

2nd Regional Workshop

Basin-wide climate change vulnerability assessment of LMB wetlands

CLIMATE CHANGE TRENDS IN THE MEKONG REGION

OVERVIEW

1. Approaches to climate change (CC) assessments –*impact vs. vulnerability*
2. Overview of CC assessments applied to the Mekong –*what is the regional experience with CC assessments*
3. Characterising uncertainty – *how confident are we with the suite of available predictions*
4. Linking climate change to wetland systems
5. Findings for the basin and for our case study sites
6. Other development pressures – *putting climate risk into context*

1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF CHANGE ARE RELEVANT?

Interested in two types of climate change

1. Changes in **average/typical** climate
2. Changes in **extreme/irregular** climate



Our capacity and approach to assess these two type of change differ

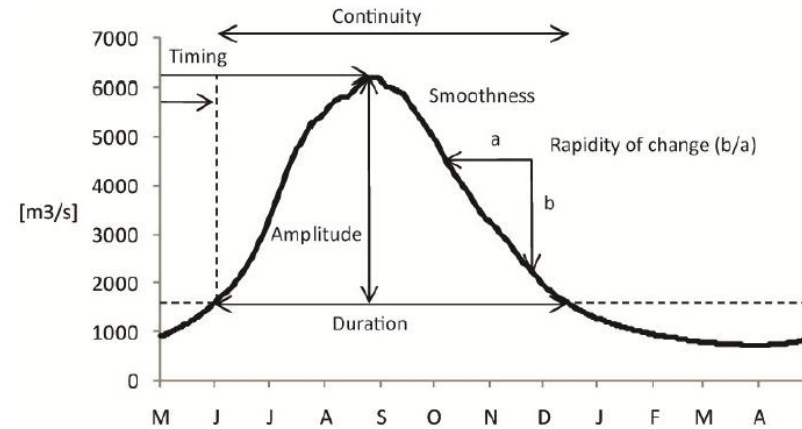
1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF CHANGE ARE RELEVANT?

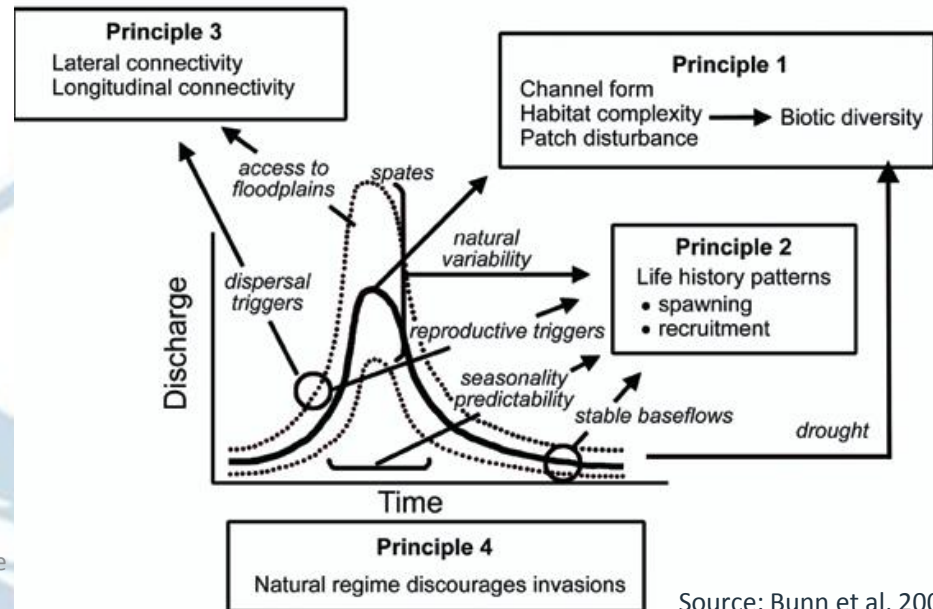
Changes in average hydro-meteorology

- Day-to-day functioning & characteristics of natural systems and dependent livelihoods
- Definition of seasonal states and functions of wetlands, including:
 - water availability, source and transport (hydrograph)
 - Onset and duration of the wet season
 - Air and water temperatures and rates of evaporation and transpiration
 - Seasonal extent of wetlands
 - Hydrodynamics (direction and speed of water movement)
 - Sediment & nutrient transport dynamics
 - Sea level, tidal dynamics and saline intrusion
 - Habitat composition
 - Water quality (e.g. saline intrusion)
- Evident in historic time-series data
- Changes in pattern are straightforward to identify even with relatively short time series

Basin wide climate



Source: Rasaenen, 2010



Source: Bunn et al, 2002

APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF CHANGE ARE RELEVANT?

Changes in extreme hydro-meteorology

- Definition of disaster and extreme states of wetlands
 - Drought
 - Fires
 - Storms and typhoons
 - Storm surge & king tides
 - Rare floods (1 in 1,000 year events)
- Coping capacity of natural systems and dependent livelihoods (setting the limits)
- Can cause major shifts in ecosystem structure
- Requires decadal or longer data to pick up & different kinds of statistical analysis

Basin wide climate char

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1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF CHANGE ARE RELEVANT?

- Scale is (almost) as important as the change itself
 - Geographic/spatial
 - Mekong is a large and diverse catchment => Often assessment at sub-basin level or eco-climatic zone is required to make assessments practical
 - Temporal
 - For Mekong Flood pulse system seasonal changes are more important than annual changes
 - For Monsoon forcing, inter-annual variability is important to understand incidence of infrequent events (drought, major storms etc)

1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF CHANGE ARE RELEVANT?

