

Initial findings of wetland and climate change impacts in Lower Stung Sen wetland, Cambodia

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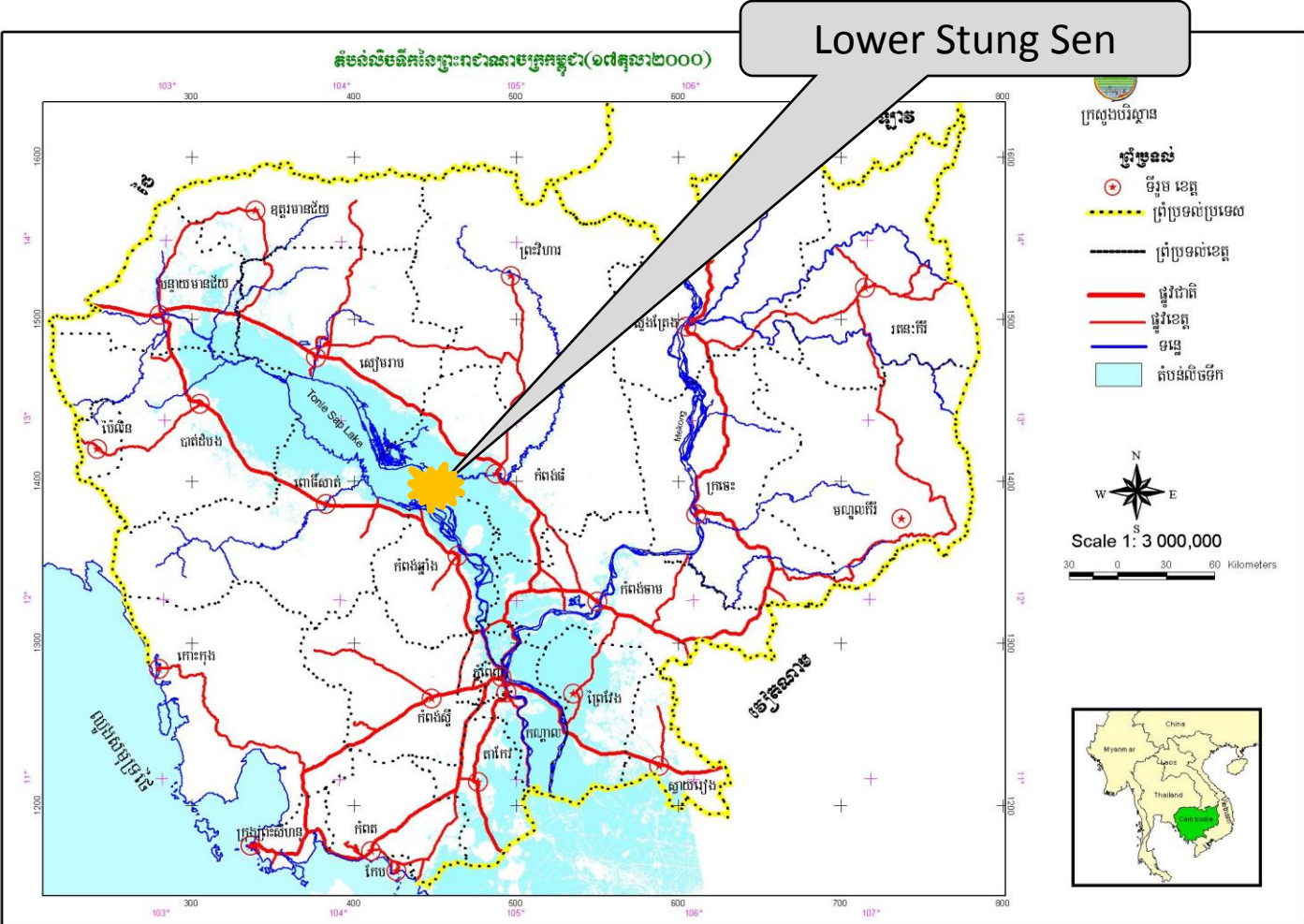
July 11-12, 2011

Hanoi

Outline

- General overview of Stung Sen Wetland site;
- Climate profile and climate change;
 - Impacts on biodiversity, habitats, ecosystem services and livelihood;
- Wetland valuation;
- Potential adaptation mechanism

Location of Stung Sen wetland



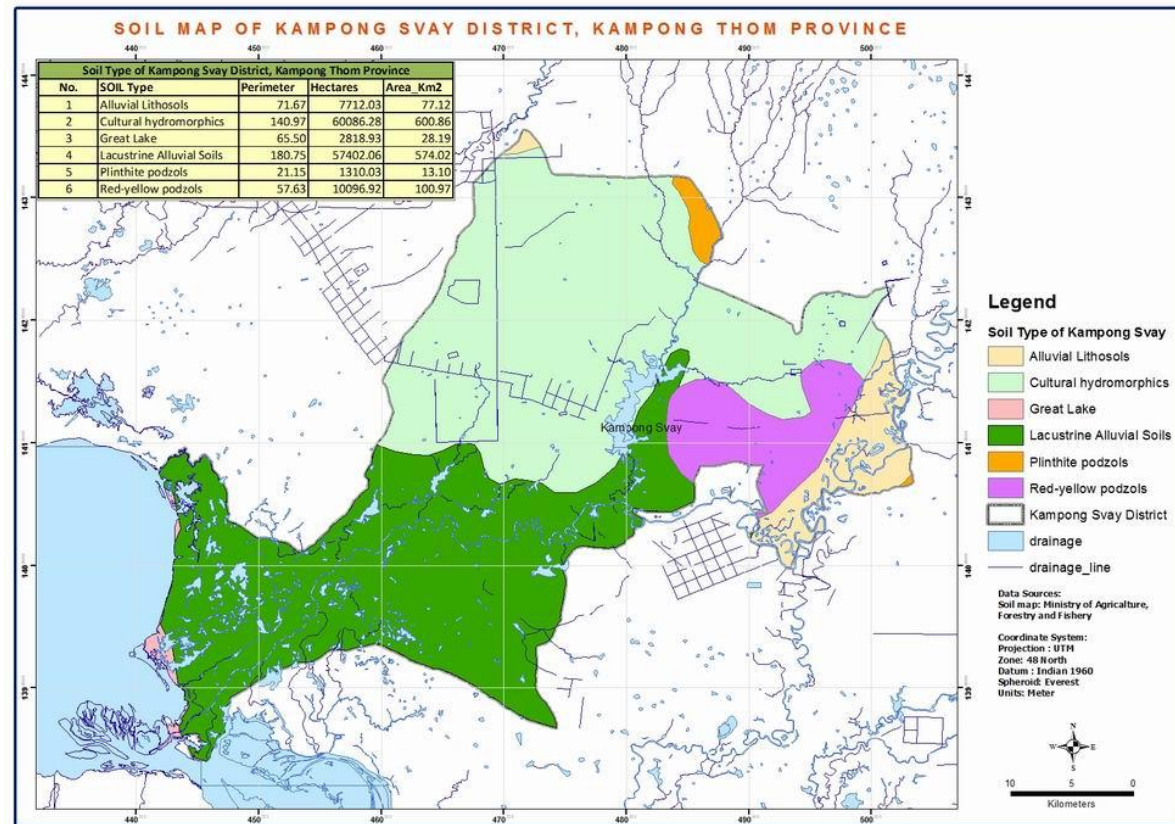
General feature and main habitats of Stung Sen Wetland

- Part of the TS floodplain system;
- Elevation: 0-10m;
- Under influence of Mekong-Tonle Sap and SS hydrology;
- Receive water from 3 major sources:
57% from the Mekong mainstream (52% through Tonle Sap river, and 5% from overland flooding), 30% from tributaries of Tonle Sap Lake, and 13% from direct precipitation.



