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

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May 9, 2014

HYDRON UMWELT und WASSERWIRTSCHAFT

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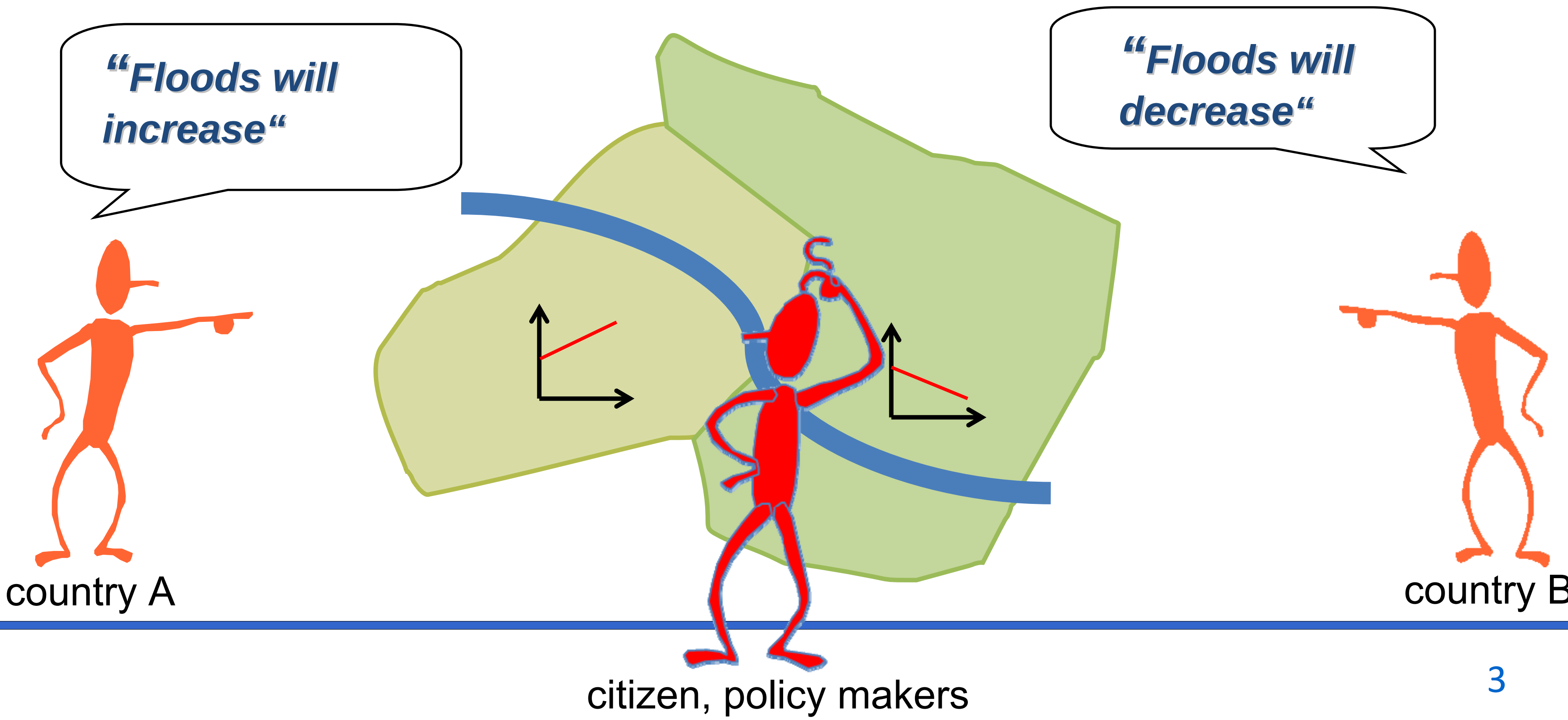
8. Summary

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



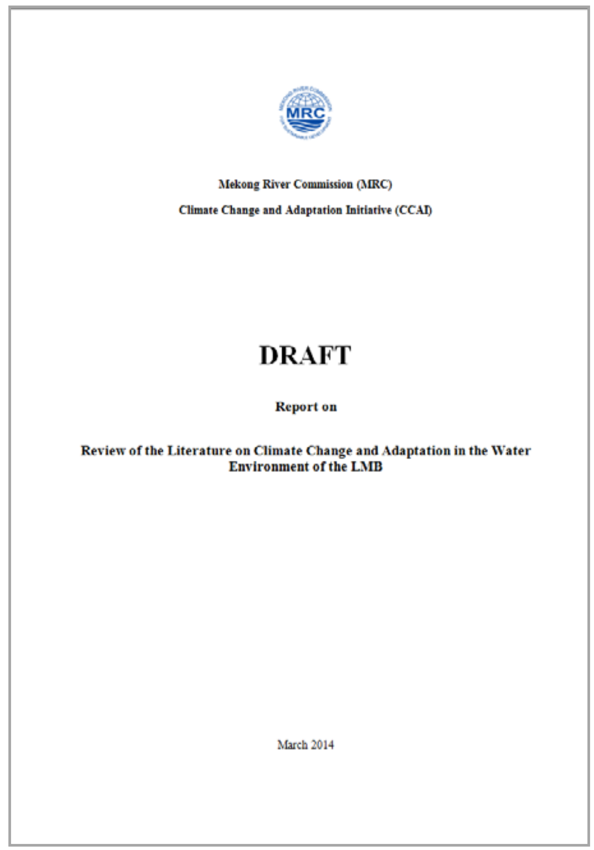
1. Common knowledge base

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

ICPR

ICPR 2009

MRC

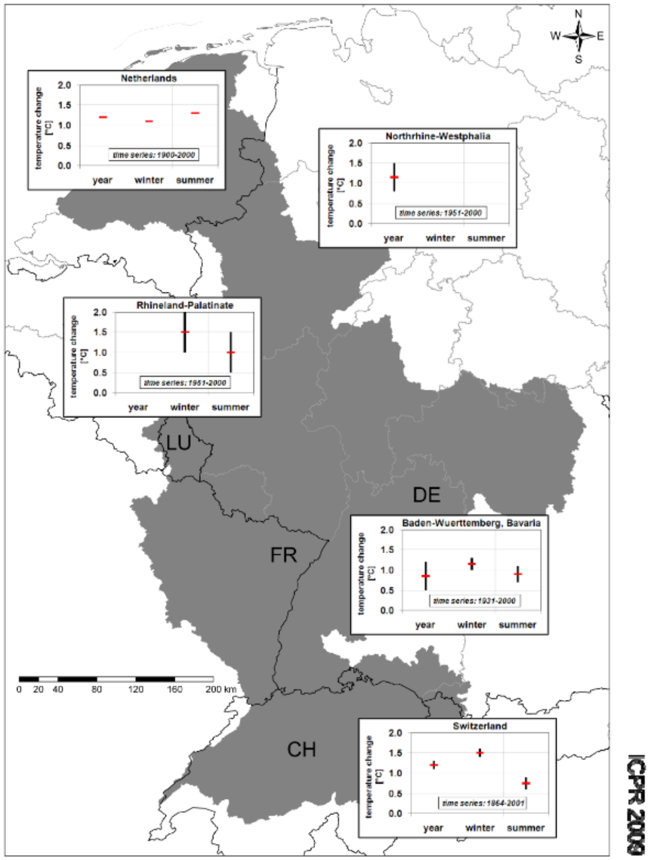


MRC CCAI 2014

2. Observed changes

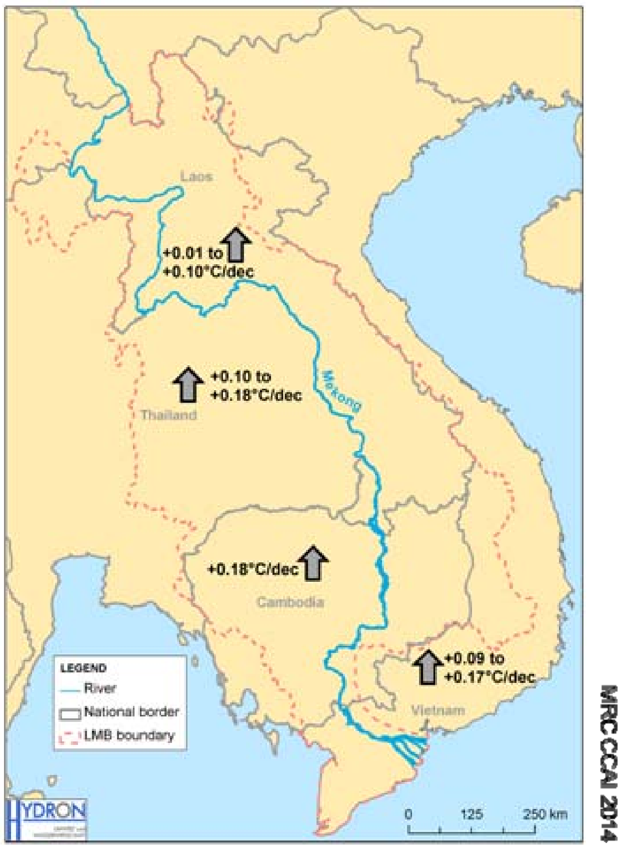
- Climate change is already observable in temperature records
- Increase ranges are similar in the Rhine and Mekong basin (+0.08 to +0.18°C/decade)

