# Mekong climate change project - agricultural impacts and adaptation

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# A component of the MRC-CSIRO Project

Three main components of the project:

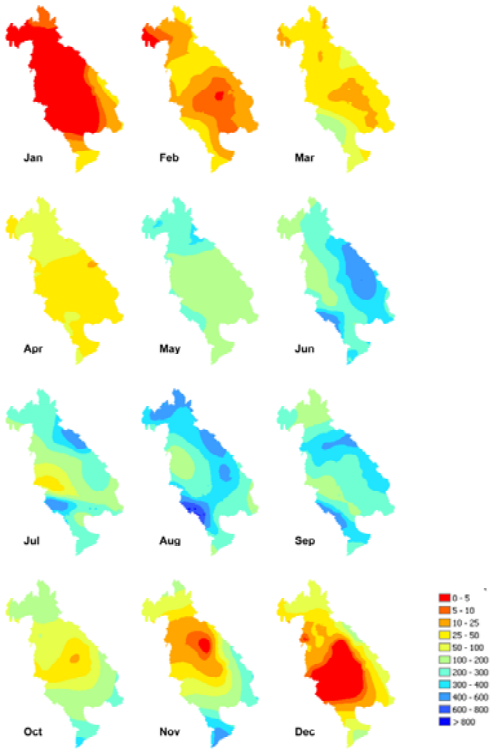
- Assessment of climate change impacts on Mekong hydrological regime – presented by Dr Hoanh
- Impacts of climate change on Mekong hydrological baseline and development scenarios – presented by Dr Kittipong
- Potential impact of climate change impacts on agriculture, fish and food security and adaptations strategies – this presentation

# Outline

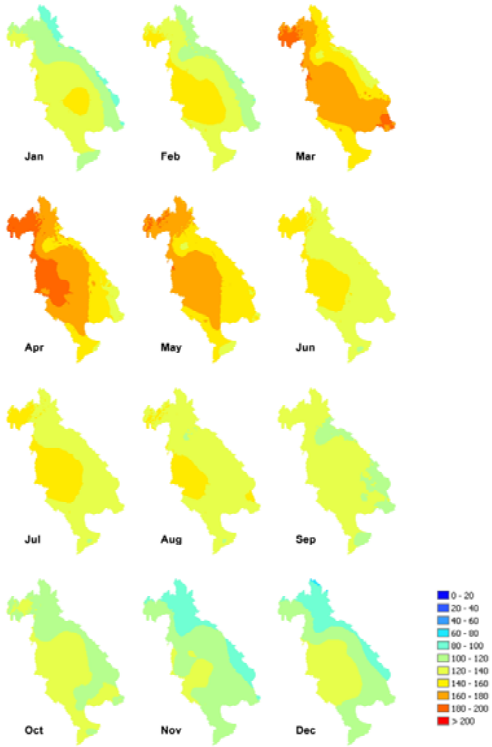
- Selection of sites for modelling
- Model set-up for the selected sites
- Modelling impact of climate change on rainfed rice and some results
- Possible adaptation strategies for rainfed rice cultivation and sensitivity analysis
- What is next

# Site selection – estimation of spatial average rainfall and PET

We have estimated spatial average rainfall and PET from the rainfall and PET surfaces of the Basin for 1980-2005




Rainfall surfaces of 1994




PET surfaces of 1994

Spatial variability in rainfall is higher than in PET

# Selection of site

- Based on the provincial average annual rainfall, provinces are divided into groups:

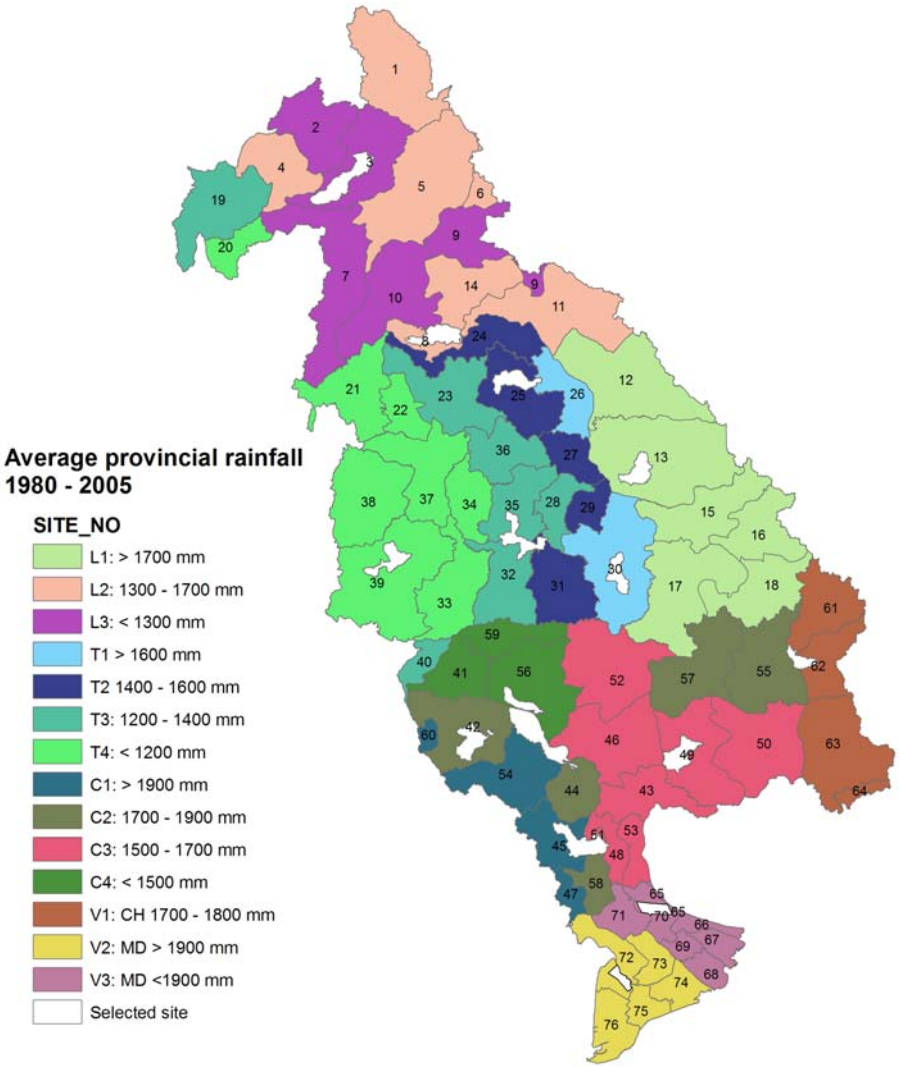
  Laos – 3

  Thailand – 4

  Cambodia – 4

  Vietnam – 3 (1 in Central Highlands, and 2 in the Delta)
- One sub-catchment as defined by the MRC-DSF from each group has been selected for modelling to represent the group
- Sub-catchment has been selected from the province having highest planting area of the  selected crop

# Selection of site – location map of rainfed rice




No of provinces in each group:

Laos 1 – 6
Laos 2 – 7
Laos 3 – 5

Thailand 1 – 2
Thailand 2 – 5
Thailand 3 – 7
Thailand 4 – 8

Cambodia – 4
Cambodia – 5
Cambodia – 8
Cambodia – 3

Vietnam 1(CH) – 4
Vietnam 2 (MD) - 5
Vietnam 2 (MD) - 7

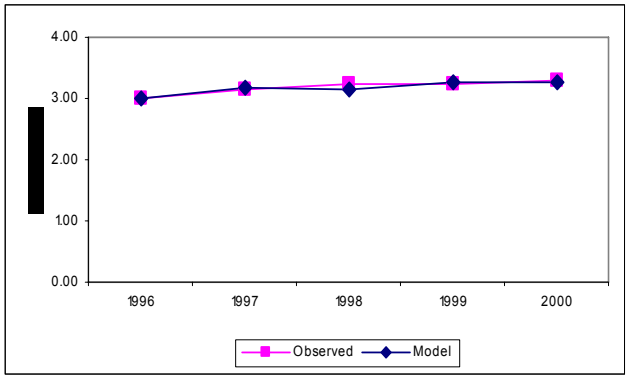
# Model selection

- We have selected AQUACROP model developed recently by FAO
- AquaCrop is a water-driven simulation model that requires a relatively low number of parameters and input data to simulate the yield response to water of most of the major field and vegetable crops cultivated worldwide.
- Its parameters are explicit and mostly intuitive and the model maintains sufficient balance between accuracy, simplicity and robustness.
- Very useful for scenario simulations and for planning purposes. It is suited for perspective studies such as those under future climate change scenarios.
- Its performance has been tested for several crops with very satisfactory results.

