Climate Change Risk Assessment: Concept & approaches

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Southeast Asia START Regional Center

Topics

- Introduction to "Climate" and "change"
  - Common misconception in climate change risk assessment
  - Multiple dimensions of climate change
- Future climate projection and climate change risk assessment
  - Scenario-based thinking
  - Making data into information
- Risk and climate change risk assessment: approached and techniques
  - What is climate risk?
  - Climate change impact assessment and risk assessment – quantitative VS qualitative approach
  - Dynamic of risk and holistic approach in climate change risk assessment

Part 1: Introduction to “Climate” and “change”

- Common misconception in climate change risk assessment
- Multiple dimensions of climate change

Introduction to "Climate" and "change"

Common misconception in climate change risk assessment

Climate ≠ Weather ≠ Extreme weather event

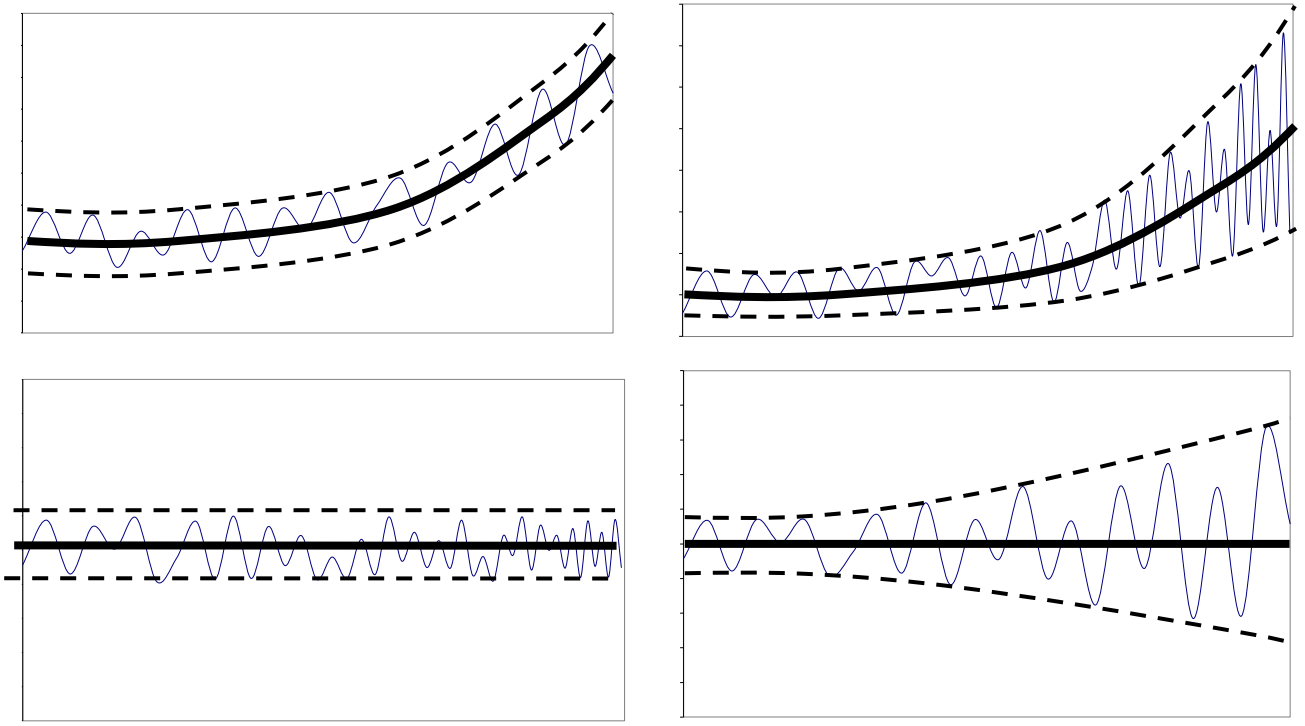
Climate change ≠ Climate variability

Climate threat ≠ Climate impact ≠ Climate risk ≠ Vulnerability

Be careful ! In many cases, these terms have been used in mixed and confusing meaning – often out of the context

Introduction to "Climate" and "change"

- Confusion on "Climate" and "Change" - mixed up between climate VS weather / change VS variability
- Over emphasize on the temperature increasing – global mean temperature
- There are many ways to look at "change"



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Introduction to "Climate" and "change"

Multiple dimensions of climate change

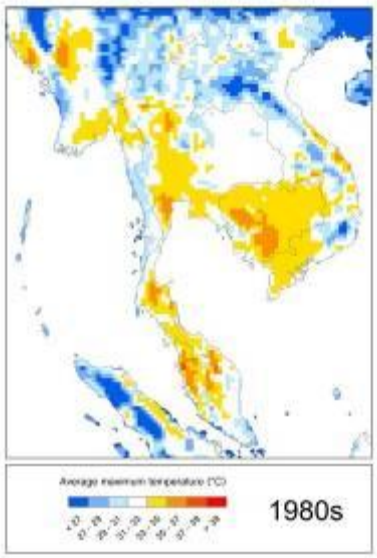
- Climate change is not uniform across space and time - overlook multiple dimensions of climate change in various aspects:
  - Magnitude – change in range of weather pattern
  - Frequency – change in return cycle of extreme weather event
  - Distribution over time and space
    - Temporal – e.g. length of season, onset – end of season, distribution of weather parameters over time
    - Geographical – e.g. area of hot area / distribution of weather parameters over geographical area

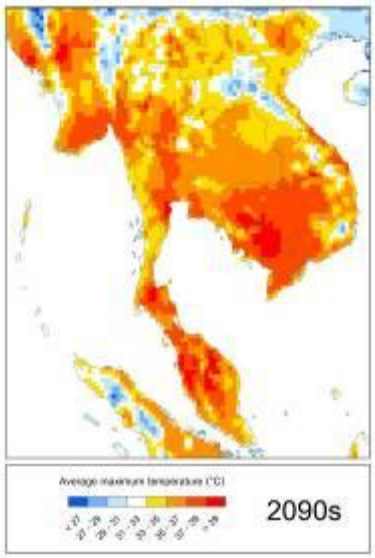
Different areas / systems / sectors have different concern on future climate change

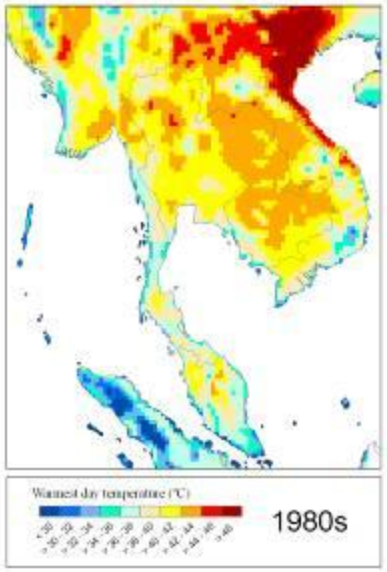
Introduction to "Climate" and "change"

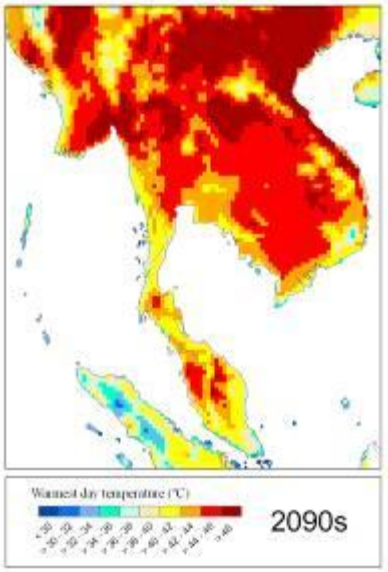
Example: Multiple dimensions of climate change - average VS extreme

Average maximum temperature VS Annual highest temperature





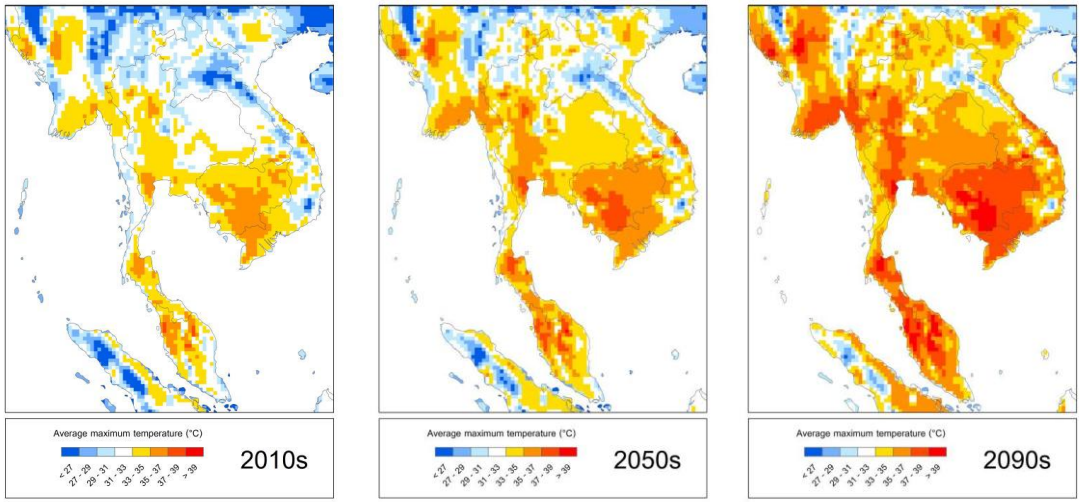




Different aspects of change bring different risks

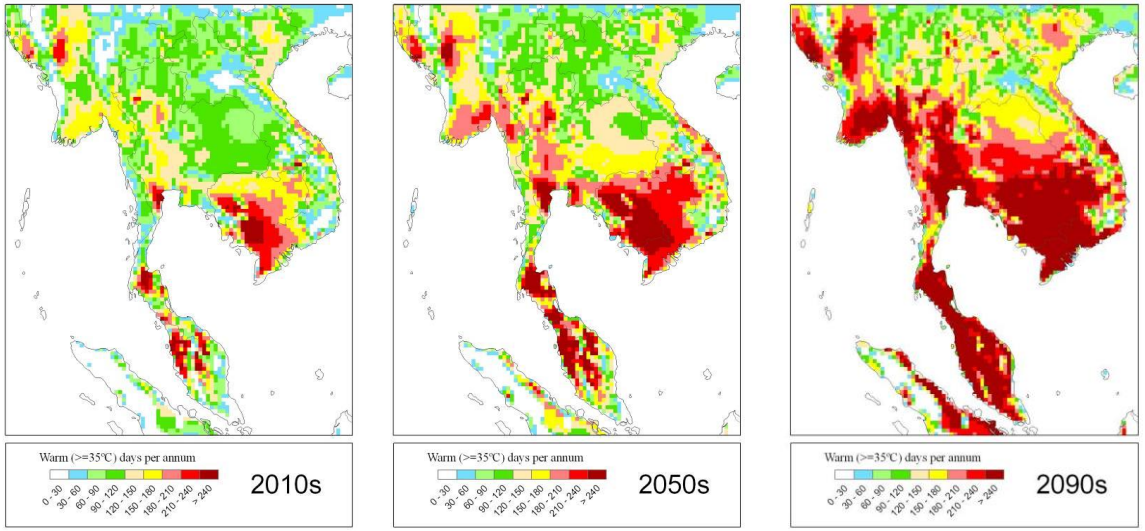
Introduction to "Climate" and "change"

Example: Multiple dimensions of climate change – space and time



Change in average maximum temperature

Change in hot period over the year



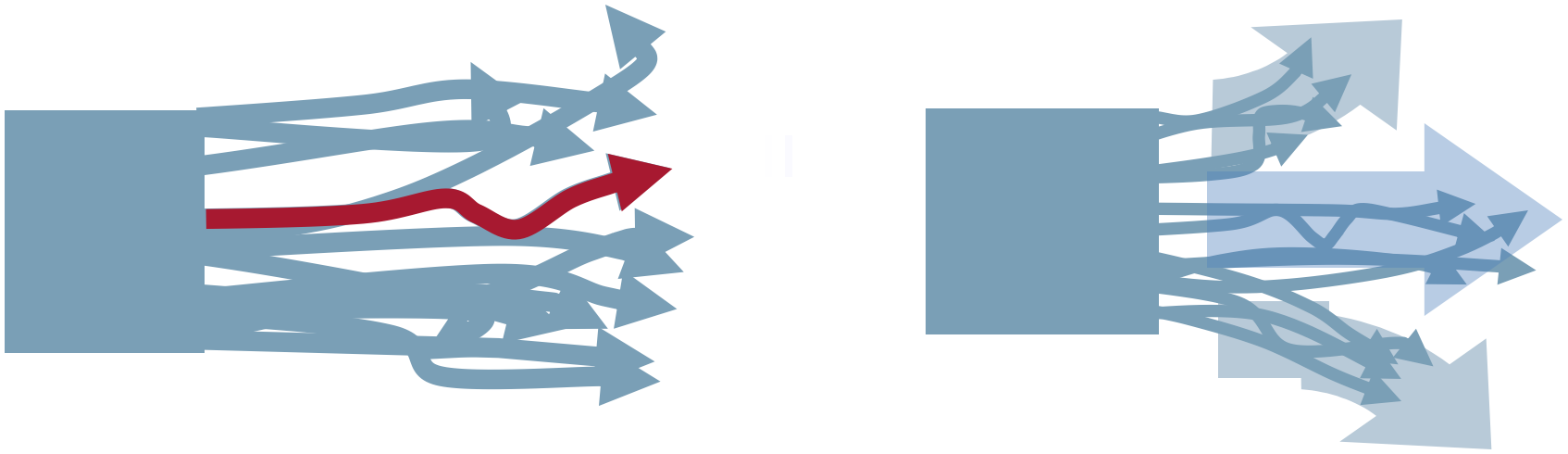
Part 2: Future climate projection and climate change risk assessment

- Scenario-based thinking
- Making data into information

Future climate projection and climate change risk assessment

Scenario Thinking: Can we really tell future?

Life is full of uncertainties – future can be unfolded in many possible ways



Scenario:

a description of possible actions or events in the future

Future climate projection and climate change risk assessment

Scenario Thinking: Can we really tell future?

Why scenarios thinking is issue of concern in climate change risk assessment?

We are looking into the future in a very long timescale – few decades, at least

Climate change is slow and complex process - Study on climate change is based on scenarios

A lot of things can change in many ways over time

Dynamic of social and economic condition is so great that we cannot forecast the future

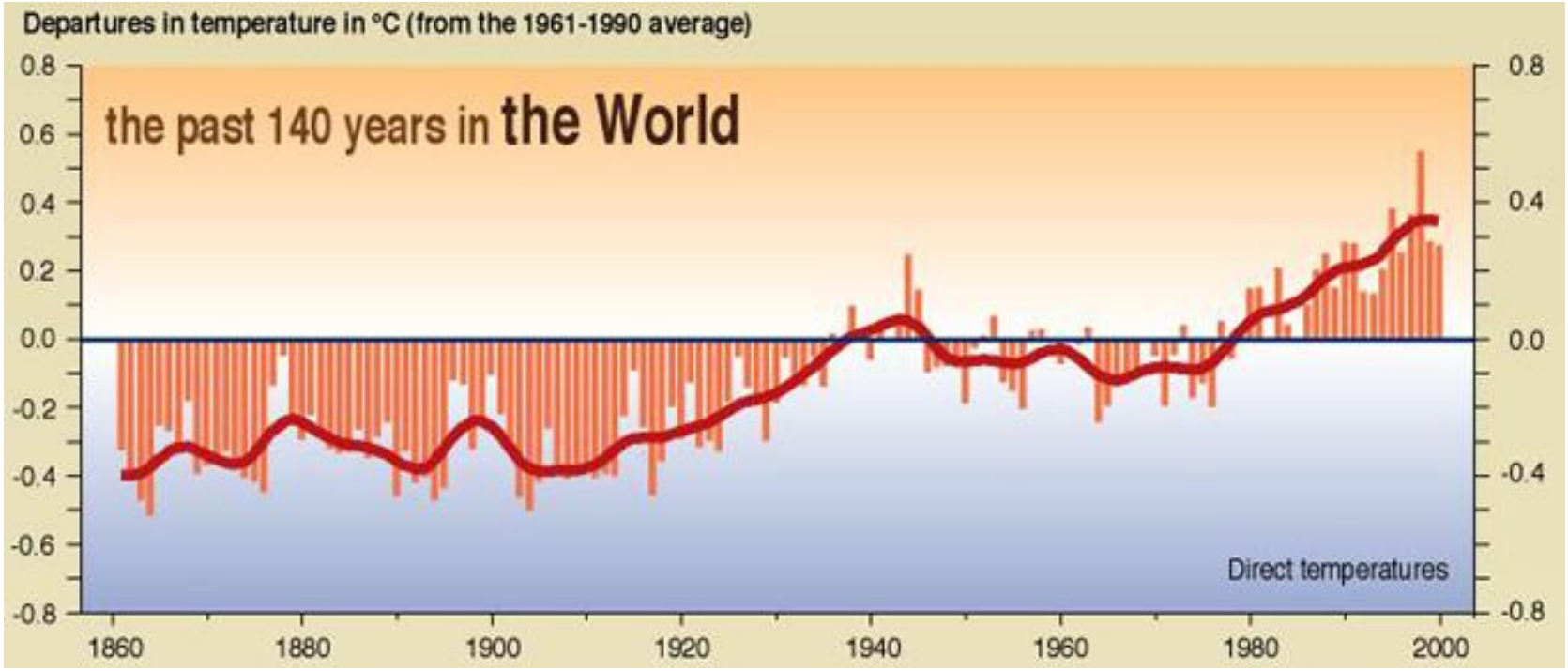
Trend of the past not necessary able to tell future

Some changes are independent to the past

Future climate projection and climate change risk assessment

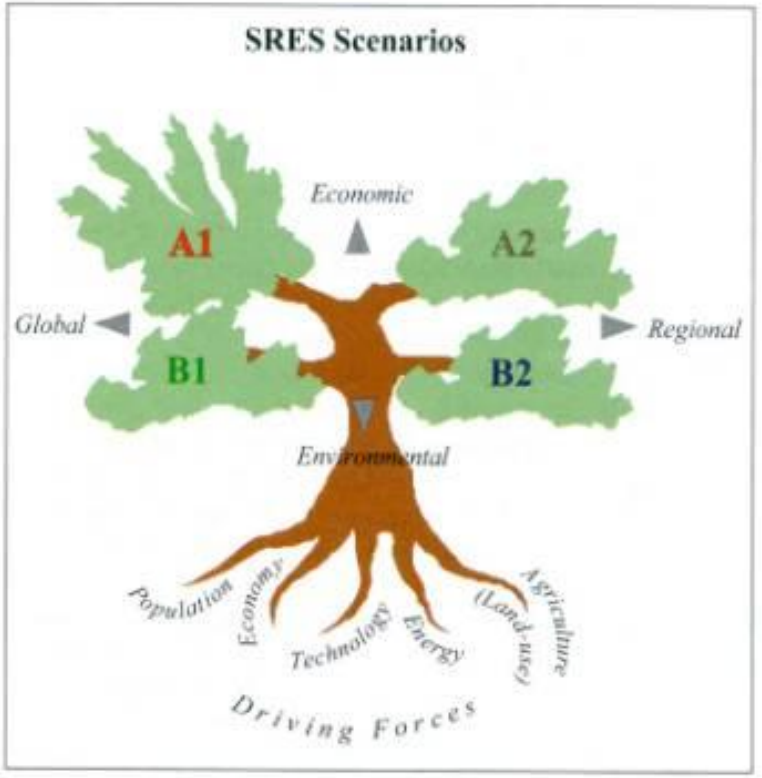
We can observe that climate change has occurred in the 20th century.