ICPR



Changes of air temperature (average, minima and maxima)

MRC



Changes of annual air temperature [°C/decade]

2. Observed changes

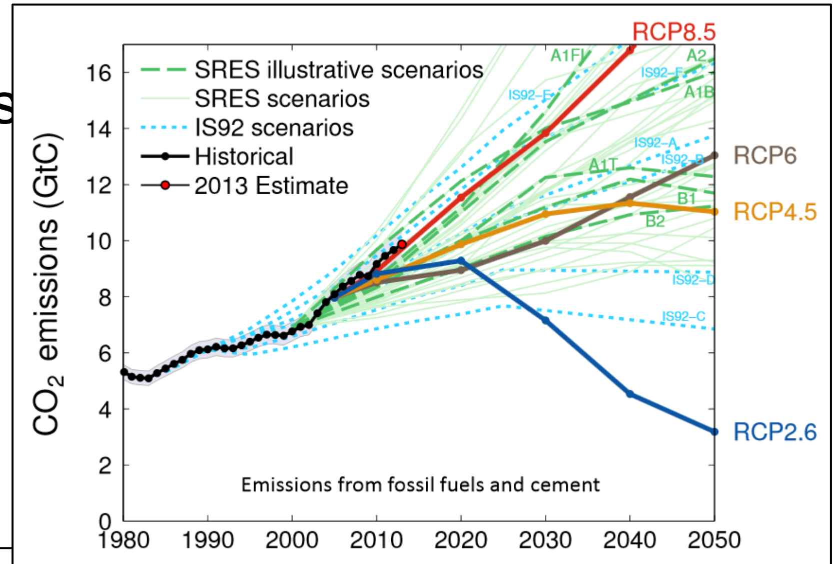
- Also sea level rise is already observable
- Climate change is already observable in temperature records, but trends are heterogeneous in time and space
- Heterogeneity represents inherent spatial variability of climate change
- But there are also differences in underlying data basis (e.g. data quality, 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.

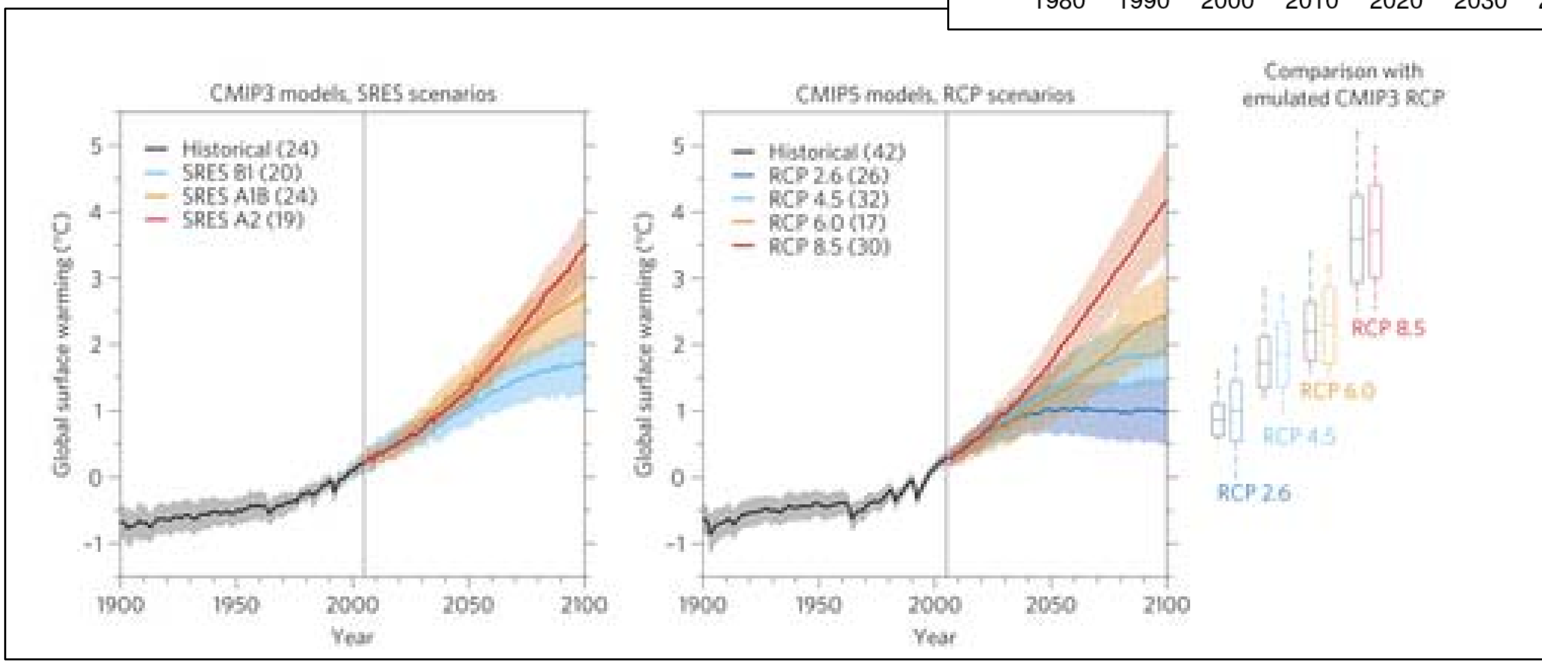
3. Climate projections

- Climate modelling is applied to as

Atmospheric greenhouse gas concentrations
Emission scenario



Le Quéré et al. 2013



Knutti & Sedláček 2013

3. Climate projections

- Climate modelling is applied to assess future climate change

<u>Atmospheric greenhouse gas concentrations</u>
Emission scenario

→

<u>Global climate model (GCM)</u>
(complex, feedback climate system)

→

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

→

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

HSG 2012

3. Climate projections

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

MRC

ICPR

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

	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 [illegible] 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.[illegible]% (A2 II)	drier and longer dry seasons