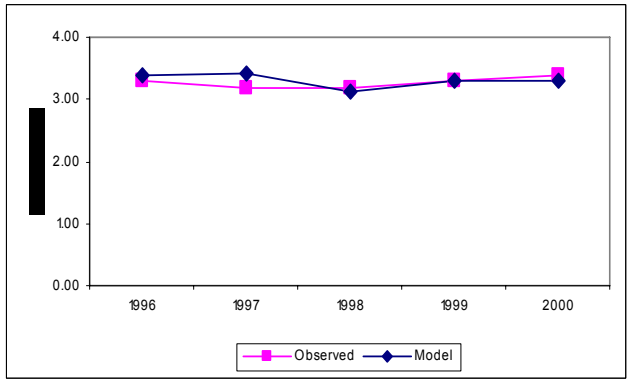
# Model set-up - data

- Model has been set up for each location considering the climatic data of the sub-catchment and provincial average yield data (only available data for yield)
- Due to the higher year to year variability of the model parameters such as planting date, fertilizer input etc. the baseline condition has been considered for 5 years (1996-2000) (MRC model has climate data up to 2000)
- Major soil class representing the area has been considered.
- Crop calendar published by the MRC (Technical Paper 11) used in defining the crop growing period for modelling.
- We tried to match the model yield with the observed yield by changing mostly the planting date, fertilizer stress and harvest index.

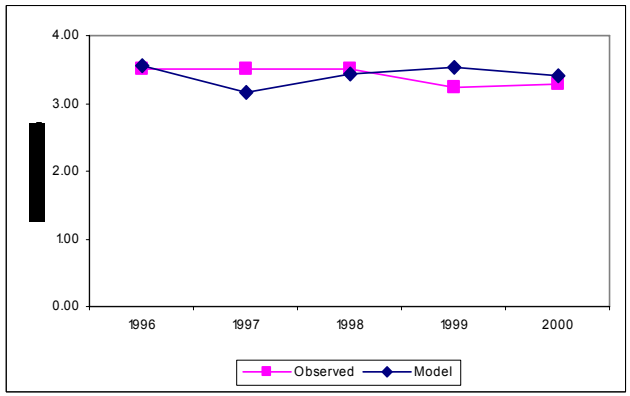
# Model set-up – observed vs modelled yield of rainfed rice for baseline condition, Laos




Laos 1 - Savannakhet

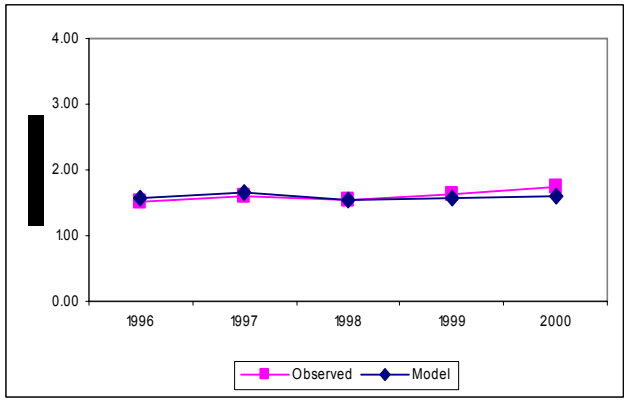



Laos 2 – Vientiane Municipality

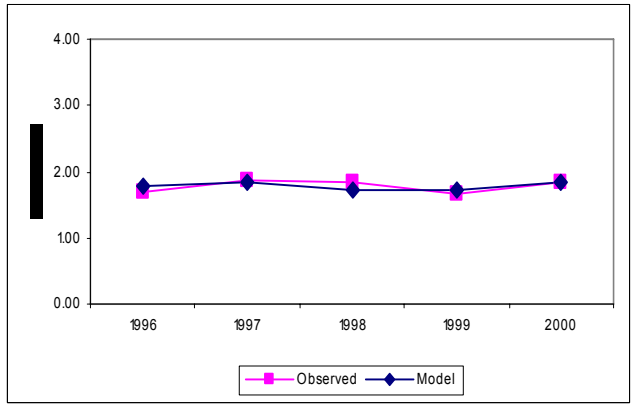



Laos 3 - Oudomxay

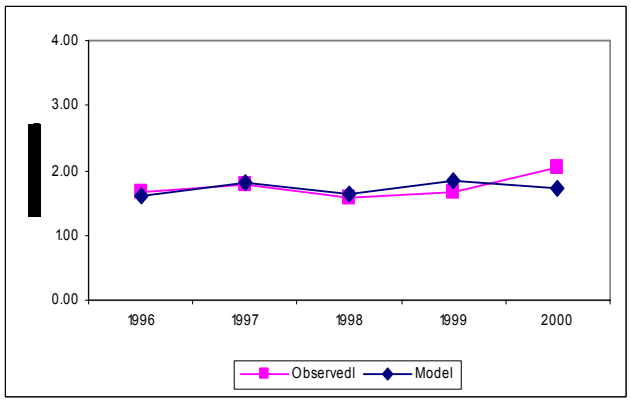
# Model set-up – observed vs modelled yield of rainfed rice for baseline condition, Thailand



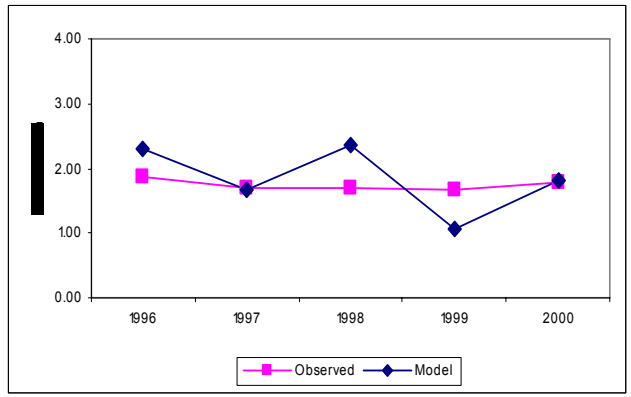

Thailand 1 – Ubon Ratchathani




Thailand 2 – Sakhon Nakhon

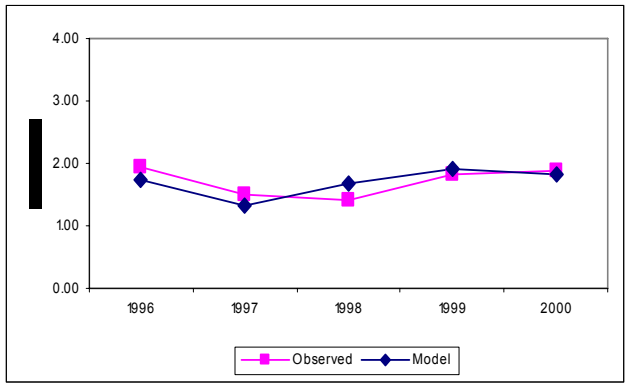



Thailand 3 – Roi Et

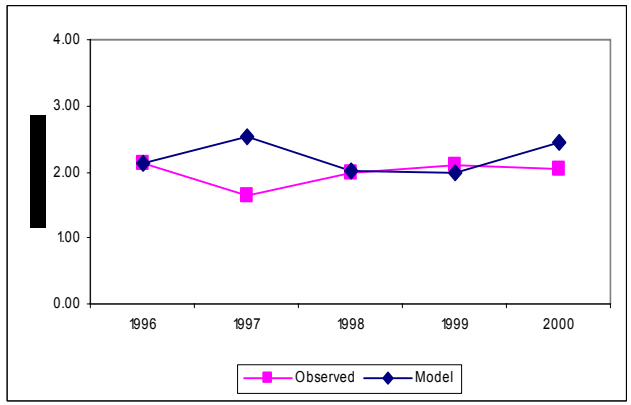



Thailand 4 – Nakhon Ratchasima

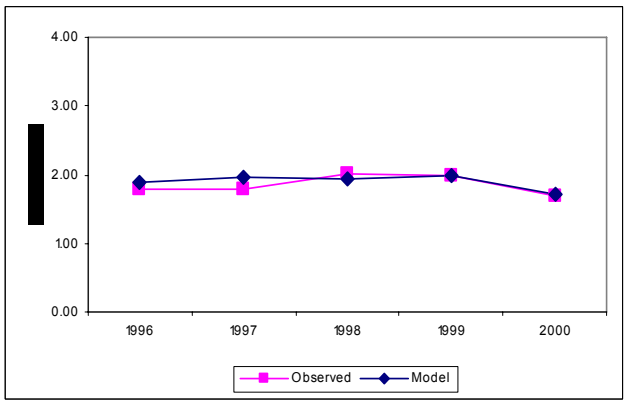
# Model set-up – observed vs modelled yield of rainfed rice for baseline condition, Cambodia