Soil characteristics

- Most soil developed in unconsolidated alluvial deposits, comprising clay, silt, sand, and gravel;
- Lacustrine alluvial is the dominant soil type in the south;
- Hydromorphics – mostly cover in the north;
- Large part of the floodplain contains humic acids from decomposition of leave litter;



Major Vegetation types (1)

- **Aquatic herbaceous communities:** dense mats of herbaceous vegetation, 1-3 m tall, that may be emergent from shallow water but are more typically floating;



- **Short-tree shrublands:** This vegetation type consists of dense, fairly homogeneous stands of 2–4 m tall trees and scrub.

Major Vegetation types (2)

- **Evergreen riverine forest:** tall and species-rich gallery forest, particularly along Stung Sen levee;



- **Swamp or gallery forest:** Is under water between 4-6 m for up to 8 months each year; mostly at the shoreline and along the major river channels as a mosaic of stands of large trees and open areas with floating aquatic vegetation typical of the lake itself.

Major Vegetation types (3)

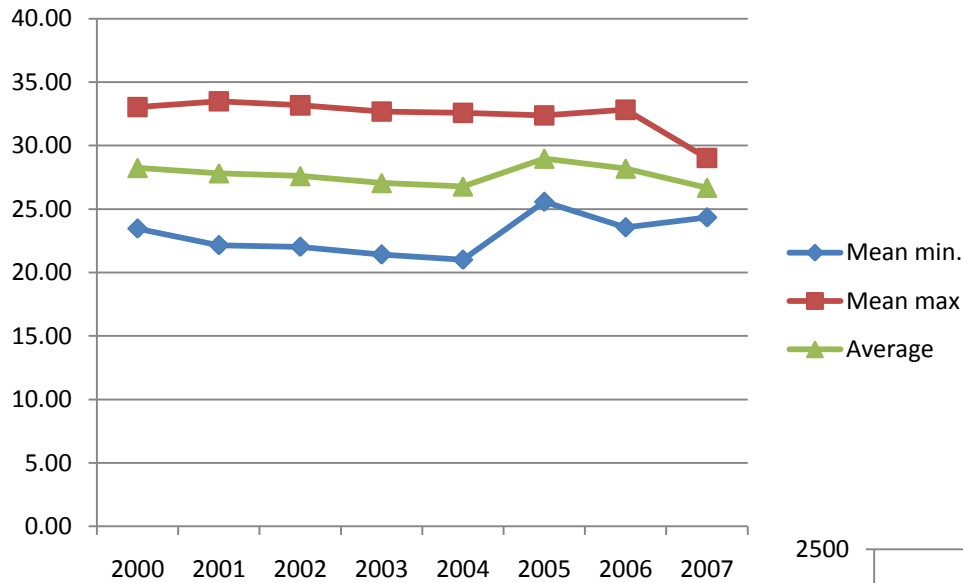
- **Grasslands:** A wide variety of grassland types occur in the middle-outer floodplain, and sedge at the south-west end.



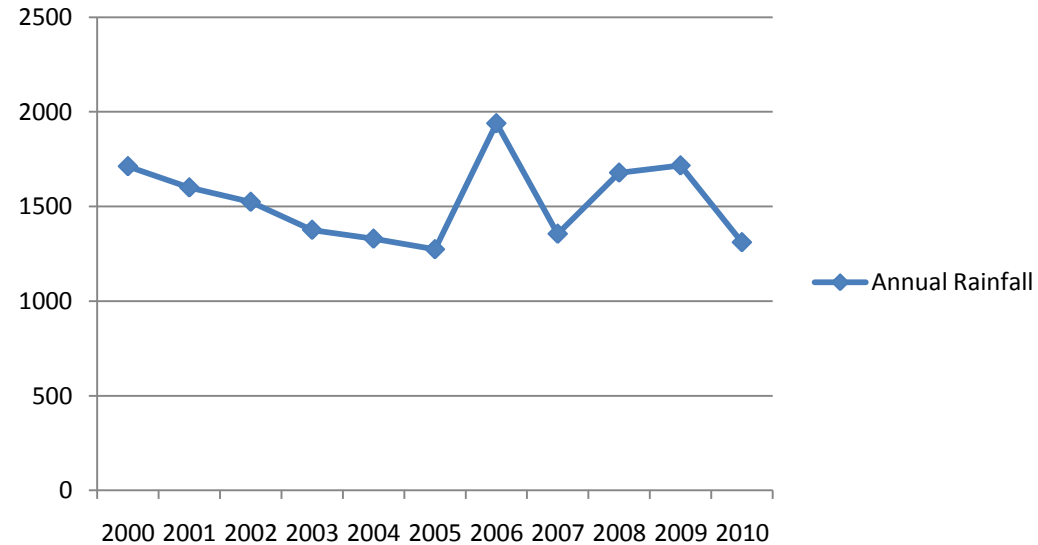
- Agriculture land: small pockets on the levee, small islands at the south, and further up north;

Current Temp and Rainfall at Kg. Thom

Annual Temp at Kg. Thom °C



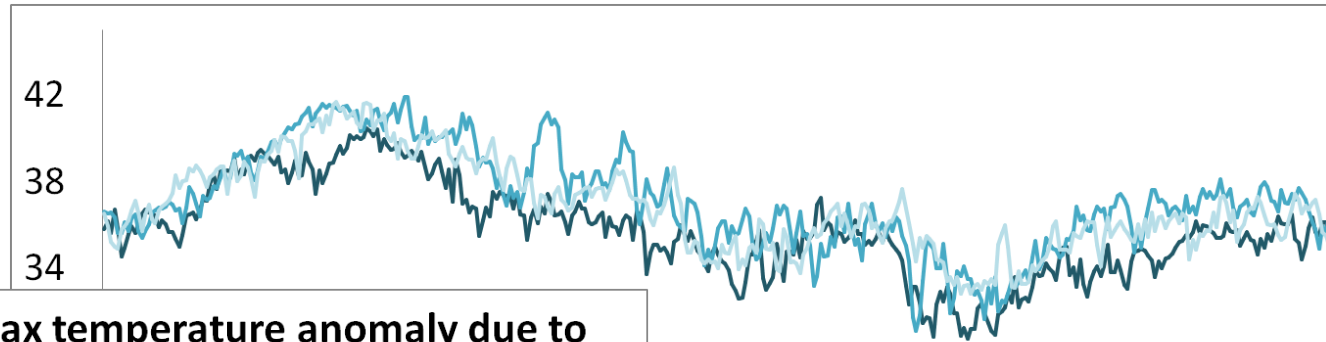
Annual Rainfall (mm)