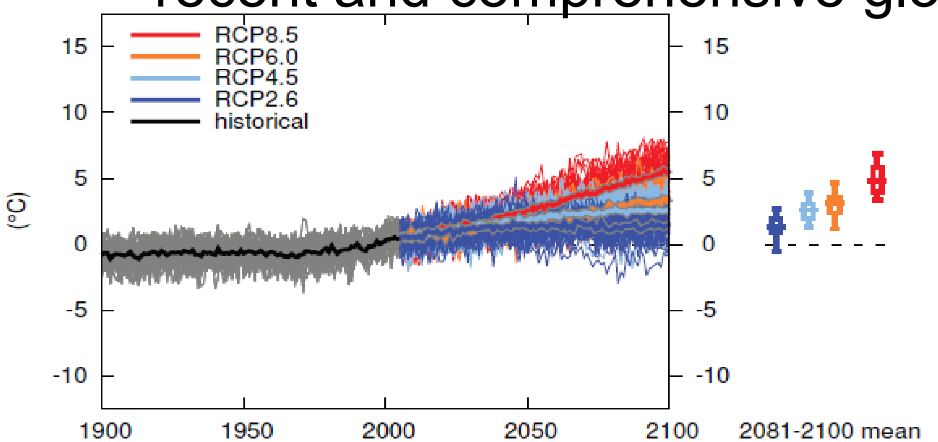
ICPR 2009

MRC CCAI 2013

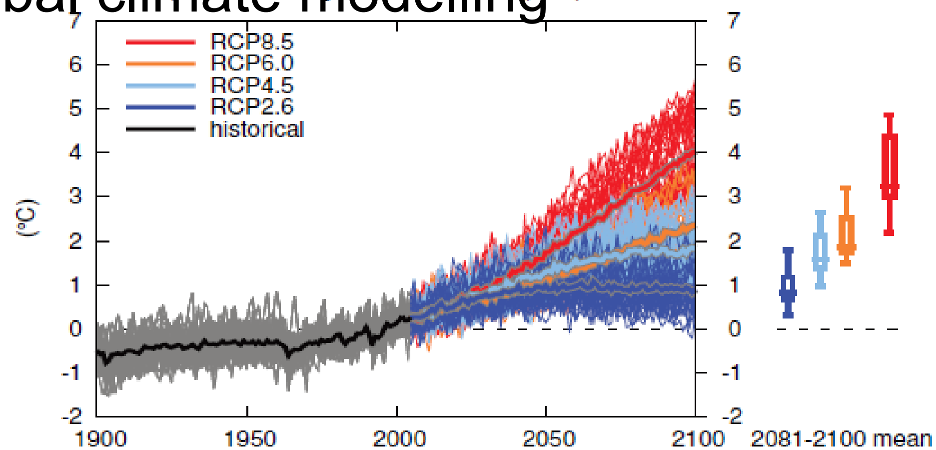
4. Projections of IPCC AR5

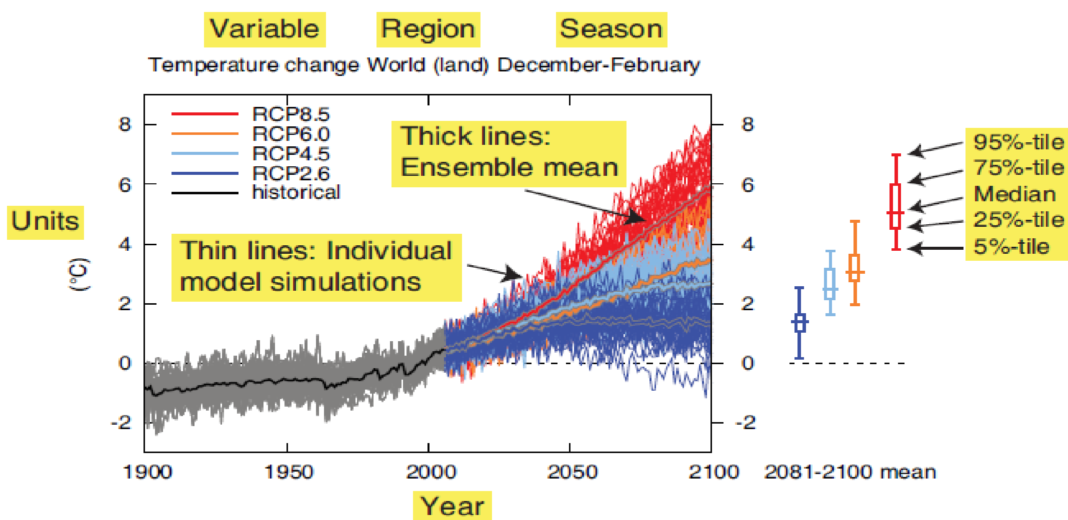
- IPCC's Fifth Assessment Report provides results of most recent and comprehensive global climate modelling

Central Europe



South East Asia



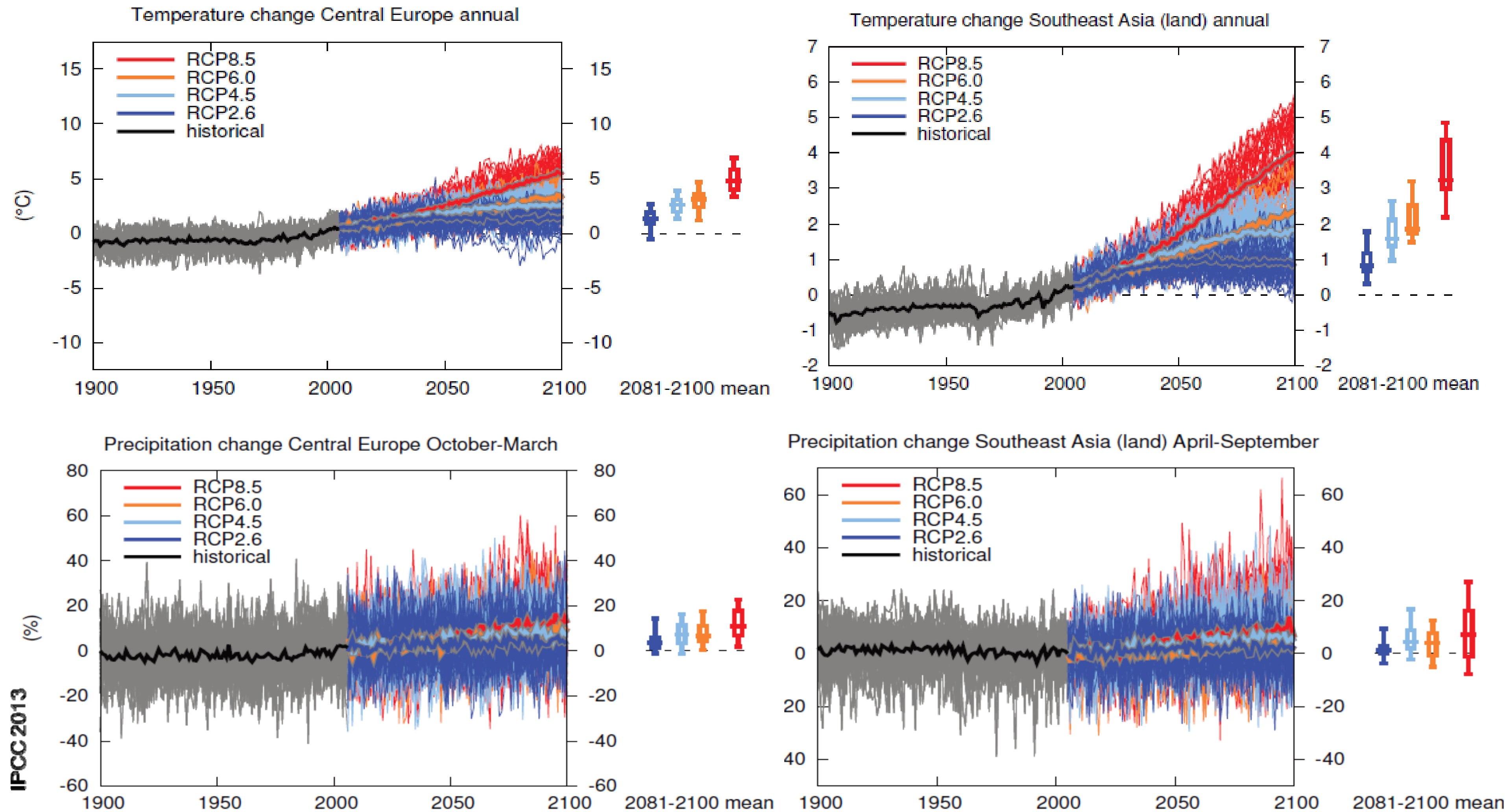


IPCC 2013

4. Projections of IPCC AR5

Central Europe

South East Asia



5. Risks projected in IPCC AR5

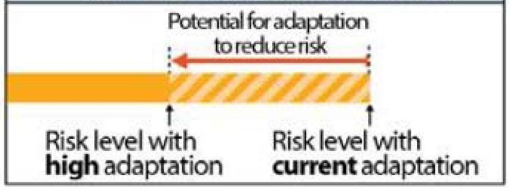
Europe

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.	
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).	
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.	

