Drought, Irrigation and Food Security in the Lower Mekong Basin

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Drought and Food-Energy-Water Nexus

- 60% food security by rice
- 13% global fish catch

- Mekong: 12th largest river
- Fulfill domestic need, irrigation, hydropower

- More than 400 dams
- 88,000 MW potential

Drought is a natural disaster that has an influence on water resources, environment, economy, and crop production.

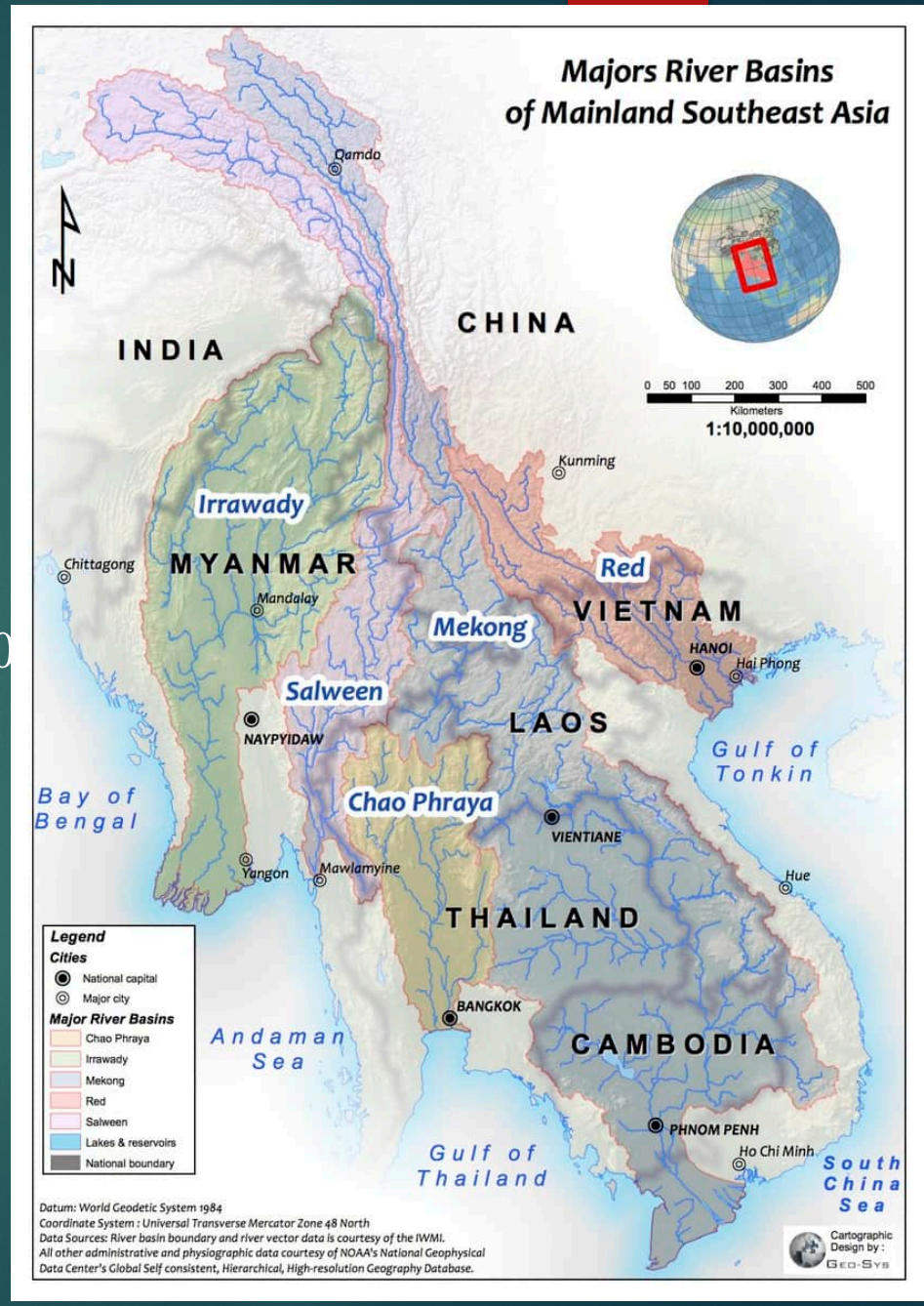
Moderate to severe droughts occurred in the Lower Mekong River Basin (LMB), and they led to massive agricultural and economic losses.

Mekong River Basin

- 12th largest in world & 7th largest in Asia
- 6 nations in southeast Asia
- Drainage area: ~765,000 sq.km.
- Annual mean flow: ~15,000 cu.km./yr
- Length: **UMRB**:~2200 km.+**LMRB**:~2600 km.

Mekong river is lifeline:

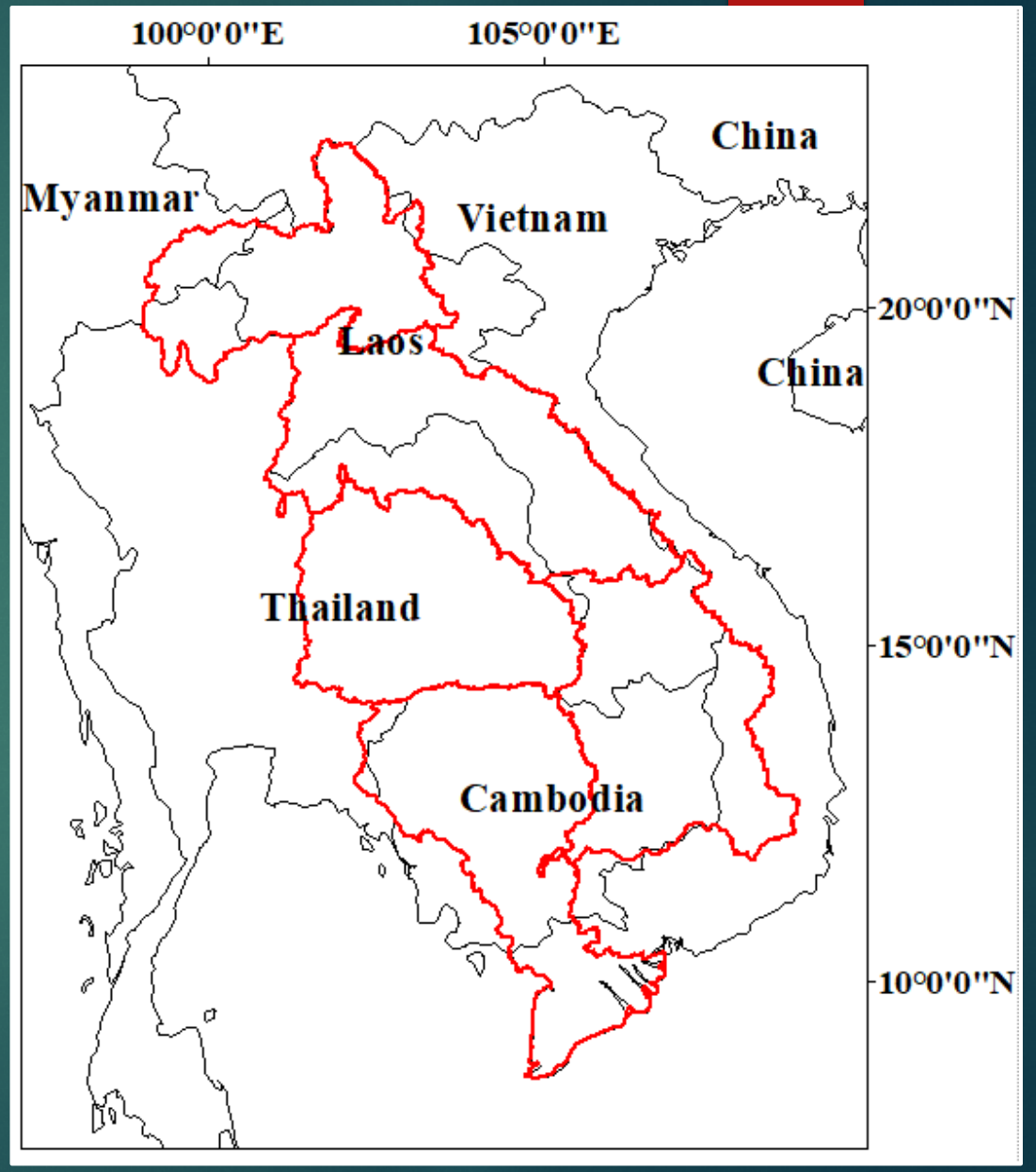
- The Mekong River basin support different ecosystems and with a huge population (60 million people)
- 60% food security is provided by rice production (15 million ha)
- 75% of population depends on fish in some areas (4.4 million tons in 2015)



Source: https://wle-mekong.cgiar.org/changes/our-research/greater-mekong-dams-observatory/