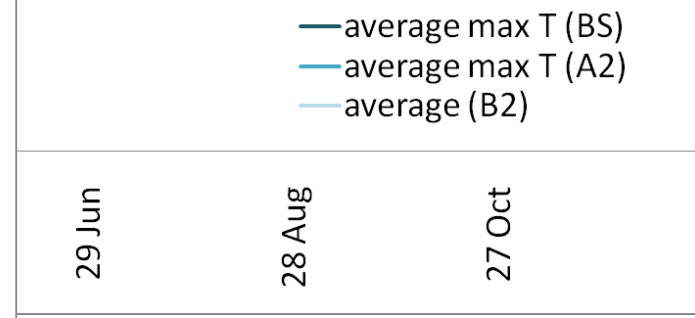
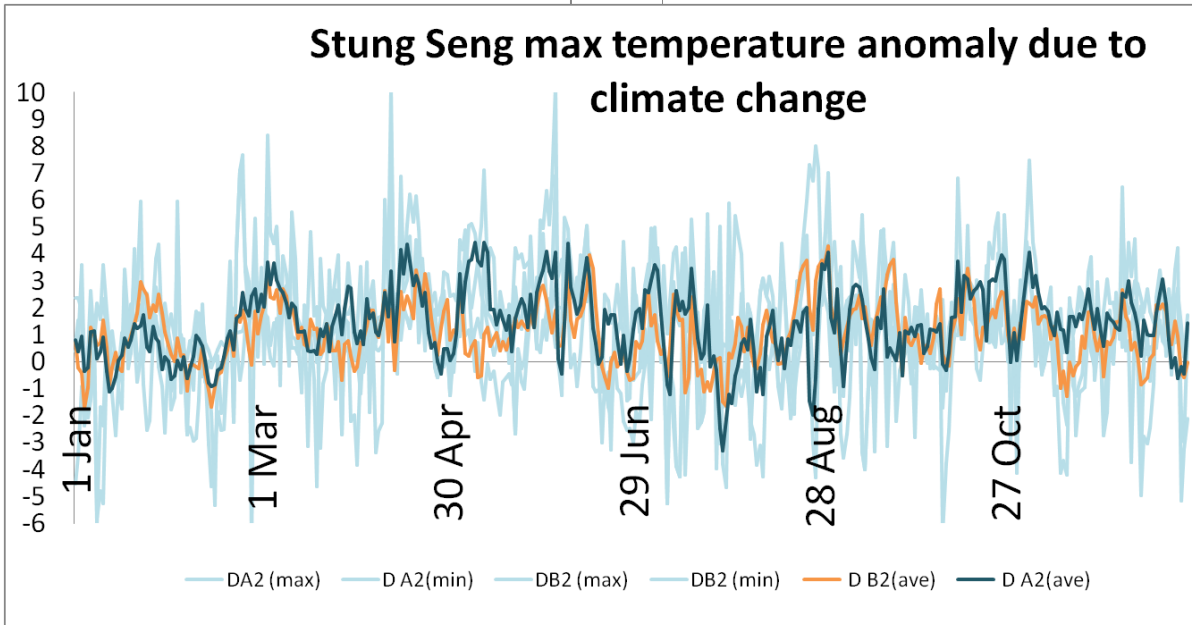
Stung Sen changes in temperature

- 1 – 1.5deg C increase in max annual temperatures
- Increases are typically greater during the wet season