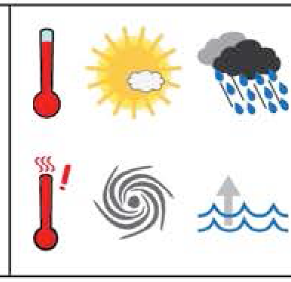
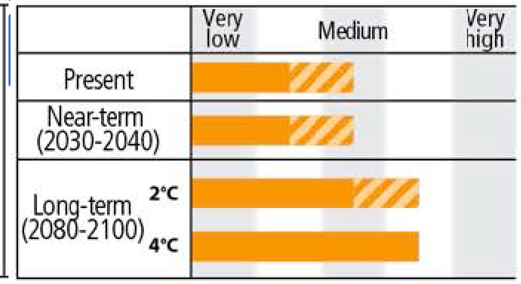
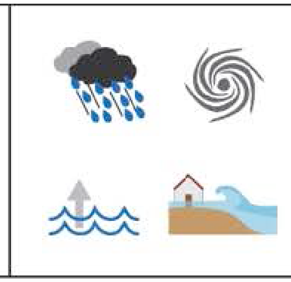
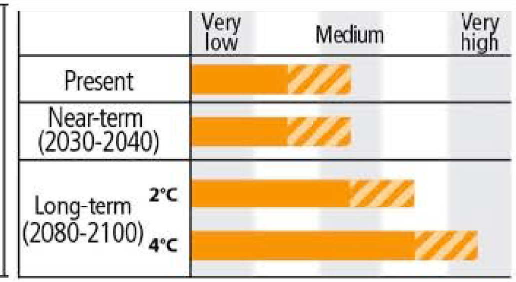
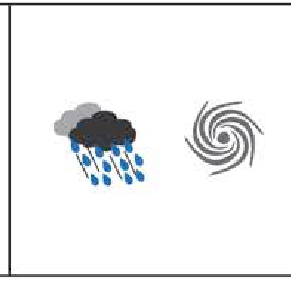
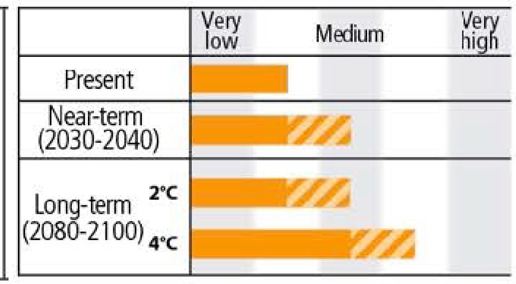
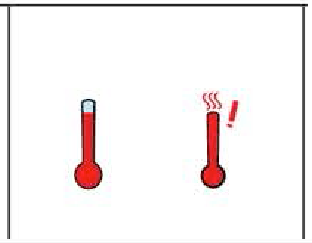
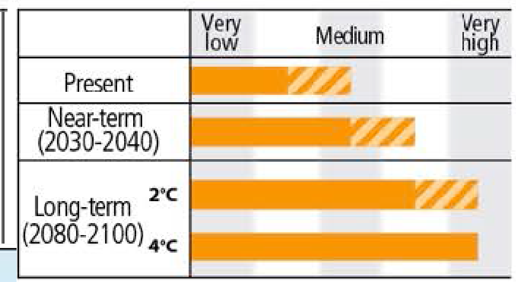
Timeframe	Risk for current and high adaptation
	Very low — Medium — Very high
Present	
Near-term (2030-2040)	
Long-term (2080-2100) 2°C	
Long-term (2080-2100) 4°C	

Climatic drivers of impacts				
Warming trend	Extreme temperature	Extreme precipitation	Damaging cyclone	Sea level

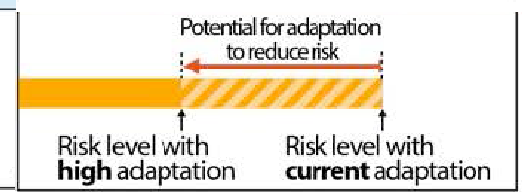
Risk & potential for adaptation



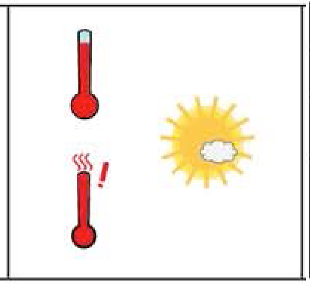
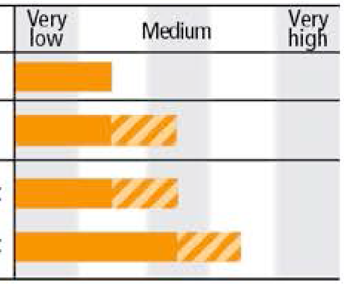
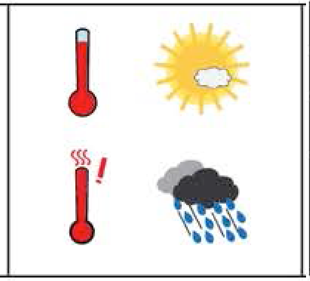
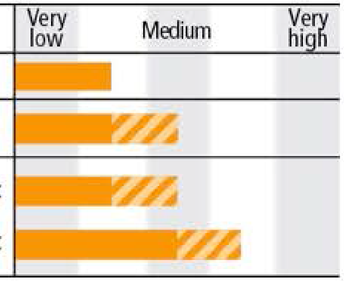
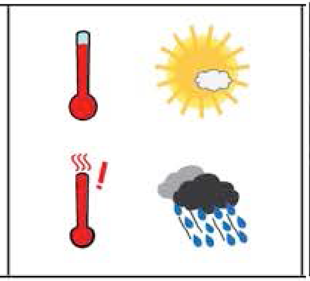
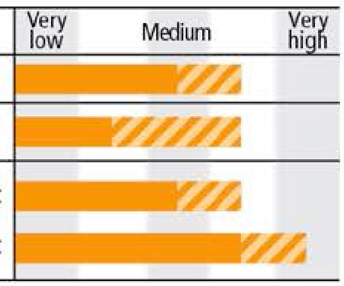
Modified from IPCC 2014

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.		
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.		
Increased risk of flood-related deaths, injuries, infectious diseases and mental disorders (*medium confidence*)	Disaster preparedness including early-warning systems and local coping strategies.		
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.		

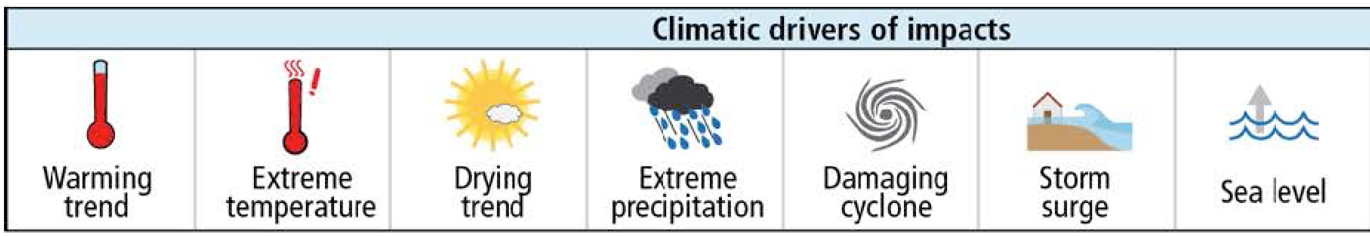
Climatic drivers of impacts

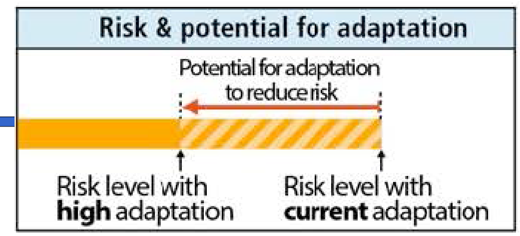


5. Risks projected in IPCC AR5

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.		Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	
Increased risk of water and vector-borne diseases (*medium confidence*)	Early-warning systems, vector control programs, water management and sanitation programs.		Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	
Exacerbated poverty, inequalities and new vulnerabilities (*high confidence*)	Insufficient emphasis and limited understanding on urban poverty, interaction between livelihoods, poverty and climate change.		Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	