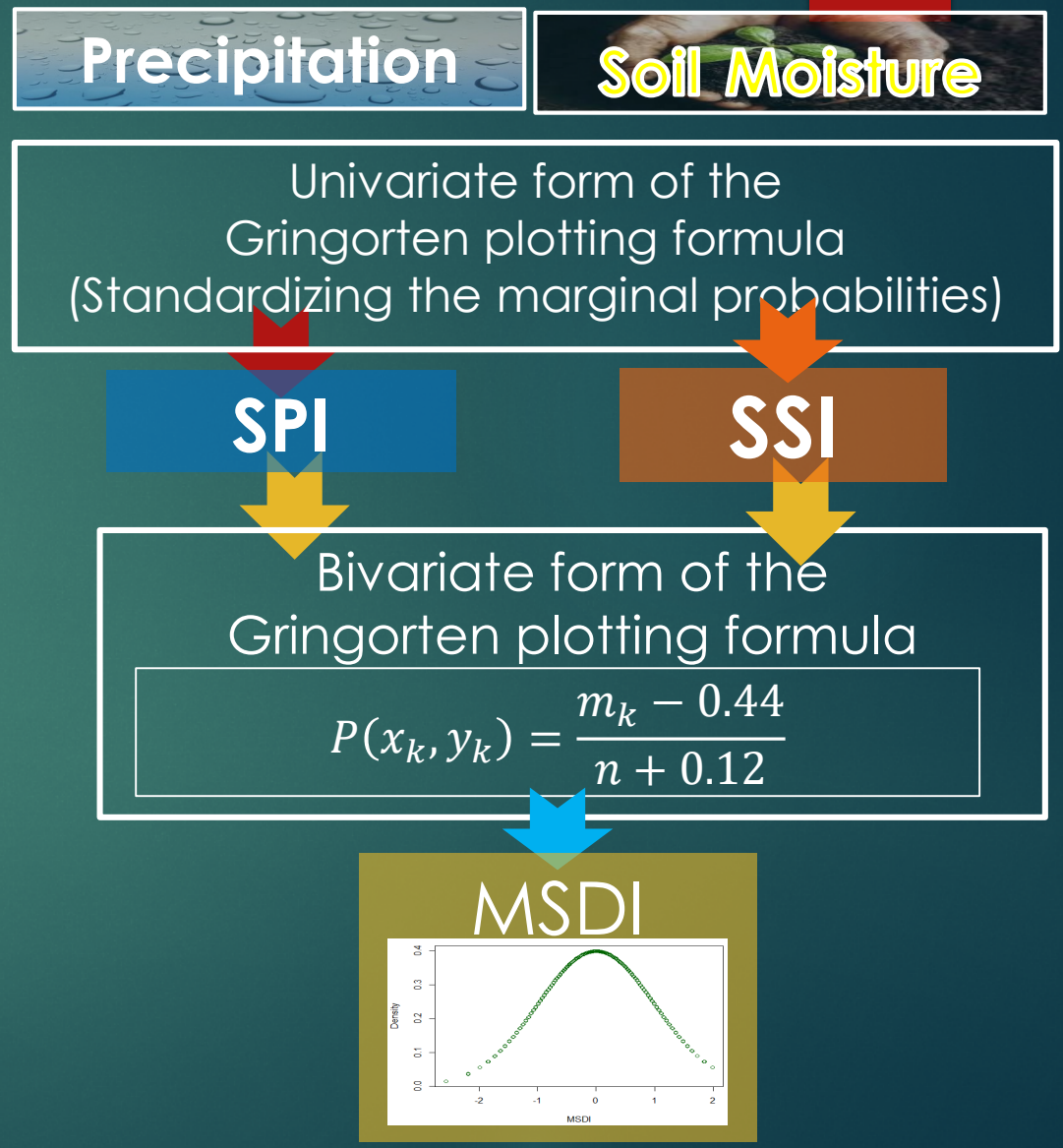
The Lower Mekong Basin Focus

- The LMB is affected by monsoonal climate and tropical cyclones; the wet season is from May to October, and the dry season is from November to April.
- The LMB was influenced by some severe droughts, occurred in 1992, 1999, 2003, and 2015 to 2016, which impacted agricultural production



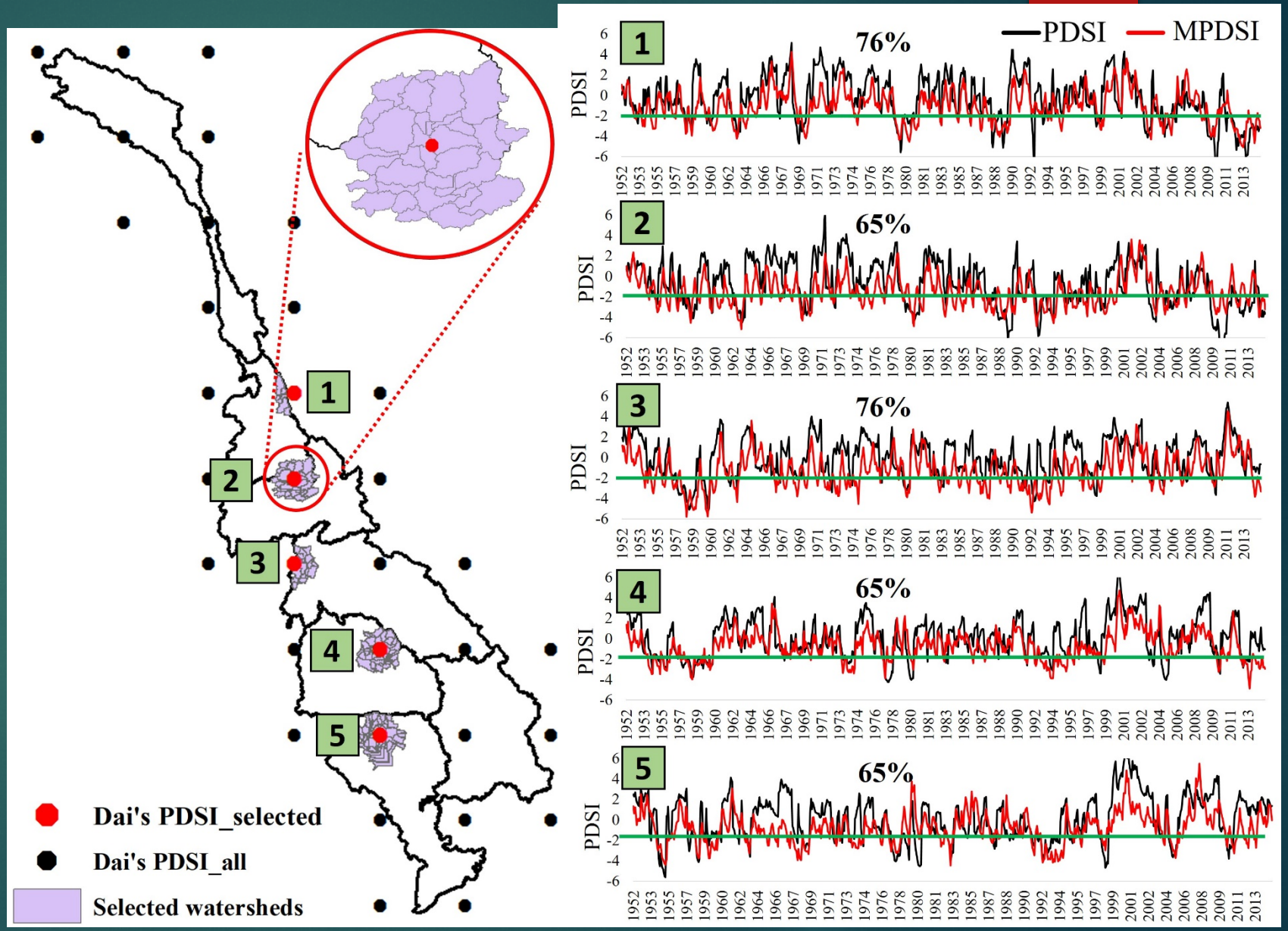
Drought indices

- Standardized Soil Moisture Index *(SSI)*
- Standardized Precipitation Index *(SPI)*
- Modified Palmer Drought Severity Index *(MPDSI)*
- Multivariate Standardized Drought Index *(MSDI)*
- The computation of MSDI is based on joint probability and distribution models.
- Drought indices evaluate the historic and future drought conditions.



