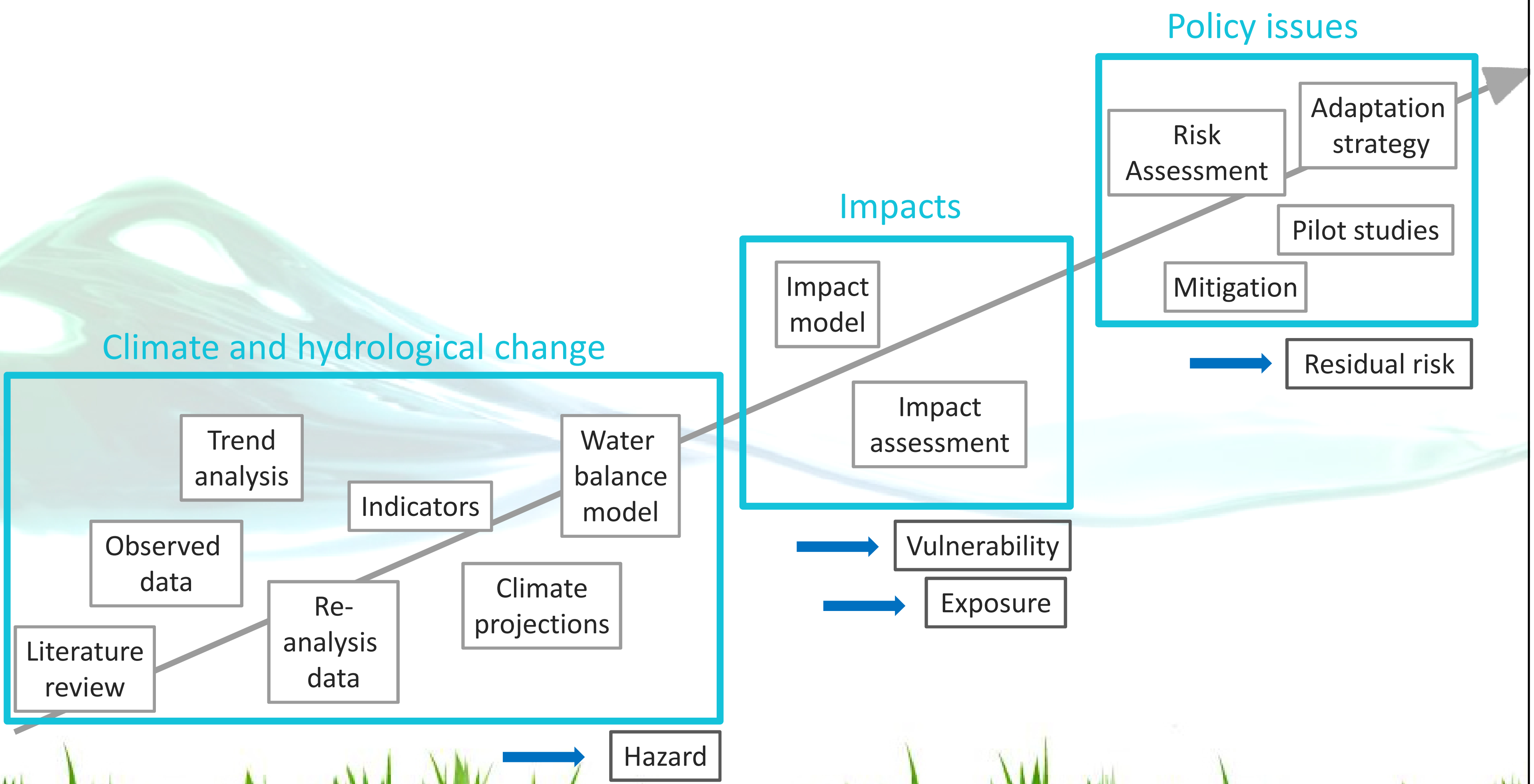


7. Uncertainty and complexity

- The approach to adaptation consists of numerous steps; associated uncertainty may cascade



8. Approach to basin-wide adaptation



8. Approach to basin-wide adaptation

Climate & hydrological change

- **Literature review** — ICPR 2009; MRC-CCAI
- **Observed data** — KLIWAS HYRAS 2013; MRC-IKMP 2013
- **Trend analysis** — CHR 2007; MRC-CCAI
- **Re-analysis data** — MRC-CCAI
- **Indicators** — UBA DAS 2011; DWD 2012; MRC-CCAI 2013
- **Climate projections** — CHR RheinBlick2050; MRC-CCAI
- **Water balance model** — ICPR 2011; BfG 2013; CHR RheinBlick2050; MRC-IKMP 2014

Rhine	Mekong
Completed	Completed
Ongoing	Ongoing

8. Approach to basin-wide adaptation

Impacts

Impact model

KLIWAS Waterways 2013

ICPR Water temperature 2014

ICPR Ecosystem 2013

Impact assessment

MRC-CCAI Food security

MRC-CCAI Ecosystems

MRC SimVa

MRC Drought

MRC Flood

CHR

Further influencing factors: e.g. basin development, hydropower

MRC Basin Development Strategy

Rhine	Mekong
Completed	Completed
Ongoing	Ongoing

8. Approach to basin-wide adaptation

Policy issues

Risk Assessment

Adaptation strategy

- *D 2011*
- *CH 2014*
- ICPR Adaptation strategy
- *EU 2014*
- *NAPA*
- *ICEM ASEAN 2012*
- MRC-CCAI Adaptation strategy