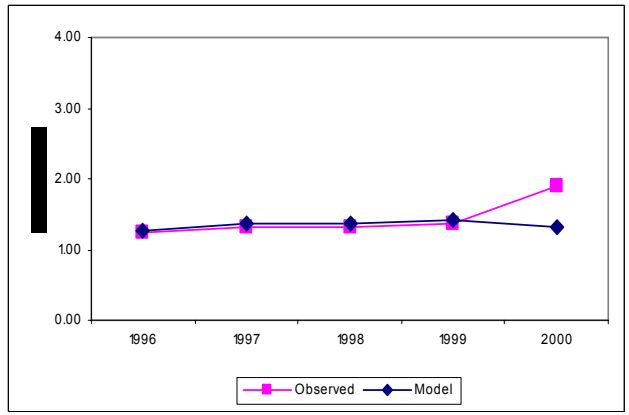

Cambodia 1 – Kampong Speu




Cambodia 2 - Battambang

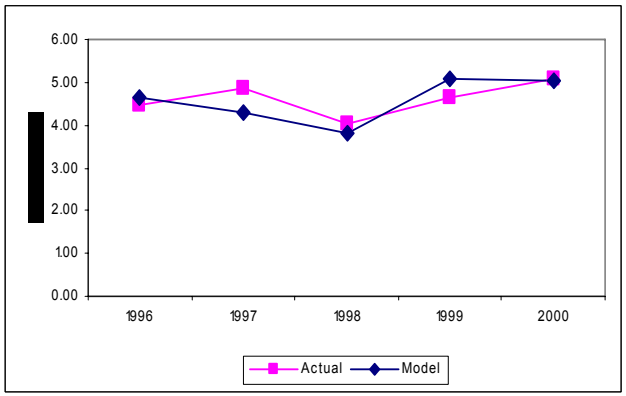



Cambodia 3 - Kratie

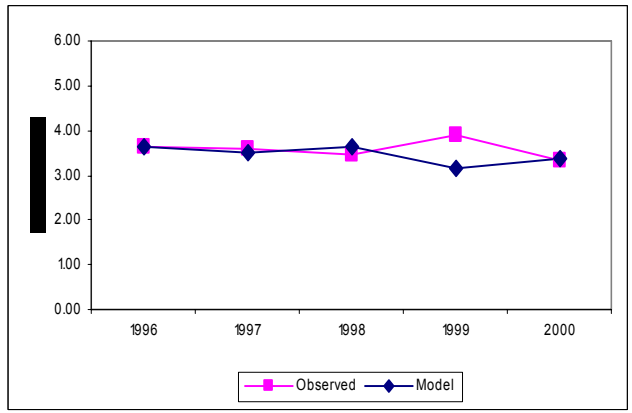



Cambodia 4 – Siem Reap

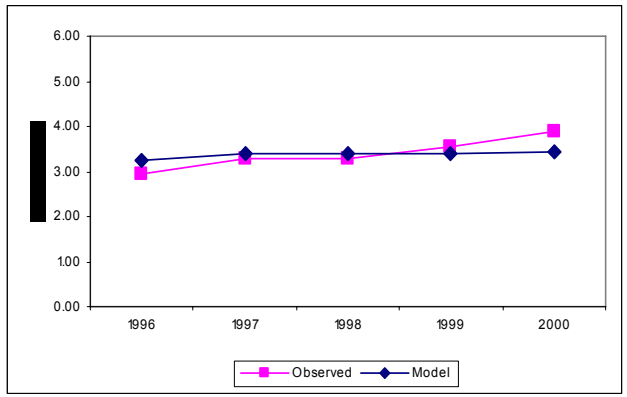
# Model set-up – observed vs modelled yield of rainfed rice for baseline condition, Vietnam




Vietnam 1 (Central Highland) – Gia Lai

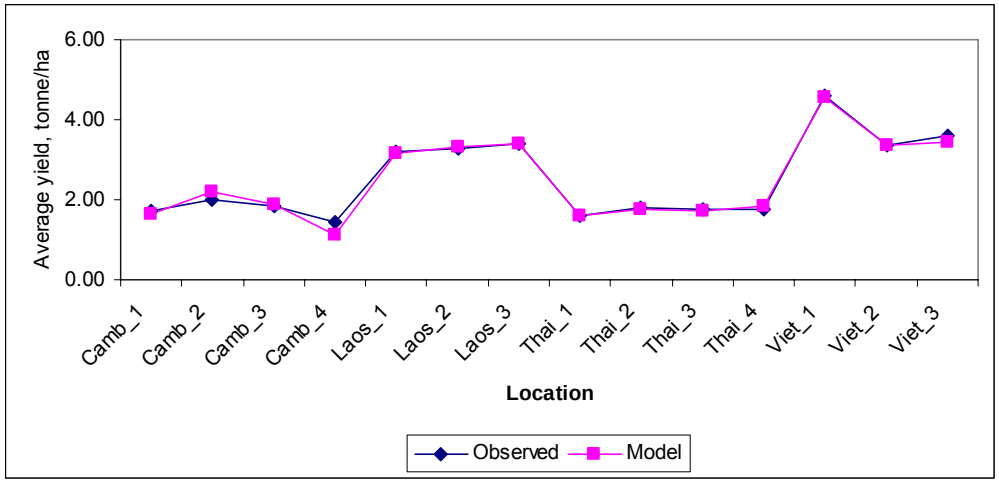



Vietnam 3 (Mekong Delta) – Kien Giang

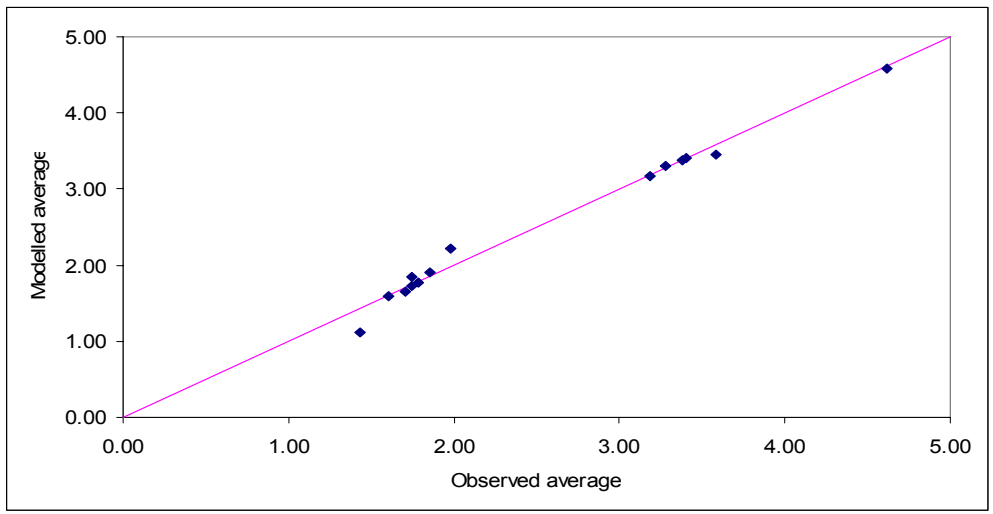



Vietnam 2 (Mekong Delta) – Dong Thap

# Model set-up – observed vs modelled yield of rainfed rice for baseline condition, overall comparison




Comparison of observed and modelled yield for all location

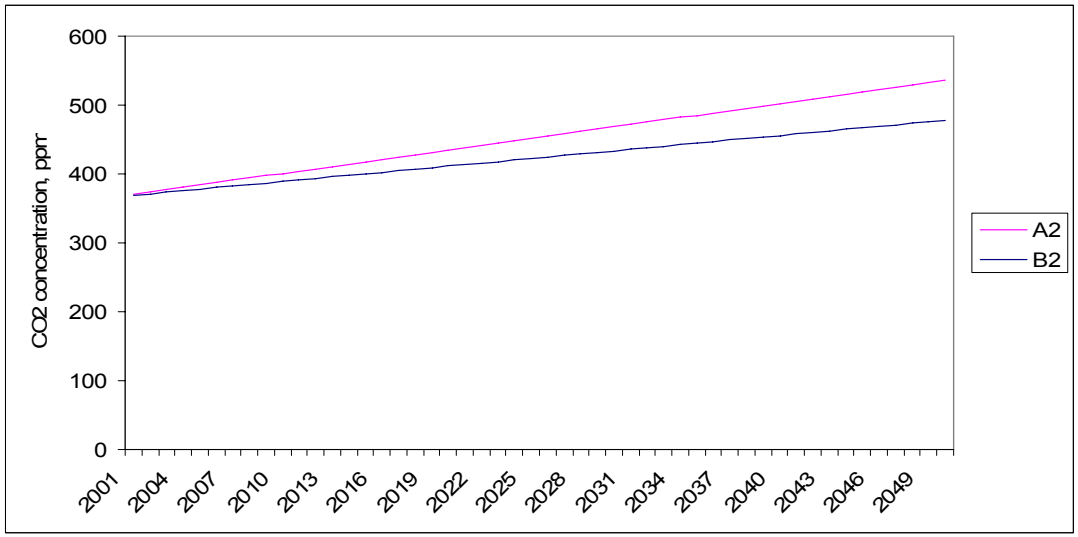



Modelled yield vs observed for all location (1:1 plot)

The model represents well the average condition for the period of 1996-2000

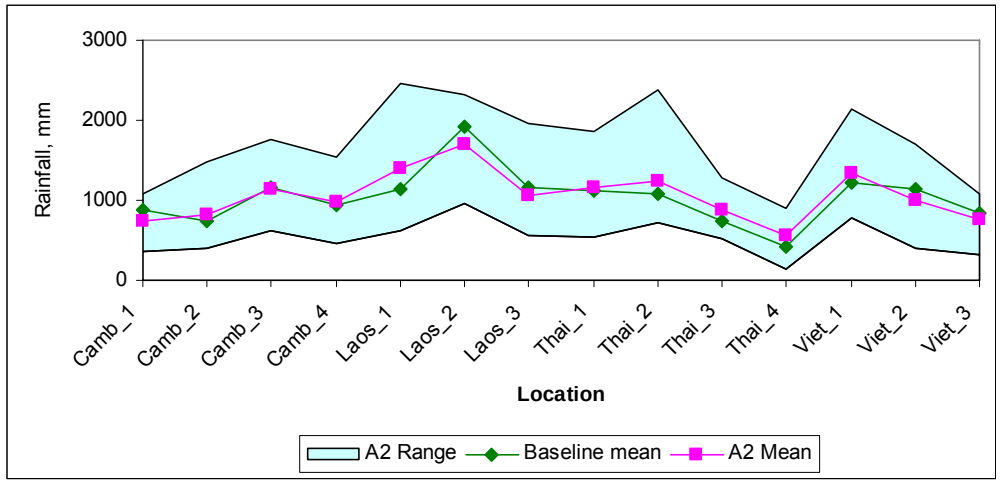
# Model run for future climate scenario

- Model set up for the baseline condition was used with changed climatic data and CO2 emission only.
- Model has been run for A2 and B2 climate scenario for the period of 2010 to 2050
- CO2 emission has been considered varying from year to year according to SRES scenario