How can we know what the future holds?



Future climate projection and climate change risk assessment

Everything starts from storyline:
4 IPCC SRES storylines – future society and greenhouse gas emission



Economic emphasis →

A1 storyline	**A2 storyline**
World: market-oriented Economy: fastest per capita growth Population: 2050 peak, then decline Governance: strong regional interactions; income convergence Technology: three scenario groups: • **A1FI**: fossil intensive • **A1T**: non-fossil energy sources • **A1B**: balanced across all sources	World: differentiated Economy: regionally oriented; lowest per capita growth Population: continuously increasing Governance: self-reliance with preservation of local identities Technology: slowest and most fragmented development
B1 storyline	**B2 storyline**
World: convergent Economy: service and information based; lower growth than A1 Population: same as A1 Governance: global solutions to economic, social and environmental sustainability Technology: clean and resource-efficient	World: local solutions Economy: intermediate growth Population: continuously increasing at lower rate than A2 Governance: local and regional solutions to environmental protection and social equity Technology: more rapid than A2; less rapid, more diverse than A1/B1

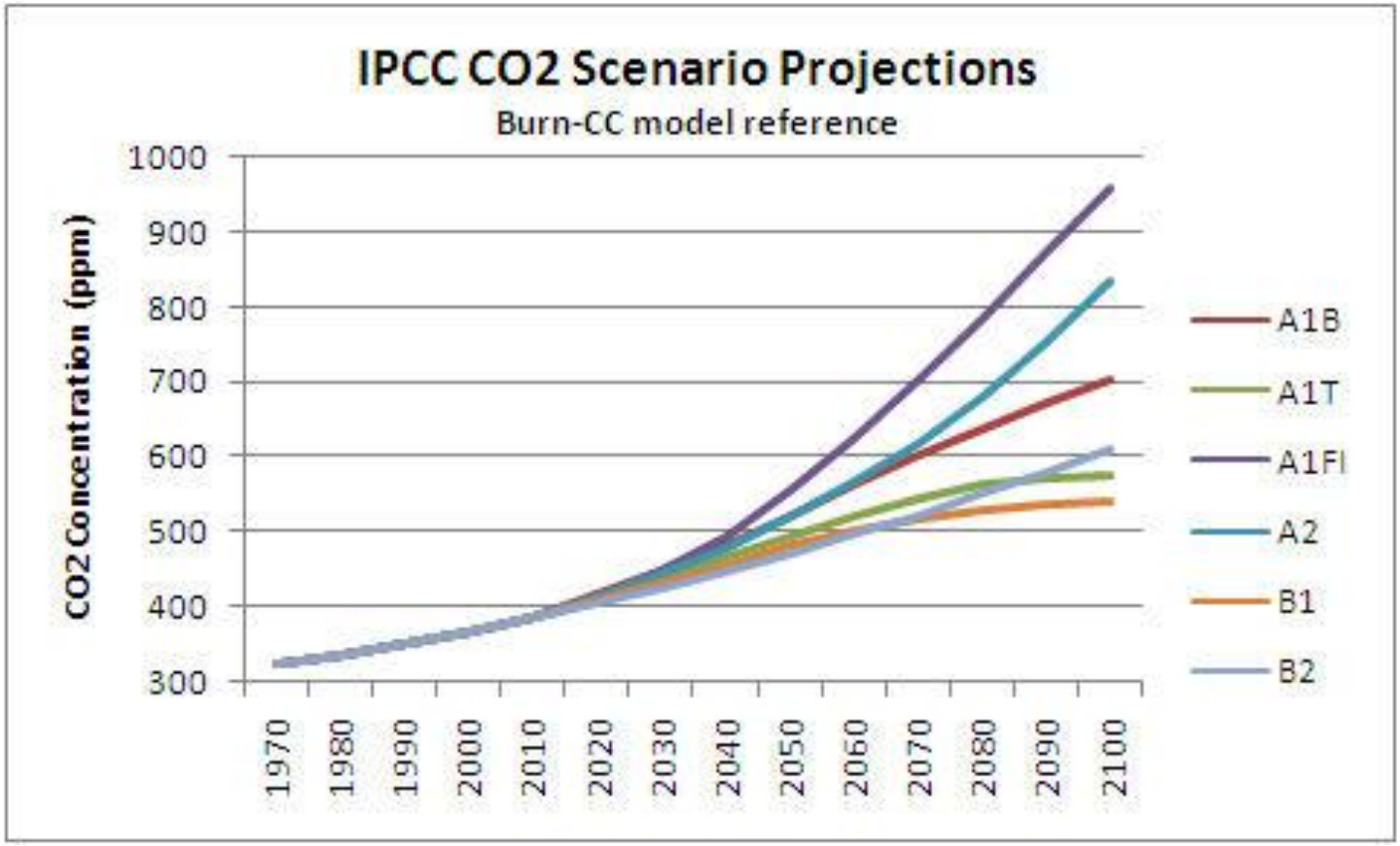
Global integration ↑

Regional emphasis ↓

← Environmental emphasis

Future climate projection and climate change risk assessment

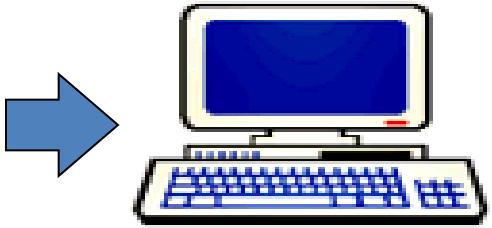
Atmospheric greenhouse gas concentration till end of 21st century: a clearer view of consequences of future society development under sets of assumptions



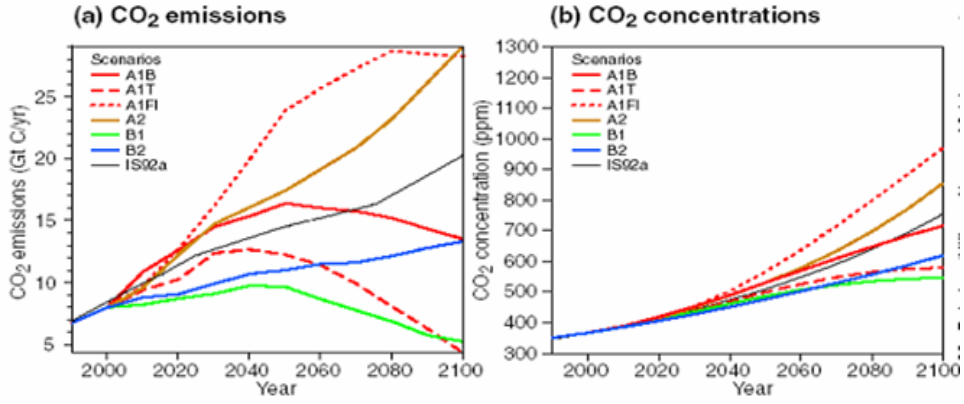
Future climate projection and climate change risk assessment

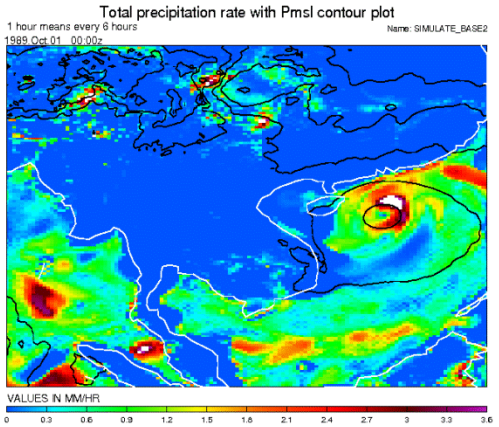
Climate model - simulation

Future GHG Scenario

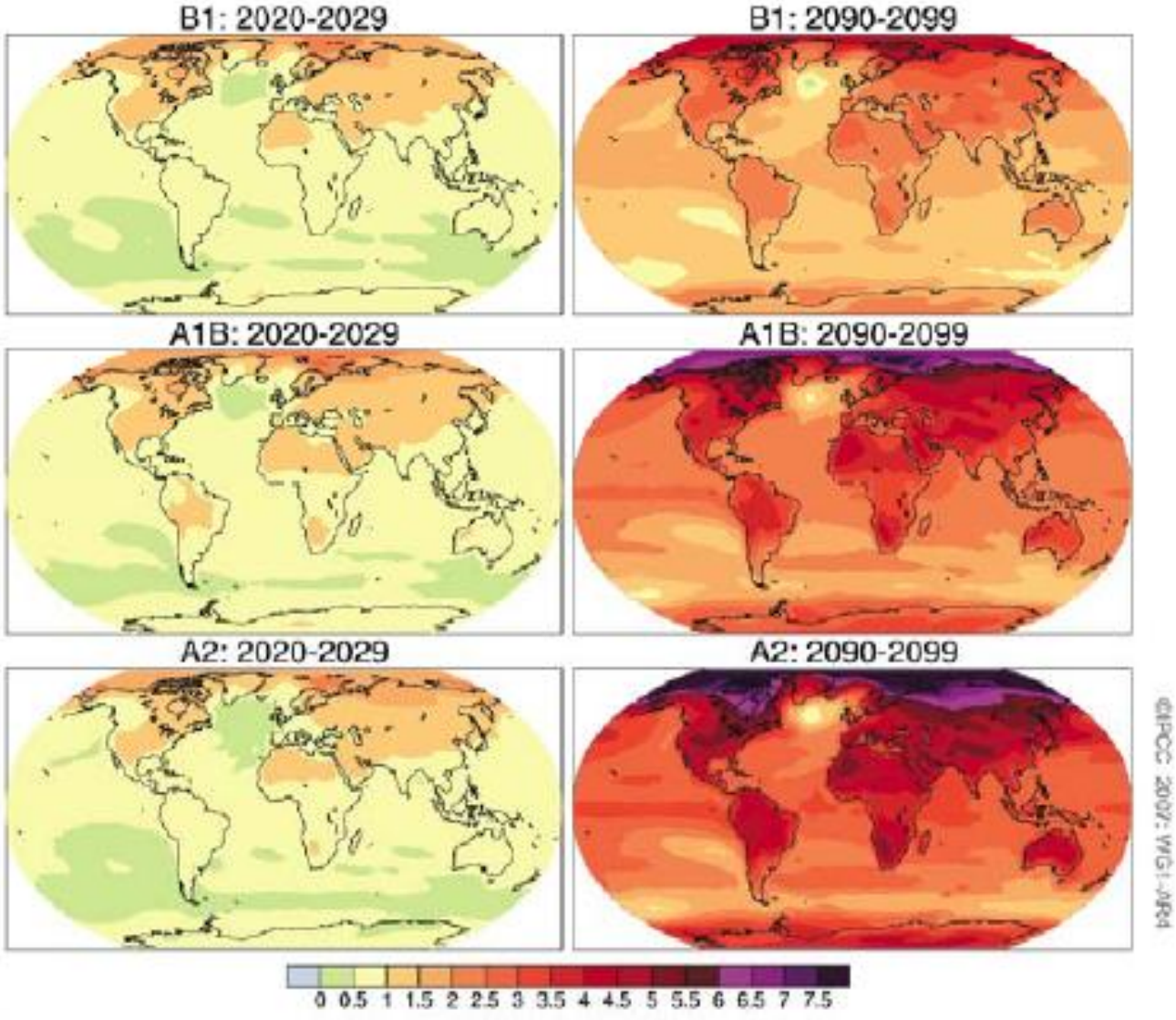


Future climate Scenarios

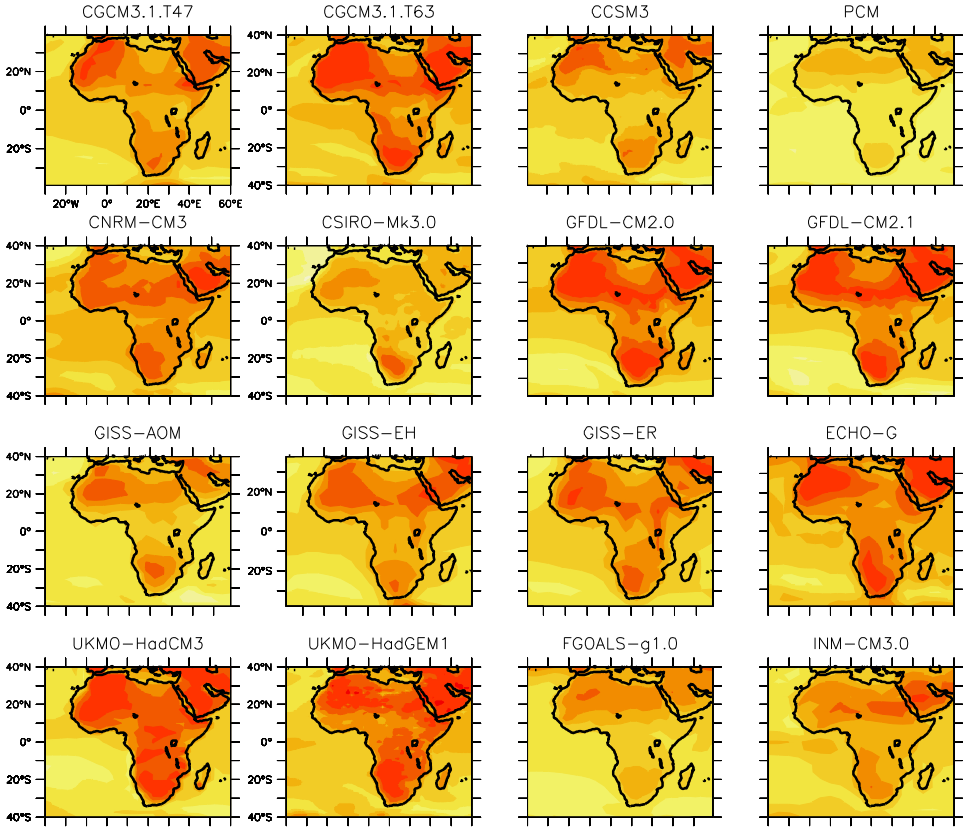




Future climate projection and climate change risk assessment



Everything starts from storylines – different set of assumptions, do not expect to get definite answer



Africa Change at the large scale
Change in annual mean temperature by 2100

Can we really tell the future?

Courtesy of Isaac Held from PCMDI AR4 model archive

Future climate projection and climate change risk assessment

Frequently asked question

Which scenario is best?

Which scenario is most likely?

Irrelevant !

Scenario does not represent future truth !

Future climate projection and climate change risk assessment

Relevant questions about scenarios:

- Which scenario is the riskiest? – worst?
- Which scenario is the driest? Wettest? Hottest? Coldest? By how much?
- Etc.

Focus on how to cover uncertainty of the future - how we may want to manage future risk

Scenarios and future climate change:

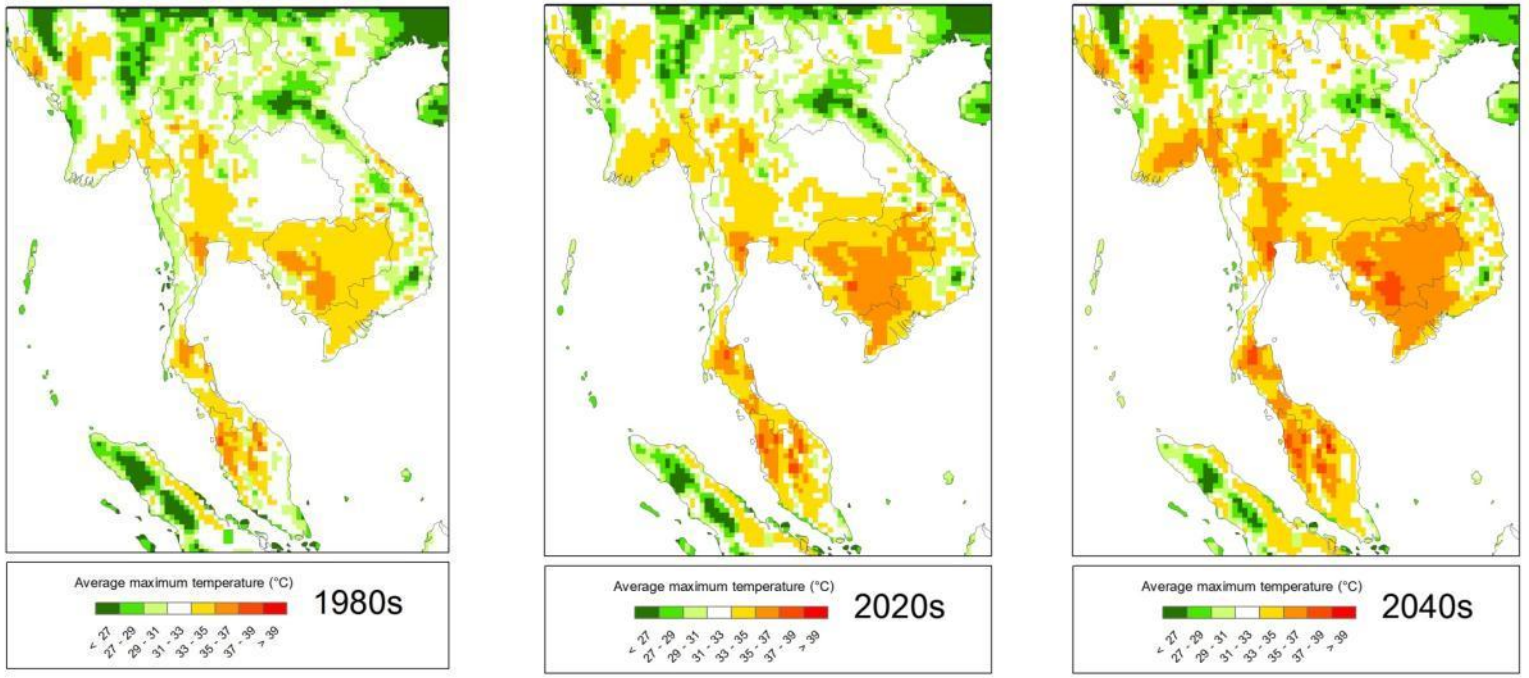
Various plausible futures to test our resilience under different circumstances