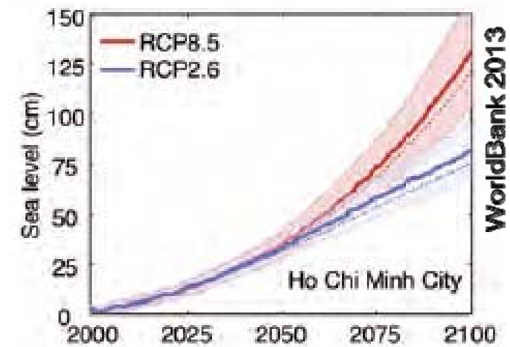
Modified from IPCC 2014

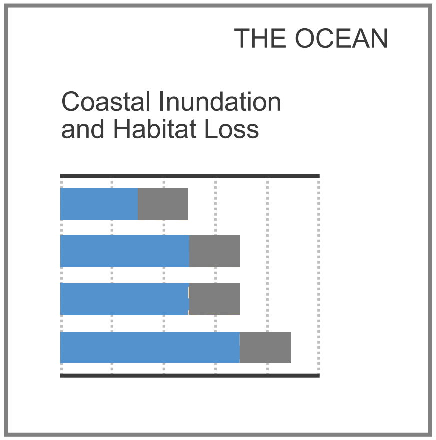


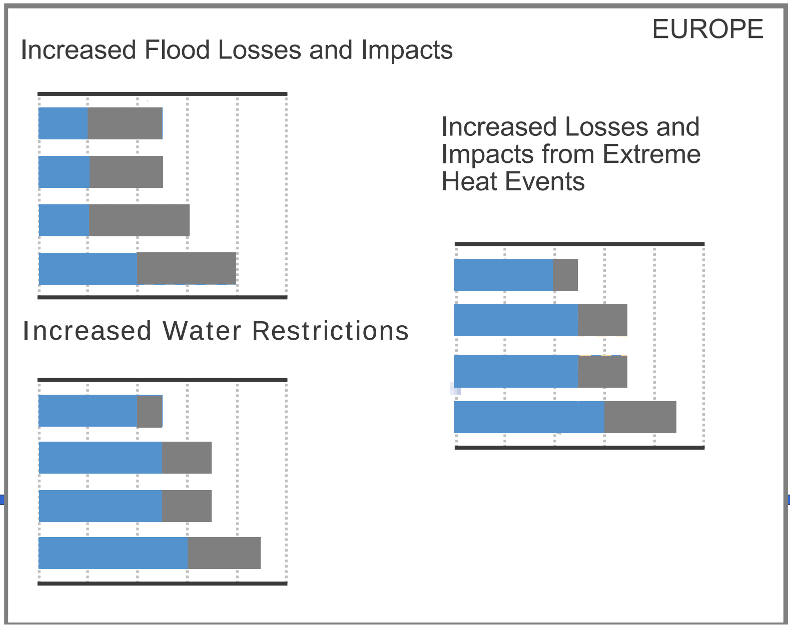


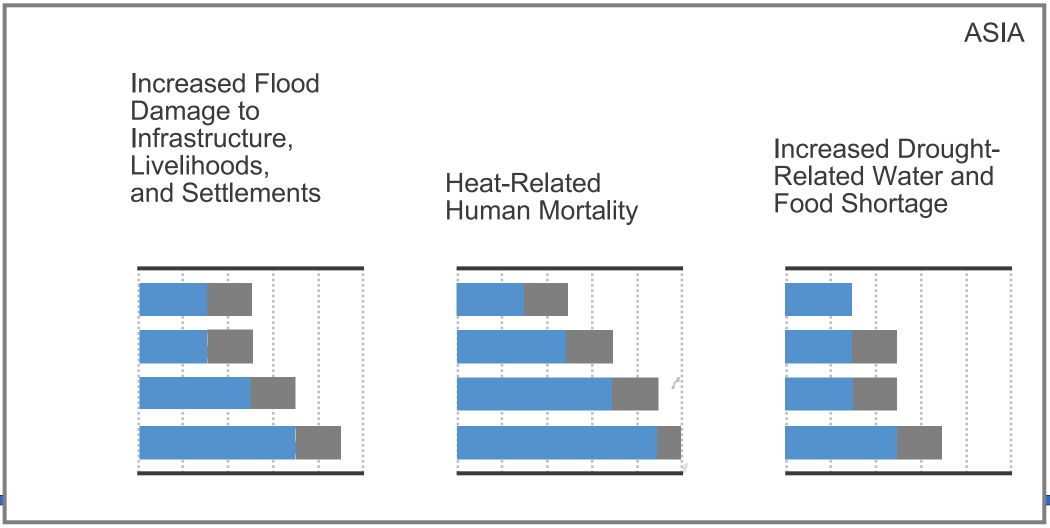
5. Risks projected in IPCC

- 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



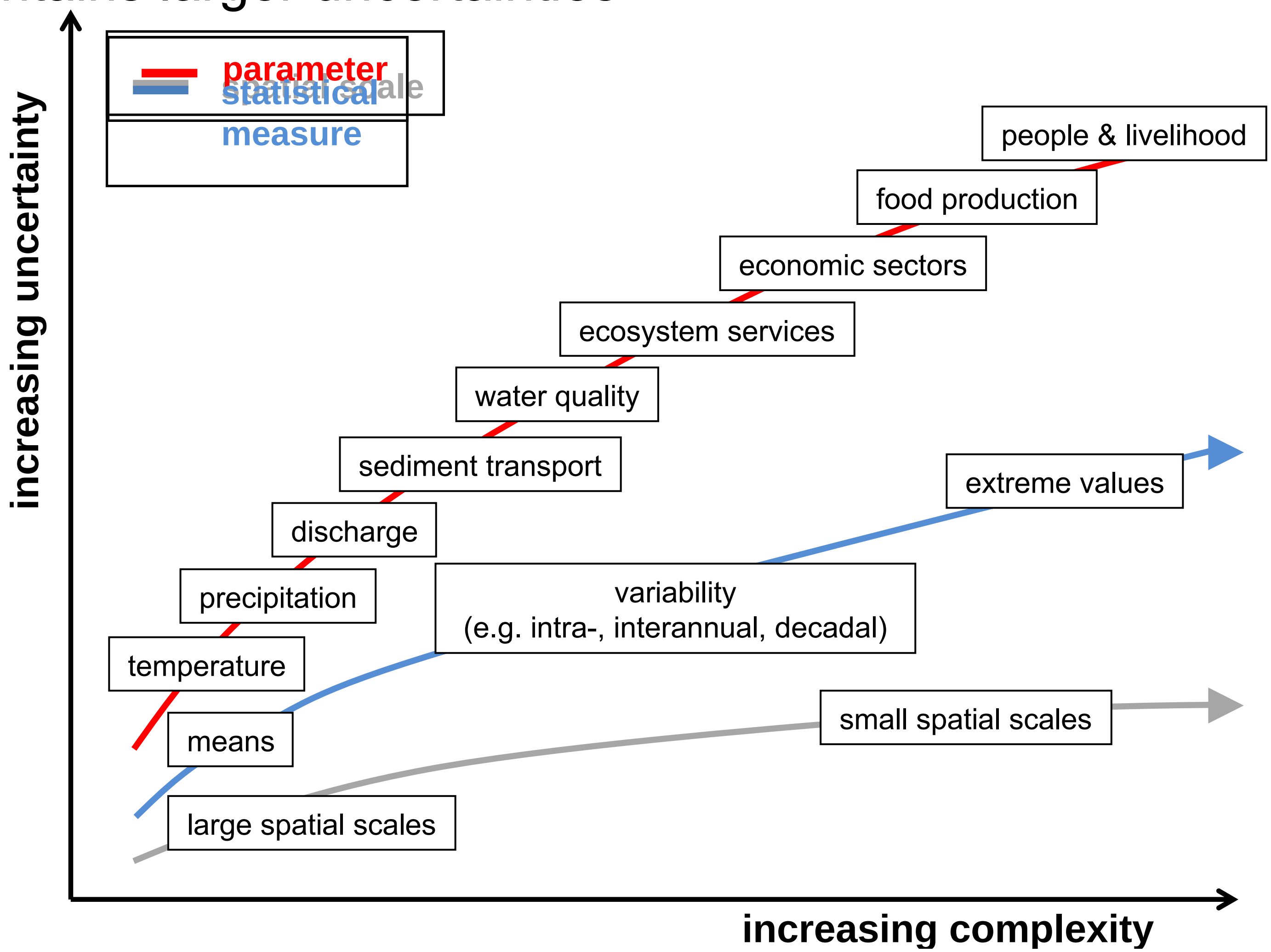






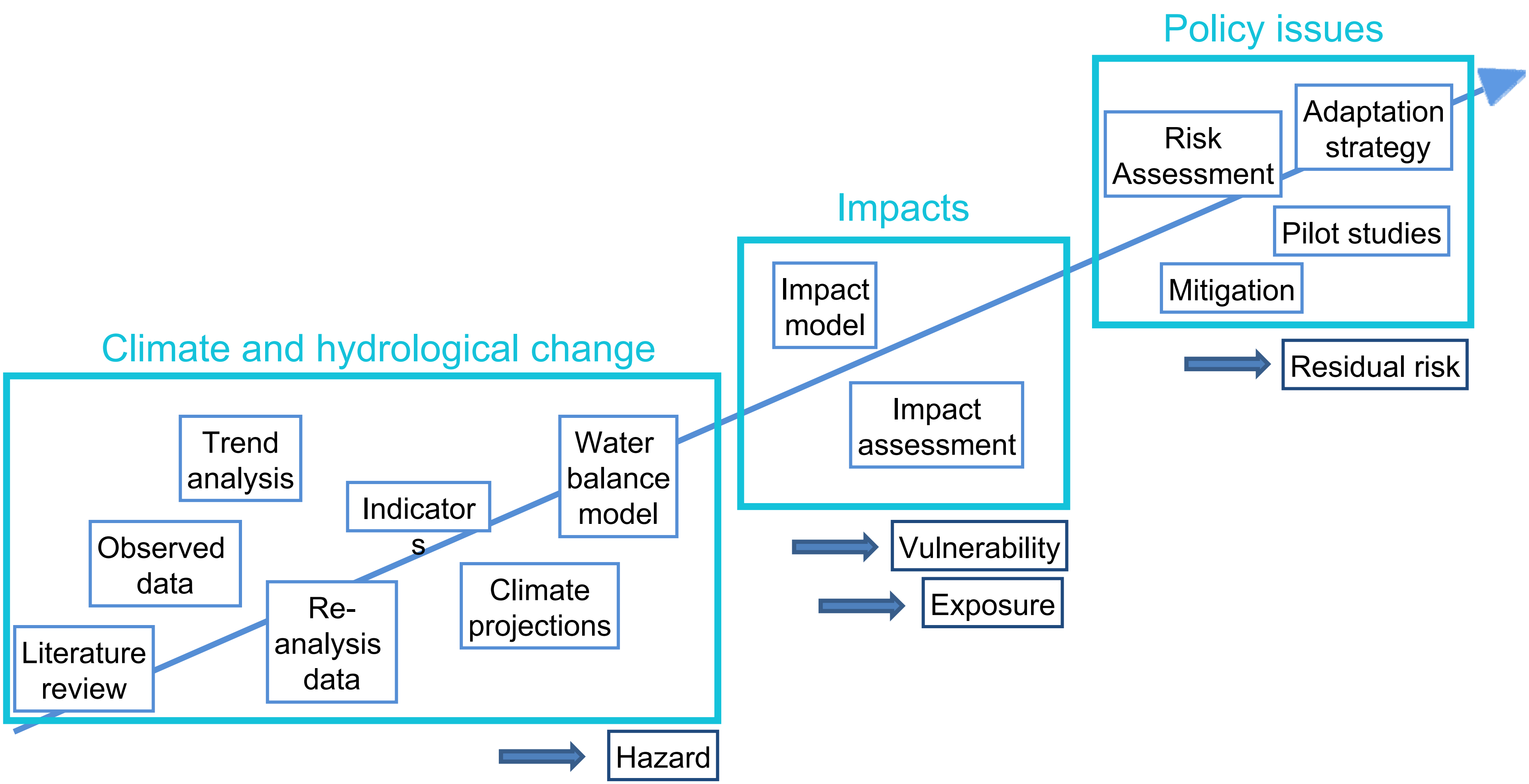
6. Uncertainty and complexity

- [illegible] ught for; [illegible] of climate change contains larger uncertainties