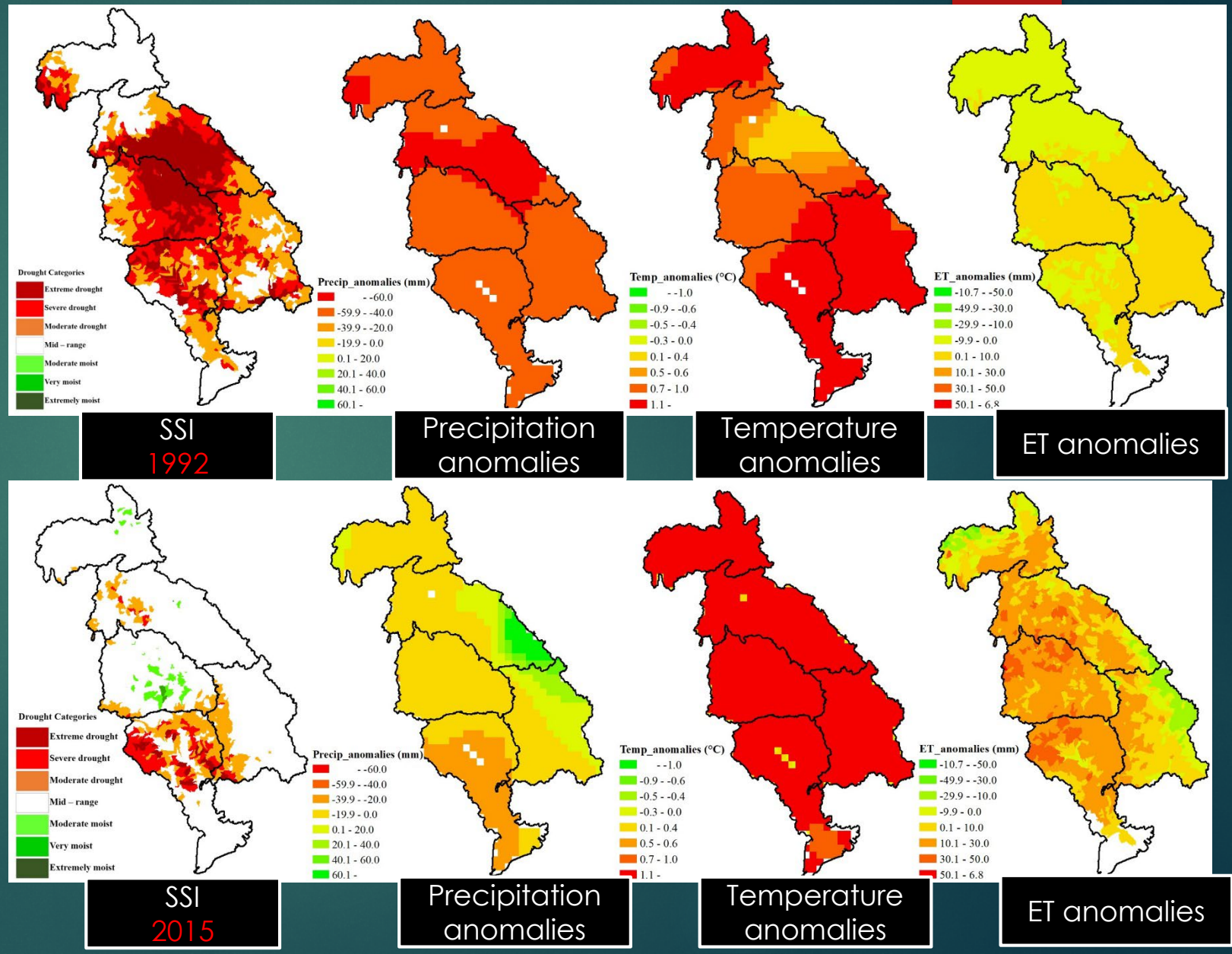
Drought in LMB

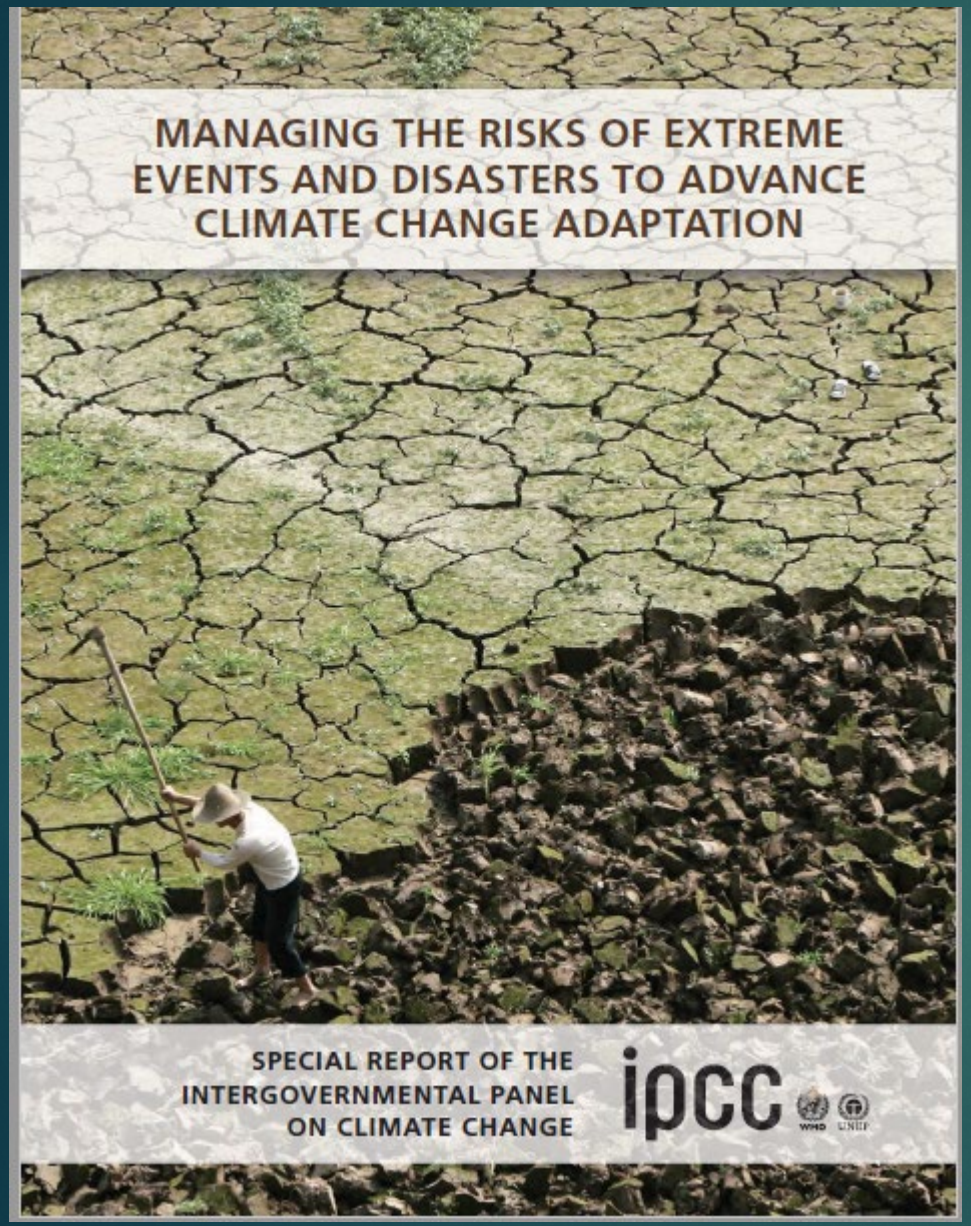
- Historic drought events were validated by the comparisons with the Palmer Drought Severity Index estimations from Dai et al. (2004) and the MDPSI values calculated by the SWAT simulation.
- Historic drought occurrences during the historic period (1953-2014) were evaluated whether the MPDSI values correctly captured the drought events when the PDSI values were -2 or less (Moderate droughts).
- Estimated MPDSI adequately captured 65% to 76% of drought conditions.