Mitigation

- *UNFCCC*
- *UNFCCC*

Pilot studies

- *Pilot studies*
- GIZ-MRC Upscaling 2013

Rhine	Mekong
Completed	Completed
Ongoing	Ongoing

8. Approach to basin-

Risk Assessment

NAPA

ICEM ASEAN 2012

MRC-CCAI Adaptation strategy

UNFCCC

Mitigation

UNFCCC

Pilot studies

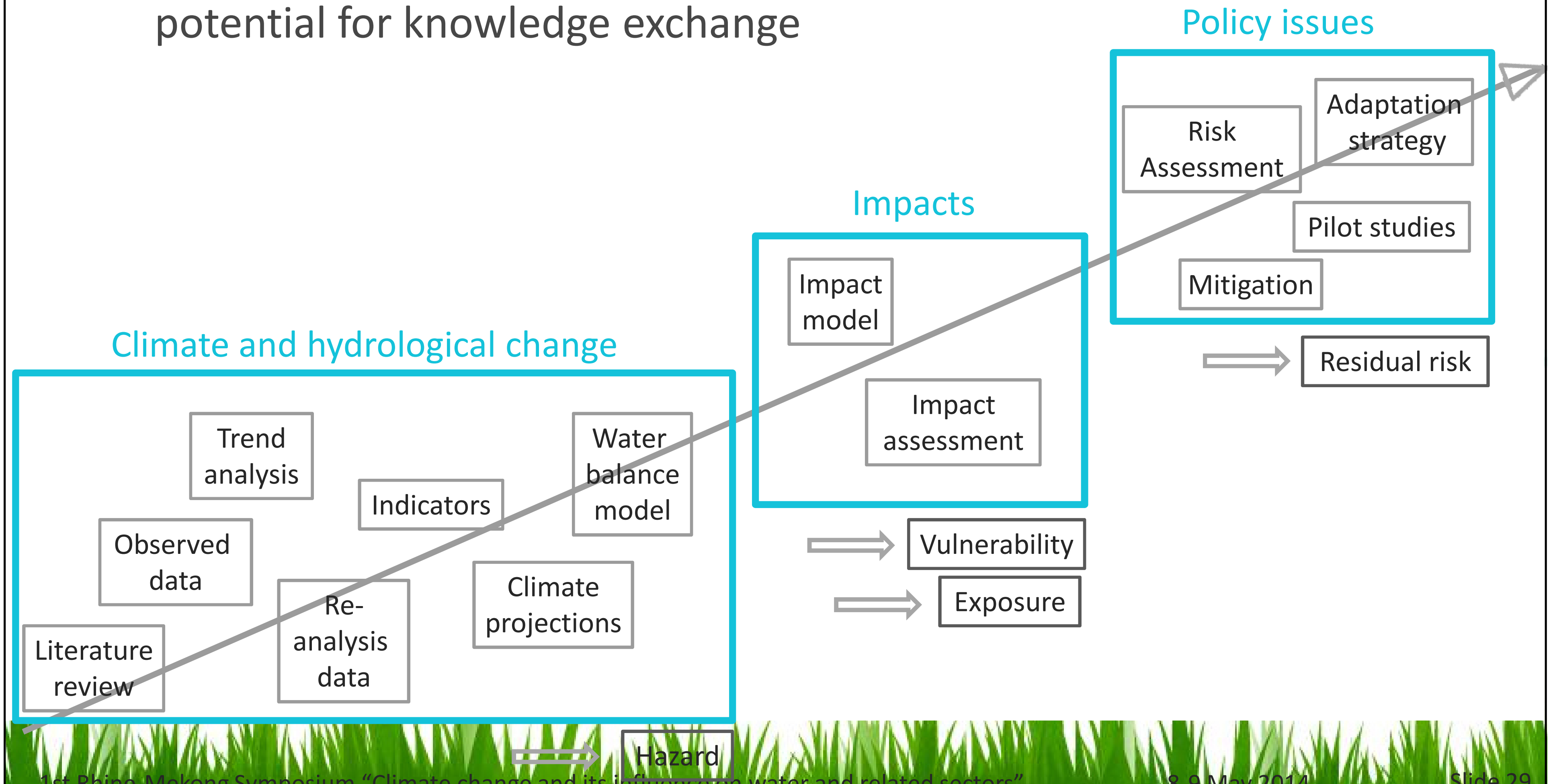
Pilot studies

GIZ-MRC Upscaling 2013

Rhine	Mekong
Completed	Completed
Ongoing	Ongoing

8. Approach to basin-wide adaptation

- Several steps on the way towards adaptation strategies have already been taken in both basins
- Similar approaches may be applied for both basins, which implies potential for knowledge exchange



Summary

- Adaptation to climate change and its impact on water related sectors requires transboundary cooperation
- Climate change is already manifest in temperature records of both basins
- Trends in precipitation so far are much more heterogeneous
- Results for future climate change feature equivocally further temperature increases for both basins, heterogeneity of precipitation projections is large for both basins
- Hazards are similar, but resulting risk may be of more substantial nature in the LMB
- For coordinated adaptation, harmonization of both, data analysis and climate modelling within the basin is desirable
- Approach towards adaptation strategy consists of these and further steps
- Several steps on the way towards adaptation strategies have already been taken in both basins
- Similar approaches may be applied for both basins, which implies potential for knowledge exchange
- The uncertainties should not stop decisions being made.

Thank you for your attention!

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