If cannot cope with it, then comes adaptation

Future climate projection and climate change risk assessment

Common misconception about using scenario for climate change risk assessment

For the fact that we can see precise result of simulation, it does not mean that it is accurate nor represent truth of the future



Example of climate change in the next 10 – 30 years

Future climate projection and climate change risk assessment

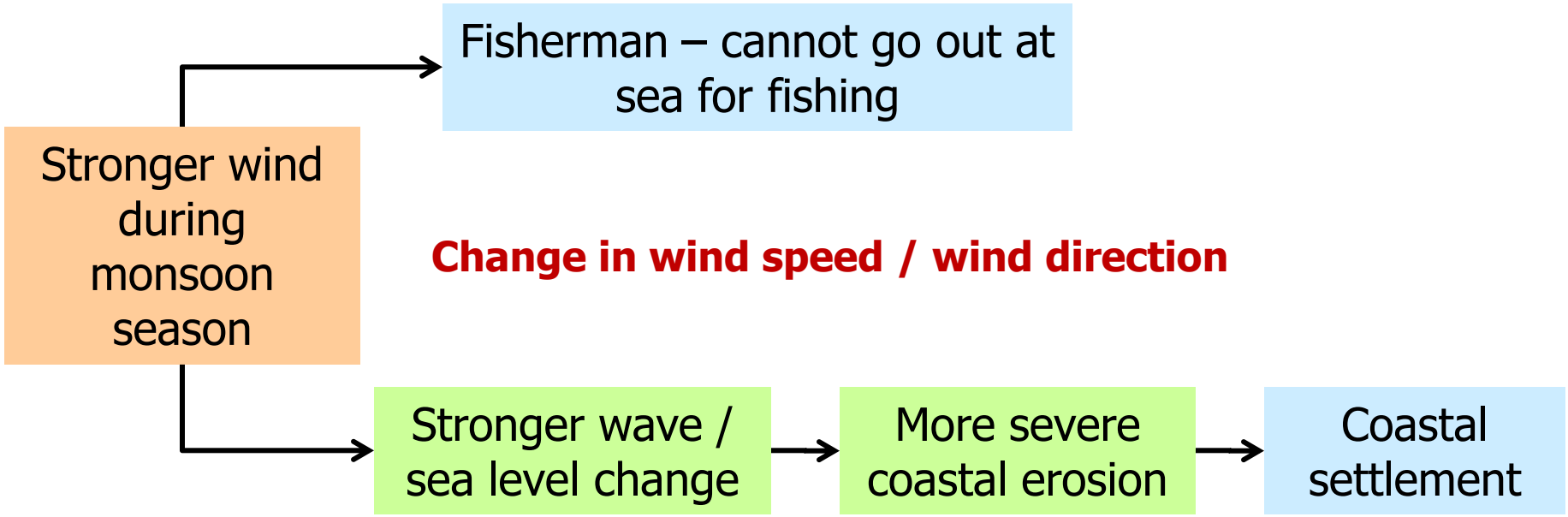
Making data into information

```
"LAT","LON","D1","D2","D3","D4","D5","D6","D7","D8","D9",
38.2,98.6,-21.0140,-19.8140,-17.3610,-19.9930,-20.7420,-1
38.2,98.8,-20.7140,-19.6720,-17.1150,-19.7070,-20.3200,-1
38.2,99.0,-20.6810,-19.7480,-17.0590,-19.5990,-20.2500,-1
38.2,99.2,-20.9170,-19.9790,-17.2790,-19.7560,-20.5230,-1
38.2,99.4,-21.1850,-20.1800,-17.5910,-20.0130,-20.8860,-2
38.2,99.6,-20.4210,-19.7310,-16.9030,-19.3700,-20.3220,-1
38.2,99.8,-19.2230,-19.0240,-15.8510,-18.3730,-19.2840,-1
38.2,100.0,-17.9770,-17.9880,-14.7490,-17.3480,-18.1250,-
```

What does this mean?

Future climate projection and climate change risk assessment

Different sectors have different concern about future climate change



Some sectors may be directly affected, but some me be affected along the chain of consequences of climate change

Future climate projection and climate change risk assessment

Different sectors have different concern about future climate change

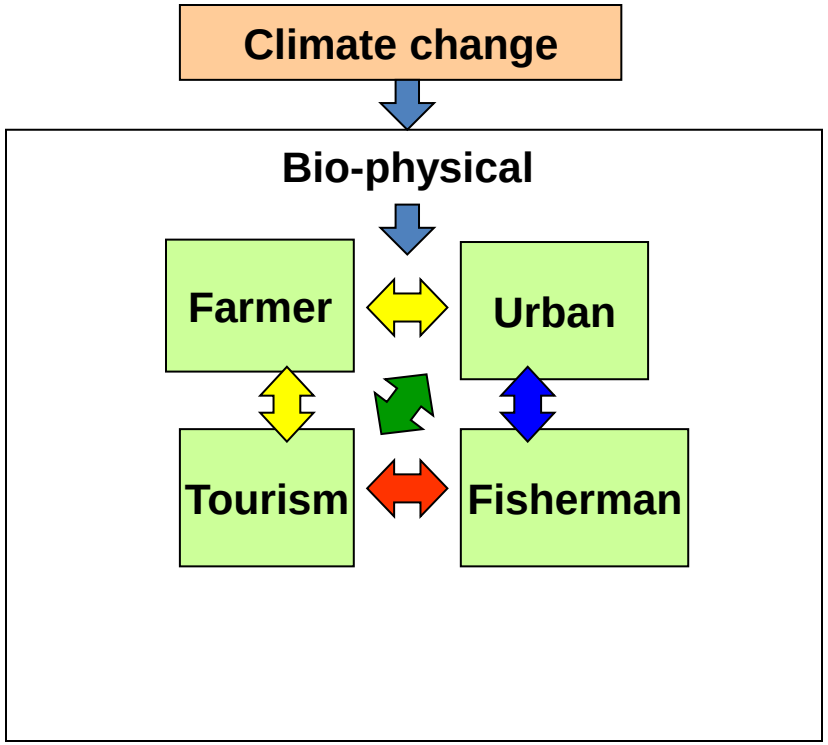
Shift and change in seasonality / rainfall distribution / etc.

↓

Coastal erosion / water resource / ecosystem integrity / Natural hazard / etc.

↓

Agriculture / Fisheries / Forest ecosystem / Tourism / Urban / Etc.



Different sectors are at risk by different climate change

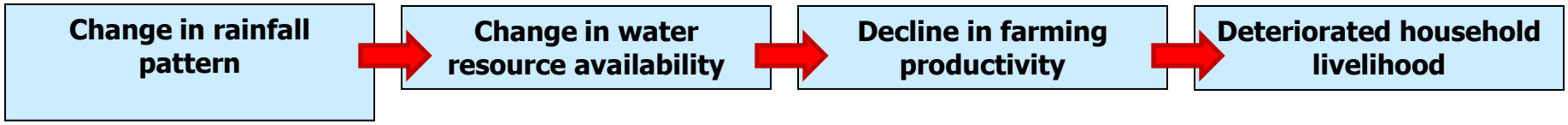
Part 3: Risk and climate change risk assessment - approached and techniques

- What is climate risk?
- Climate change impact assessment and risk assessment – quantitative VS qualitative approach
- Dynamic of risk and holistic approach in climate change risk assessment

Risk and climate change risk assessment - approached and techniques

What is climate change risk?

- The threat posed by a change, i.e. the probability of an adverse impact
- In climate change, always climate induced risk
- Climate change impact causes chain of consequences – from bio-physical to human livelihood



Climate risk in the future may not be as it was any more

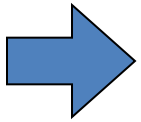
Risk and climate change risk assessment - approached and techniques

Climate change impact assessment and risk assessment – quantitative VS qualitative approach

Using future climate data to assess climate change risk

Example of data: Daily maximum temperature

LAT	LON	D1	D2	D3	D4	D5	D6
18.4	103.6	22.97	23.04	24.38	25.53	25.06	25.57
18.4	103.8	23.33	23.48	24.68	25.85	25.34	25.73
18.2	103.6	23.26	23.43	24.87	25.97	25.41	25.97
18.2	103.8	23.17	23.31	24.58	25.79	25.24	25.60



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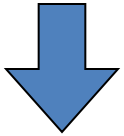
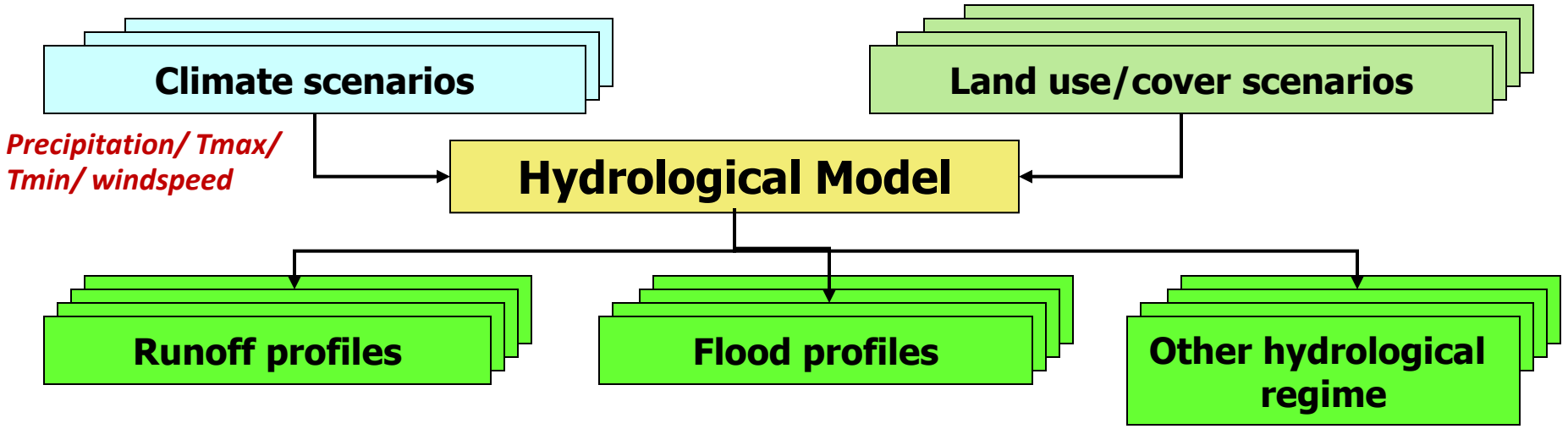


Risk and climate change risk assessment - approached and techniques

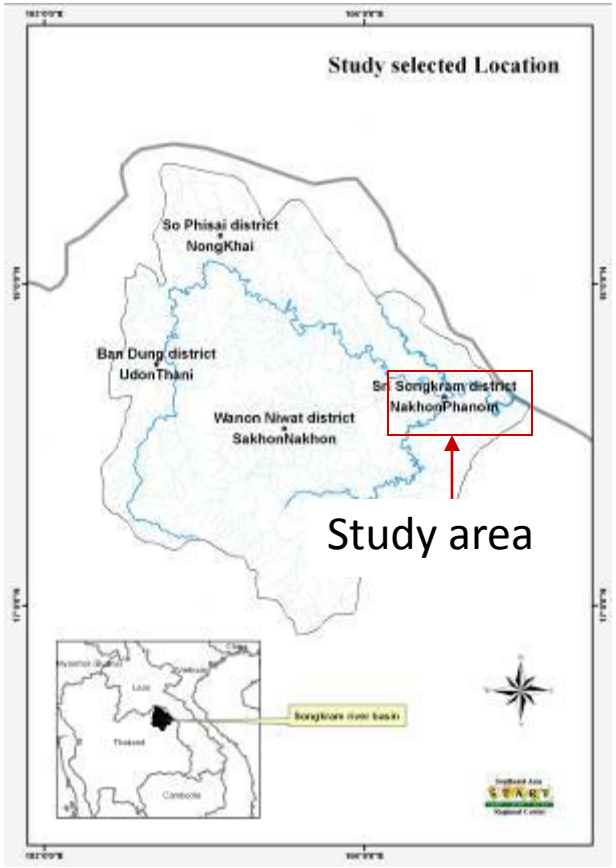
Input to impact analysis for risk assessment – quantitative analysis

Case studies: hydrological analysis



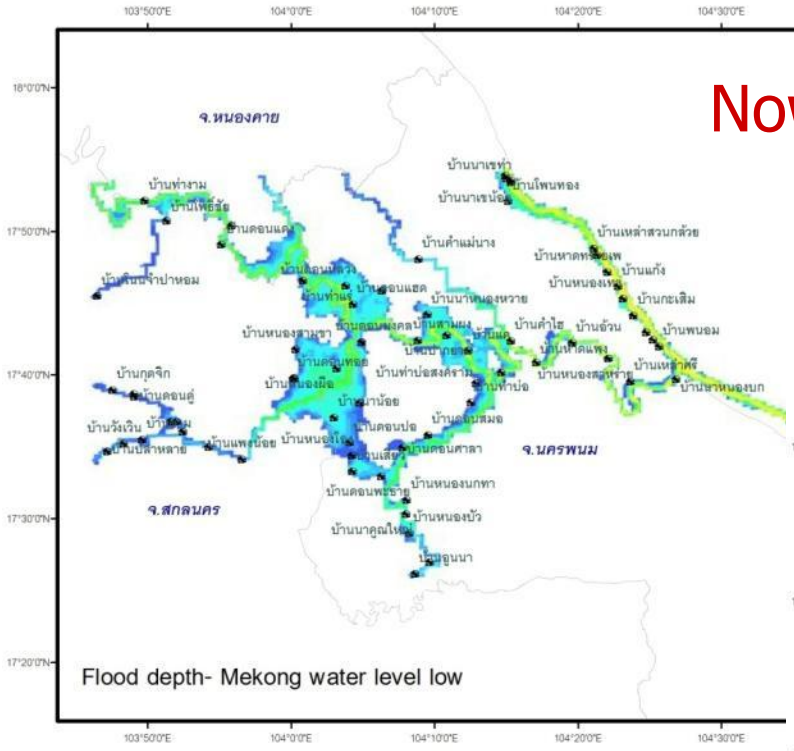
Risk and climate change risk assessment - approached and techniques