	Annual	dry	wet
A2	1.4	1.3	1.4
B2	1.1	0.9	1.2

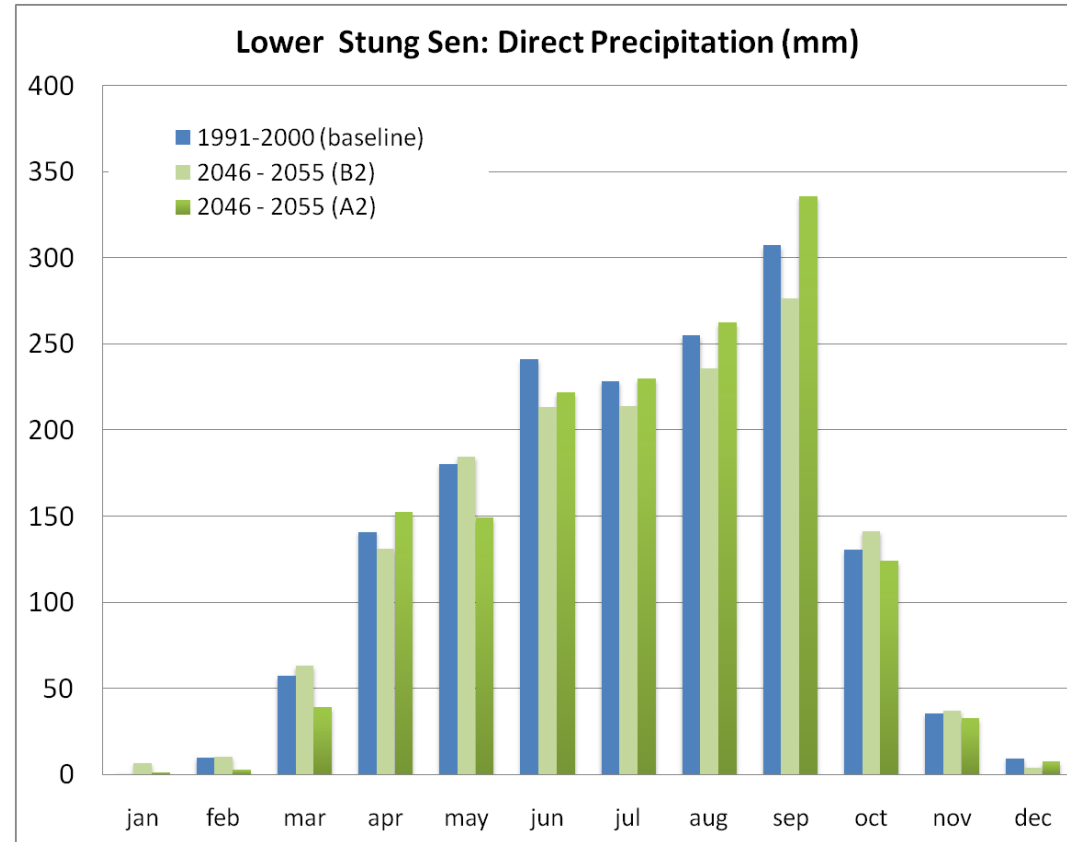


Stung Seng max temperature anomaly due to climate change



Stung Sen changes in precipitation

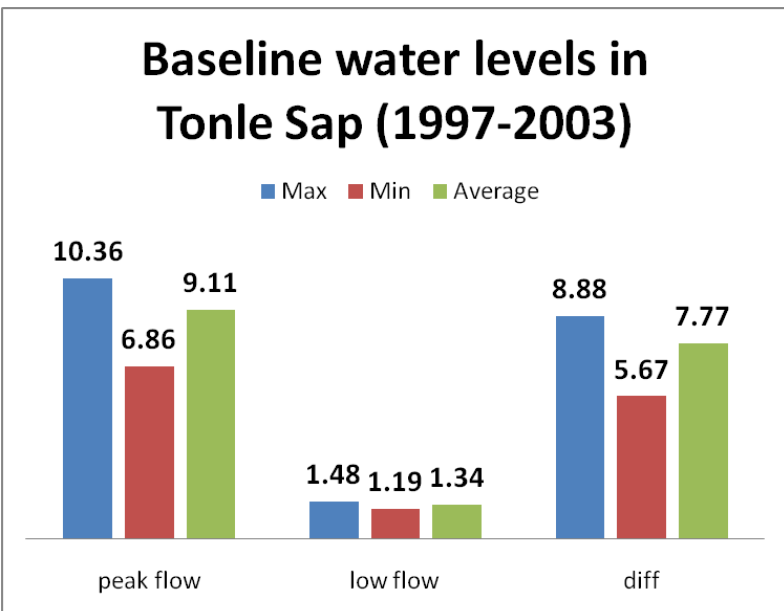
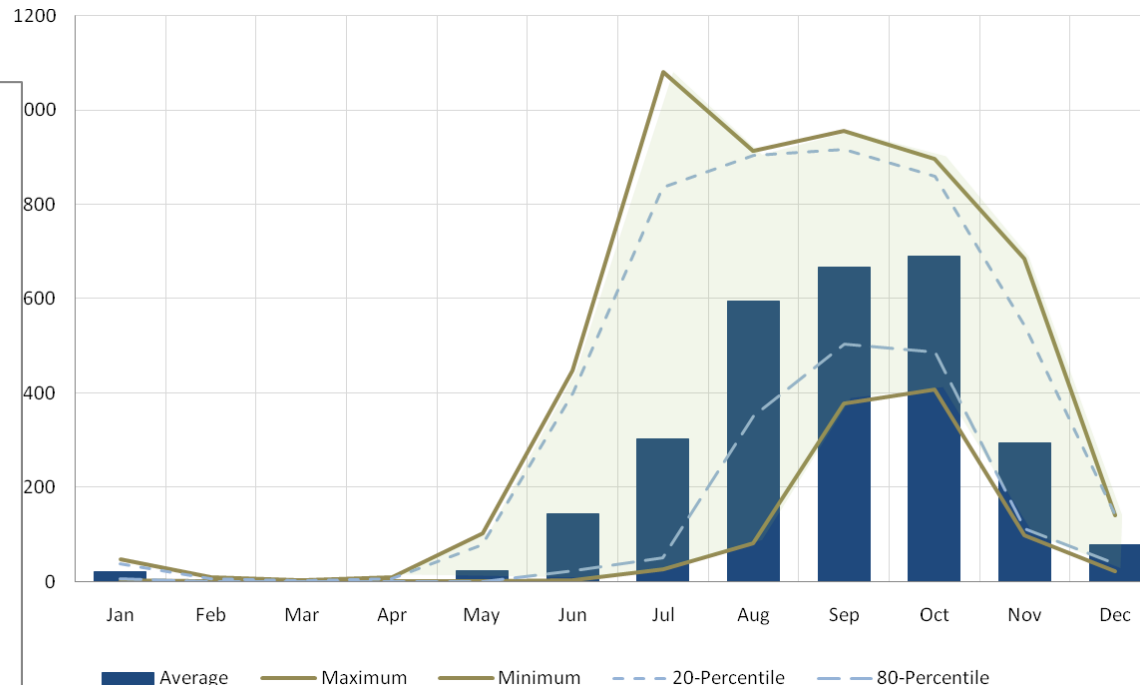
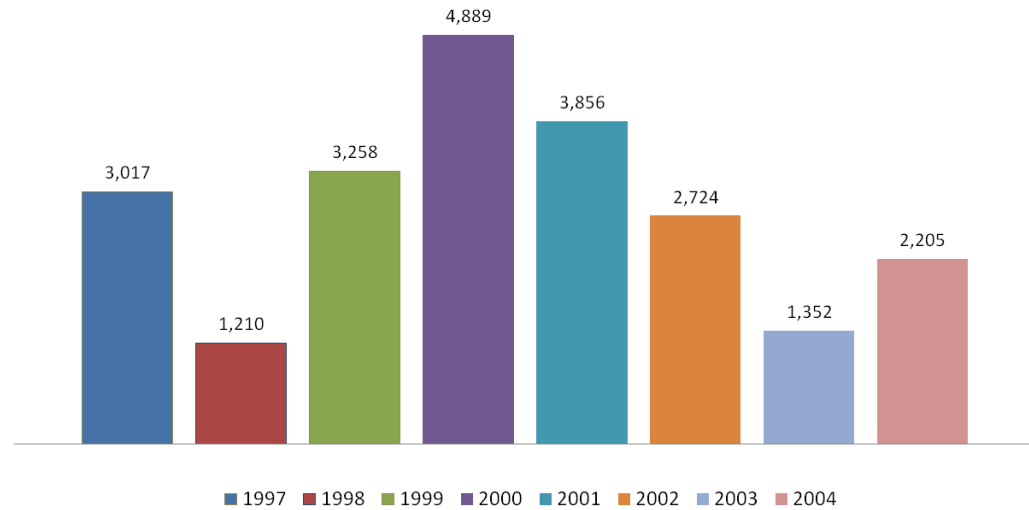
- Marginal change in seasonal and annual precipitation
- Some months will experience more significant change



	precipitation (mm)		
	wet season	Dry season	annual
baseline	1305	293	1,598
A2	1302	258	1,560
B2	1208	312	1,520

Existing hydrology of Stung Sen

- High inter-annual variability of Stung Sen River hydrology



Potential change in Temperature

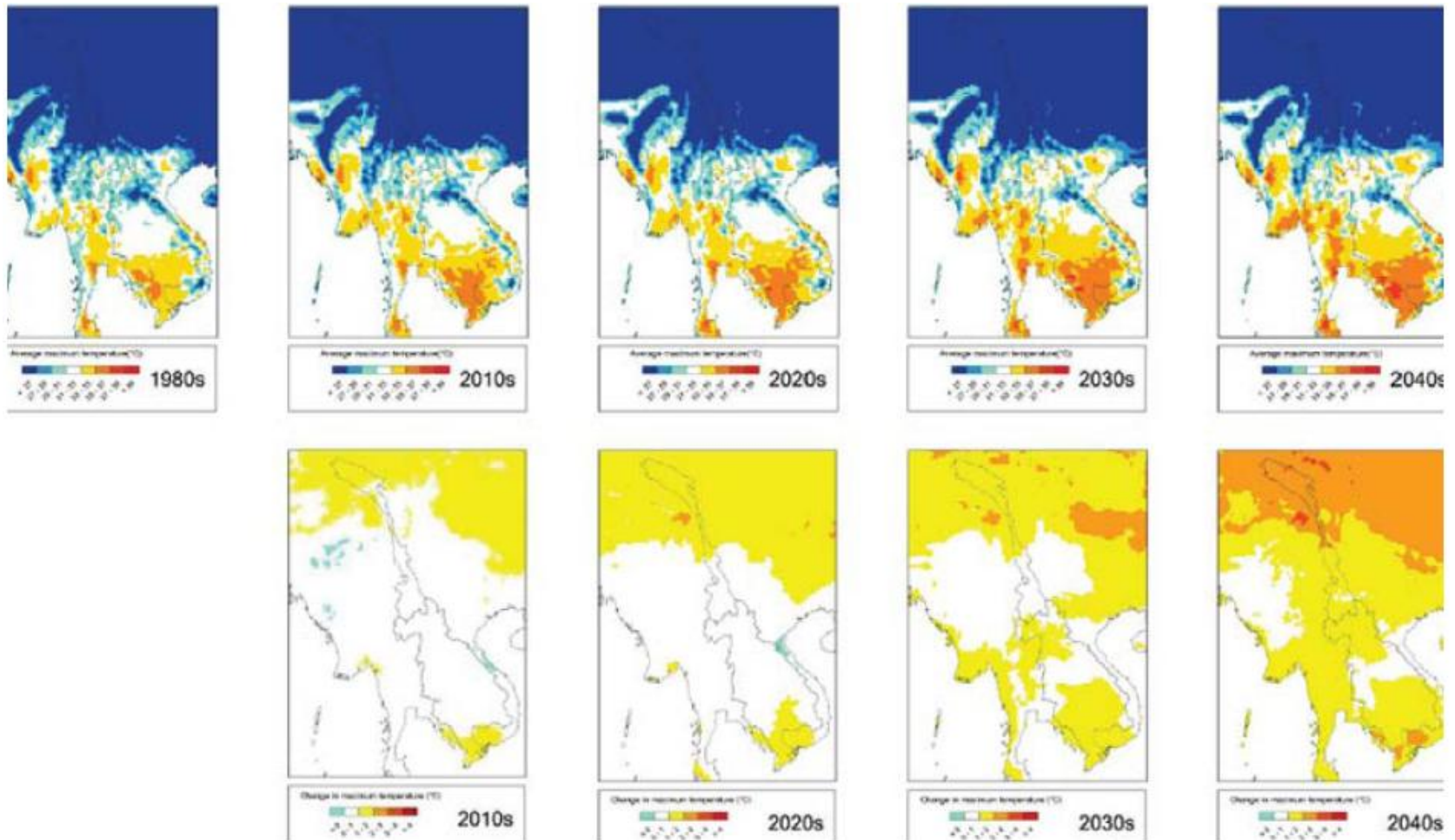


Figure 1. Average daily maximum temperature (top) and future change in maximum temperature compared to the baseline decade of 1980s (bottom) under A2 climate scenario.