Modified from Pianc 2008

7. Approach to basin-wide adaptation



7. Approach to basin-wide adaptation

Climate & hydrological change

CHR 2007
Trend analysis
MRC-CCAI

UBA DAS 2011
DWD 2012
Indicators
MRC-CCAI 2013

ICPR 2013
BfG 2013
CHR RheinBlick2050
Water balance model
MRC-IKMP 2014

KLIWAS HYRAS 2012
Observed data
MRC-IKMP 2013

Re-analysis data
MRC-CCAI

CHR RheinBlick2050
Climate projections
MRC-CCAI

ICPR 2009
Literature review
MRC-CCAI

Rhine	Mekong
Completed	Completed
Ongoing	Ongoing

7. 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 Ecoystems

MRC SimVa

MRC Drought

CHR

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

MRC Basin Development Strategy

Rhine
Completed
Ongoing

Mekong
Completed
Ongoing

7. Approac

Risk Assessment

strategy

NAPA

ICEM ASEAN 2012

MRC-CCAI Adaptation strategy

UNFCCC

Mitigation

UNFCCC

Pilot studies

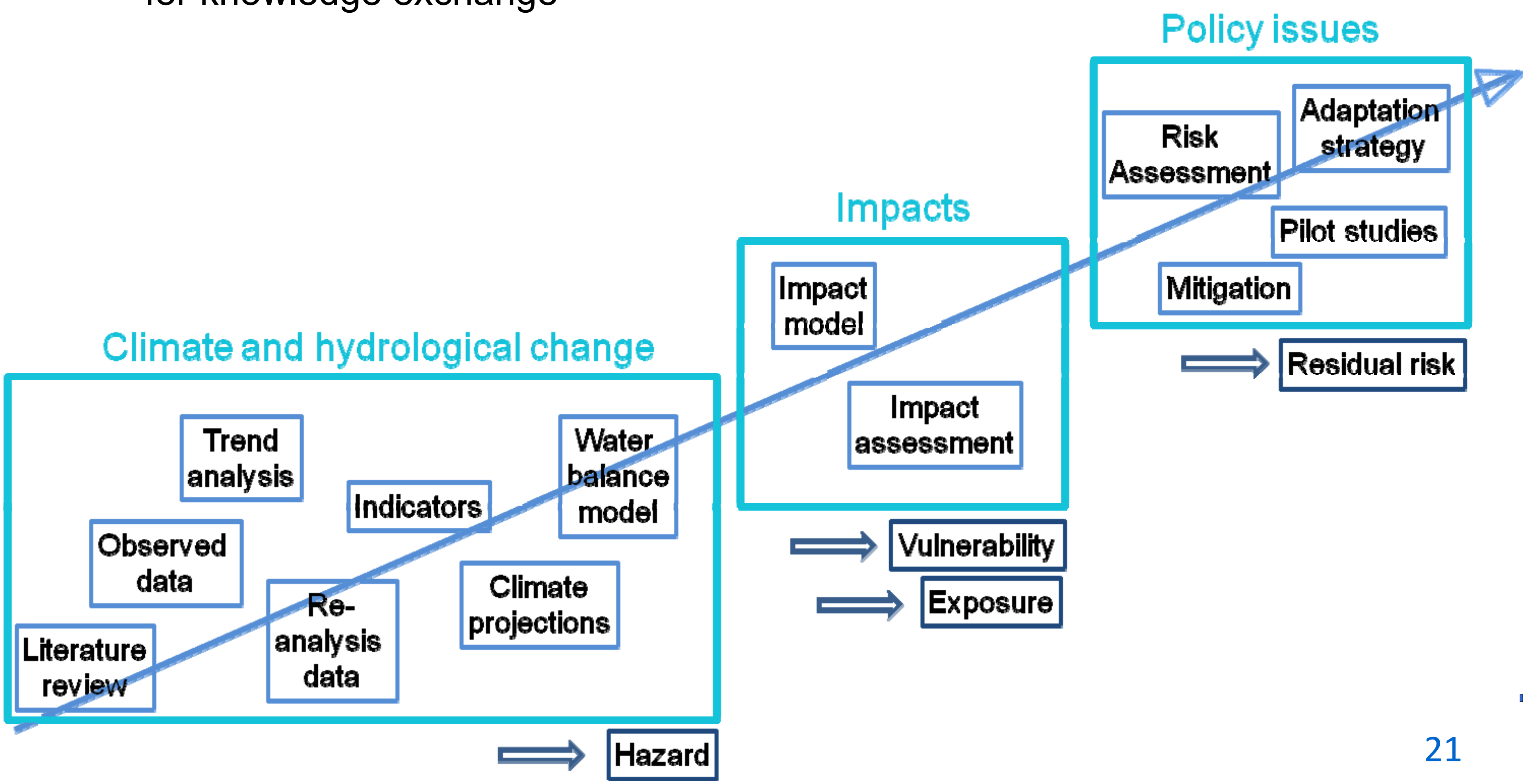
Pilot studies

MRC-CCAI Upscaling 2013

Rhine	Mekong
Completed	Completed
Ongoing	Ongoing

7. 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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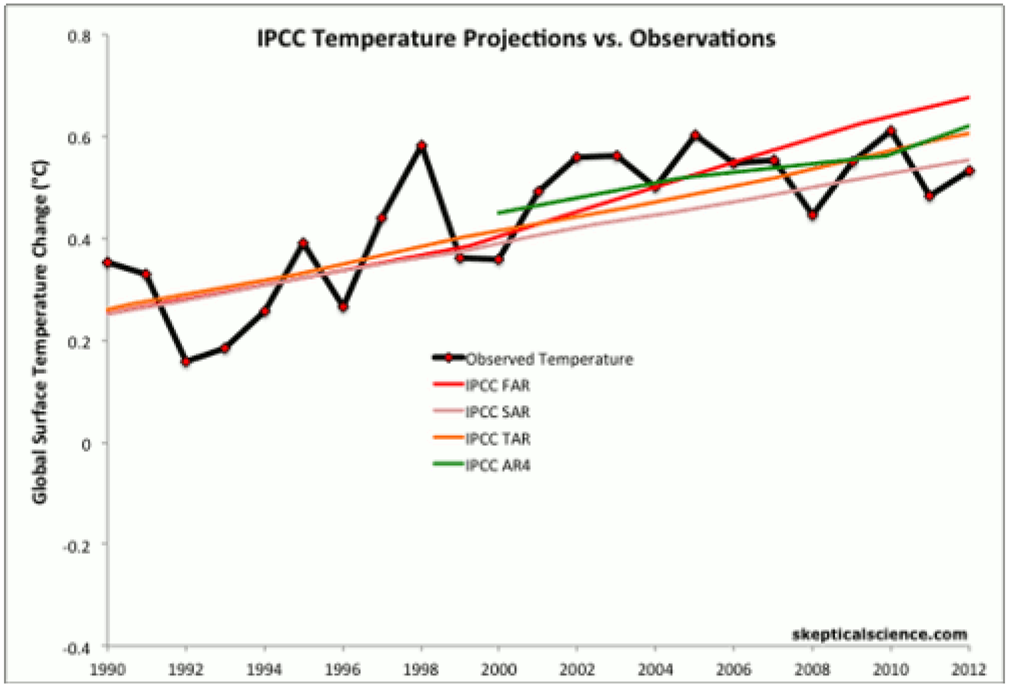
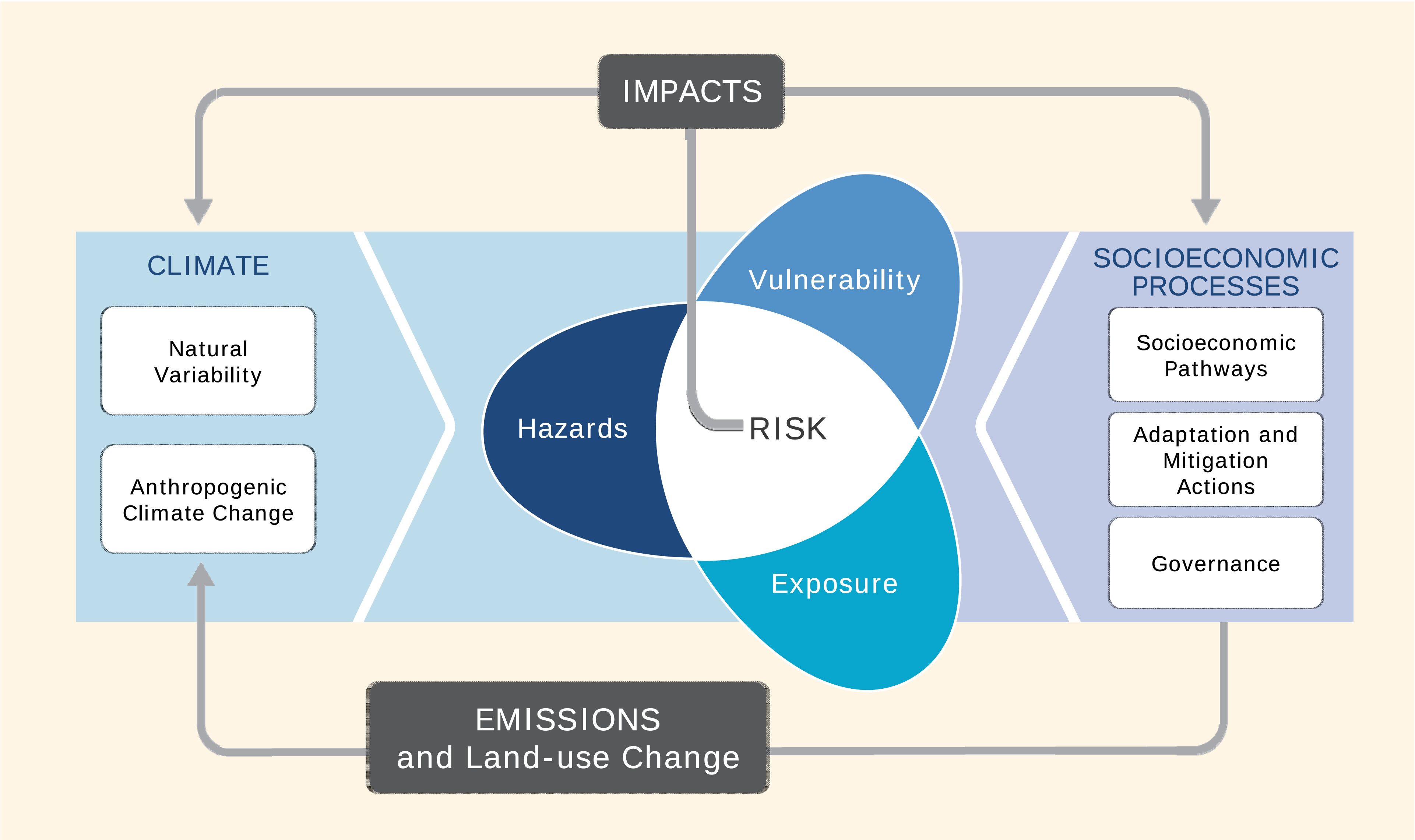
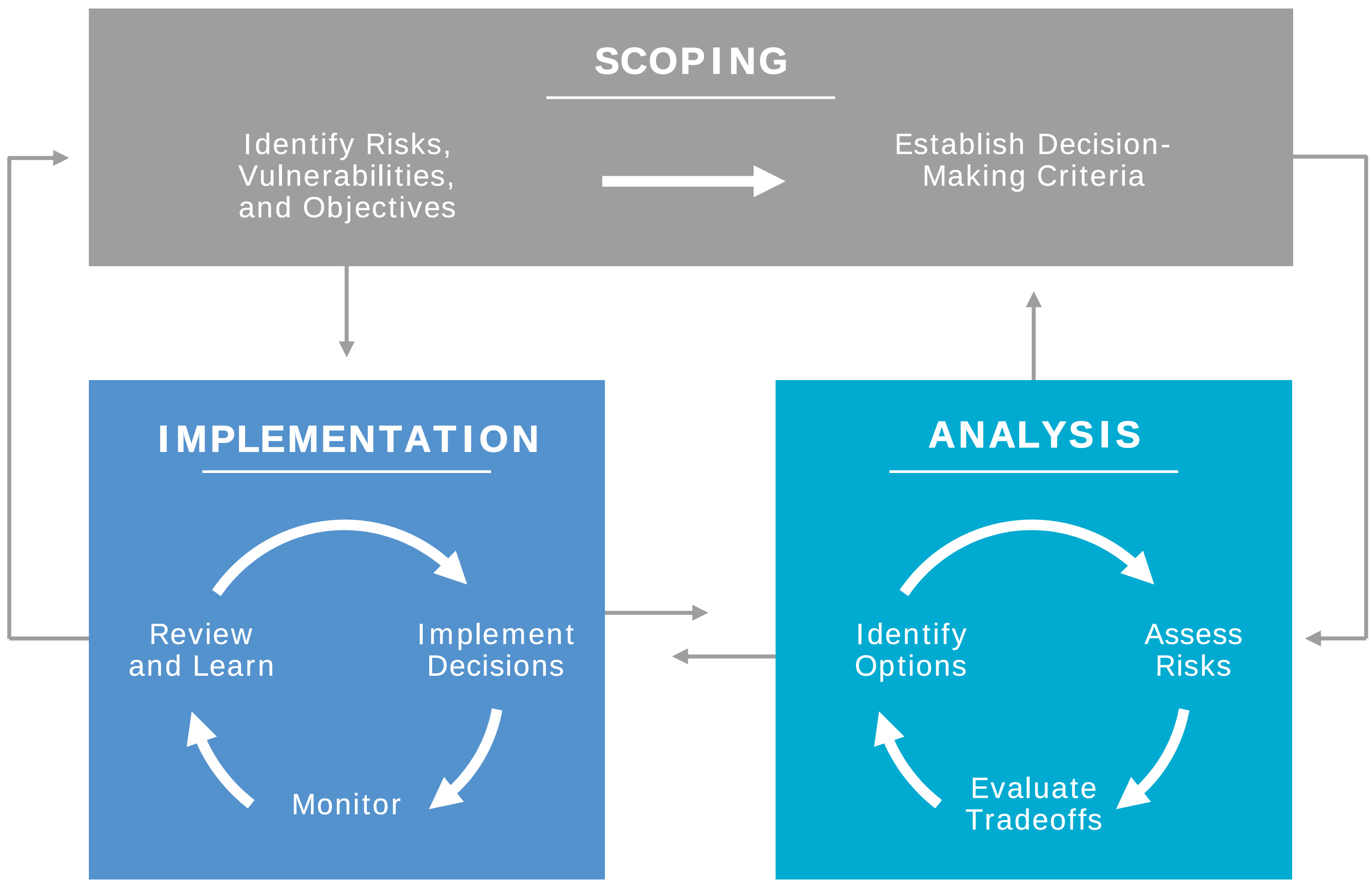
WG3: Climate change adaptation