Case study in Lower Songkram River basin - Thailand

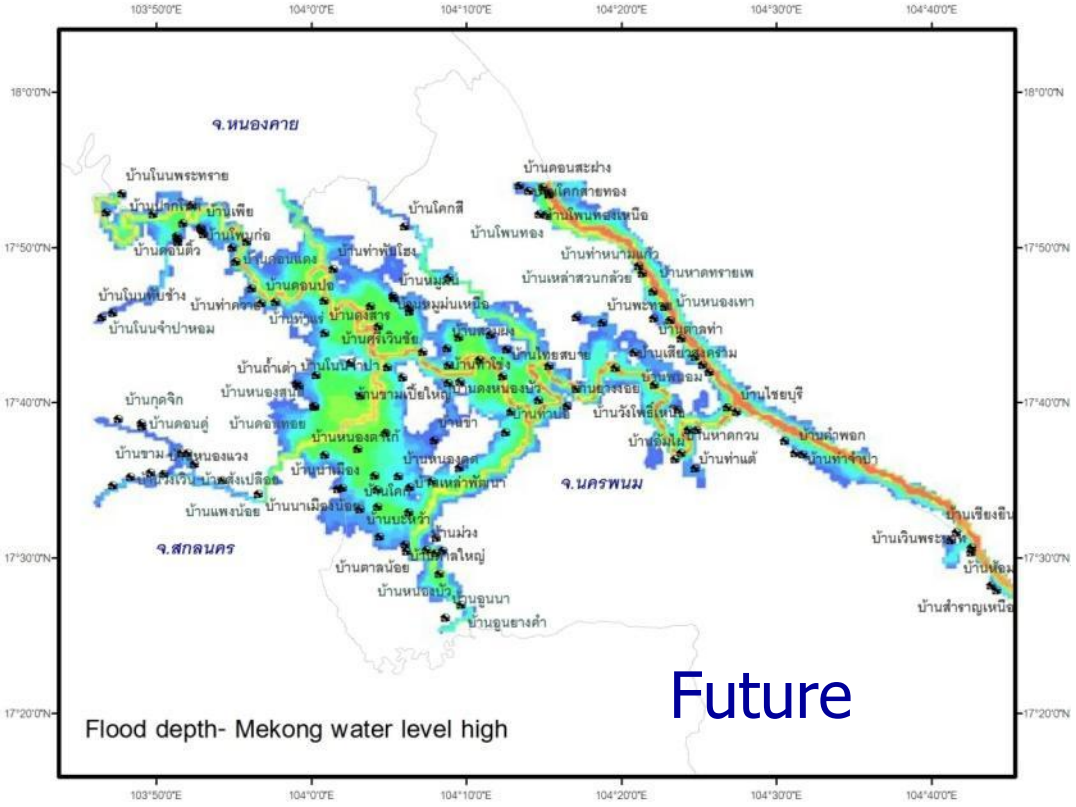


Risk and climate change risk assessment - approached and techniques

Change in flood boundary in lower Songkram River basin



Now

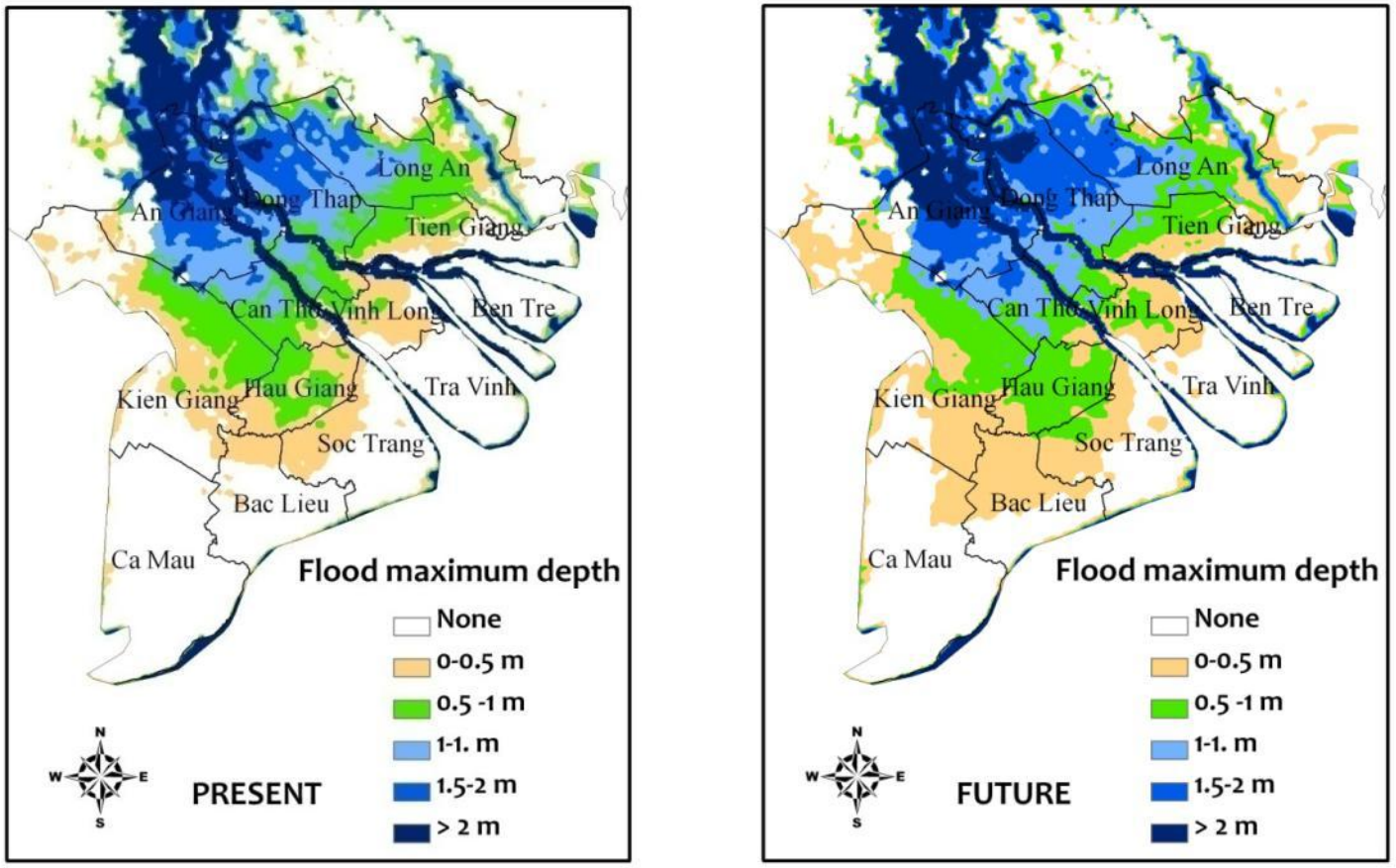


Future

Source: WUP-Fin Group, MRCS

Risk and climate change risk assessment - approached and techniques

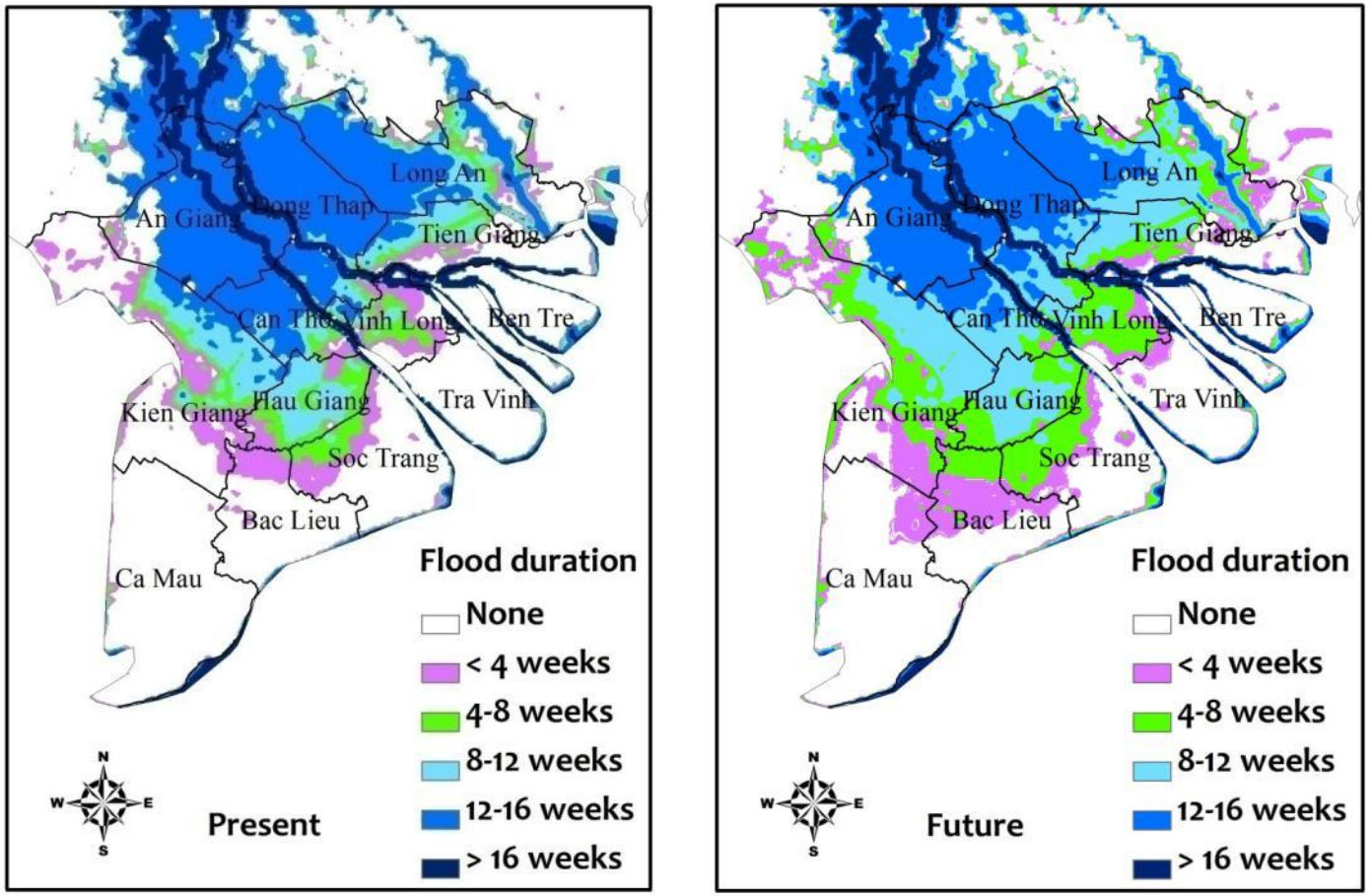
Change in future flood risk in Mekong River delta



Flood boundary may expand in the future.

Risk and climate change risk assessment - approached and techniques

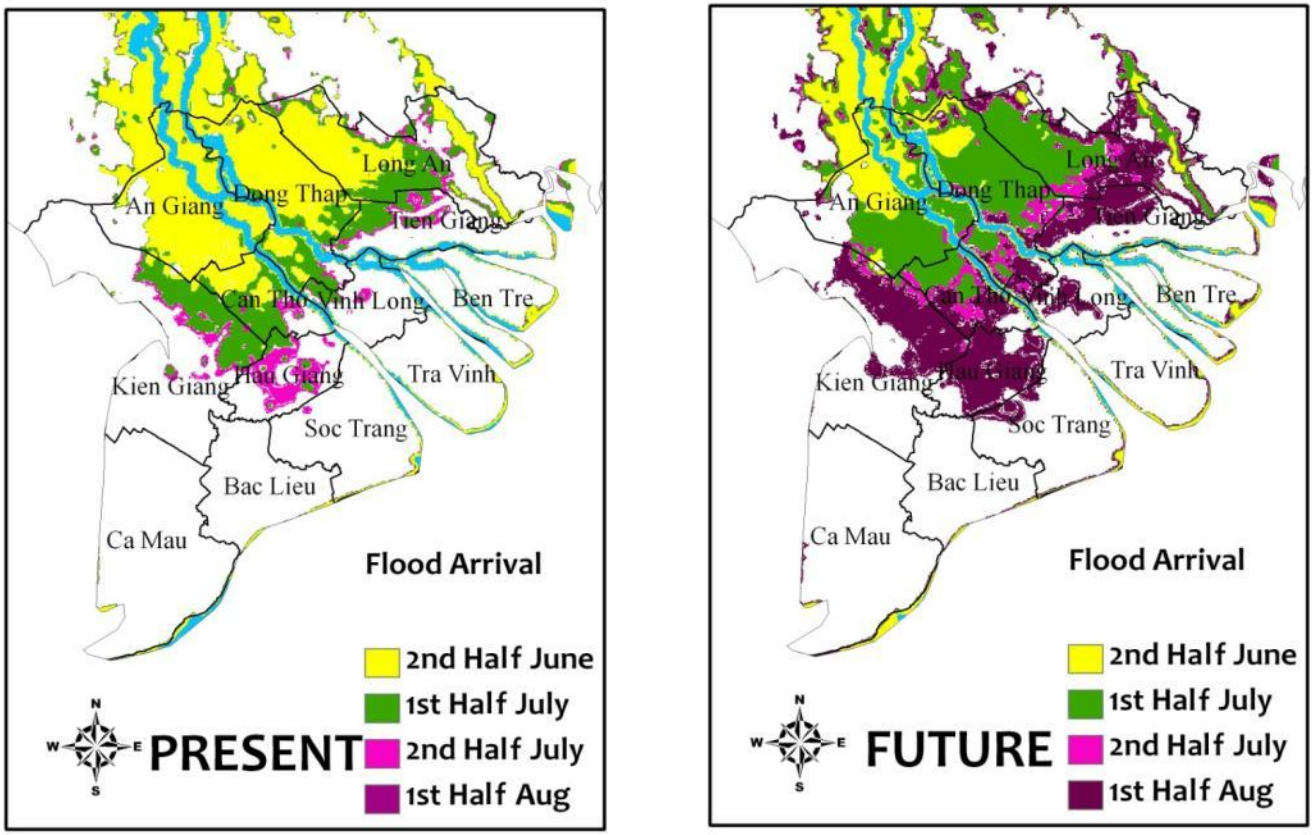
Change in future flood risk in Mekong River delta



But duration of flood may be shorter in the future.

Risk and climate change risk assessment - approached and techniques

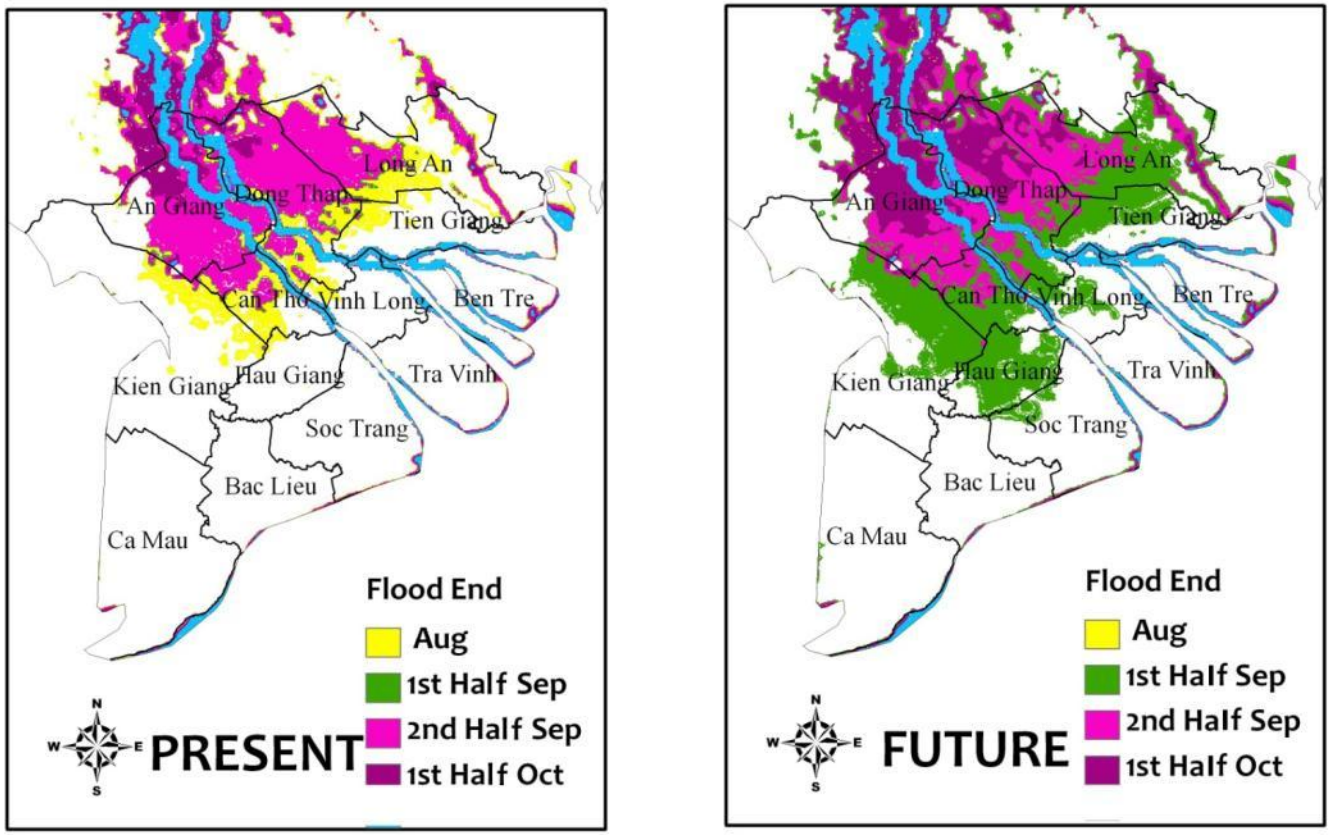
Change in future flood risk in Mekong River delta



Serious flood – 50cm (river overflow) may arrive 2 weeks late in future.

Risk and climate change risk assessment - approached and techniques

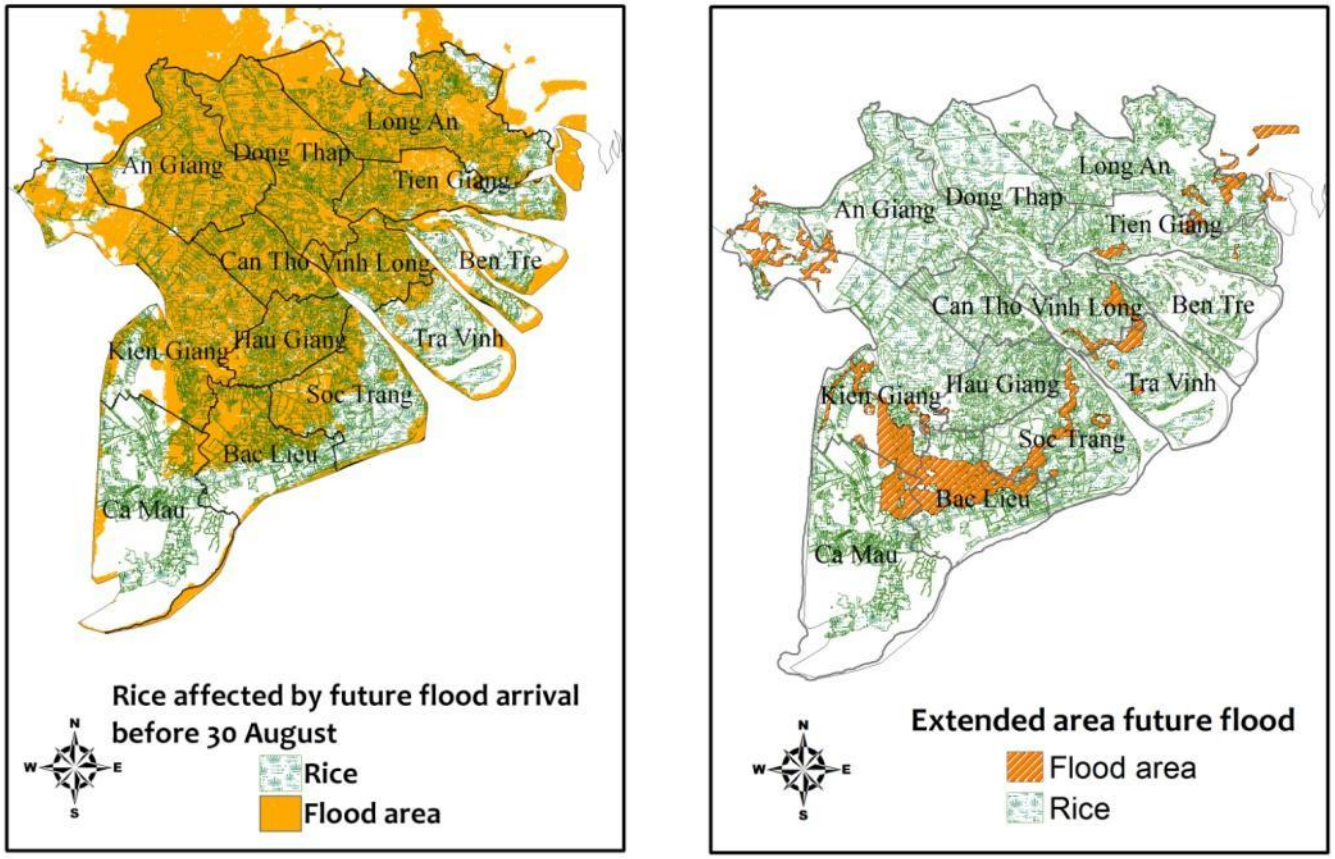
Change in future flood risk in Mekong River delta



Serious flood (50cm) may end 2 weeks late in future

Risk and climate change risk assessment - approached and techniques

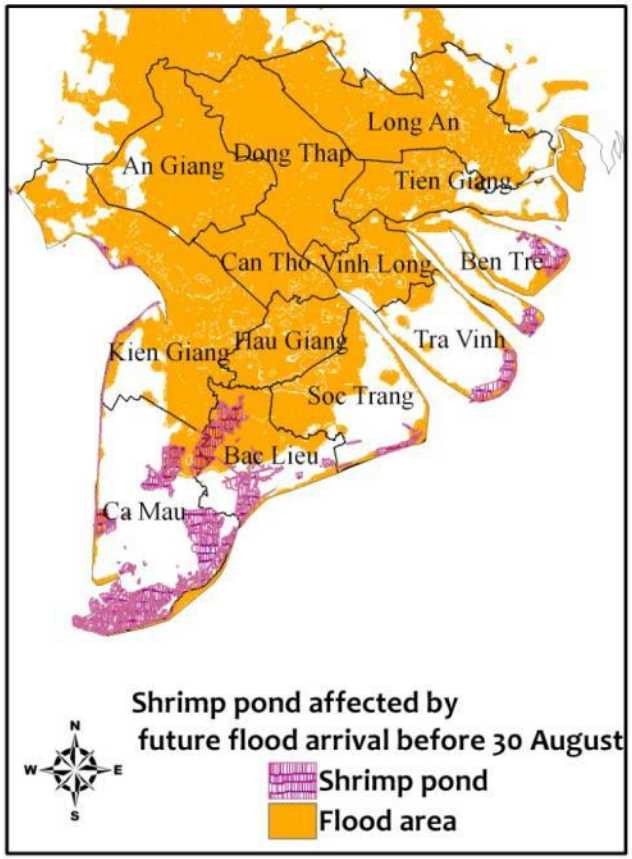
Change in future flood risk in Mekong River delta