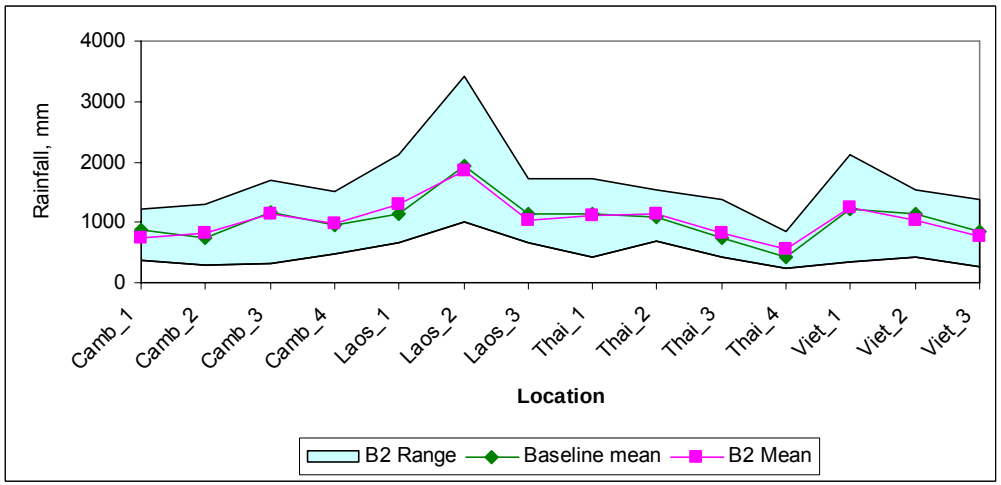



CO2 emission scenario

# Results – rainfall during the growing season of rainfed rice

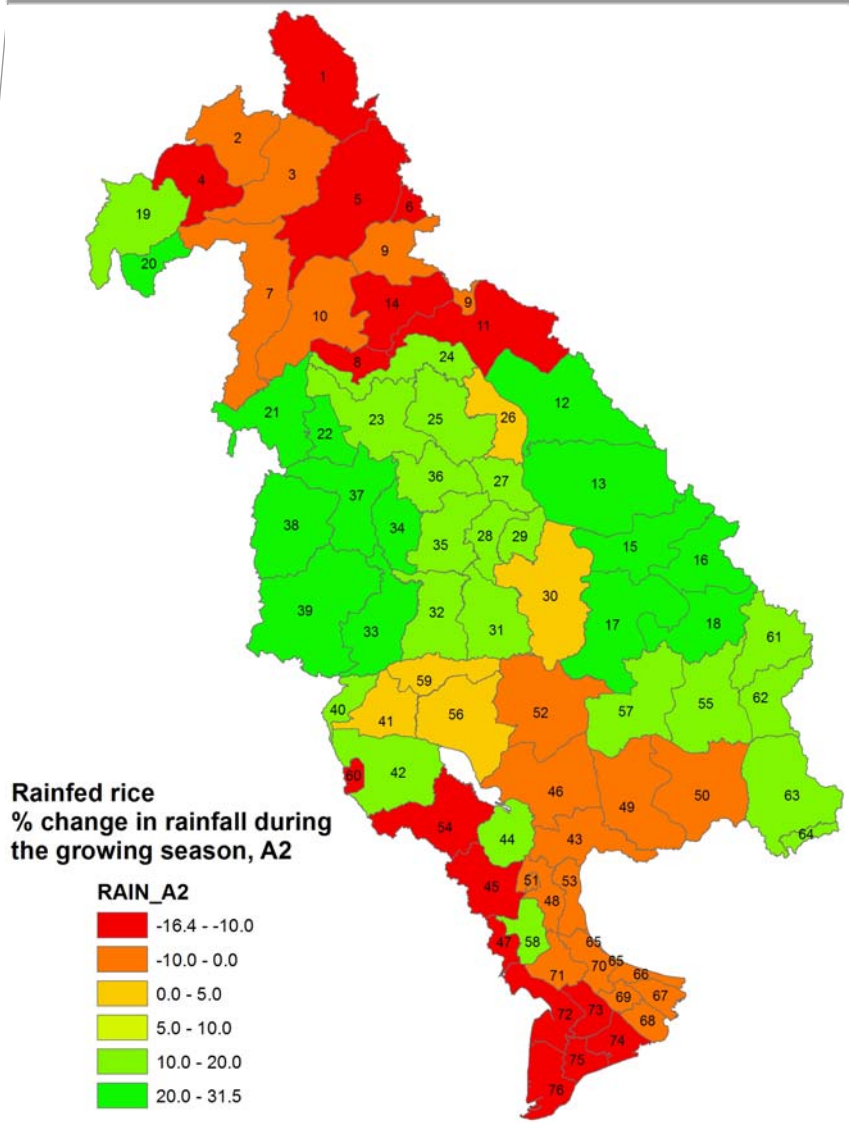


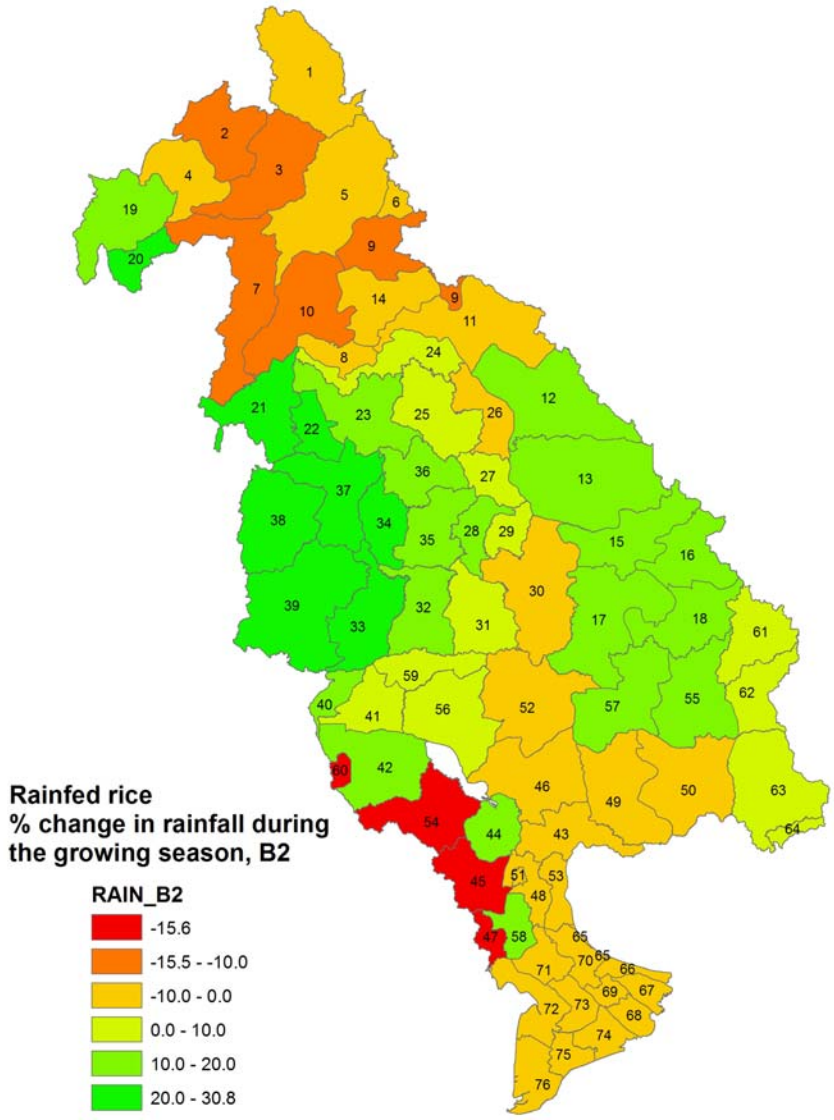

A2 Scenario



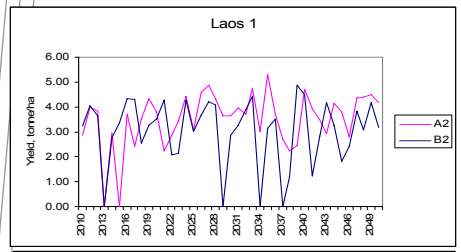

B2 Scenario

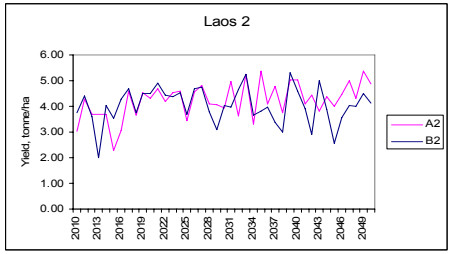
# Results – rainfall during the growing season of rainfed rice (up-scaling)