Potential change in precipitation

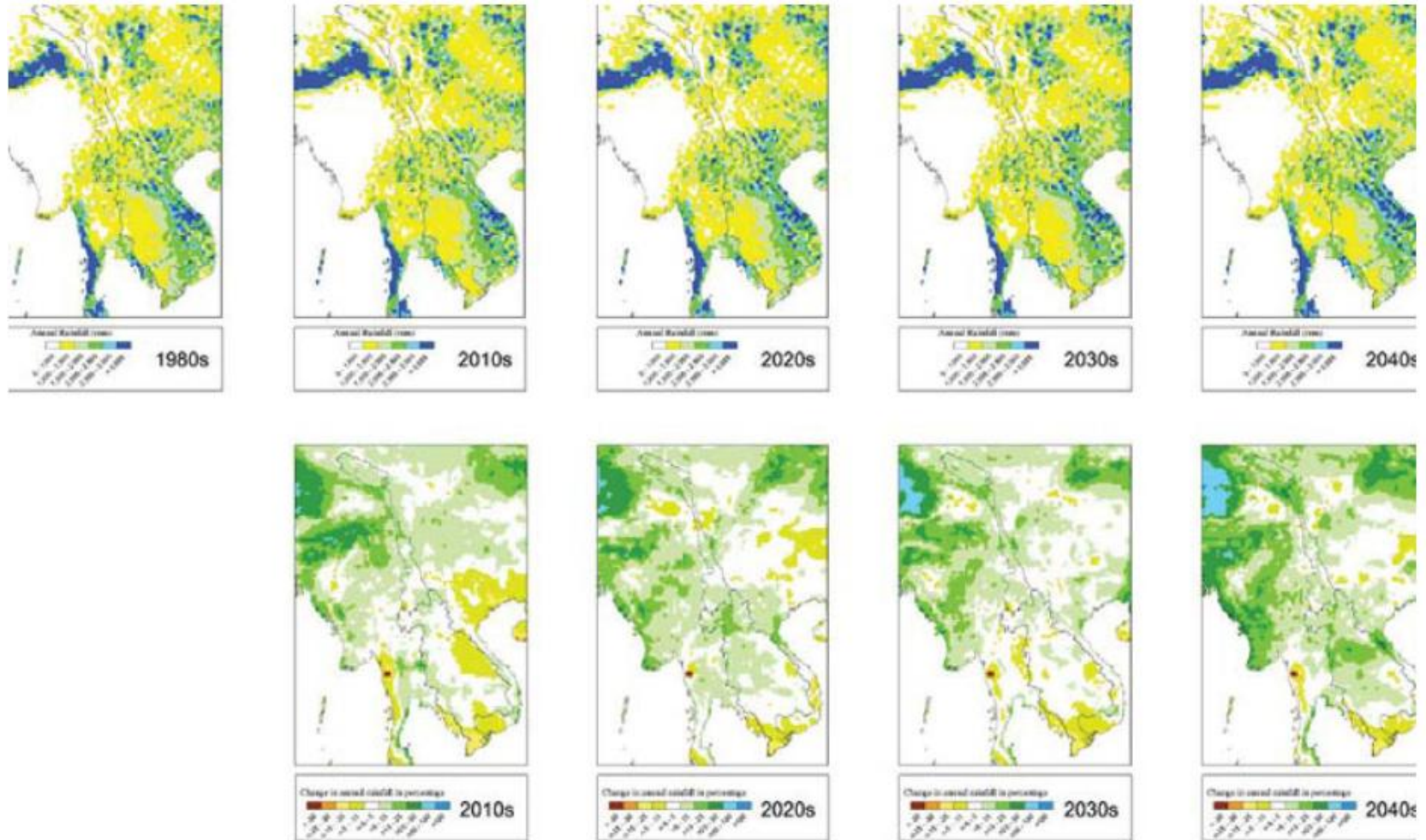
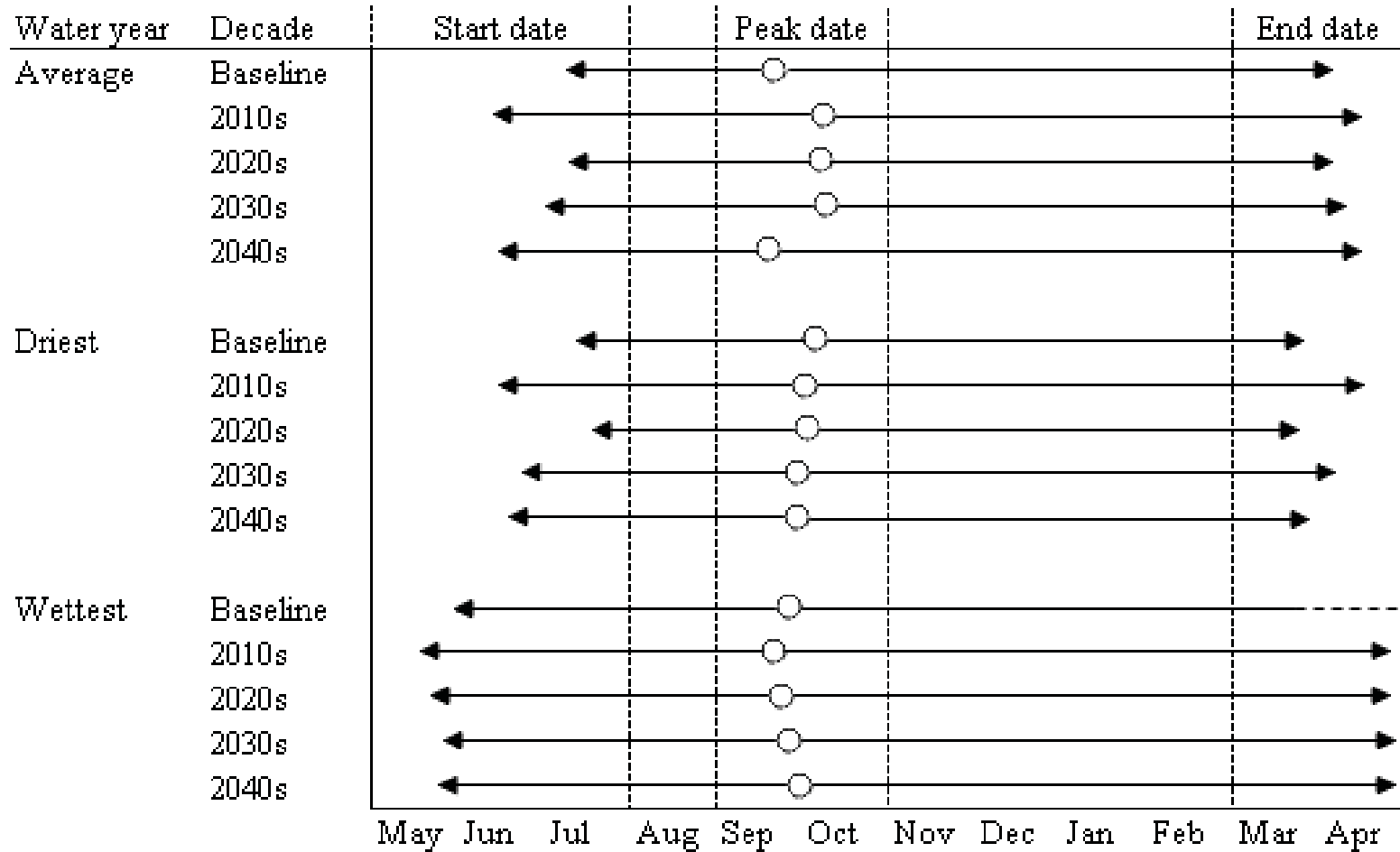


Figure 2. Average annual rainfall i.e. precipitation (top) and future change in the annual rainfall compared to the baseline decade of 1980s (bottom) under A2 climate scenario.

Potential impacts of CC on flood pulse



Start, peak and end dates of flooding in the Tonle Sap lake-floodplain system

Average changes in the Tonle Sap flood pulse characteristics and other hydrological variables for the period of 2010-2049 compared to baseline period (1995-2004).