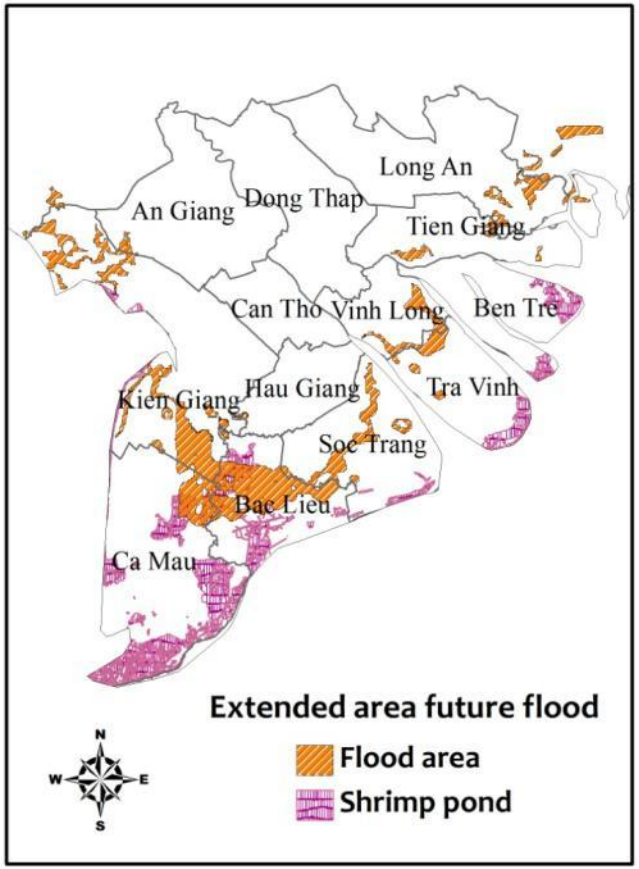


Serious flood (50cm) may start before end-August and affect the Summer-Autumn rice crop

Risk and climate change risk assessment - approached and techniques

Change in future flood risk in Mekong River delta

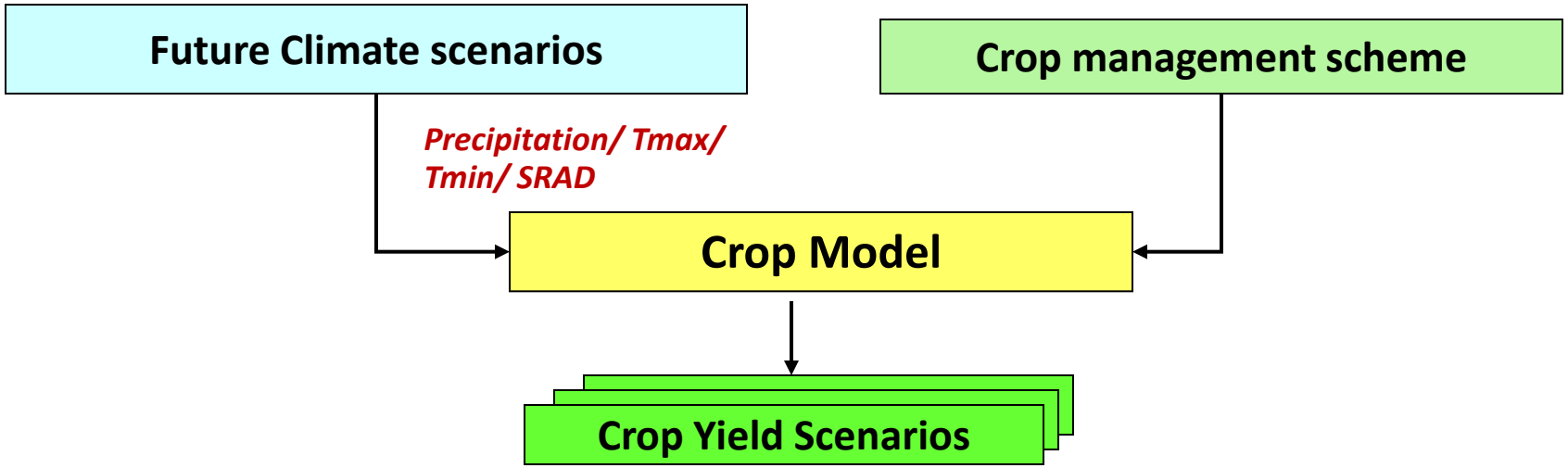




Extended flood area that put shrimp pond at risk

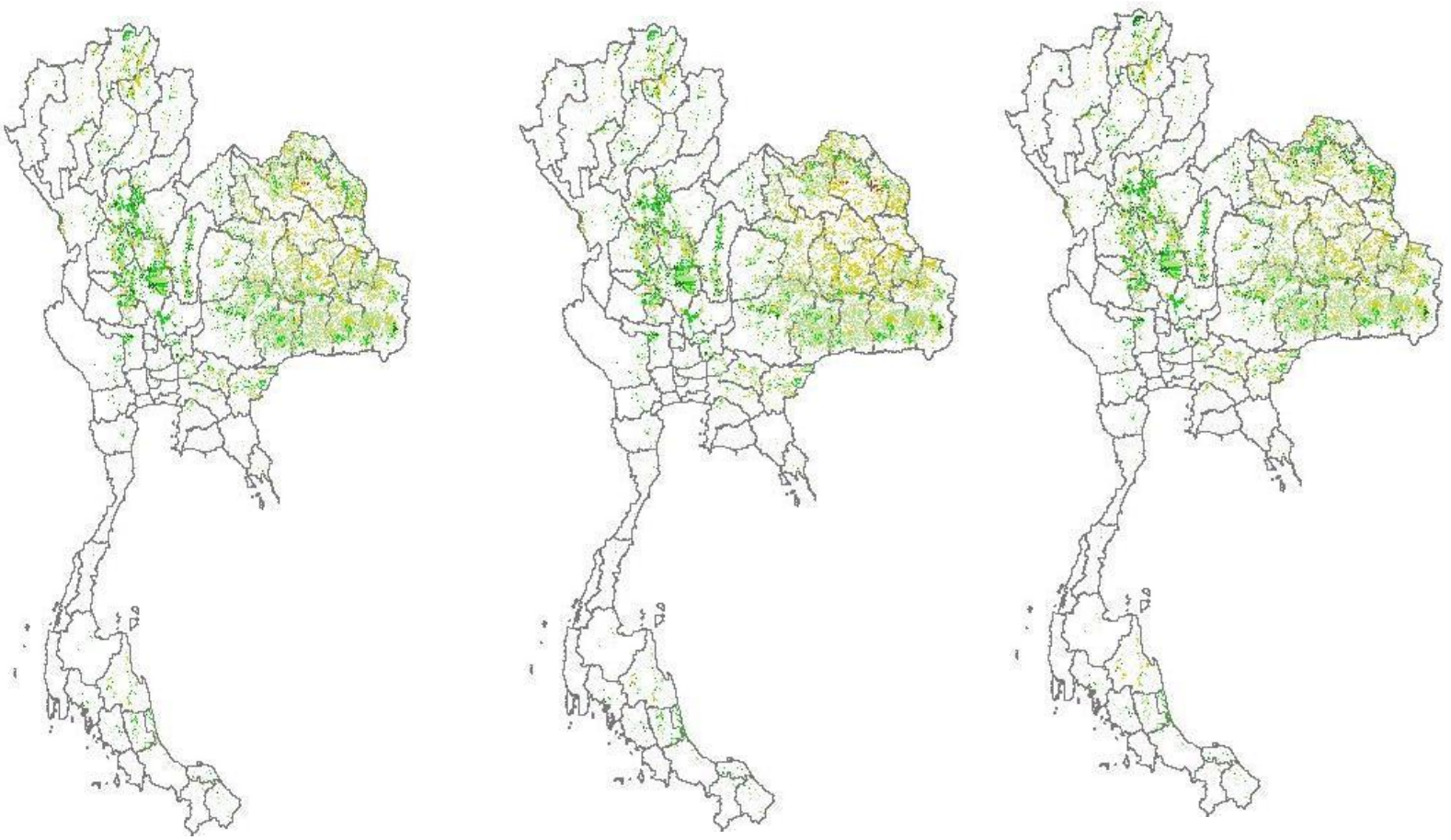
Risk and climate change risk assessment - approached and techniques

How does future climate pattern alter rice productivity?



Rice productivity: kg/ha

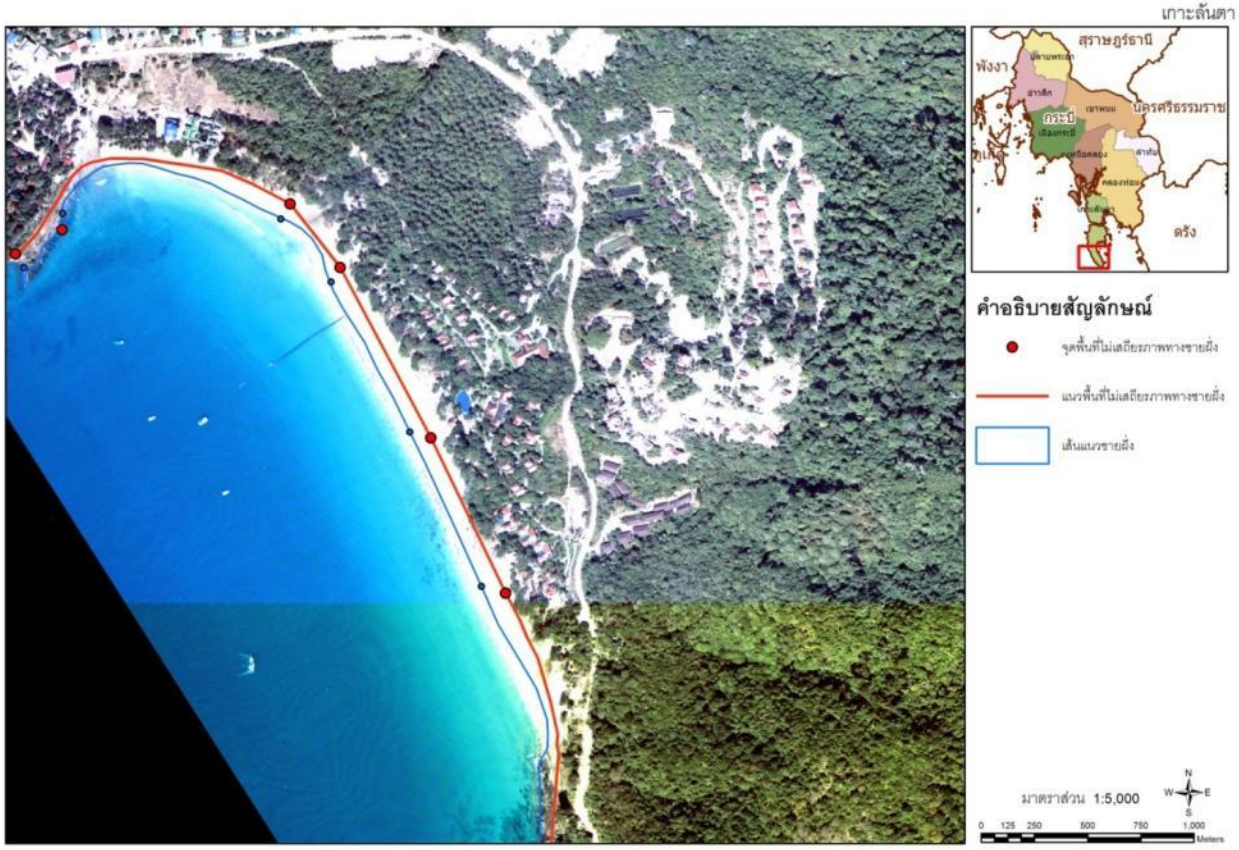
Risk and climate change risk assessment - approached and techniques



Rain-fed rice yield during 1990s vs 2030s vs 2050s

Risk and climate change risk assessment - approached and techniques

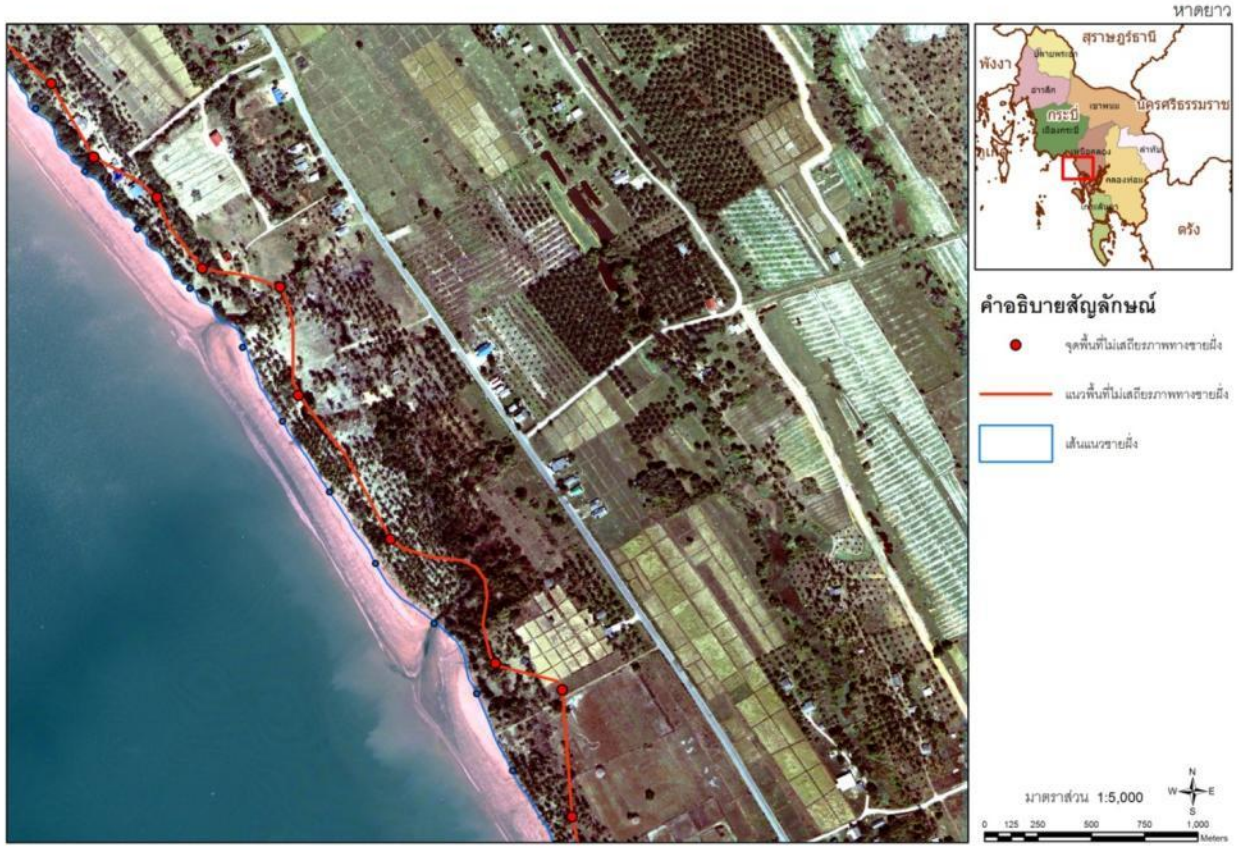
Coastal zone impact and risk assessment



Impact of sea level change on shoreline stability

Risk and climate change risk assessment - approached and techniques

Coastal zone impact and risk assessment



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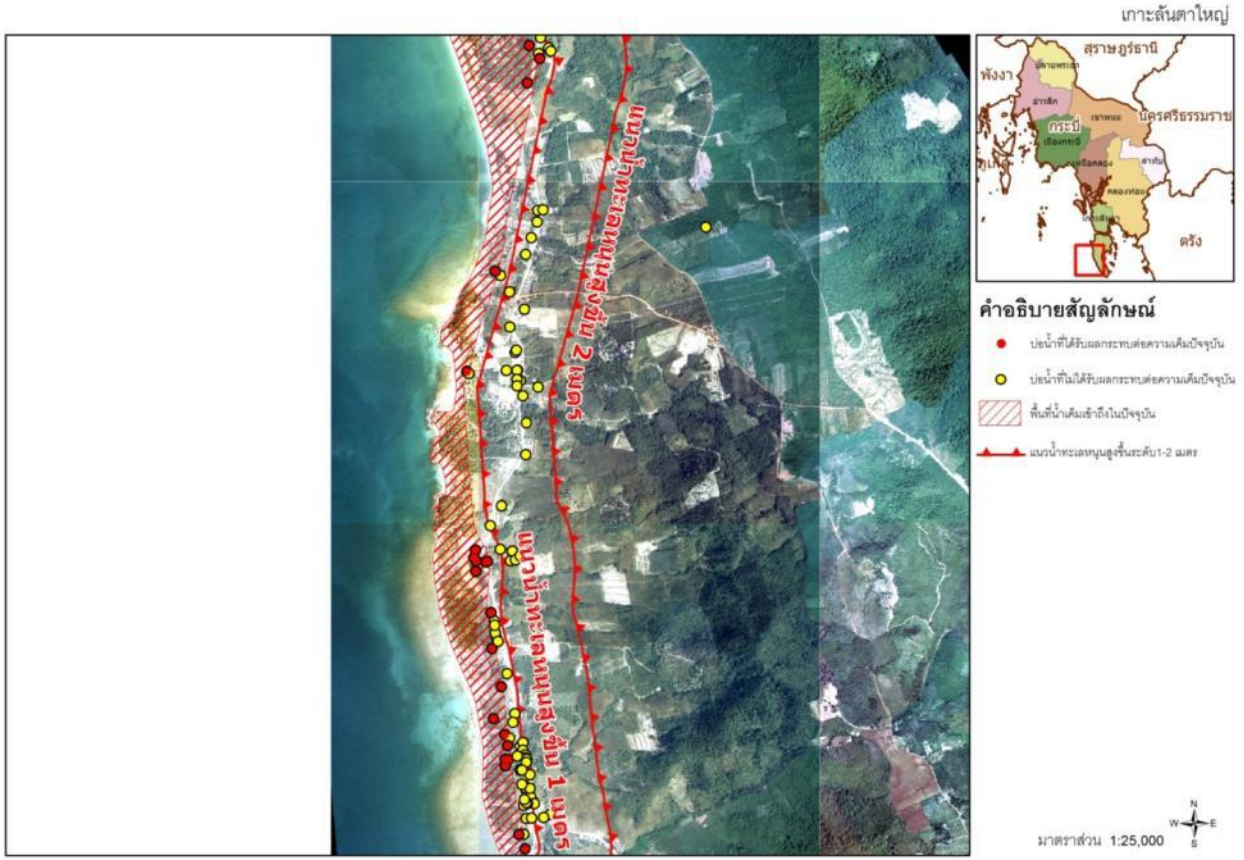
Risk and climate change risk assessment - approached and techniques