Drought extent in relation to P, T and ET

- SSI was calculated by the estimated soil moisture from the SWAT simulation.
- Major drought conditions in 1992 and 2015 were derived based on the results of SSI.
- Moderate to severe droughts occurred some regions where the precipitation deficits or temperature increases that led to an ET increase.




MANAGING THE RISKS OF EXTREME EVENTS AND DISASTERS TO ADVANCE CLIMATE CHANGE ADAPTATION
SPECIAL REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
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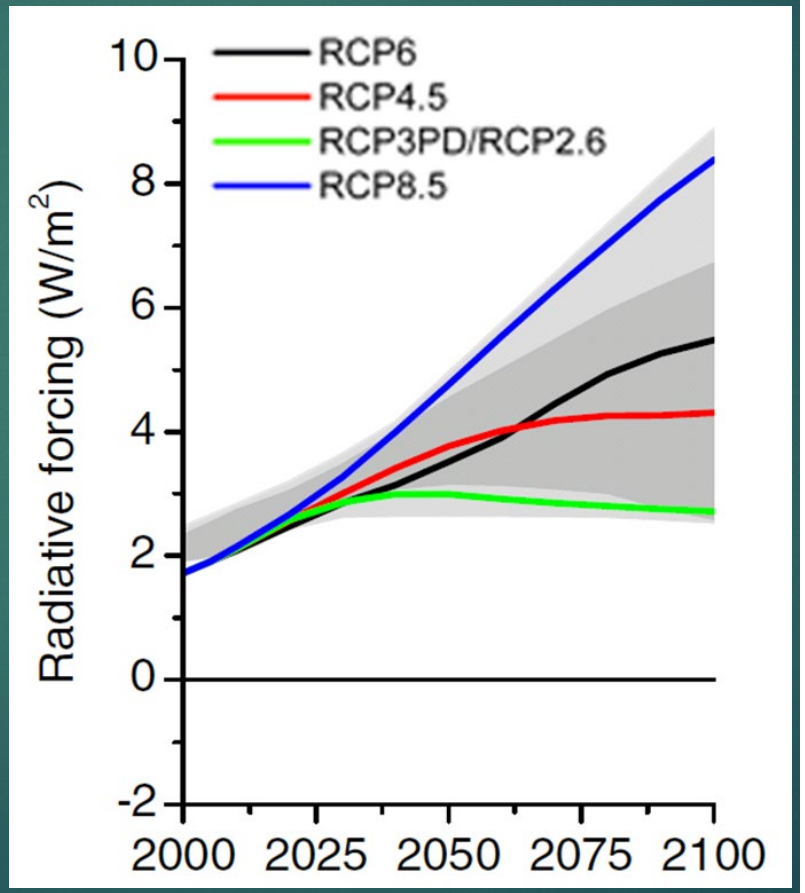
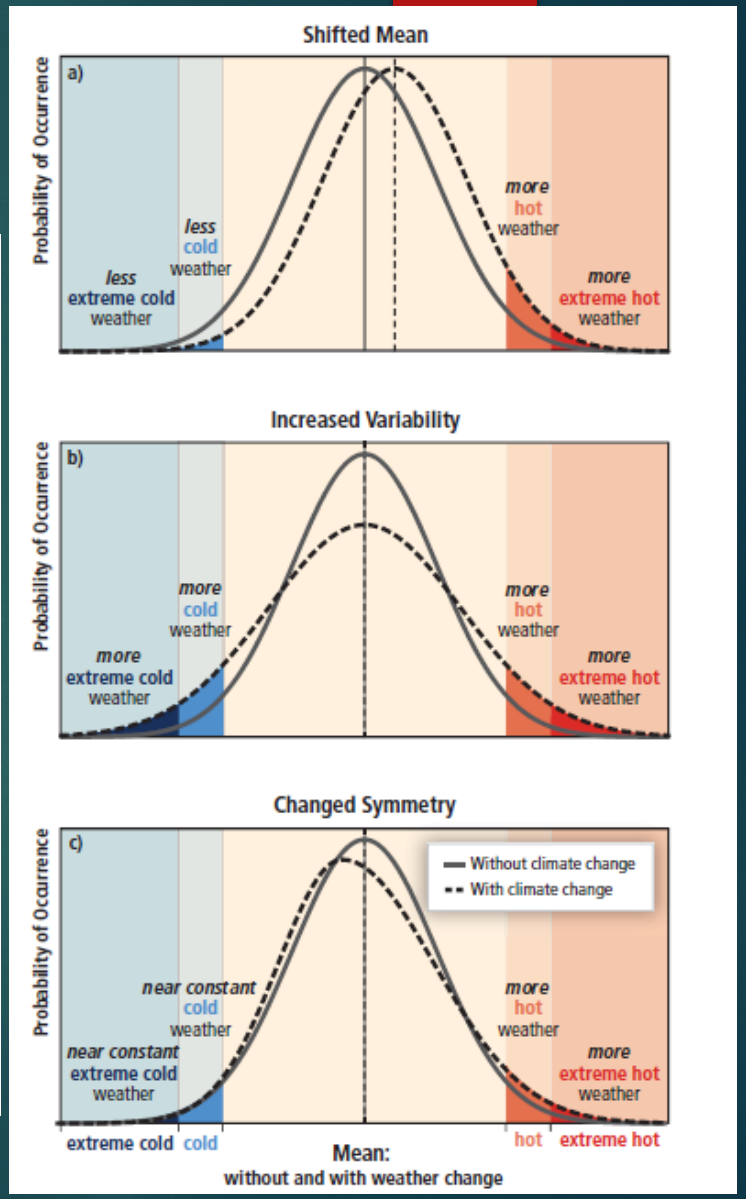
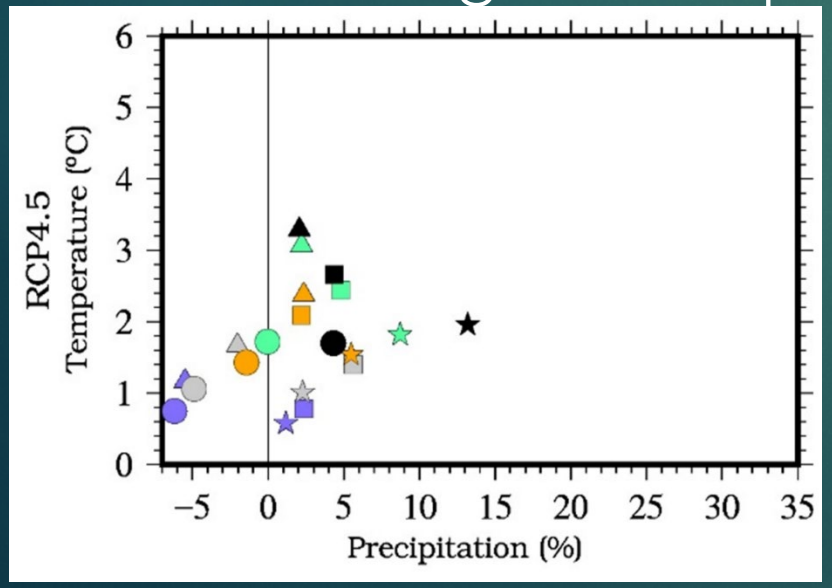