CHARACTERISTIC	SEA	BASIN	BASIN+SEA
Average water level (Feb–Jul) [cm]	+2	+25	+26
Average water level (Aug–Jan) [cm]	+0.3	+7	+7
Annual cumulative flooded area [1000 km ²]	+5	+81	+84
Annual maximum water level [cm]	+0.5	+11	+11
Annual maximum flooded area [km ²]	+8	+181	+182
Flood start date [d]	-0.3	-12	-13
Flood peak date [d]	0	+2	+2
Flood end date [d]	+1	+4	+5
Flood duration [d]	+2	+19	+20

Trend of climate change impacts on the characteristics of the Tonle Sap flood pulse and other hydrological variables as average of all simulated climate scenarios

HYDROLOGICAL VARIABLE	CHANGE	DESCRIPTION
Average water level (Feb–Jul)	↑	Very likely increases
Average water level (Aug–Jan)	↑	Likely increases
Annual cumulative flooded area	↑	Very likely increases
Maximum water level	↑	Likely increases
Maximum flooded area	↑	Likely increases
Flood start date	←	Very likely occurs earlier
Flood peak date	→ / ←	Occurs possibly later in the average years and earlier in the driest years
Flood end date	→	Likely occurs later
Flood duration	↑	Likely increases

Potential impacts of CC on habitats

Wetland habitat	Potential impacts
Open water	<ul style="list-style-type: none"> Higher evaporation, higher water level on average, more sediment from more intense rainfall, flow of water hyacinth in channels;
Littoral	<ul style="list-style-type: none"> Longer and higher flooding, some existing areas may be permanently under water, higher temperature, more sediment may be settled as a result of more intense rainfall and the loss of flooded forest, vegetation community features may change and may shift upward as a result of higher water level;
Beaches	<ul style="list-style-type: none"> Mostly flooded, some may be permanently under water,
Small isolated waterholes	<ul style="list-style-type: none"> More evaporation, may increase connectivity in the normal year but may dry out in the dry year; more water hyacinth may accumulate in the normal year but less in the dry year;
Banks (draw down zone)	<ul style="list-style-type: none"> Less exposed time; Change in location and intensity of erosion;
Riparian vegetation zone	<ul style="list-style-type: none"> Longer inundation, higher level of flooding;
Alluvial reaches	<ul style="list-style-type: none"> More sedimentation, at the delta in particular;
Riverine flooded forest	<ul style="list-style-type: none"> Earlier, and prolonged inundation;
Islands and riverbanks	<ul style="list-style-type: none"> Deeper and longer inundation;
Riparian vegetation zone	<ul style="list-style-type: none"> Earlier, and prolonged inundation; structure of the vegetation may change and dominant by species that are more resistant to longer inundation;
Flooded forests	<ul style="list-style-type: none"> Longer and deeper inundation;
Floodplain grasslands	<ul style="list-style-type: none"> Longer and deeper inundation and some become permanently under water;

Potential impacts on selected biodiversity (1)

Species / assemblage	Potential impacts
Flora and vegetation	
<i>Sesbania javanica</i>	<ul style="list-style-type: none"> • May benefit from more sedimentation, may shift upward to higher area;
<i>Phragmites karka</i>	<ul style="list-style-type: none"> • May benefit from more sedimentation but also affect from erosion at some places, higher risk to fire;
<i>Gardenia cambodiana</i>	<ul style="list-style-type: none"> • Higher water level and temperature and irregular seasonality may affect its growth
<i>Combretum trifoliatum</i>	<ul style="list-style-type: none"> • May suffer from irregular seasonal flooding, and may shift to higher grounds
<i>Calamus palustris</i>	<ul style="list-style-type: none"> • May suffer from prolonged flooding;
<i>Brownlowia paludosa</i>	<ul style="list-style-type: none"> • May suffer from prolonged and higher flooding
<i>Barringtonia acutangula</i>	<ul style="list-style-type: none"> • May suffer high water level in the dry season or stress from extreme water level that limit its growth as it depends on seasonality;

Potential impacts on Selected biodiversity (2)

Species / assemblage	Potential impacts
Aquatic invertebrates	
<i>Macrobrachium lanchesteri</i>	<ul style="list-style-type: none"> • May benefit from more extensive flood areas but may suffer from accessibility to flooded grassland;
Fish	
<i>Channa micropeltes</i>	<ul style="list-style-type: none"> • May suffer from change in seasonality, but may benefit from higher flooding, • Changed/damaged food supply due to change in quality of habitats
<i>Cirrhinus microlepis</i>	<ul style="list-style-type: none"> • Changed in seasonality, flood pulse that trigger migration; • Changed/damaged food supply due to change in quality of habitats
<i>Catlocarpio siamensis</i>	<ul style="list-style-type: none"> • May suffer from changed in seasonality that trigger their migration; • Reduced foraging ability due to changed siltation from increased storms in the catchment; • Changed/damaged food supply due to change in quality of habitats,
<i>Pangasianodon gigas</i>	<ul style="list-style-type: none"> • Impacts from change in seasonality, flood pulse that trigger migration; • Reduced foraging ability due to changed siltation from increased storms in the catchment; • Changed/damaged food supply due to change in quality of habitats
<i>Henicorhynchus siamensis</i>	<ul style="list-style-type: none"> • Better accessibility to river system; • Change in sediments that may affect feed availability
<i>Thynnichthys thynnoides</i>	<ul style="list-style-type: none"> • Changed in seasonality, flood pulse that trigger migration; • Changed/damaged food supply due to change in quality of habitats
<i>Probarbus jullieni</i>	<ul style="list-style-type: none"> • Impacts from change in sand and gravel substrates, due to Its intolerant of habitat alteration; • May enhance access route in the dry season, but less available spawning and feeding grounds;

Potential impacts on selected biodiversity (3)

Species / assemblage	Potential impacts
Amphibians	
<i>Hoplobatrachus rugulosus</i> and <i>Bufo melanostictus</i>	<ul style="list-style-type: none"> • May have to escape to shallow wet areas as many are deeply inundated; • May impact on sex ratio and tadpole survivor, new nesting sites may be available ;
Reptiles	
<i>Crocodylus siamensis</i>	<ul style="list-style-type: none"> • May suffer from change in pattern of habitats; • Altered sex ratios + hatchling survivorship due to rising temperatures; • Loss of nesting grounds;
<i>Batagur baska</i>	<ul style="list-style-type: none"> • Altered sex ratios + hatchling survivorship due to rising temperatures; • Loss of nesting grounds;
<i>Hieremys annandalii</i>	<ul style="list-style-type: none"> • May suffer from change in habitats and not higher ground is available to them as the upper fringe of the flooded forest have become rice field; • Altered sex ratios + hatchling survivorship due to rising temperatures;
Birds	
Cormorant and Darter	<ul style="list-style-type: none"> • May suffer from change in composition trees used for staging; • Change in feeding grounds as water stays higher in the dry season; • May suffer from change in timing when habitats are available for spawning;
Greater Adjutant and Ibis	<ul style="list-style-type: none"> • May suffer from longer flooding of grasslands used as feeding grounds
Greater Spotted Eagle	<ul style="list-style-type: none"> • May suffer from change in extend and flooding time of grassland and scrubland;
Mammals	
Long-Tailed Macaque	<ul style="list-style-type: none"> • Could suffer from change of scrubland features and have to face more with human activities;
Hairy-nosed Otter	<ul style="list-style-type: none"> • Loss of access to suitable habitats as the flood is higher