Coastal zone impact and risk assessment



Impact of sea level change on aquifer contamination

Risk and climate change risk assessment - approached and techniques

Making information out of data

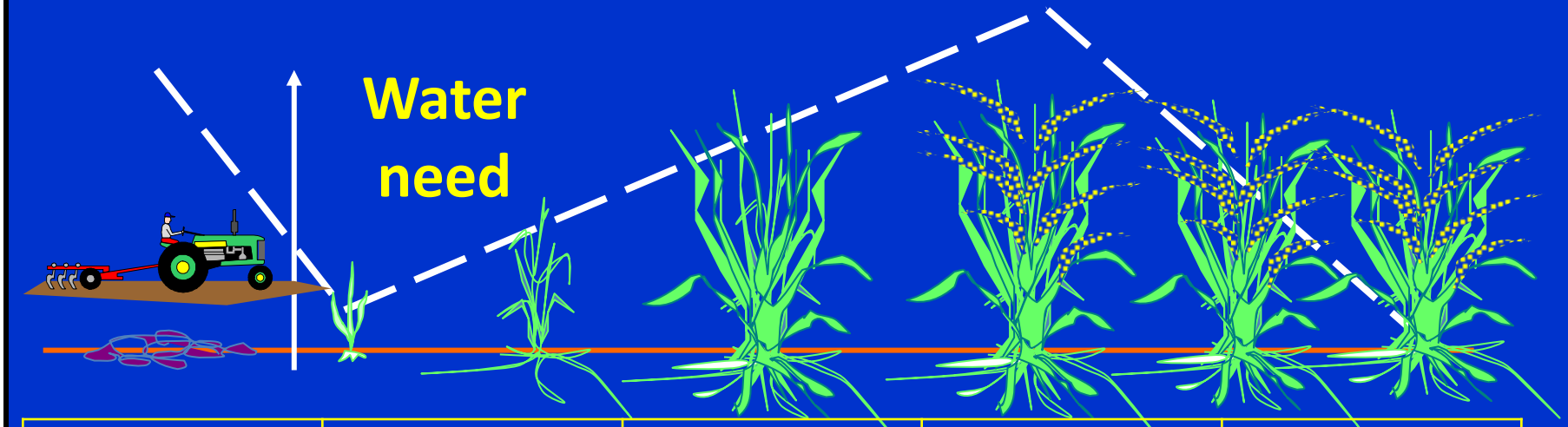
semi quantitative & qualitative approach

Look at climate change risk from perspective of the sector / system / community

Developing indicators for risk assessment

Risk and climate change risk assessment - approached and techniques

- Case study in the Mekong River Delta – Rice yield will be at risk if:
  - Drought in early Summer – Autumn rice crop (15/5 – 15/6)
    - Total rainfall in 5 days is less than 100 mm.
    - Total rainfall in 5 consecutive days after sowing/transplanting day is less than 50 mm.
  - High temperature in early Summer – Autumn rice crop (1/5 – 30/5) :
    - High temperature in 5 continuous days after sowing/transplanting day is higher 40·C.
  - Dry spell in flowering period of Summer – Autumn rice crop (20/7 – 10/8):
    - Total rainfall in 7 continuous days is less than 150 mm.

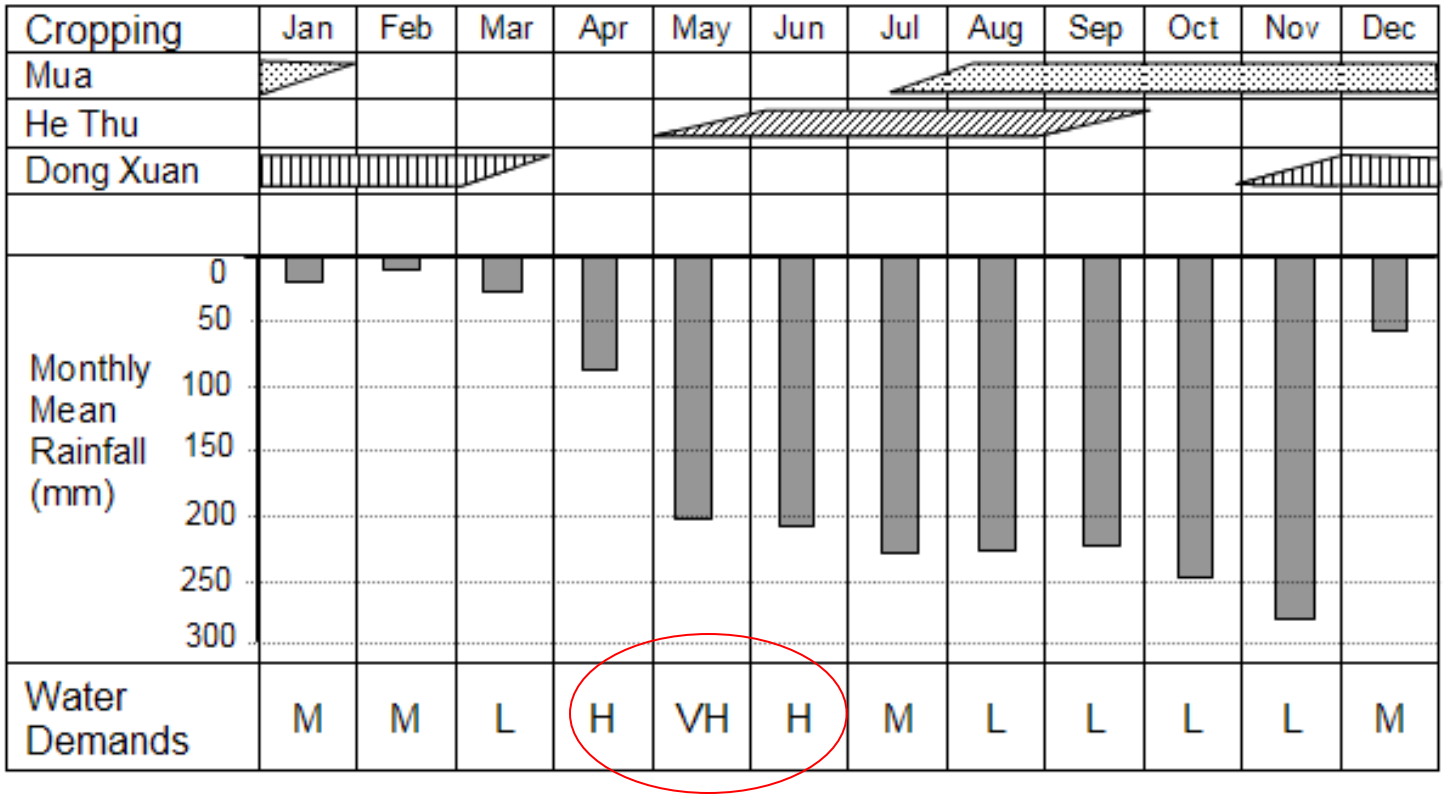


April	May	June	July	August

Plough	Sow/ Transplant	Budding	Max. bud	Flowering	Green grain	Ripening
Max. water	Medium water	Increasing water		High water	Decreasing water	
10 - 20 cm	5- 10 cm	2 – 10 cm		10 cm	5 – 0 cm	

Risk and climate change risk assessment - approached and techniques

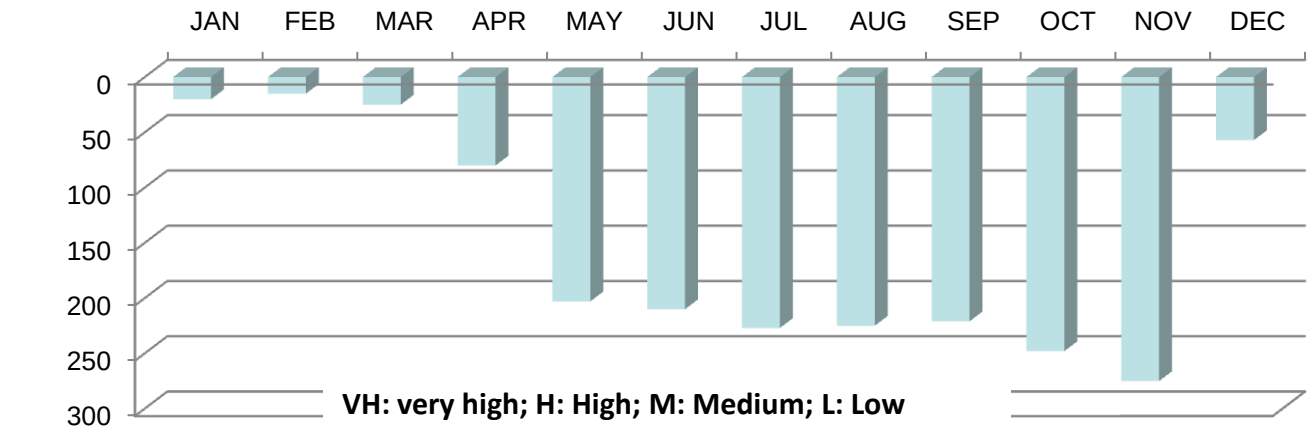
Look at key climate concerns of the sector



Cropping calendar, monthly rainfall and water demands in the MD

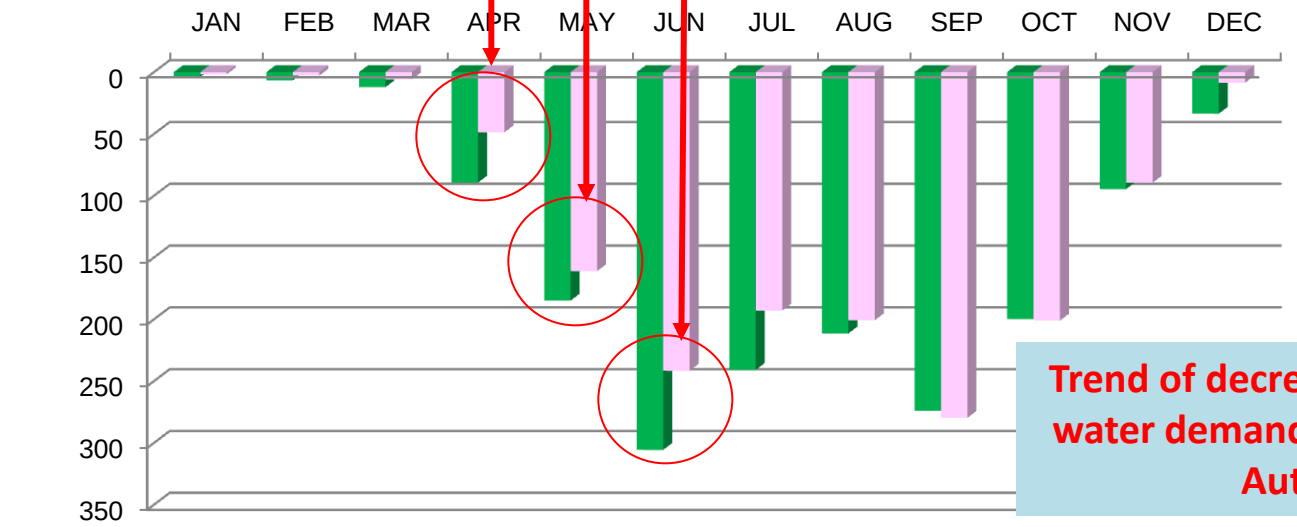
VH: very high; H: High; M: Medium; L: Low

Risk and climate change risk assessment - approached and techniques



VH: very high; H: High; M: Medium; L: Low

Water Demands	M	M	L	H	VH	H	M	L	L	L	L	M



Preferred rainfall distribution condition

Rainfall distribution

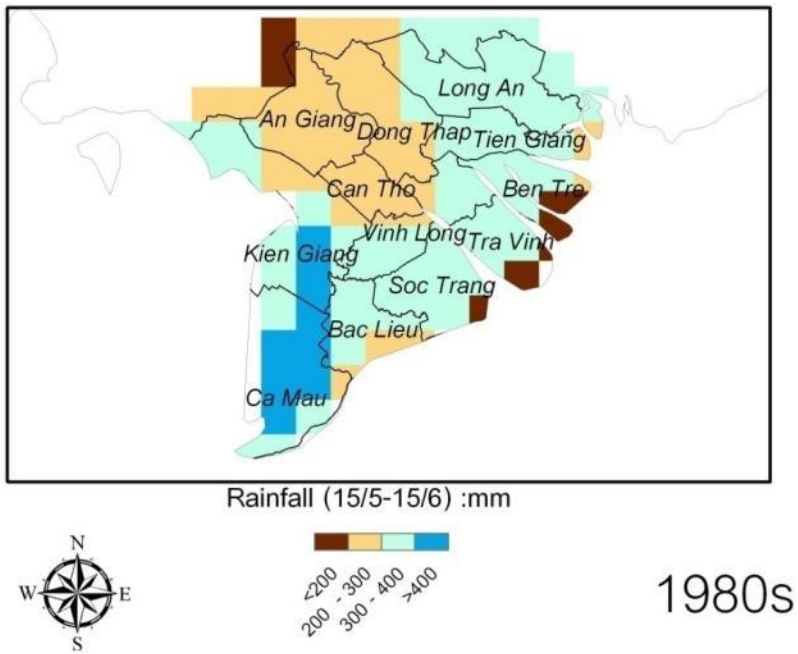
Present vs Future

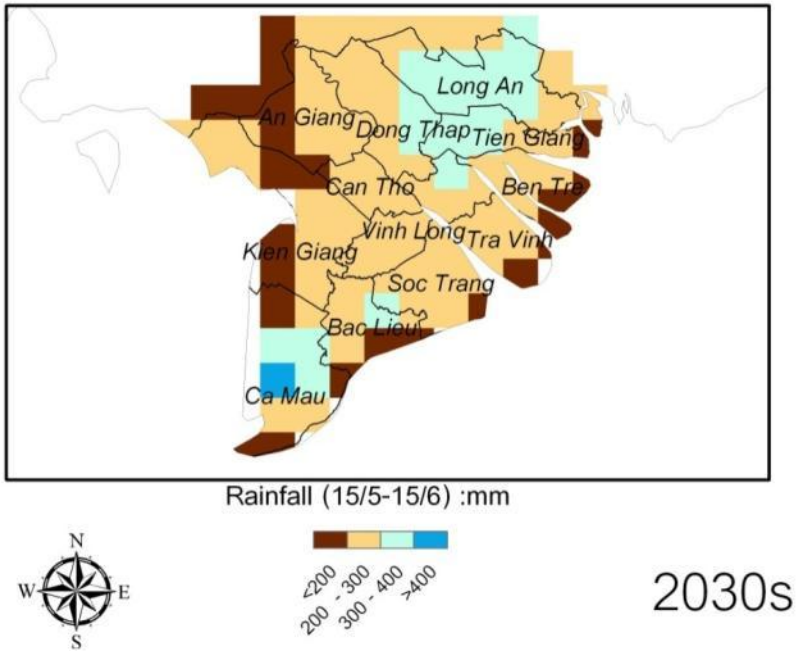
PRESENT

FUTURE

Trend of decreasing rainfall during high water demand period: early Summer – Autumn rice crop

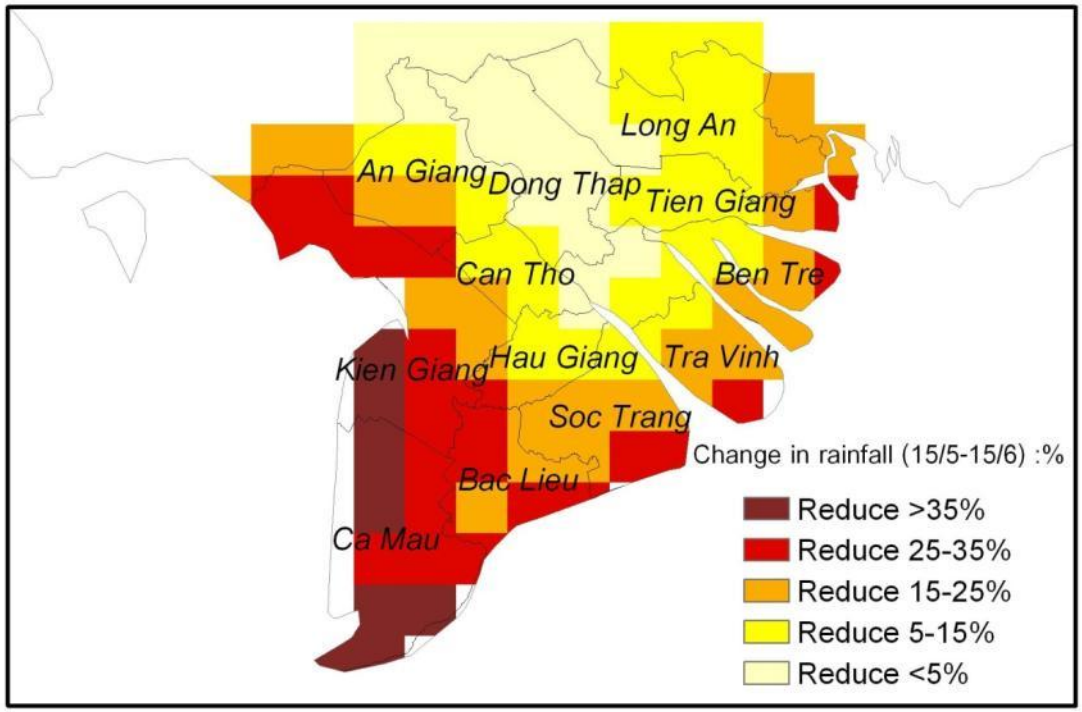
Risk and climate change risk assessment - approached and techniques





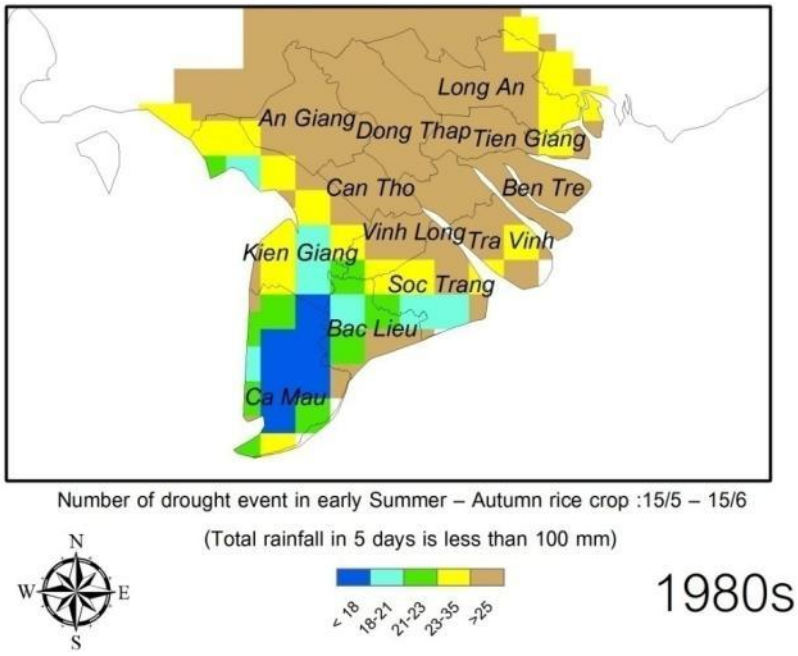
Total rainfall in early Summer – Autumn rice crop (mid-May to mid-June) will decrease

Risk and climate change risk assessment - approached and techniques



Total rainfall in early Summer – Autumn rice crop will reduce !!!