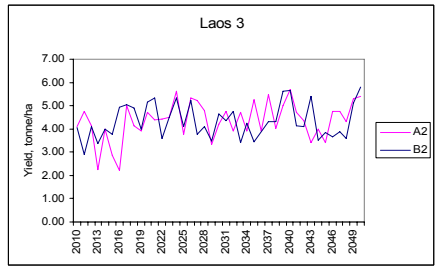


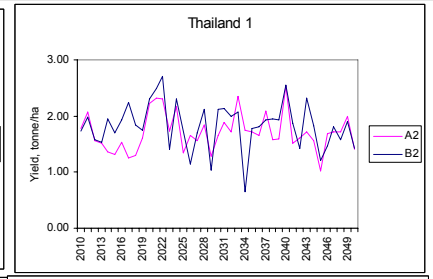



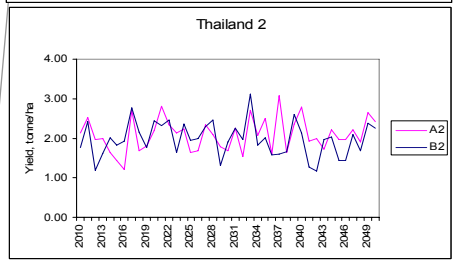
# Results – variation in yield of rainfed rice

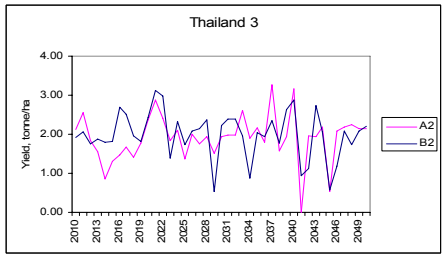


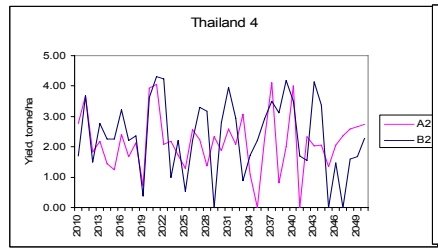



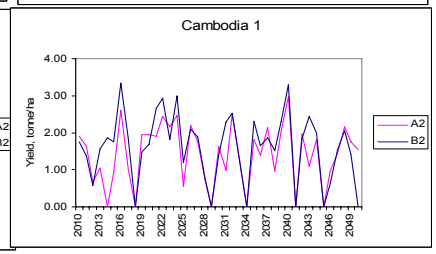



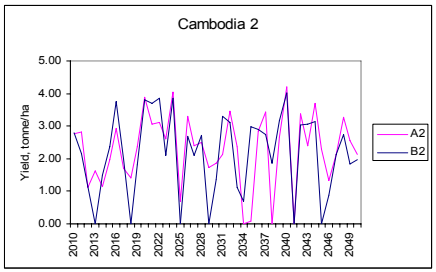



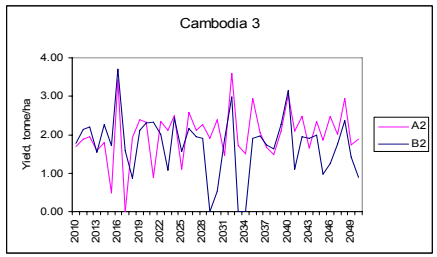



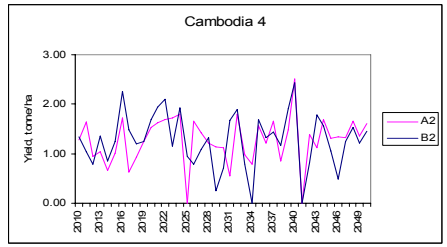



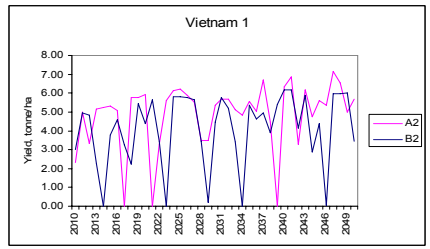



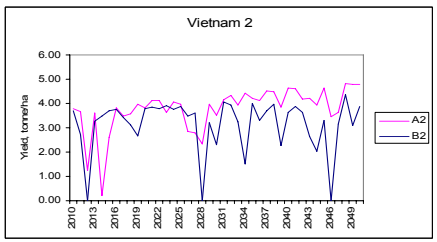



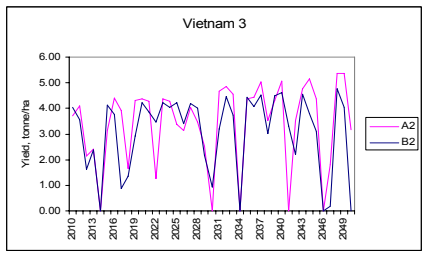



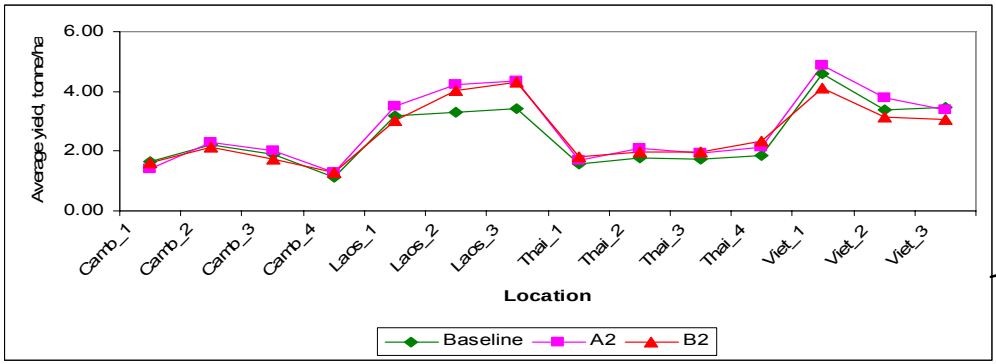



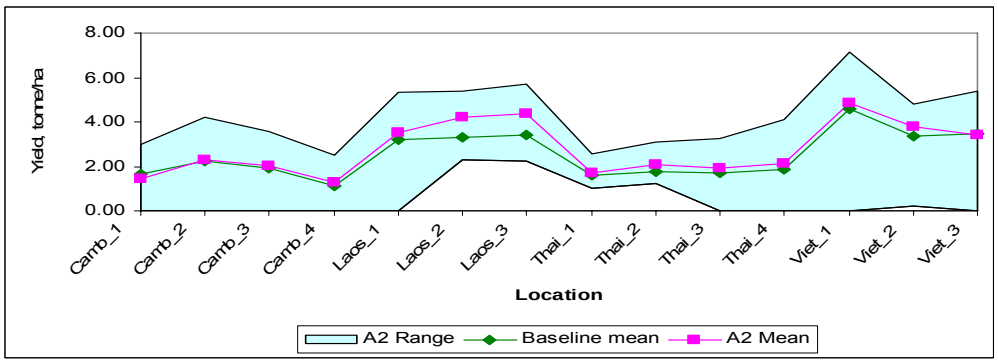




For some location there was no harvest of crops for several years during the simulation period

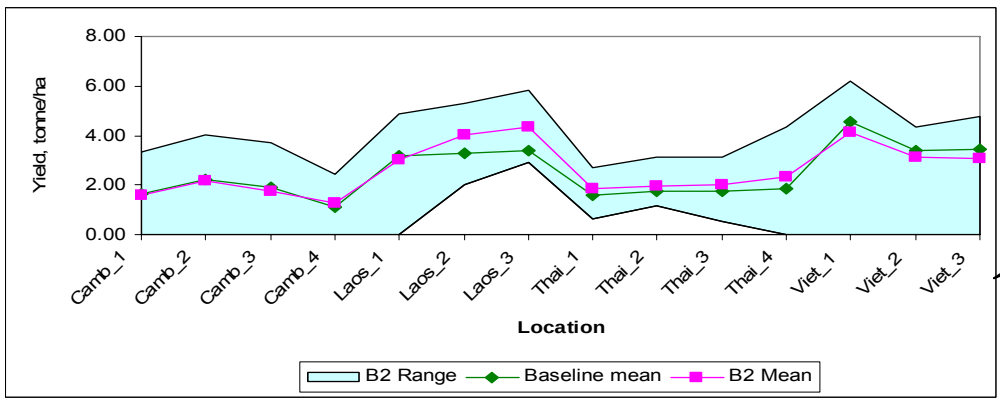
# Results – variation in yield of rainfed rice