- We are more confident of predictions:
 - At larger spatio-temporal scales
 - Regular/annual hydro-meteorological events
- But we are often more interested in:
 - changes at smaller spatio-temporal scales
 - Extreme and regular changes in climate
 - e.g. our case study sites

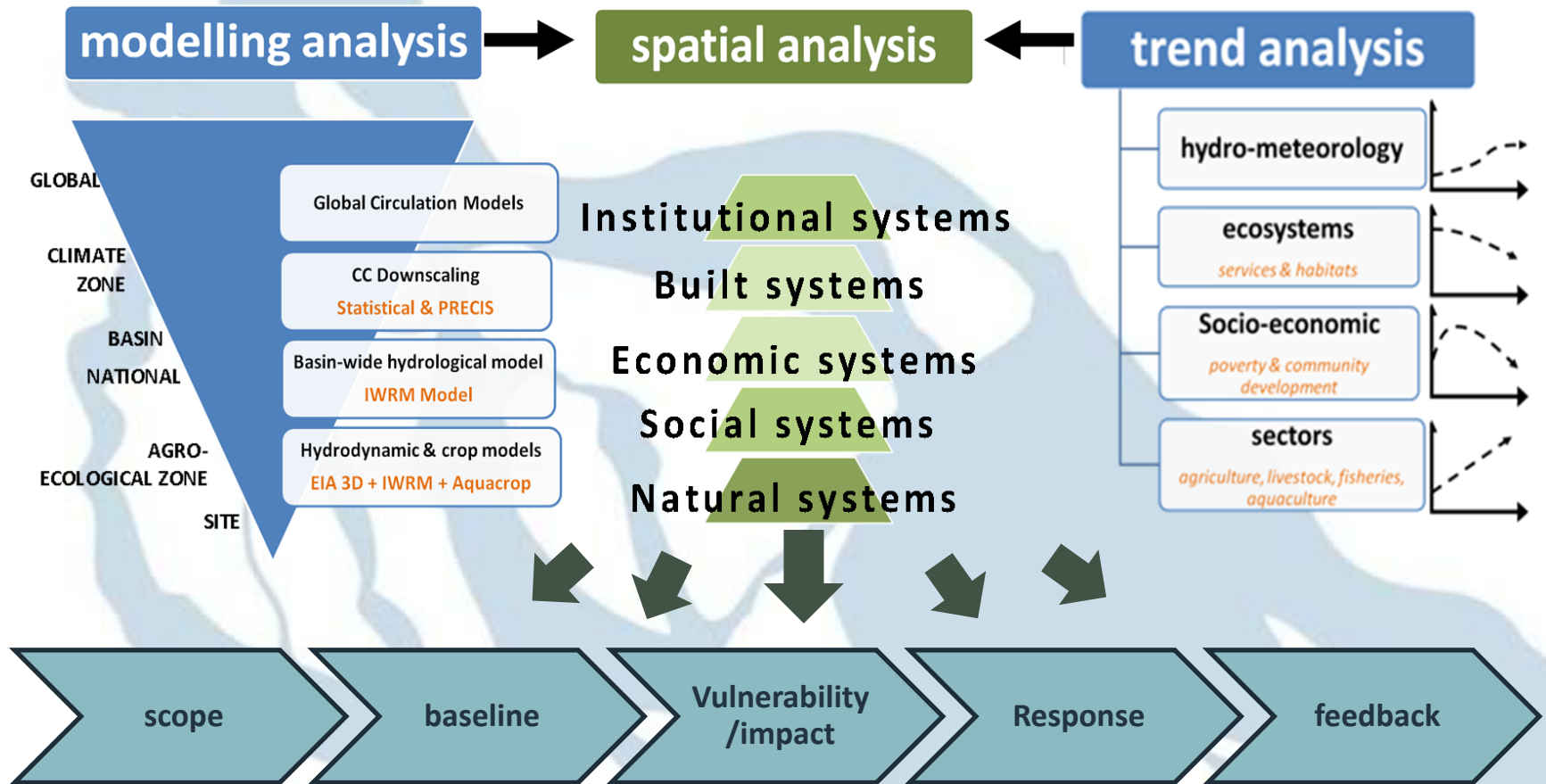
1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF ASSESSMENTS ARE THERE?

- Wide range of disciplines involved in CC assessments
- Many different methods and approaches, some are:
 - Impact focussed
 - vulnerability focussed
 - rely on future projections
 - Rely on historic trends

1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF ASSESSMENTS ARE THERE?