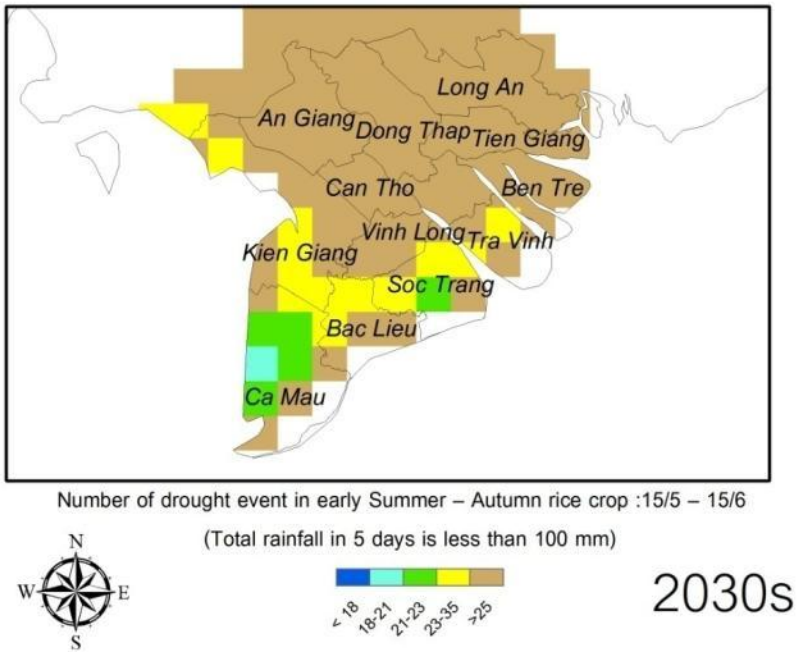
Risk and climate change risk assessment - approached and techniques



Number of drought event in early Summer – Autumn rice crop :15/5 – 15/6

(Total rainfall in 5 days is less than 100 mm)

1980s



Number of drought event in early Summer – Autumn rice crop :15/5 – 15/6

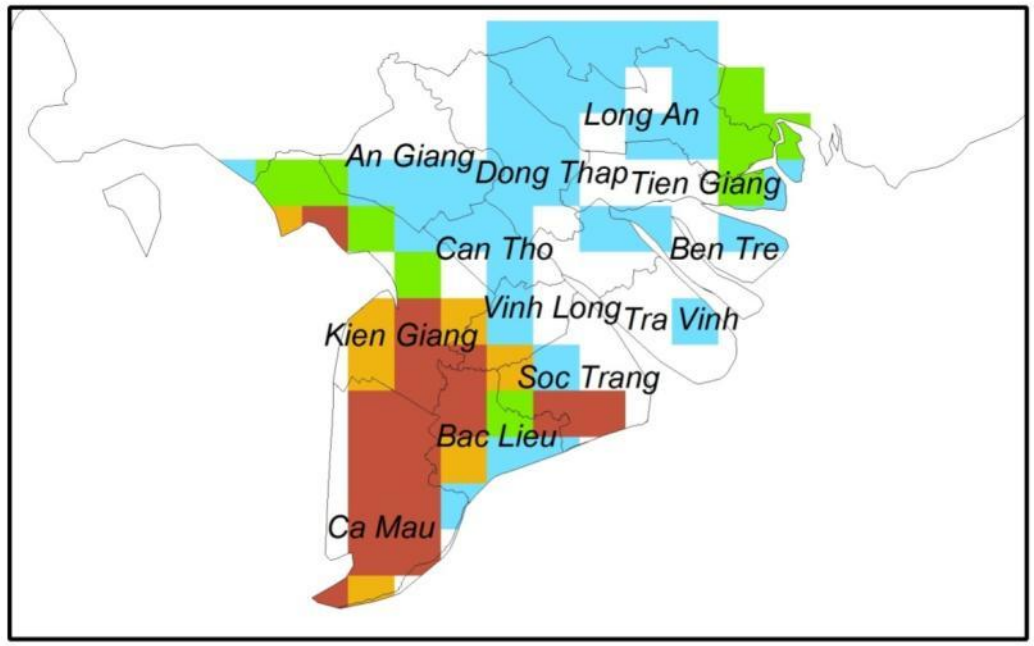
(Total rainfall in 5 days is less than 100 mm)

2030s

Higher risk of drought event in early Summer – Autumn rice crop !!!

(Chance of dry spell – 5-day total rainfall is less than 100 mm. may increase)

Risk and climate change risk assessment - approached and techniques



Change in number of drought event in early Summer – Autumn rice crop :15/5 – 15/6

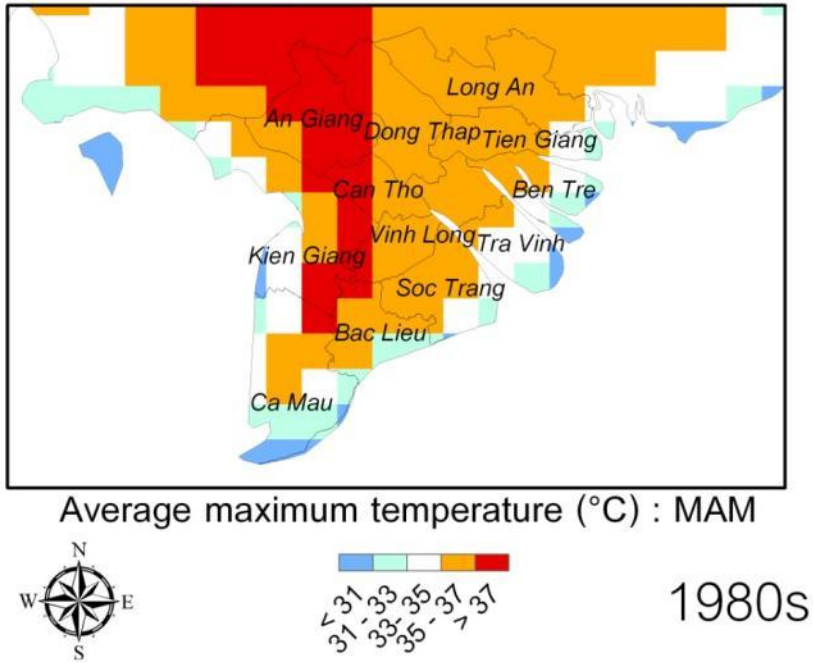
(Total rainfall in 5 days is less than 100 mm)

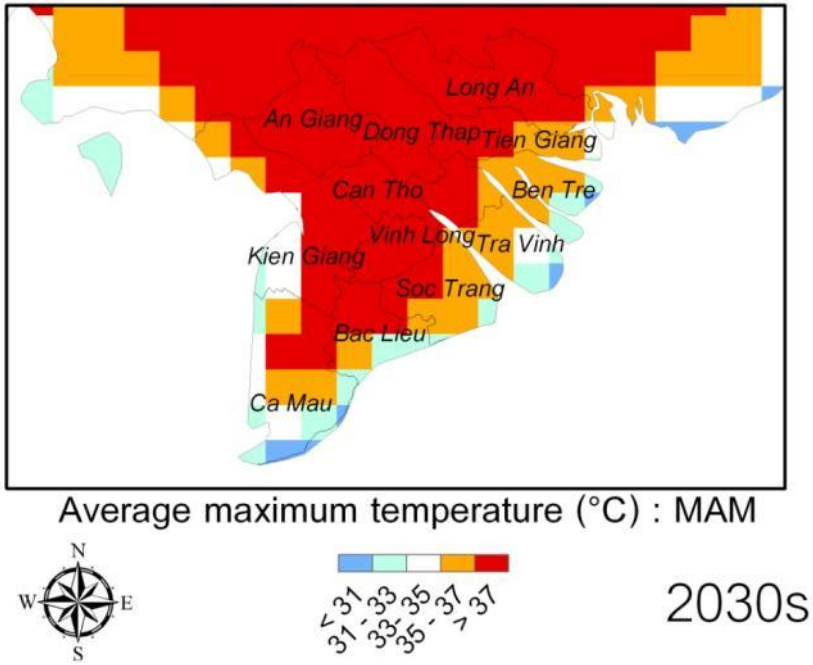
2030s

Number of drought event in early Summer – Autumn rice crop will increase !!!

Risk and climate change risk assessment - approached and techniques

Average max. temperature in March – April – May



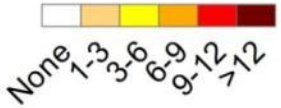


Higher risk of heat effect on rice in early crop season !!!

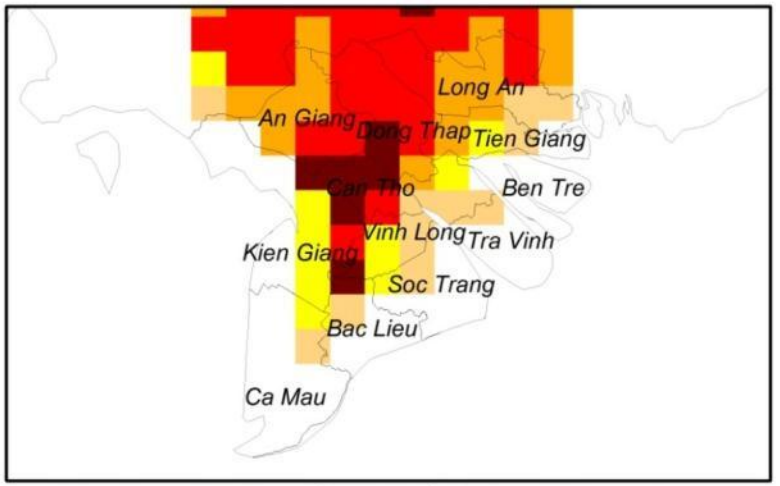
Max. temperature will increase

Risk and climate change risk assessment - approached and techniques

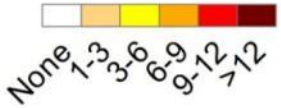
Number of 4 days (40 °C) during 10 years



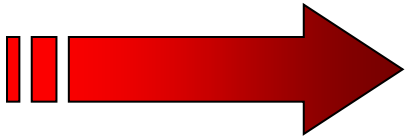
1980s



Number of 4 days (40 °C) during 10 years



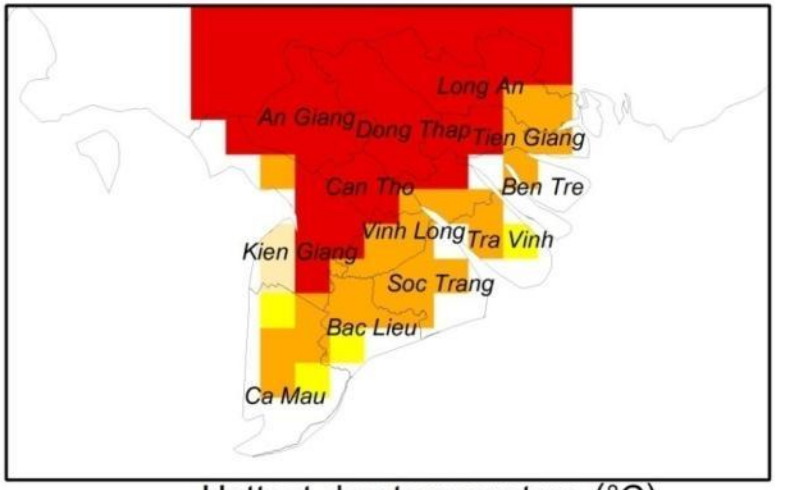
2030s



Higher risk of heat effect on rice in early crop season !!!

Number of hot period (4-hot-days > 40°C) in early Summer – Autumn rice crop (mid-May to mid-June) will increase !!!

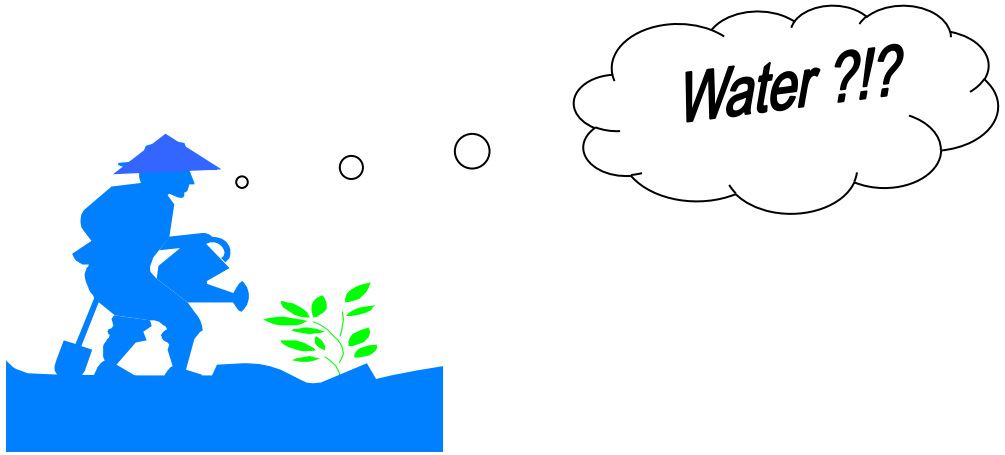
Risk and climate change risk assessment - approached and techniques



Higher risk of heat effect on rice during crop season !!!

Extreme max. temperature areas will increase !!!

Risk and climate change risk assessment - approached and techniques



Higher risk in shortage of water at beginning of Summer – Autumn rice crop

In general, compared 1980s, the rainy season in 2030s:

+ starts late about 2 weeks (15/4 – 30/5)

+ total yearly rainfall amount reduces about 20%

+ in the future the farmers have to pay more for pumping water

Risk and climate change risk assessment - approached and techniques

Selecting indicators for climate change risk assessment

Table 1 | A summary showing simplified, estimated impacts of hydropower development and climate change on selected hydrological indicators in the Tonle Sap area. Impact timescale refers to the time horizon within which the impacts are expected to start to occur*

Hydrological variable	Impact: development	Impact: climate	Certainty of climate impact
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 average years and earlier in driest years
Flood end date	←	→	Likely occurs later
Flood duration	↓	↑	Likely increases
IMPACT TIMESCALE	Short–medium (~5–30 years)	Medium–long (~20–100 years)	

Risk and climate change risk assessment - approached and techniques

Dynamic of risk and holistic approach in climate change risk assessment

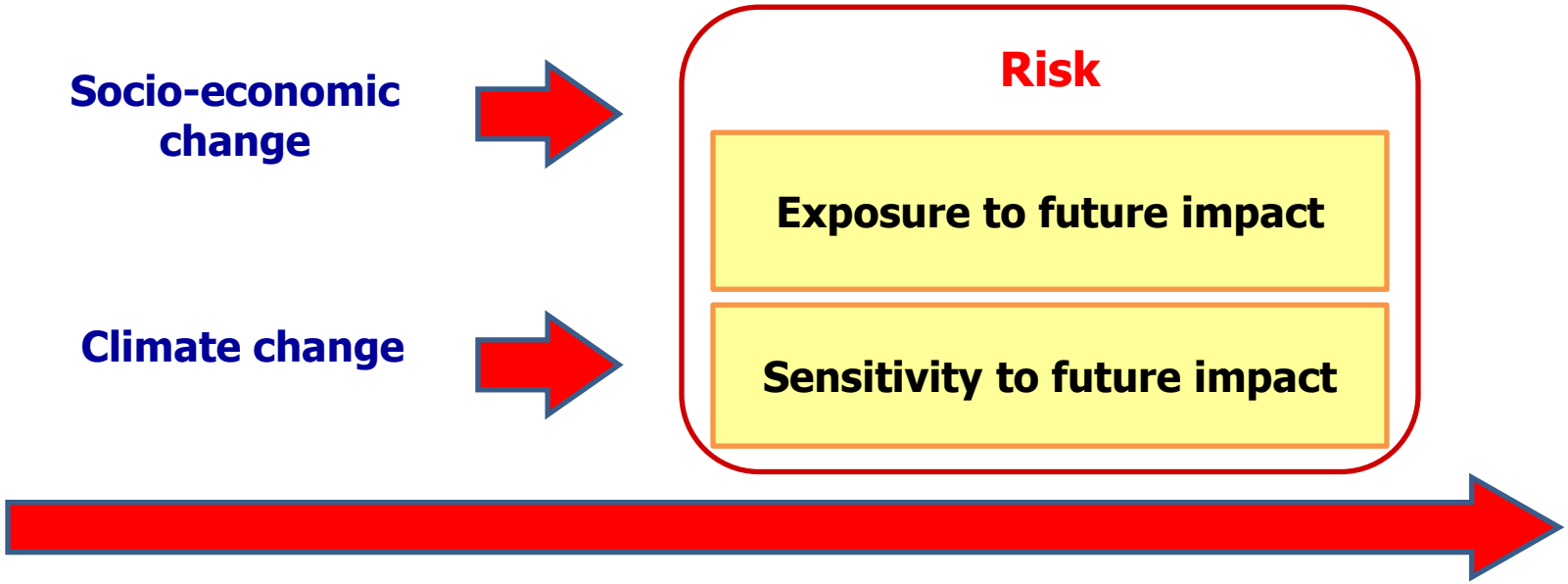
- Climate change is not the only factor that may put sector at risk in the future, but also change in the sector from consequence of development
- Different sectors / systems / people are at risk differently and response differently – however, may affected others