Comparsion of baseline average yield with A2 and B2 average

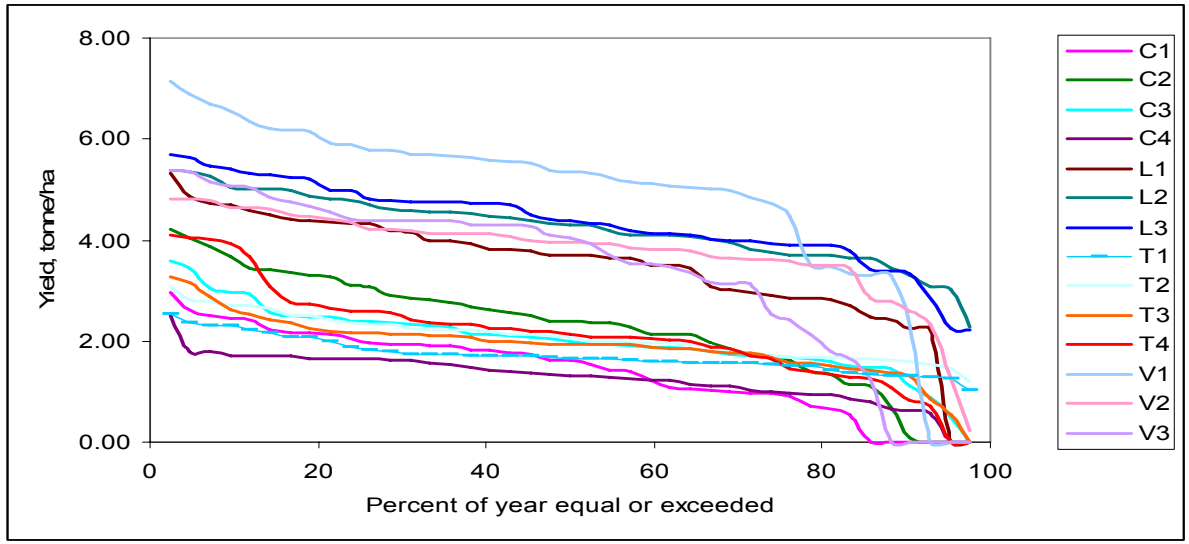



A2 range

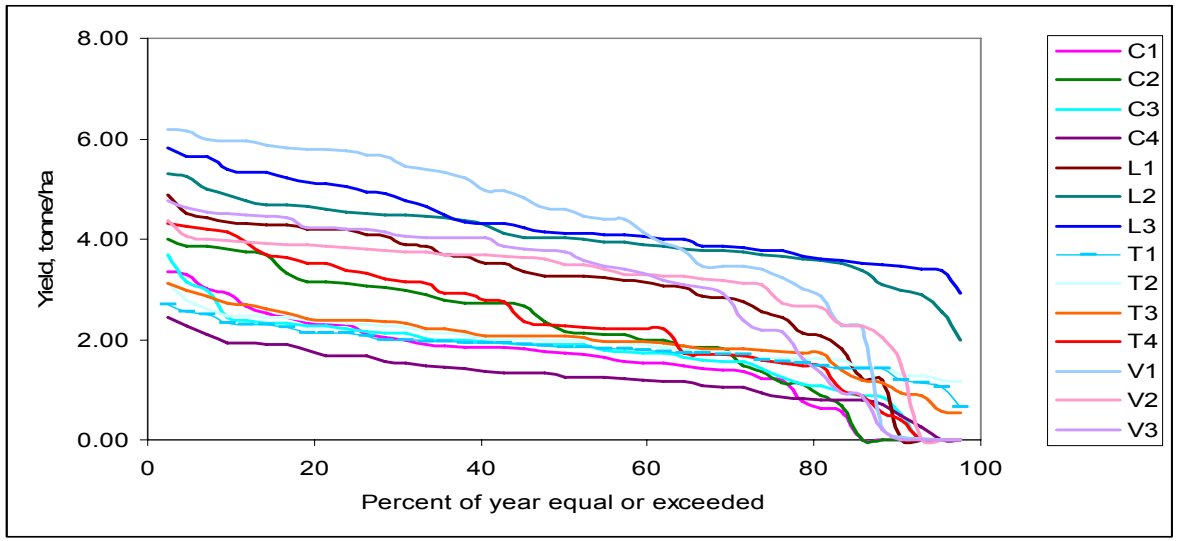



B2 range

# Results – probability of yield




A2



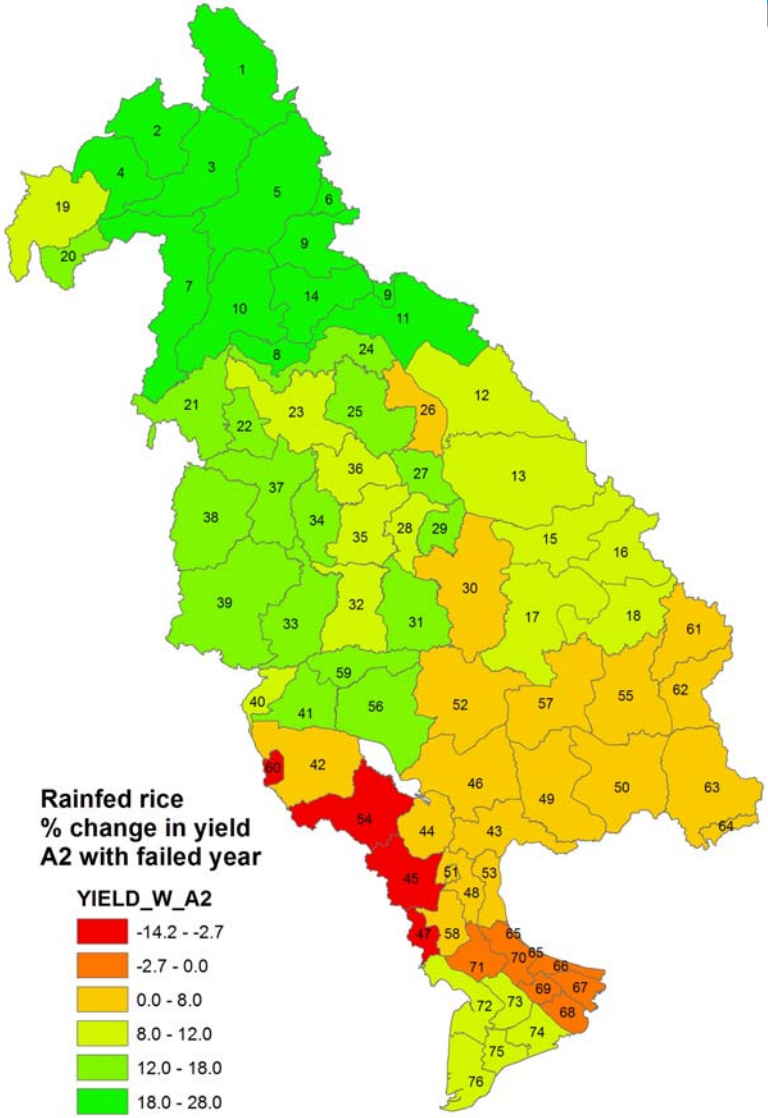

B2

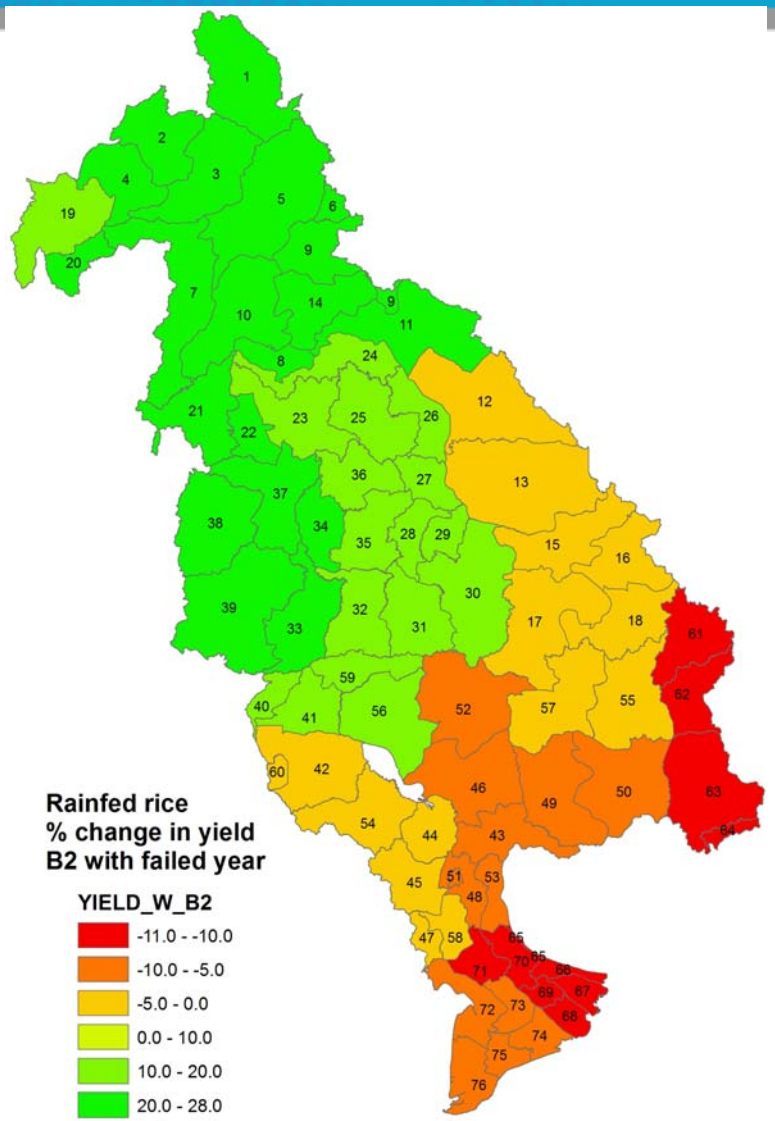
# Results – change in average yield for the scenarios compared to the baseline