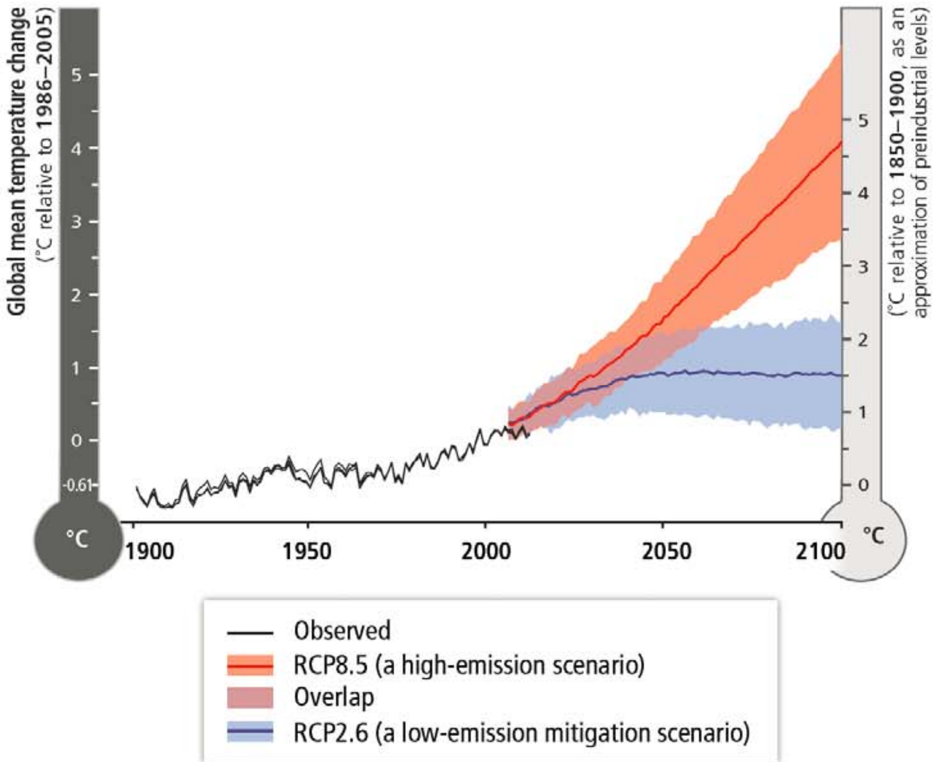
- How to involve China as Upper Mekong Basin Country to MRC?
- There are different interests in the development of different countries in the Mekong Basin; mechanism and procedure for benefit sharing.
- How to make MRC to be efficient partner among other players in water and related resources management, development and planning?
- MRC is not the basin authority, it just river basin commission, what should be best suitable roles and responsibilities of all parties concerned (MRCS, NMCSs, and Line Agencies.
- How MRC can effectively deliver its products useful to the Member countries?

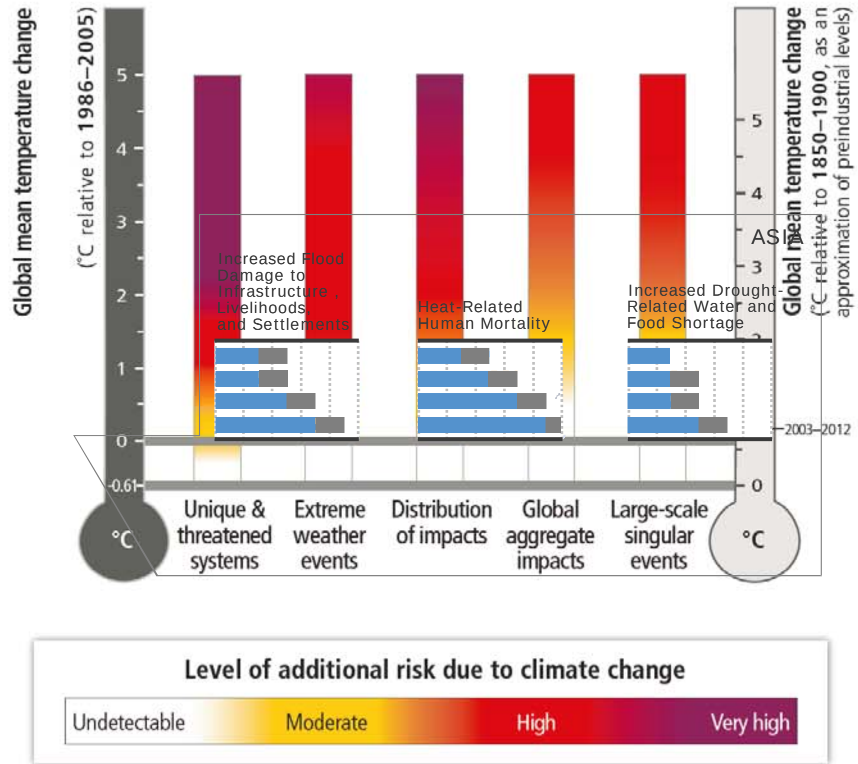
WG3: Climate change adaptation




IMPACTS
CLIMATE
Natural Variability
Anthropogenic Climate Change
Vulnerability
Hazards
RISK
Exposure
SOCIOECONOMIC PROCESSES
Socioeconomic Pathways
Adaptation and Mitigation Actions
Governance
EMISSIONS and Land-use Change


SCOPING
Identify Risks, Vulnerabilities, and Objectives
Establish Decision-Making Criteria
IMPLEMENTATION
Review and Learn
Implement Decisions
Monitor
ANALYSIS
Identify Options
Assess Risks
Evaluate Tradeoffs


Global mean temperature change
(°C relative to 1986–2005)
(°C relative to 1850–1900, as an approximation of preindustrial levels)
1900
1950
2000
2050
2100
°C
Observed
RCP8.5 (a high-emission scenario)
Overlap
RCP2.6 (a low-emission mitigation scenario)


ASIA
Increased Flood Damage to Infrastructure, Livelihoods and Settlements
Heat-Related Human Mortality
Increased Drought-Related Water and Food Shortage
2003–2012
Unique & threatened systems
Extreme weather events
Distribution of impacts
Global aggregate impacts
Large-scale singular events
Level of additional risk due to climate change
Undetectable
Moderate
High
Very high

4. Climate projections

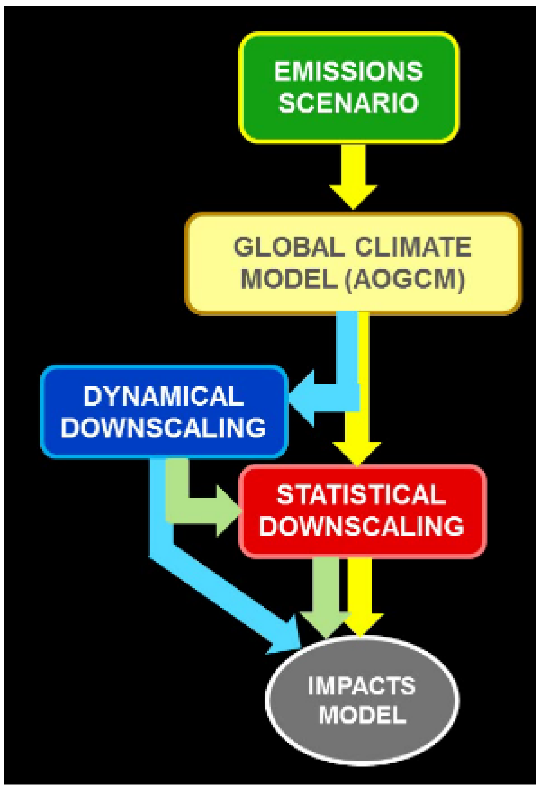
- Climate modelling is applied to assess future climate change

<u>Atmospheric greenhouse gas concentrations</u>
Emission scenario

<u>Global climate model (GCM)</u>
(complex, feedback climate system)

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

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



Dixon et al. 2013