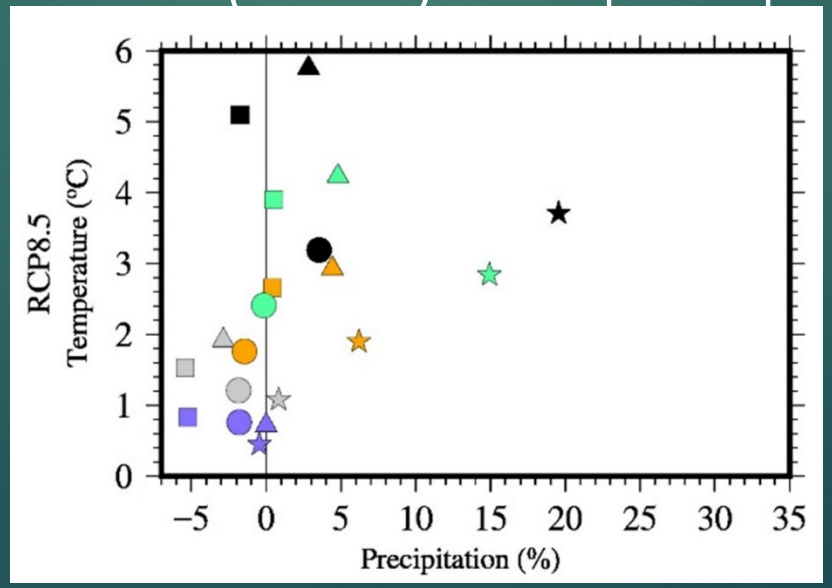

RCP6
RCP4.5
RCP3PD/RCP2.6
RCP8.5
Radiative forcing (W/m^2)
10
8
6
4
2
0
-2
2000
2025
2050
2075
2100


Shifted Mean
a)
Probability of Occurrence
less extreme cold weather
less cold weather
more hot weather
more extreme hot weather
Increased Variability
b)
Probability of Occurrence
more extreme cold weather
more cold weather
more hot weather
more extreme hot weather
Changed Symmetry
c)
Probability of Occurrence
Without climate change
With climate change
near constant extreme cold weather
near constant cold weather
more hot weather
more extreme hot weather
extreme cold
cold
hot
extreme hot
Mean:
without and with weather change