| Site | Province | Change (%) from the baseline condition with failed year | | | | | |
|---|---|---|---|---|---|---|---|
| | | Rainfall, A2 | Rainfall, B2 | With failed year | | Without failed year | |
| | | | | Yield, A2 | Yield, B2 | Yield, A2 | Yield, B2 |
| L1 | Savannakhet | 23.4 | 14.1 | 10.3 | **-4.3** | 16.0 | 6.0 |
| L2 | Vientiane Municipality | **-12.2** | **-3.3** | 28.1 | 21.9 | 28.1 | 21.9 |
| L3 | Oudomxay | **-7.9** | **-10.6** | 27.6 | 26.6 | 27.6 | 26.6 |
| T1 | Ubon Ratchathani | 2.9 | **-0.8** | 7.7 | 15.1 | 7.7 | 15.1 |
| T2 | Sakon Nakhon | 14.3 | 5.1 | 17.6 | 11.4 | 17.6 | 11.4 |
| T3 | Roi Et | 17.2 | 11.2 | 10.8 | 15.1 | 13.6 | 15.1 |
| T4 | Nakhon Ratchasima | 31.5 | 30.8 | 16.5 | 27.7 | 22.5 | 37.8 |
| C1 | Kampong Speu | **-16.4** | **-15.6** | **-14.2** | **-2.9** | 0.6 | 13.7 |
| C2 | Battambang | 12.7 | 12.2 | 2.7 | **-3.0** | 10.8 | 13.7 |
| C3 | Kratie | **-1.3** | **-0.6** | 6.3 | **-8.4** | 9.0 | **-1.1** |
| C4 | Siem Reap | 3.5 | 5.0 | 14.6 | 14.5 | 20.5 | 20.3 |
| V1 | Gia Lai | 11.3 | 2.8 | 6.4 | **-10.1** | 14.8 | **-5.5** |
| V2 | Kiên Giang | **-10.9** | **-9.7** | 11.9 | **-6.8** | 11.9 | 0.6 |
| V3 | Đồng Tháp | **-8.8** | **-7.6** | **-1.6** | **-11.0** | 12.1 | **-1.4** |

- Yield increases in A2 scenario for all sites except two
- In B2 scenario, in general yield decreases in Cambodia and Vietnam
- Yield increase is higher in A2 than that of B2
- For few location (eg. L1 and V2) yield increase in A2 and decreases in B2

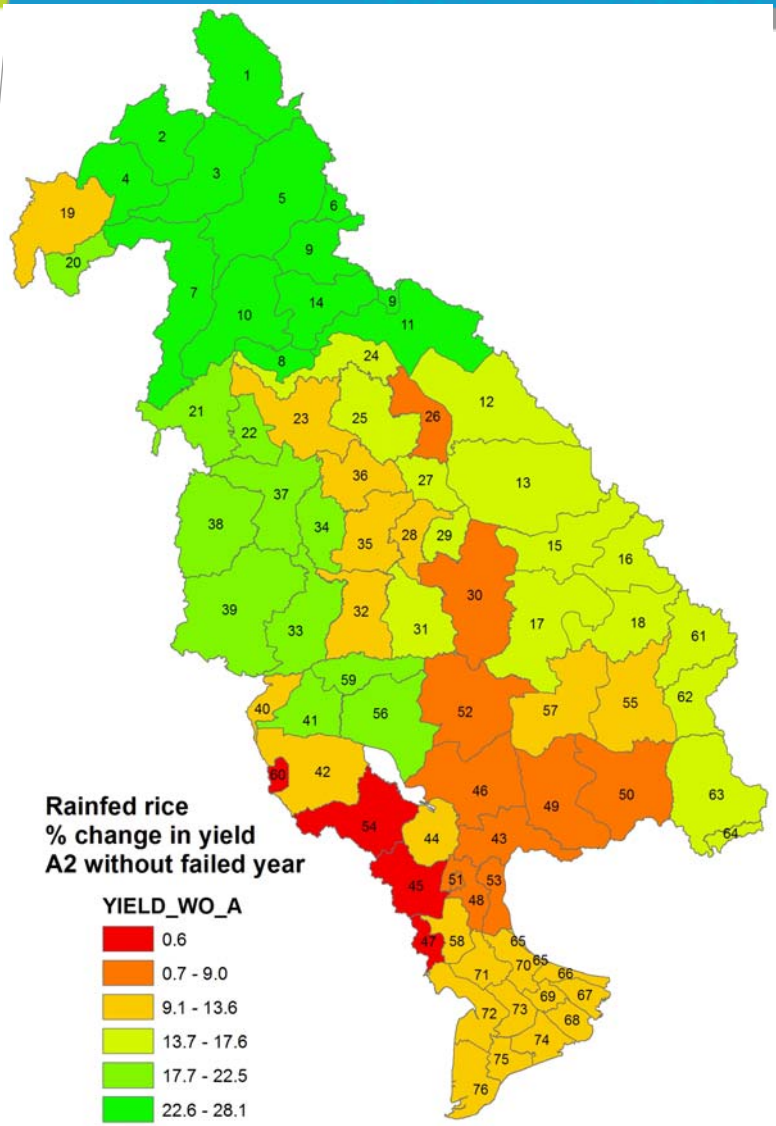
# Results – change in average yield (up-scaling with failed year)