1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

WHAT KINDS OF ASSESSMENTS ARE THERE?

impact assessments

- Future focussed
- Focussed on threat and impact of climate change
- Lots of modelling and attempts to quantify impacts
- Dominated by the scientific community (e.g. IPCC)
- Favoured by planners because it provides hard numbers
- Often used in CC proofing infrastructure

vulnerability assessments

- Focussed on understanding of bio-physical and socio-economic systems and their sensitivity to change
- Focussed on existing and past situation
- Less effort to quantify specific future impact
- Favoured by non-scientists and communities because it builds on their existing knowledge base
- Often used in community CC response planning

1 APPROACHES TO CLIMATE CHANGE (CC) ASSESSMENTS

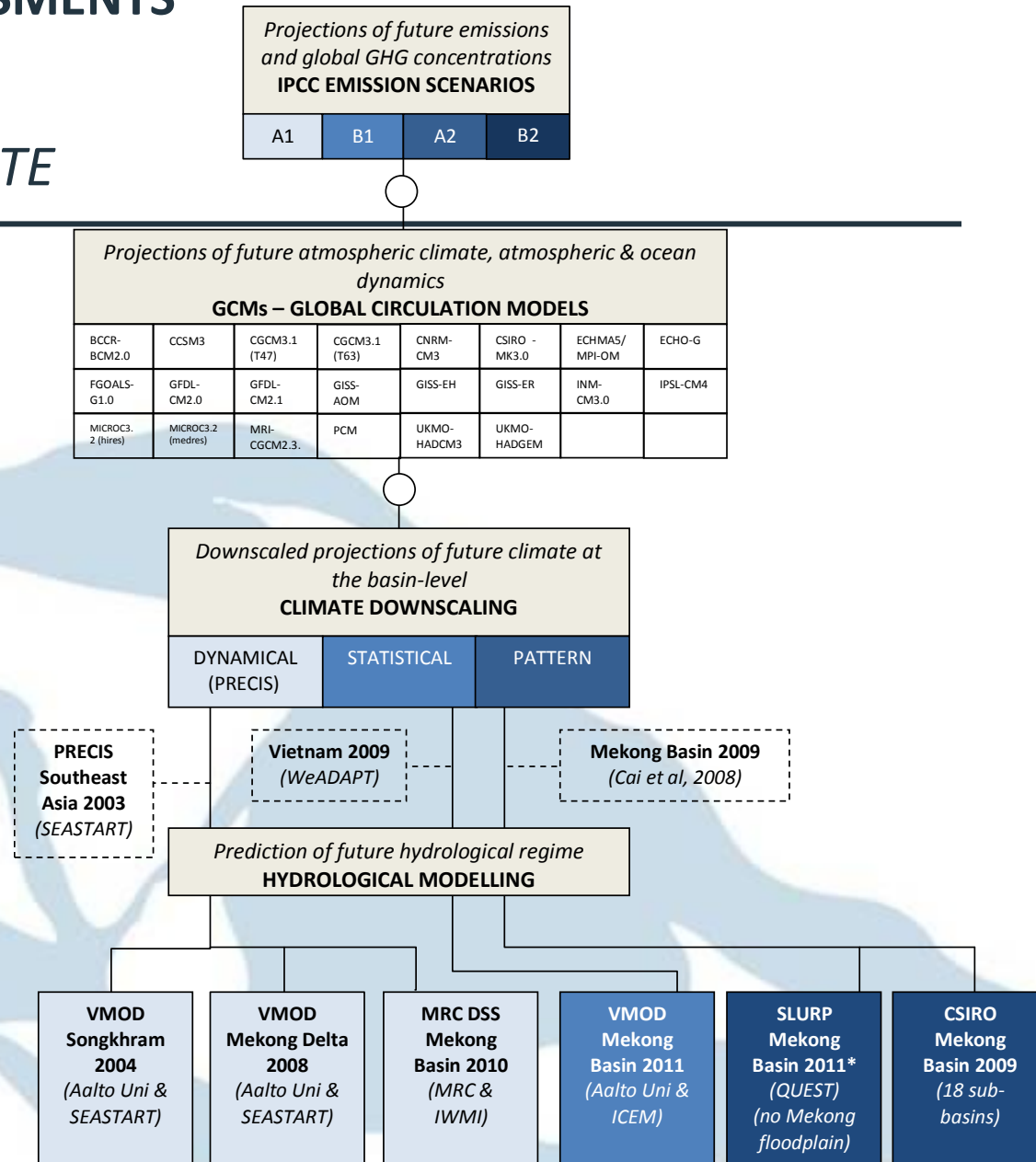
WHAT KINDS OF ASSESSMENTS ARE THERE?

- In this study we needed to incorporate both:
 - **Future impact:** Climate change modelling with
 - 2 IPCC Scenarios
 - 7 GCMs
 - Two downscaling methodologies
 - Basin wide modelling
 - Sub-catchment/case study-level analysis
 - **Past risks:** Detailed assessment of historic trends in:
 - Hydro-meteorological parameters
 - Ecological parameters
 - Socio-economic parameters
- By building on the large body of existing CC work for wetland systems

APPLIED TO THE MEKONG

MAJOR ASSESSMENTS TO DATE

- **SEA START (2009)**
 - dynamic downscaling of IPCC A2 and B2 climate data for Southeast Asia
 - up to 2100,
 - using ECHAM4 GCM and PRECIS downscaling model
- **CSIRO (2009)**
 - Pattern downscaling of 11 GCMs
 - Compared range and unweighted multi-model mean changes
 - Focussed on changes in one water year (2030)
- **MRC CC Assessment of the Mekong flow regime (2010)**
 - using SEA START downscaled climate data
 - Averaged changes over the period 2010-2050,
 - focused on changes in the flow regime of the mainstream Mekong River
- **This study and Mekong FUTURES (2011)**
 - statistical downscaling for 6 GCMs
 - Up to 2100
- **Other assessments at national and sub-basin level**