Climate models

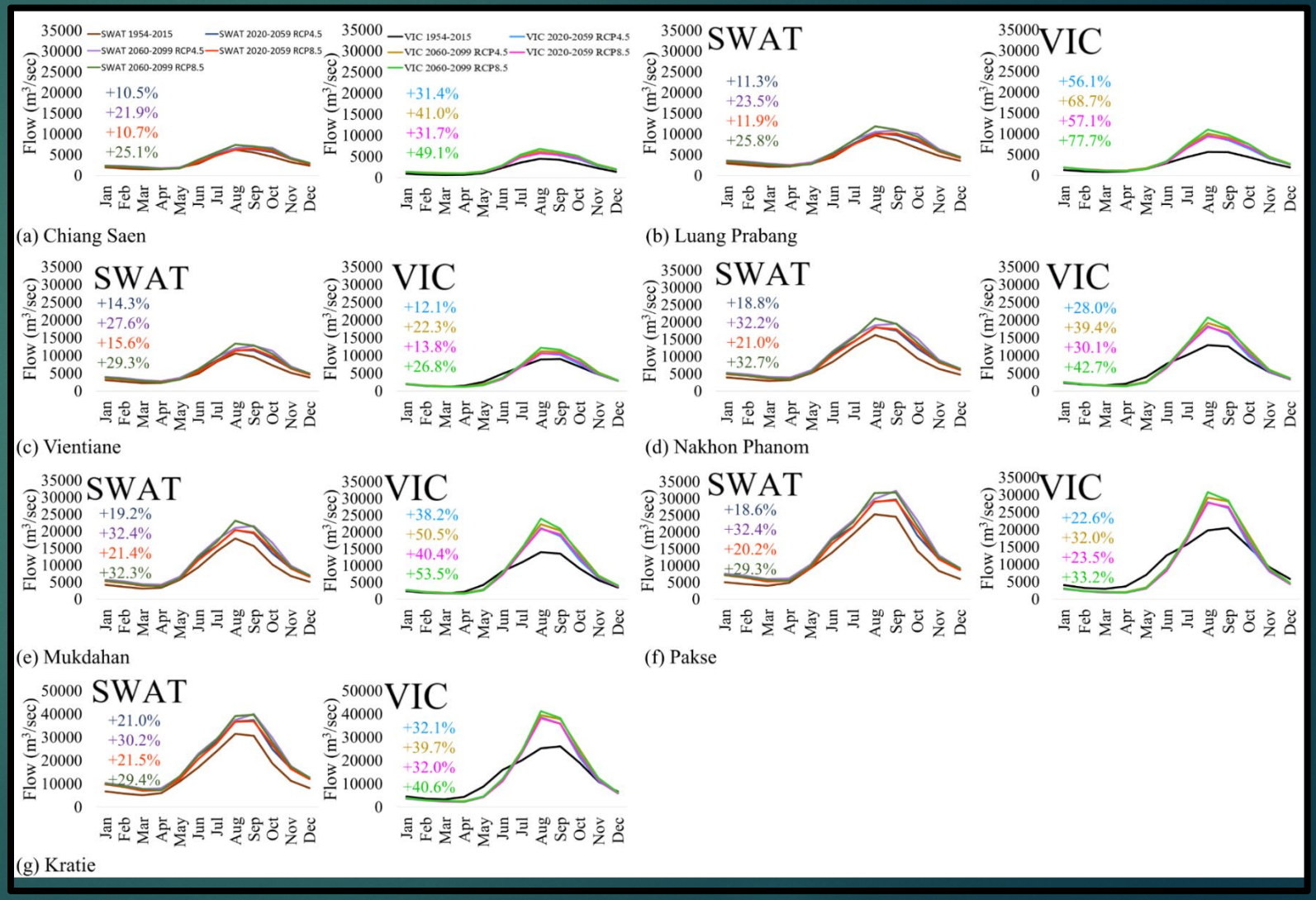
- Four climate models: GFDL-ESM2M, IPSL-CM5A-LR, MIROC-ESM-CHEM and NorESM1-M
- Bias corrected and statistically downscaled to 0.25-degree resolution by the Intersectoral Impact Model Intercomparison Project (ISI-MIP)
- RCP4.5 and RCP8.5
- A wide range of temperature (1-6 °K) and precipitation changes (-5 to 20