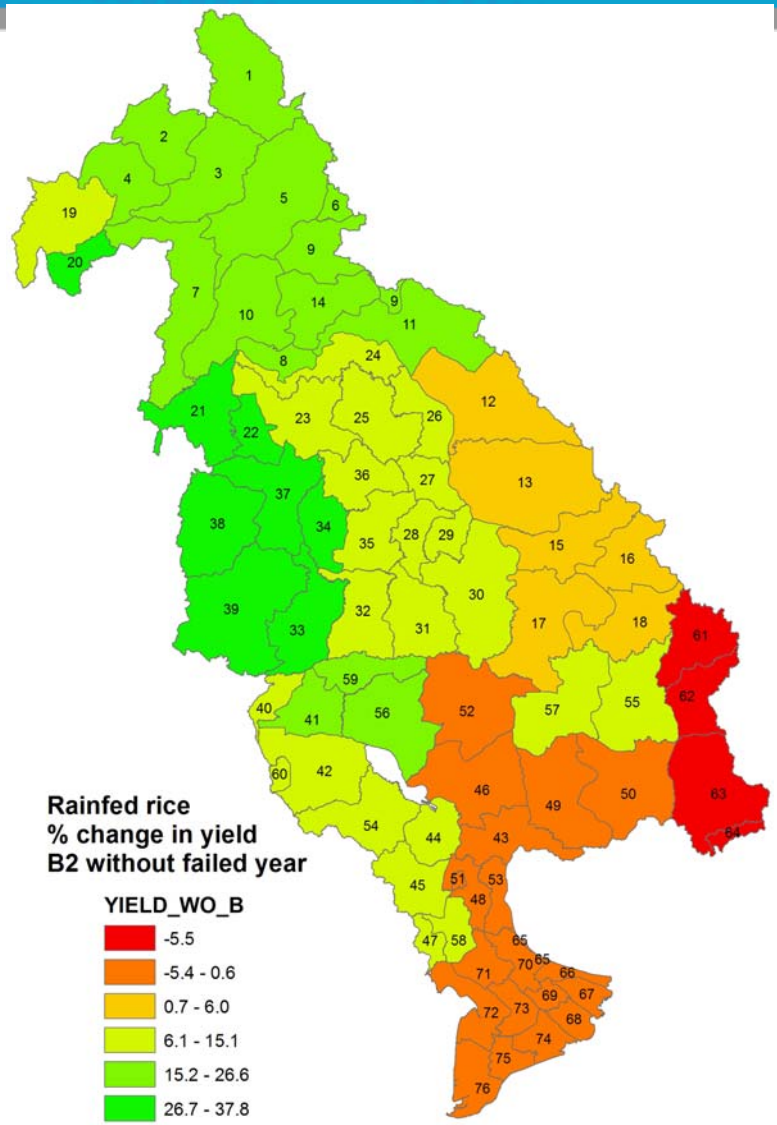


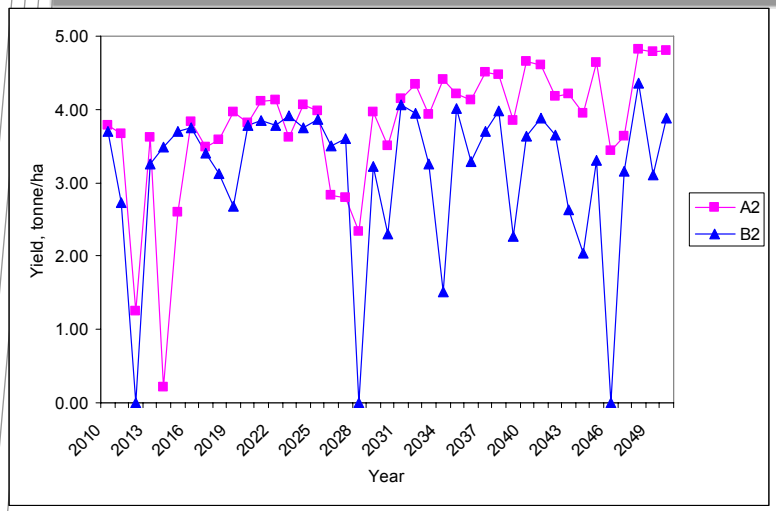

MRC CSIRO

# Results – change in average yield (up-scaling without failed year)

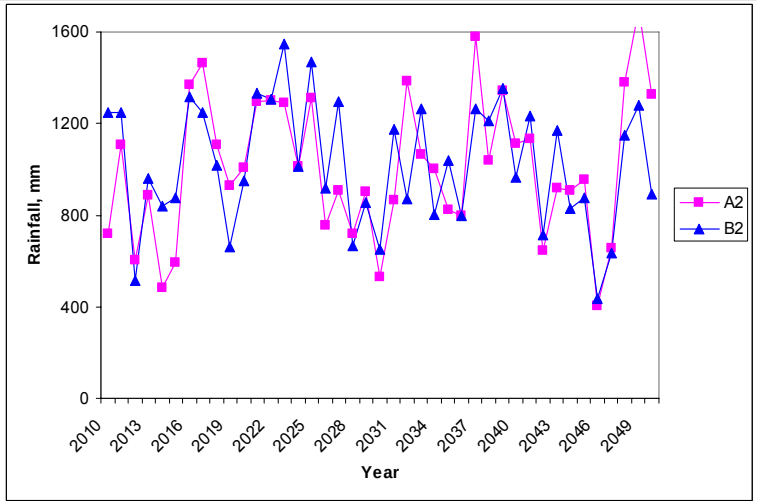


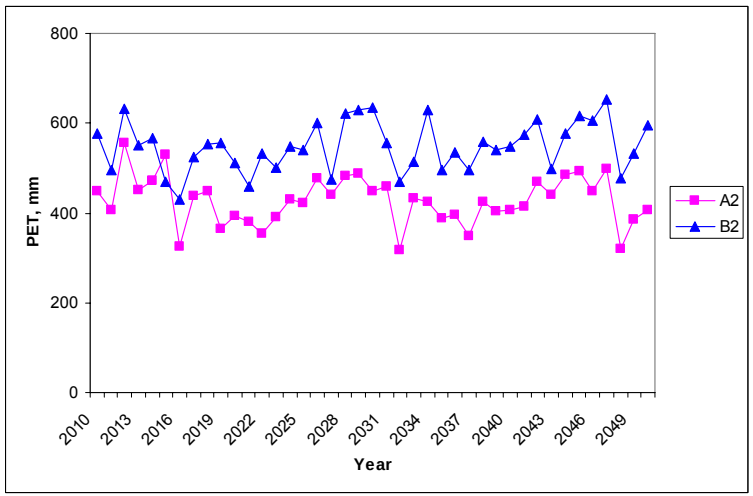
# Results – why yield is 12% higher in A2 and 7 % lower in B2 for location V2 (Upper Mekong Delta)



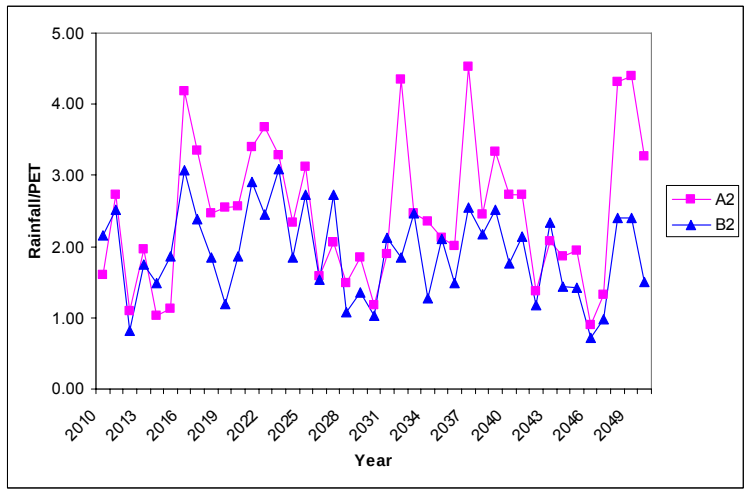

Yield




Rainfall




PET




Rainfall/PET

MRC

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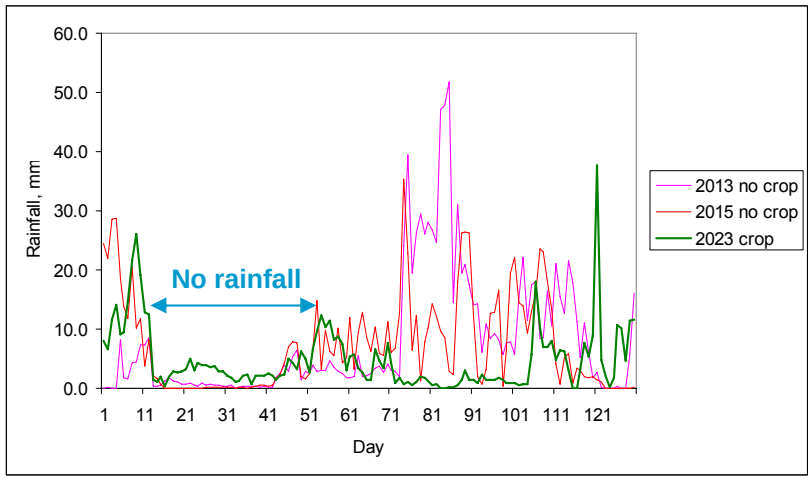
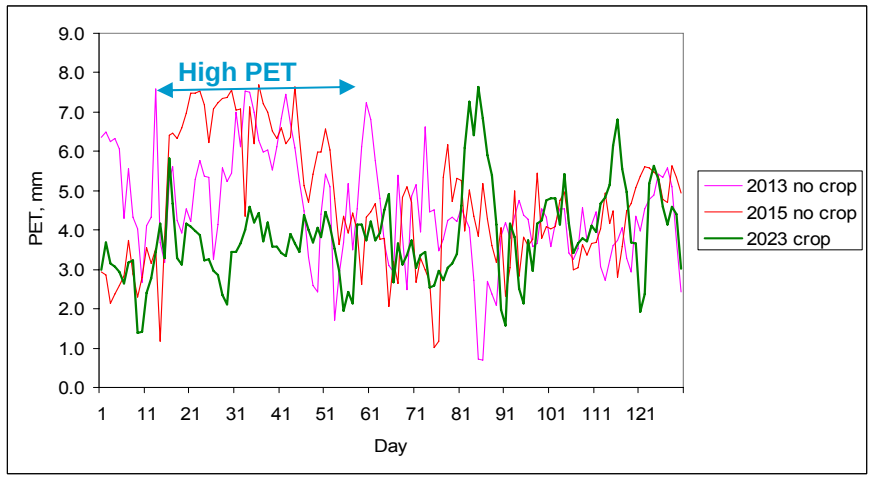
# Results – No yield with much higher growing season rainfall

Site L1, Scenario A2

| Year | Rainfall, mm | PET, mm | Yield, tonne/ha |
|---|---|---|---|
| 2013 | 1025 | 588 | 0.00 |
| 2015 | 952 | 608 | 0.00 |
| 2023 | 630 | 499 | 3.44 |




Daily rainfall




PET

- For about a month there was no rainfall in 2013 and 2015 while the PET was very high, so crop died during this period. Though there was lot of rainfall afterwards.
- In 2023, rainfall was low so was PET but crop did not suffer severe drought.
- While total amount of rainfall is important, the distribution of rainfall is equally important for crop growth.

# Conclusions so far…..

- It is likely that yield will not be affected by the climate change for most part of the basin (does not consider extreme event such as flood, storm, cyclone damage, etc.)
- There is potential to increase yield particularly in Laos and Thailand
- Yield increase is higher in A2 scenario
- The trend of the results is grossly similar to that of the other studies (Eastham et al., 2008; Chinavanno 2004; SEA START RC, 2006; IRRI, 1995)

# What is next - rainfed rice

- Run the model by changing the planting date by two weeks forward and backward and compare the results
- Reduce fertilizer stress by some percentage and compare the results
- Use supplementary irrigation
- Literature suggest high CO2 concentration increases rice yield – test for the Mekong
- More?

# What is next – other crops & food security

- Consider other crops such as irrigated rice, maize, sugarcane, etc. (no of crops depends on the time and resources)

- Analysis of basin overall food security considering future population growth

# What is next - fish

1. Capture:
    1. flow response functions of production vs flow - very few studies show this
    2. Expert judgement based on fish - river ecology and flow changes
2. Aquaculture - primarily driven by policy and economics - not affected by climate change?

# Climate change in the Mekong

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