These changes are dynamic and connected – holistic view is required

Risk and climate change risk assessment - approached and techniques

Dynamic of risk and holistic approach in climate change risk assessment

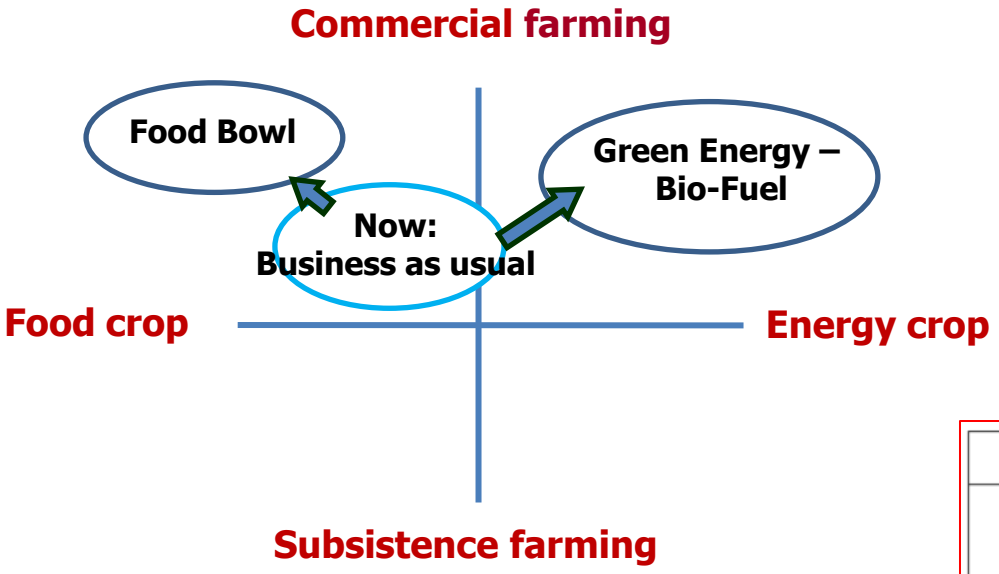
- The changes that affect the risk are dynamic

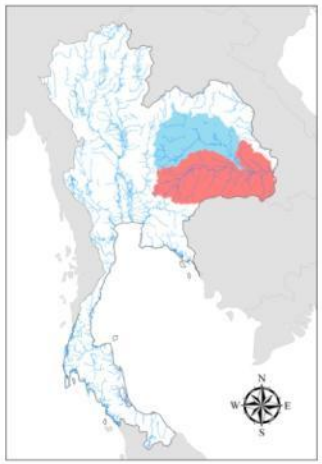


Climate change is not the only factor that may put sector at risk in the future, but also change in the sector from consequence of development

Risk and climate change risk assessment - approached and techniques

Example: Different development directions bring different context to think about climate change adaptation: Case study Chi-Mun River Basin



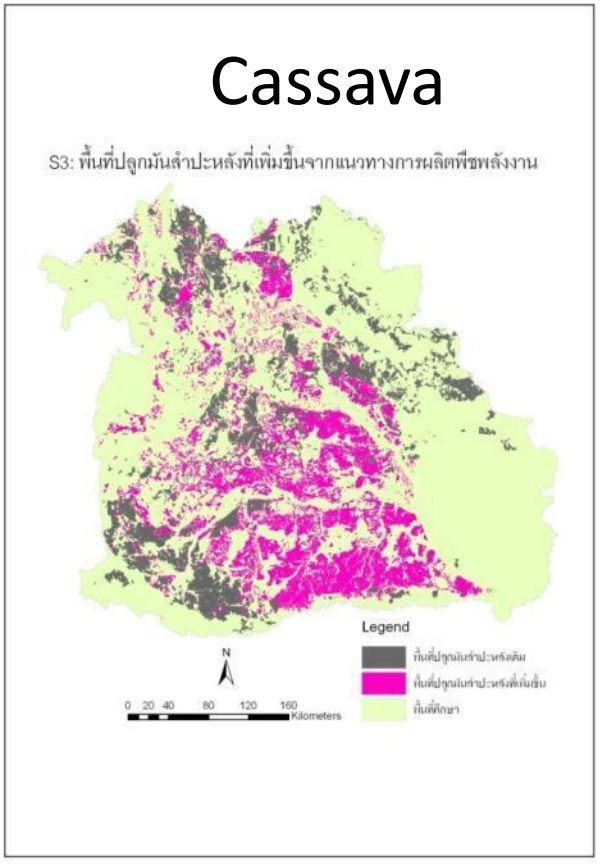


	Future scenario	
	Food Bowl	Green Energy - Biofuel
Wet season / Rainfed rice	↓	↓
Dry Season / Irrigated rice	↑	↑
Sugarcane	→	↑
Cassava	→	↑
Other crops	↓	↓

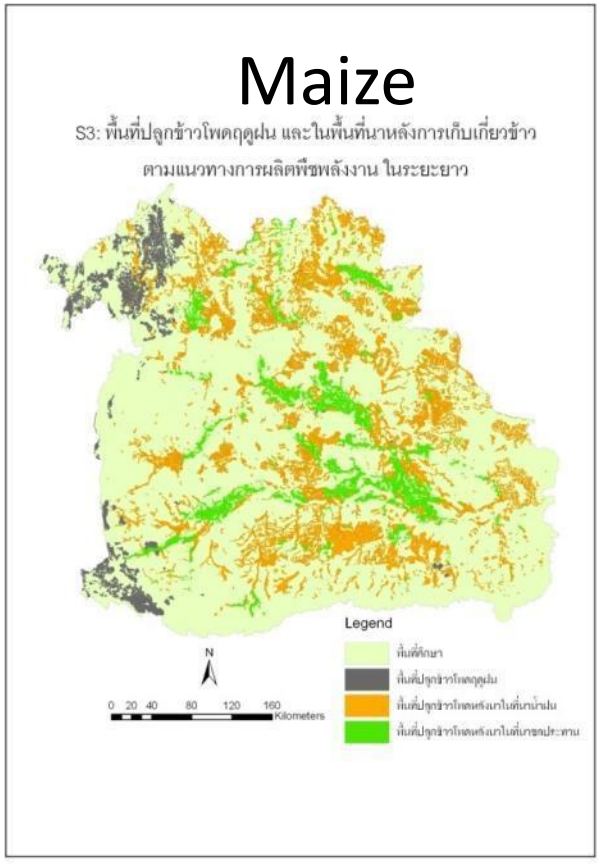
Risk and climate change risk assessment - approached and techniques

Different crop production area – scenarios of the future

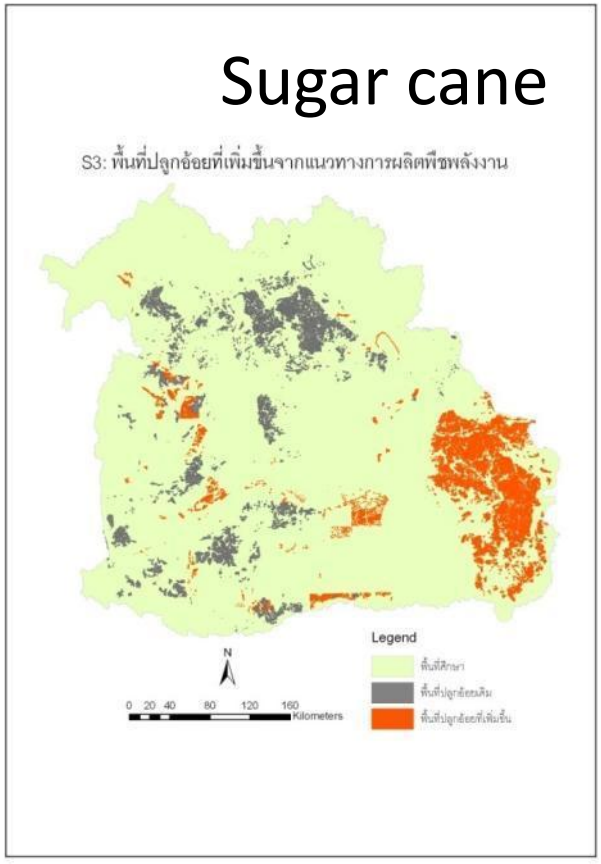
Cassava



Maize

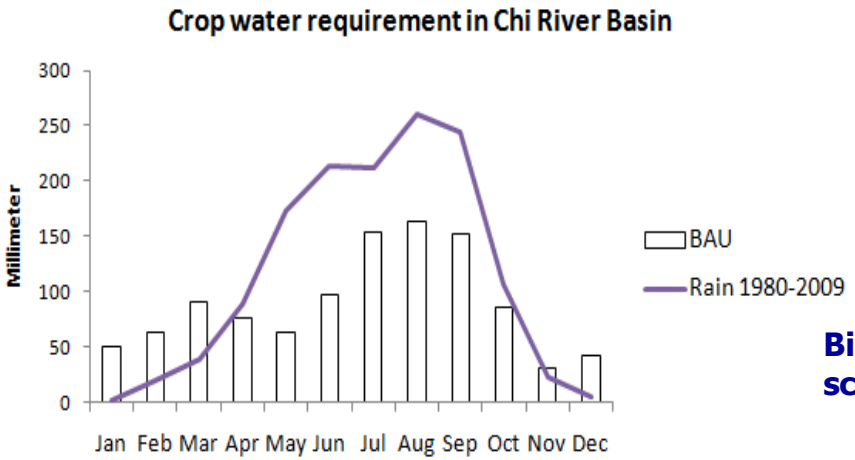


Sugar cane

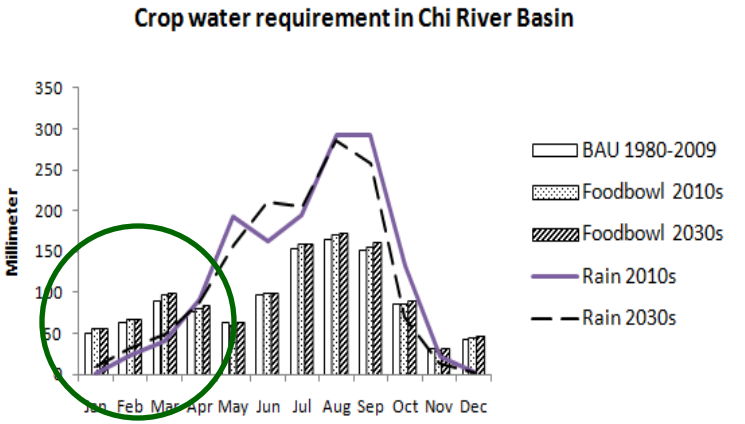


Risk and climate change risk assessment - approached and techniques

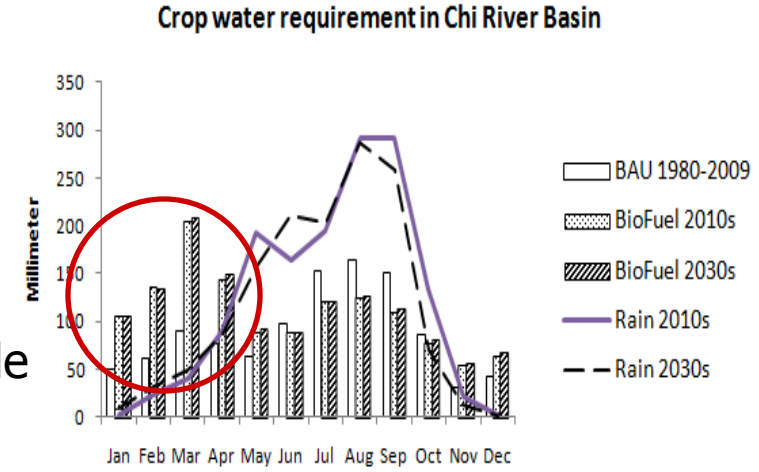
Different cropping pattern in the future make different water demand



Food-bowl scenario



Bio-fuel scenario



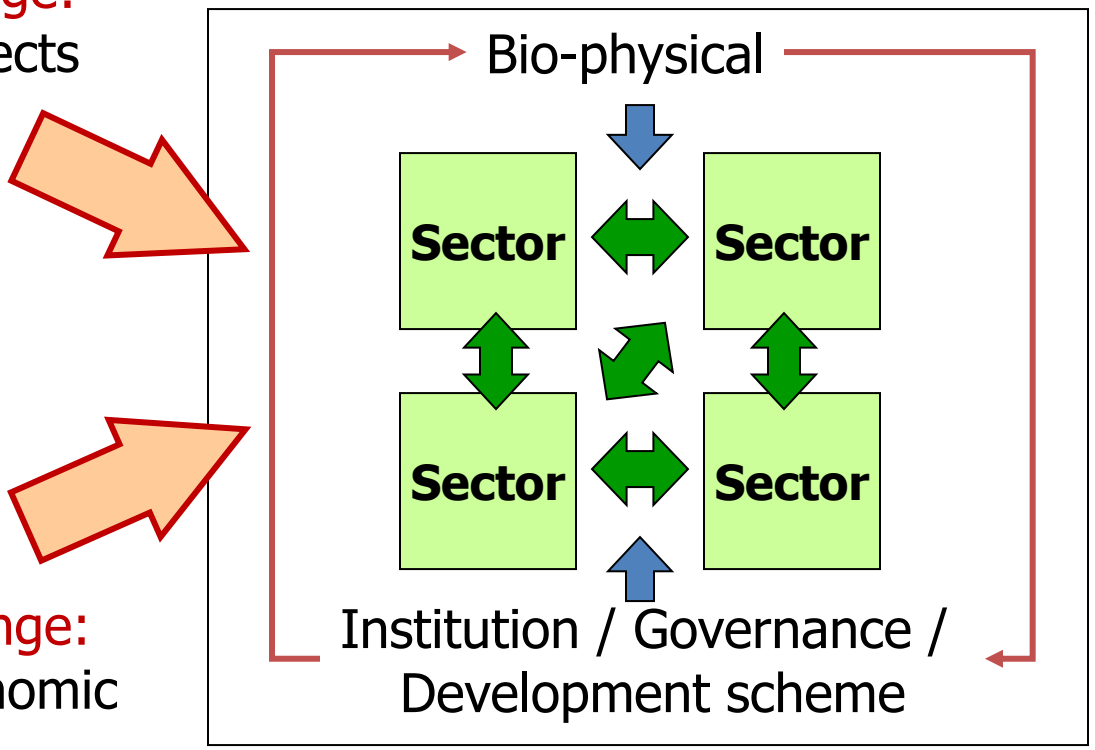
Different climate risk: Higher risk on water shortage in dry season if focus on renewable crop?

Cannot assess risk by looking climate change as isolate issue

Risk and climate change risk assessment - approached and techniques

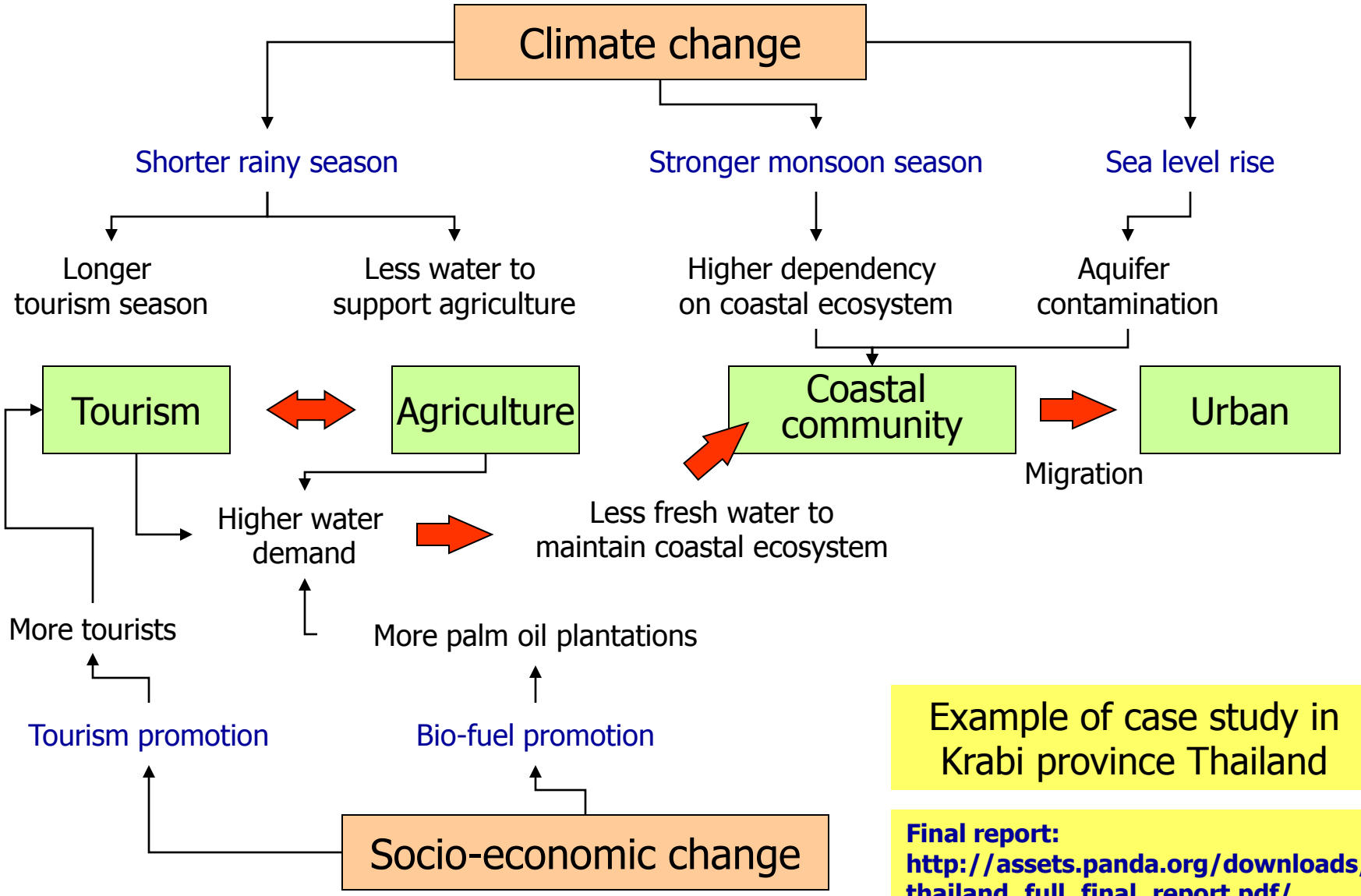
Different sectors with inter-relation – requires holistic view to understand risk

Future change:
Natural aspects



Future change:
Social & economic aspects

Risk and climate change risk assessment - approached and techniques



Example of case study in Krabi province Thailand

Final report: http://assets.panda.org/downloads/thailand_full_final_report.pdf/

Conclusion

- Understanding climate change needs to put into context of "Climate" and "change"
- Do not take future climate change as definite future, also think of multiple futures
- Climate change is not jut a change in average of temperature, precipitation, etc. There are multiple dimensions of change, need to be put into proper context for risk assessment
- Assessing climate change risk could be either quantitative or qualitative approach, but be careful
  - Quantitative analysis tend to lead people to see this climate risk as "forecast" rather than scenario projection;
  - Looking into far future, dynamic of drivers of risk is of high concern
  - holistic view is required in planning risk assessment process

Southeast Asia START Regional Center

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Thank you

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