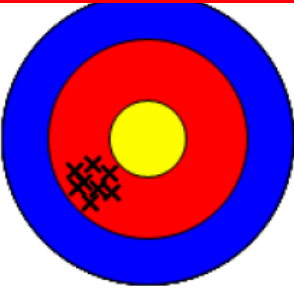

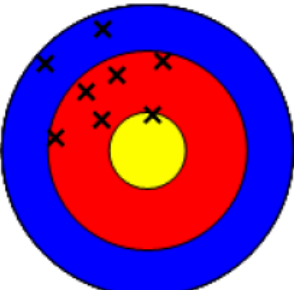


- Uncertainty is specific to the approach, tools and data used
- Wide range of uncertainty in understanding impact and vulnerability to climate change:
 1. Quality & availability of time-series data of historic situation
 2. Accuracy of data collection techniques
 3. In-built assumptions & parameterization of Basin hydrological models
 4. Understanding of basin hydro-met system (*e.g. groundwater connectivity*)
 5. **IPCC emission scenarios**
 6. **CC models & downscaling techniques**
 7. **Understanding of the complex global hydro-met system**

- Three groups of uncertainty:
 1. *Statistical uncertainty*
 - Can be quantified by probability
 2. *Scenario uncertainty*
 - Can only be specified in terms of a range of outcomes
 3. *Recognised ignorance*
 - Realise there are unknowns which cannot yet be estimated
 - e.g. how monsoon system will respond to temperature changes

CHARACTERISING UNCERTAINTY

CC-SPECIFIC UNCERTAINTY

	Accurate	Inaccurate (systematic error)
Precise		
Historic data		
Imprecise (reproducibility error)		
Future predictions		

Source: Swart, 2010

- CC introduces new forms of uncertainty into our understanding of wetland systems
- **Recognised ignorance** of systemic changes can introduce inaccuracies (e.g. Monsoons, cloud cover)
- **Scenario modelling** can make understanding more imprecise
 - Different **scenarios** result in differing pace and scale of change
 - Different **models** can lead to differing estimates for the range and pace of changes within one scenario

CHARACTERISING UNCERTAINTY

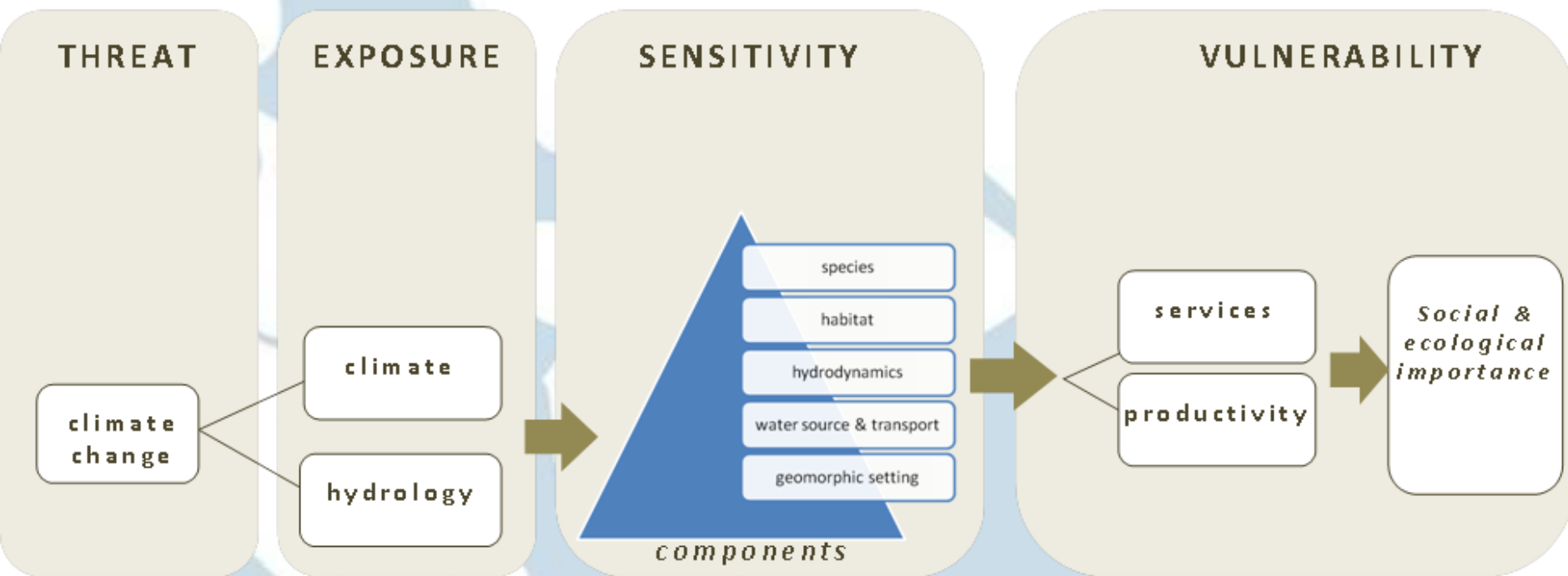
COPING WITH UNCERTAINTY

- High levels of uncertainty - in scenarios, models and interpretation of impacts
- Climate change requires that decision makers take the precautionary approach in managing risks associated with development
- In response to the uncertainty, we need to:
 - a) talk in terms of trends and ranges rather than precise predictions
 - b) identify trends and vulnerabilities based on past events and patterns
 - c) understand the effects of existing adaptation to past extreme events and regular climate