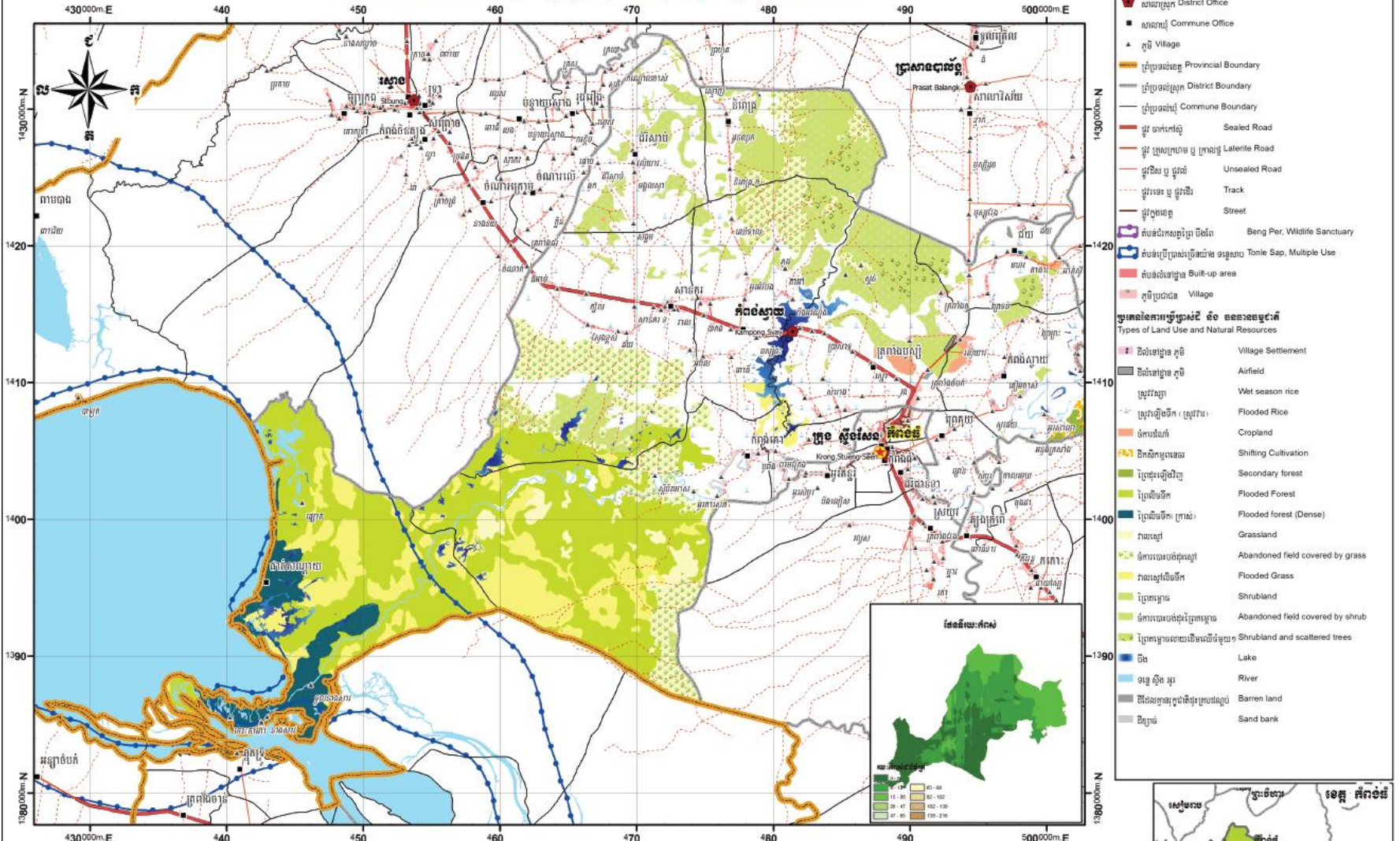
Suggested adaptation strategies

- Taking eco-system based approach:
 - Assess the need to and enhance the complementing role between terrestrial environment upstream of Stung Sen and of Tonle Sap floodplain;
 - Avoid disruption of fish mobility into the flooded forests as well as upstream the Mekong;
- Taking territorial/area approach:
 - Ensure the protection of terrestrial forest upstream of Stung Sen to curtail increasing erosion from potential increased torrential rains; and
 - Enhance and enforce existing flooded forest zoning system to ensure sufficient green belt is retained surrounding the Tonle Sap floodplain;
- Adopting planning and management approaches that are an informed, strategic and participatory
 - Ensure integrated land use planning;
- Forging more flexible, adaptive, learning institutions:
 - Enhance existing fishing lot, and CFi and CPA systems to protect the flooded forests and local biodiversity;

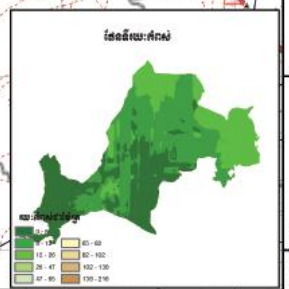
Land use: Stung Sen

ផែនទីប្រើប្រាស់ដី និង ធនធានធម្មជាតិ ស្រុកកំពង់ស្វាយ ខេត្តកំពង់ឆ្នាំង

Land Use and Natural Resources of Kampong Svay District (0602), Kampong Thum Province



- សញ្ញាសំគាល់**
- ភ្នាក់ងារខេត្ត Province Office
 - ភ្នាក់ងារស្រុក District Office
 - ភ្នាក់ងារកុម្មុយន៍ Commune Office
 - ភូមិ Village
 - ព្រំប្រទល់ខេត្ត Provincial Boundary
 - ព្រំប្រទល់ស្រុក District Boundary
 - ព្រំប្រទល់កុម្មុយន៍ Commune Boundary
 - ផ្លូវ ចាក់កៅស៊ូ Sealed Road
 - ផ្លូវ គ្រួសារក្រហម ឬ គ្រួសារ ឡាតេរី Laterite Road
 - ផ្លូវរឹង ឬ ផ្លូវដី Unsealed Road
 - ផ្លូវទេស ឬ ផ្លូវលើ ឃ្នក Track
 - ផ្លូវក្រុង Street
 - សំបកដីរក្សាព្រៃ បឹងព័ទ្ធ Beng Per, Wildlife Sanctuary
 - សំបកប្រើប្រាស់ប្រើប្រាស់ ទន្លេតូនេ ឬ ទន្លេតូនេ ទៀត Tone Sap, Multiple Use
 - សំបកដីទៅក្នុង Built-up area
 - ភូមិប្រជាជន Village
- ប្រភេទប្រើប្រាស់ដី និង ធនធានធម្មជាតិ**
Types of Land Use and Natural Resources
- ប្រជាជន ភូមិ Village Settlement
 - ប្រជាជន ភូមិ Airfield
 - ប្រាំងវស្សា Wet season rice
 - ប្រាំងវស្សា (ប្រាំង) Flooded Rice
 - ដំណាំដំណាំ Cropland
 - ដំណាំប្រមូលផល Shifting Cultivation
 - ព្រៃធម្មជាតិ Secondary forest
 - ព្រៃធម្មជាតិ ទាប Flooded Forest
 - ព្រៃធម្មជាតិ (ក្រាស់) Flooded forest (Dense)
 - រាងកាយ Grassland
 - ដំណាំដំណាំដំណាំ Abandoned field covered by grass
 - រាងកាយ ដំណាំដំណាំ Flooded Grass
 - ព្រៃធម្មជាតិ Shrubland
 - ដំណាំដំណាំដំណាំ Abandoned field covered by shrub
 - ព្រៃធម្មជាតិ ដំណាំដំណាំ Shrubland and scattered trees
 - បឹង Lake
 - ទន្លេ ភ្លុំ អូរ River
 - ដីដាច់ខ្ទប់ ដំណាំដំណាំ Barren land
 - ដីក្រាម Sand bank



ស្ថាប័នប្រតិបត្តិការ: អគ្គនាយកដ្ឋានប្រើប្រាស់ដី និង ធនធានធម្មជាតិ ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និង ត្រីមាស
(ក.ក.ក.ស)

ប្រព័ន្ធប្រកាស: Universal Transverse Mercator
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ស្ថិតិ: UTM