Peakflows differences – Future periods

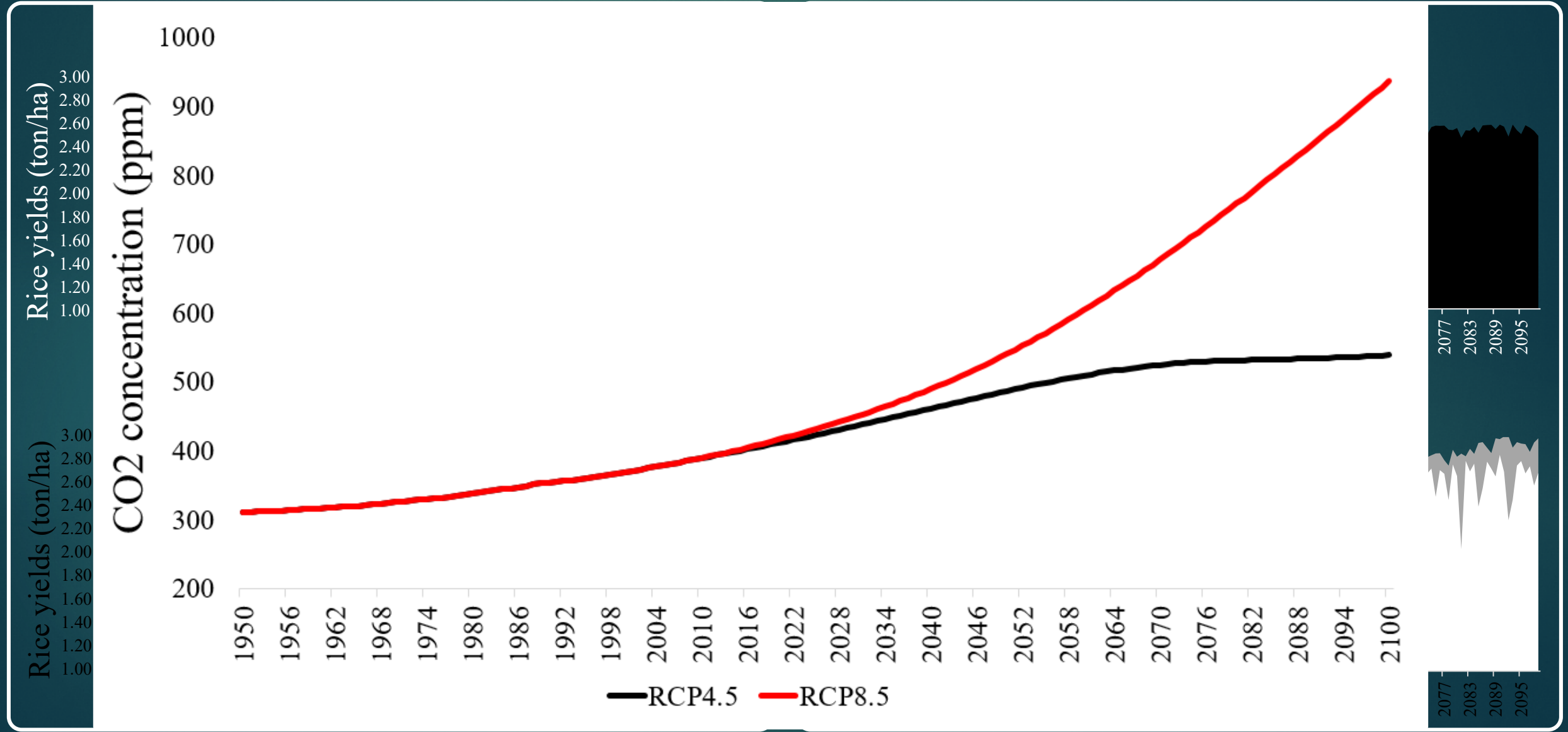
- Due to increased precipitation in the basin, as predicted by most of the GCMs, hydrological flow simulation had shown similar increases in peakflows, ranging from 10- 70% between RCP 4.5 and 8.5 scenarios.
- Model responses to streamflow were primarily due to increased precipitation.
- Reductions in the dry season flows were not evident, and counterintuitively the management of reservoirs and their releases can augment them.



Time series of rice yields (rain-fed)

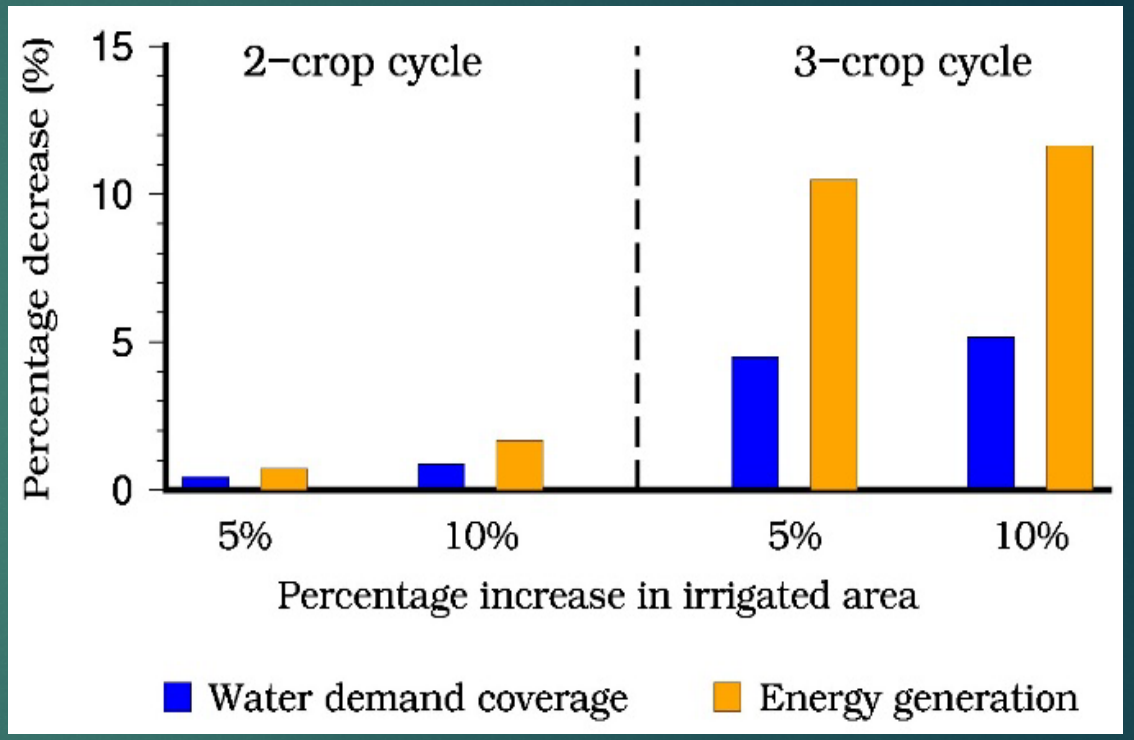
Cambodia (mean of 20 provinces)

Vietnam (mean of 16 provinces)



Effect of irrigation on water supply and energy generation

- Energy generation by the dams are more affected by the increase in the irrigated area as compared to the water demand coverage by agriculture sector.
- Decrease in the water demand and energy generation due to 5% and 10% increase in the irrigated area was estimated as 0.55% and 1%, respectively.
- Inclusion of the extra crop in the cycle exacerbates the energy generation loss to ten-fold with additional 4% loss in water supply per year.



Percentage decrease in water demand coverage and energy generation for 5% and 10% increase in irrigated area under 2-crop cycle and 3-crop cycle per year scenarios

Summary

- Ability of the Mekong system to absorb shocks as well as to provide food, water and energy security needs a systems approach.
- Key factors of resiliency for food production under drought conditions
  - Precipitation changes in a changing climate
  - Choice of crop in rainfed agriculture
  - Water storage capability harnessing hydropower and increased wet season flows