4

LINKING CLIMATE CHANGE TO WETLAND SYSTEMS

CONCEPTUAL FRAMEWORK



Source: ICEM, 2011

- Indicators are developed to link Threat – *Sensitivity - Vulnerability*
 1. *Size of the seasonally flooded area that defines the extent of the wetland area*
 2. *Extent of hydrological modification*
 3. *Change in sediment load entering and remaining in the wetland*
 4. *Areas of different habitat making up the wetland*
 5. *rates of change of wetland habitats*
 6. *Number and types of species at risk*
 7. *Presence and spread of Invasive species*
 8. *Changes in provisioning services*
 9. *Changes in regulating services*
 10. *Changes in cultural services*
 11. *Changes in supporting services*
 12. *Use of wetland products*

5

FINDINGS FOR THE BASIN AND FOR OUR CASE STUDY SITES

BASIN-WIDE SUMMARY

Climate change	Modelling team								
	Snidvongs et al. (2003)	TKK & START (2008)	Hoanh et al. (2003)	Hoanh et al. (2010)	Eastham et al. (2008)	Johnston et al., 2009	McSweeney et al. (2008a & 2008b)	ADB (2009)	Ruosteenoja et al. (2003)
Coverage	Lower Mekong Basin		Mekong Basin				Cambodia, Viet Nam	Thailand, Viet Nam	SE Asia
Scenarios	-	A2	A2, B2	A2, B2	Broad range – focus on A1B	A2, B2	A2, A1B, B1	A1F1, B2	A1F1, A2, B1, B2
Period	From [1×CO ₂] to [2×CO ₂]	1960-2099	1960-2099	1985-2050	1951-2000 and 2030	1960-2049	1970-2090	1990-2100	1961-2095
Temperature	+ 1 to +3°C (over 100 year period)	Will increase	+0.026 to +0.036°C/y	+0.020 to +0.023°C/y	+0.012 to +0.014°C/y	+0.023 to +0.024°C/y	0.00 to +0.06°C/y	+0.03 to +0.06°C/y	+0.01 to +0.05°C/y
Annual rainfall	Will increase	Will increase	-1.64 to +4.36 mm/y	+ 1.2 (B2) to +2 (A2) mm/y	+0.1 to +9.9 mm/y	No significant change	+0.3 to +0.6 mm/y	1990-2050: -1.62 to +1.26 mm/y (B2); -1.14 to 0.66 mm/y (A1F1) 1990-2100: +3.27 to +4.91 mm/y (A1F1) and -1.63 to -2.45 mm/y (B2)	Almost always insignificant
Rainy season	Wetter rainy season and 1-month delayed	Wetter rainy season and 1-month delayed		Wetter rainy season: +1.2 (B2) to +1.5 (A2) mm/y	Wetter rainy season (+1.7 to +6.1 mm/y)	Wetter rainy season in North and Gulf of Thailand (From +0.2 to +0.6 mm/y)	Wetter rainy season : +0.8 to +1.5 mm/y (KH); +0.4 to +1.5 mm/y (VN)		Wetter rainy season and 1-month delayed
Dry season	Dry season drier and longer	Dry season drier and longer		Wetter dry season in UMB +0.9 mm/y and insignificant change in LMB	Dry season rainfall to increase north, and to decrease in the south	Drier dry season on both sides of Gulf of Thailand (-2.5 to -2.8 mm/y)	Drier dry season: -0.7 to -0.1 mm/y (KH); -0.3 to -0.1 mm/y (VN)		Dry season drier and longer

5 FINDINGS FOR THE BASIN AND FOR OUR CASE STUDY SITES

BASIN-WIDE SUMMARY

- Increased variability between wet and dry season rainfall
 - Wet season gets wetter and the dry drier (nett increase)
- Onset and duration of the seasons will change
 - Delay in the start of the wet season
 - Reduced prevalence of important transition seasons
- Water stress, drought and dry spells will increase as dry season rainfall becomes more erratic
- Run-off will increase in response to wet season rainfall changes
 - Largest increases for UMB, left-bank tributaries of Lao PDR (i.e. for current zones of high water and sediment production)
- Rates of evaporation will increase in response to warming temperatures
- Case study sites were chosen for their significance not availability of existing assessments => many of our sites have not yet undergone detailed CC analysis

5 FINDINGS FOR THE BASIN AND FOR OUR CASE STUDY SITES

CASE STUDY SUMMARY – MAINSTREAM WETLANDS

- *Siphandone & Stung Treng*
- Changes in hydrology more important than changes in rainfall
- greater variability of seasonal flows and precipitation
- Changes in flow will have important geomorphological implications



5 FINDINGS FOR THE BASIN AND FOR OUR CASE STUDY SITES

CASE STUDY SUMMARY – MEKONG FLOODPLAIN

- *Lower Stung Sen and Tram Chim*
- Hydrology dominated by complex water supply from a number of sources
 - *Overbank flooding – annual flooding*
 - *Direct rainfall & sheet flow for flood duration and maintenance of dry season standing water*
 - *Tributary and Mekong interactions*
- Maintaining hydrological connectivity increasingly important for floodplain wetlands under CC
- Water stress states likely to be more frequent

5 FINDINGS FOR THE BASIN AND FOR OUR CASE STUDY SITES

CASE STUDY SUMMARY – TRIBUTARY FLOODPLAINS

- *Xe Champhone*
- Upland precipitation is more important than direct precipitation
- Already a highly variable system which will become more so
- Increases in daily temperature are expected to fluctuate higher than in other LMB locations