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Population view on wetlands: Stung Sen

Trends	Stung Sen
Wetland pollution	↑
Fish stock (wetland, river)	↑↓
Flooded forest	↓
Fuel wood	=
NTFP	=
Wild bird	↑
Wild animal	↓

Wetlands ecosystem services trends: Stung Sen

1- Provisioning services	Present importance	Future importance
Food production for fish and habitat	High	↑
Water retention for domestic and other uses	High	↑
Fuel wood, log, peat and fodder	High	↑
Medicinal plant	Medium	↑
Ornamental species	Medium	=

Wetlands ecosystem services trends: Stung Sen

2- Regulating services	Present importance	Future importance
Climate regulation/ sink greenhouse gas	High	=
Water regulation /groundwater recharge	High	=
Water purification/ natural treatment	High	=
Erosion protection, sediment disposal	High	↑
Natural hazard regulation/ Flood, storm control	High	=

Wetlands ecosystem services trends: Stung Sen

3- Cultural services	Present importance	Future importance
Spiritual value	High	=
Recreation activities	Medium	↑
Natural aesthetic	High	=
Educational activities	Medium	=

Wetlands ecosystem services trends: Stung Sen

4- Supporting services	Present importance	Future importance
Biodiversity/ habitat for species	High	↑
Fish spawning and nursery area	High	↑
Soil formation, sediments retention, accumulation of organic matters	High	↑
Nutrient recycling storage, recycling, processing, and acquisition of nutrients	High	↑
Pollination habitat for pollinators	High	=

Socio-economic activities: Stung Sen



	1998	2008
No. of commune		1
No. of villages		6
No. of household	1,203	1,145
Total population	6,669	5,777 (-1,42% vs 1.54%)
Poverty rate		43.1%
No. of migrants		232

Fishing activities	Amount	HH involved
Fishing as main job		800
No. of fishing boat		1367
Aquaculture		144

Socio-economic activities: Stung Sen

	Area (ha)	Yield (t/ha)	Price (\$/t)	HH involved
Rice production	23	3	150 - 227	
Other crops: corn	22	3.2		
	Amount (m3)			HH involved
NTFP				
Timber				
Fuel wood				1,145

Economic valuation: Stung Sen

Hypothesis: 92% of HH: commercial fishermen. Method use: PRA (in 2005 US\$ value).

2- Fishing activities	HH survey 2011	Hab, Bhattarai, 2007 (Tonlé Sap river)
Cost (US\$/year/HH)		1,957
Fishing net	450	93
Boat & engine		96
Gasoline	2,453	480
Opportunity own labor cost		675
Boat maintenance	50	63
Other costs		550
Benefit (US\$/year/HH)		2,337

Considering family fisherman works 300 days per annum, 100 days for closed season and 200 days for open season

Livelihoods and Local Adaptations

Perceived Changes

- Rivers, lakes and streams - shallow
- Stung Sen river - many places people can walk across
- Storms destroy floating houses and other assets
- Absence of water from Mekong flow to Tonle Sap (2 years) – July or August
- Change in raining pattern: normal starts in May-June BUT this year starts in April and drought with increased temperature in May and June.
- Change in water receding (4 years already): normal starts in Nov BUT now starts in Dec.

Wetland Dependent Livelihoods

- Fishing is a major occupation for vast majority of local people in Phat Sanday commune and followed by
- Dry season rice cropping, vegetable gardening, collection of aquatic resources and animal raising.
- Some local fishermen raise cat fish in cage – *Paugasius* spp
- Average 15 – 90 Kg fish catch per day in open season and 3-10 Kg in close season.
- Fish for local consumption and sale (Chhnok Tru market)
- Many local fishermen got medium size loan credit from micro finance institutions and private bank for their fishing gears and boat transport.

Livelihood Trends and Changes

- Loss of floating houses and other assets
- Corns and other crops destroyed by floods.
- Change from 2 to 1 crop per year (corn)
- High mortality of pigs and chicken – in dry season
- Human health – hot fever, diarrhea, cold, stomach, etc. in early of the year.
- Flooded forests clearance – important fish habitats
- Wildlife animals decline BUT likely increase of some waterbirds species

Livelihood Trends and Changes

- Fish significantly decline compared to last 10 years.
- Few fish species disappeared from catch: Small-scale mud carp, *Datnioides microlepis*, cat fish *Pangasius* spp, etc.
- Illegal and licensed forms of fishing
- Number of fishermen has increased

Development Challenges and Trends

- Flooded forest clearance – lotus planting, dry season rice cropping by outsiders (approx 100 hectares)
- Few local people clear forest land outside their commune to plant cassava with their loan debts.
- Fishing lots concessions within the core zone of Tonle Sap Biosphere Reserve – weak management

Development Challenges and Trends

- A number of irrigations and reservoirs – in operation and being planned for dry rice planting and fishing;
- Hydropower projects are planned in upper Stung Sen river & other;
- Wetlands rely on water quantity and quality from Mekong river and Tonle Sap lake tributaries – 6 provinces.

Local Adaptive Capacity

- Community fisheries and community protected areas established – capacity strengthening and resource support required
- Flooded forest replanting by ADB projects.
- Fish culture as livelihood strategy by local fishermen
- Water sanitation (safe) supply – ADB TSSL project
- Awareness raising and education on environment and fisheries resource – Environment's Day, etc.
- Cambodian Red Cross plays important roles in disaster emergency assistance.

Proposed Adaptation Strategies

- Expansion of replanting of flooded forests
- Strengthening of community fisheries and community protected areas.
- Legal awareness to key stakeholders and local people
- Establishment of village and commune disaster management committees.
- Expansion of fish culture activities
- Appropriate agriculture technology – resilient to droughts and floods
- Other vocational skills training

Policy and Institutional Review Wetlands and Climate Change

National and Sub-national Levels

Institutional Setup

- MOE, MAFF, MOWRAM, CNMC, Sub-national administrations play important roles in wetlands management and sustainable use.
- MOE – key player
- Tonle Sap Authority – coordinating the management, conservation and development of Tonle Sap region
- Tonle Sap Biosphere Reserve – reconcile biodiversity conservation with sustainable development (secretariat, committee, provincial working groups,)
- However, coordination among them remains weak
- Fisheries Administration at sub-national level under supervision MAFF.
- Not under reporting line and authority of the sub-national administrations

National and Sub-national Levels

Legislations, Policies and Plans

- As mentioned in Stung Treng presentation – a number of:
- Tonle Sap authority - royal decree and sub decree
- Tonle Sap Biosphere Reserve - royal decree and sub decree
- Key wetlands governance instruments are not in place yet
- A framework for mainstreaming climate resilience into development planning into the national and sub-national levels will be developed under the CCCA.

Local Level – commune/village

- Tonle Sap Biosphere Reserve Management Plan developed (Core areas)
- Environment rangers in place
- Capacity strengthening and resources required
- Sangkat Fisheries Administration – fisheries law enforcement
- Admin and Economic Crimes Polices and Police Military – protection and law enforcement
- Community fisheries & community protected areas – required capacity strengthening
- Village and commune disaster management committees are not in place.
- Commune council - administrative management, resource mobilization, local development & sectoral coordination

Discussions and Conclusions

- Limited financial resources for wetland management both from government and development partners;
- Unclear and overlapping roles and responsibilities among key players and sectoral players;
- Institutional setup for Tonle Sap management is complex;
- Potential role to be played under the current D&D framework in multi-sectoral coordination, planning, and management taking territorial/area approach.

Proposed Adaptation Strategies

- Use D&D framework as multi-sectoral planning, coordination and management mechanism for wetland management and sustainable use;
- Mainstreaming climate resilience into Ramsar wetlands management planning;
- National wetlands governance instruments should be developed with special attention of climate change;
- Capacity building of key stakeholders at national, sub-national and local levels on wetland management and climate change adaptation.