- **4 types of human-induced change for Mekong wetlands:**
 1. **Climate change**
 - *Increased concentration of GHGs in atmosphere*
 2. **Changes to the rainfall - run off response regime**
 - *Land clearing & deforestation*
 3. **Change to surface water volumes**
 - *Water abstraction for human use (irrigation & water supply)*
 4. **Change to basin storage capacity**
 - *hydropower*

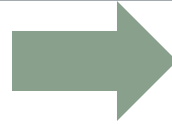
PUTTING CLIMATE CHANGE INTO CONTEXT

LAND CLEARING, DEFORESTATION & CHANGES TO RUN OFF

Land clearing & deforestation

1960 – 2000

- National deforestation rates
 - Yunnan province from 55% to 33%
 - Thailand from 53% to 29%
 - Lao PDR 60% to 41%
 - Cambodia 70% to 53%
 - Vietnam 42% to 30%
- ~17-20% of the Mekong basin has been cleared since the 1960s and this is likely to increase
- Will continue to have impacts on tributary and localised run off volumes, but not basin-wide hydrology
- Important for case study sites
- Presents a significant methodological difficulty for up-scaling



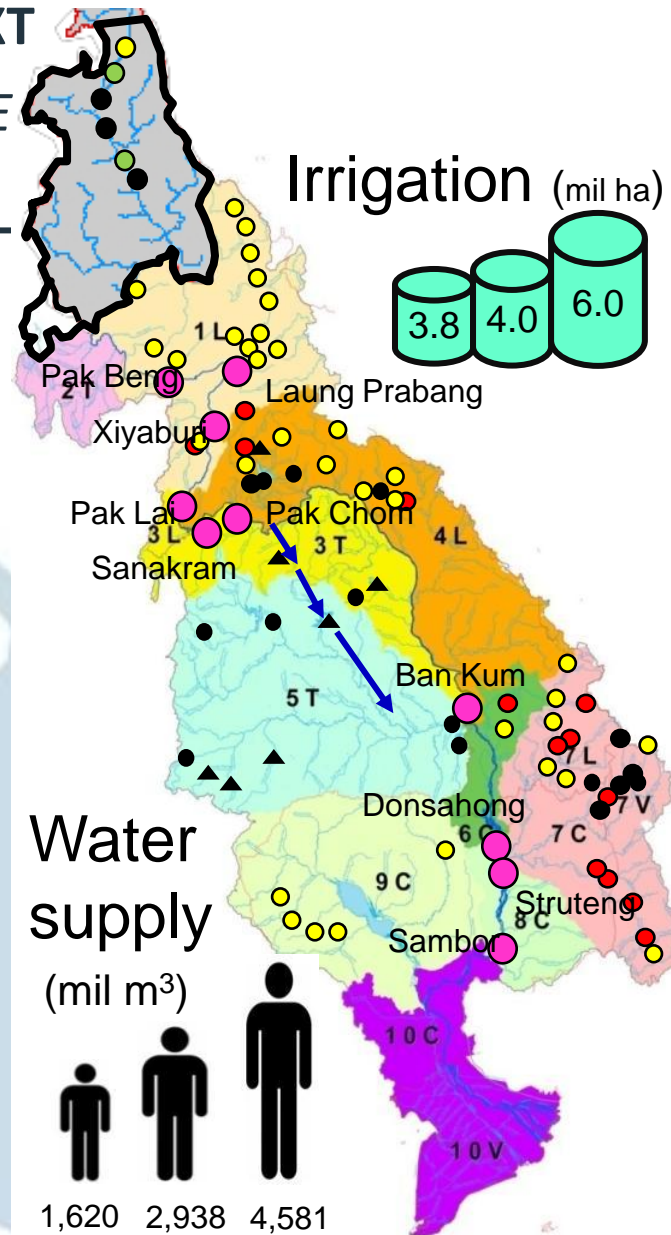
Changes to the run off regime

- Change in land cover can affect runoff/infiltration balance
- Land clearing has seen significant local/tributary impacts
- needs to be at very large scales to affect regional hydrology

PUTTING CLIMATE CHANGE INTO CONTEXT

ABSTRACTION & SURFACE WATER VOLUME

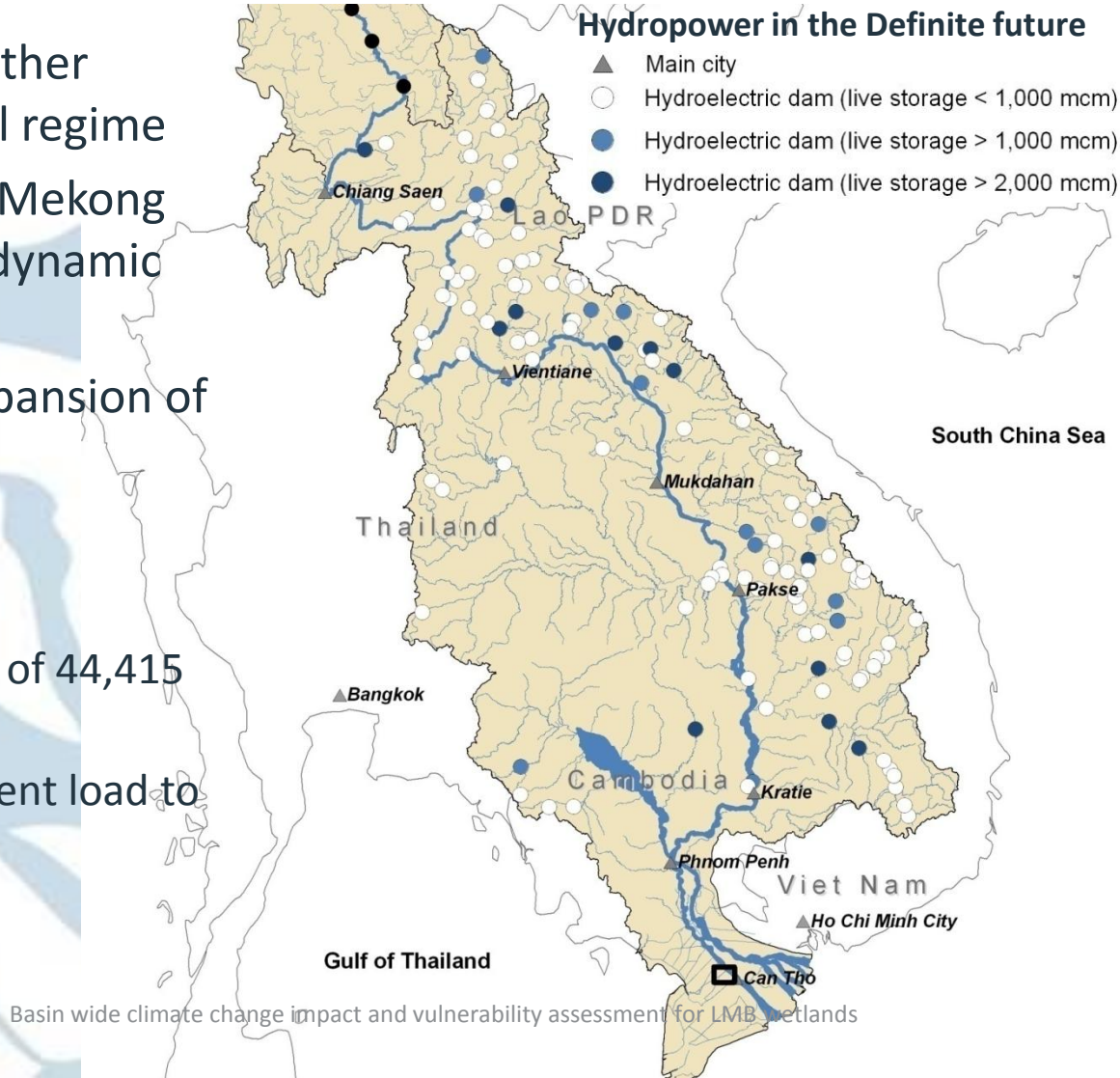
- Applied irrigation accounts for 5% of mean total volume of basin run off
 - An order of magnitude lower than forest evapotranspiration*
 - Domestic & industrial use is another order of magnitude below this*



PUTTING CLIMATE CHANGE INTO CONTEXT

OTHER DRIVERS OF CHANGE - HYDROPOWER

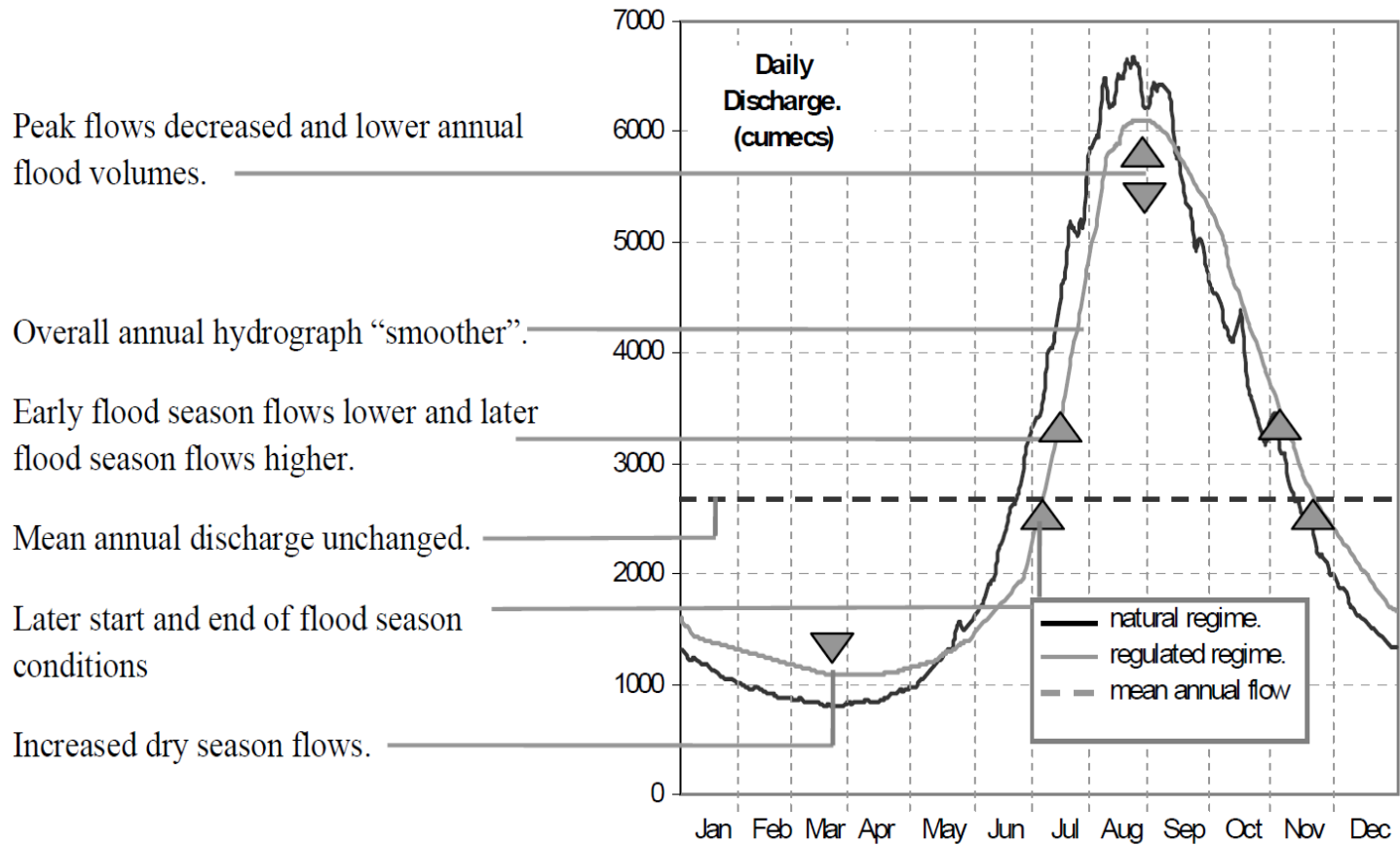
- Wetlands are vulnerable to other pressures on the hydrological regime
- Over thousands of years the Mekong River has reached a state of dynamic equilibrium
- Recent & continued rapid expansion of hydropower
- By 2015 (definite future)
 - 46 hydropower projects
 - Combined storage capacity of 44,415 million m³
 - 50-75% reduction of sediment load to the Mekong floodplain



6

PUTTING CLIMATE CHANGE INTO CONTEXT

OTHER DRIVERS OF CHANGE - HYDROPOWER



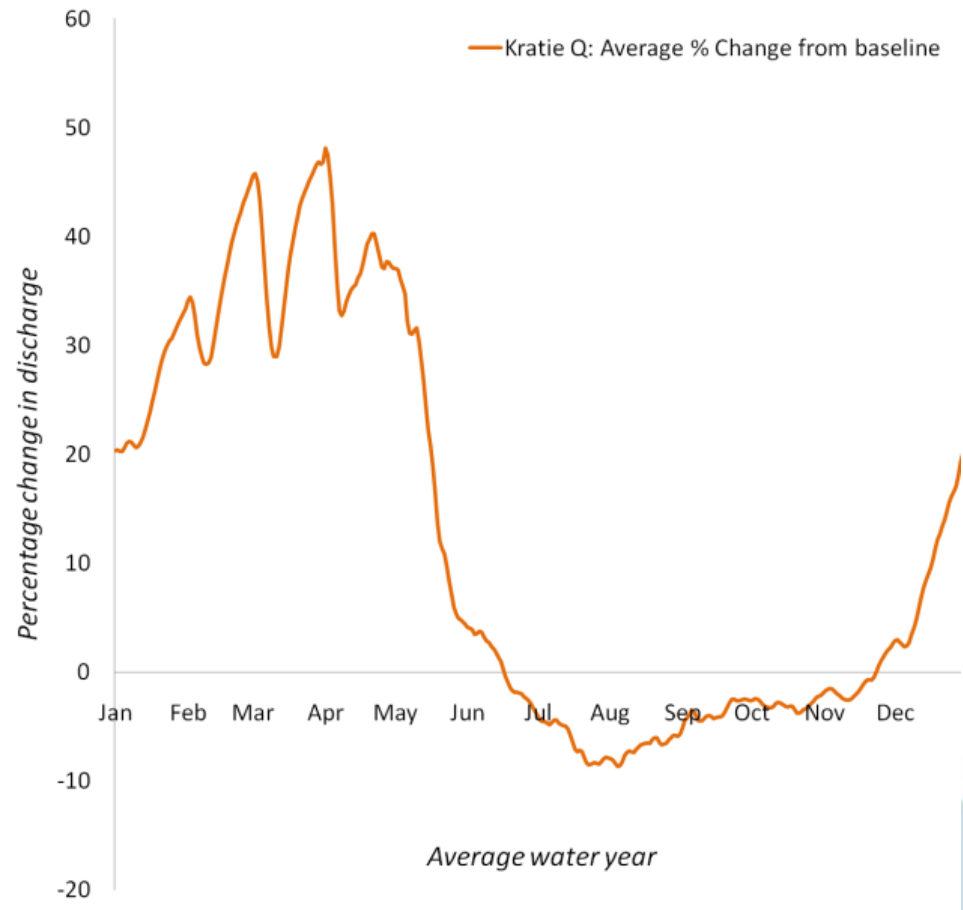
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PUTTING CLIMATE CHANGE INTO CONTEXT

OTHER DRIVERS OF CHANGE - HYDROPOWER

BDP Definite Future scenario:

- 20-50% increase in dry season discharge
- Increase in dry season duration
- ~10% reduction in wet season flows and reduction in flood peak
- Reduction in wet season duration
- Shortening of transition seasons
- Changes in frequency of extreme events through storage and flushing





Thank you!