Climate Change Impacts on Agriculture Water Use in the LMB

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Mekong River Commission Secretariat
Outline

- Agriculture in LMB
- Future change in demand and supply of food products from agriculture
- Influence of socio economic development on future agriculture
- Impacts of climate change in agriculture
- Possible adaptation measures in agriculture
1. Agriculture in LMB

- Agricultural contribution to GDP has been declining but still large.
- Agriculture is the first point of intervention in raising living standards, improving livelihoods and mitigation poverty.
Agriculture in LMB

- High water level in wet season and low in dry season
- Agricultural area is limited by floods and droughts
- Raifed rice cropping is dominant in NE Thailand, Laos and Cambodia
- Area of irrigation in Mekong Delta is by far the largest in LMB
- Irrigation is required for dry season
## Cropping pattern for Laos, Cambodia and NE Thailand

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<tr>
<th>Crop</th>
<th>Jan</th>
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### Mekong River Commission
2nd Mekong Climate Change Forum

6 – 8 October 2014
Siem Reap, Cambodia
### Cropping pattern for Mekong Delta

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#### Growing period (days)

- **Deepwater rice (no longer cultivated)**: 250-300
- **Spring/summer rice**: 95-110
- **Winter/spring**: 95/110
- **Summer/autumn rice**: 110-120
- **Coastal area rice**: 95-110
- **Coastal rice**: 95-100
- **Continuous rice**: 95-100
- **Upland crops**: 365

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2. Future change in demand and supply of food products from agriculture

- Growth rate of population is still high.
- Food demand will increase.
- Irrigation development will play an important role in increasing production to meet increased food demand in future.
- One key factor limiting aspirations of Cambodia and Lao PDR to raise food production is water resources, infrastructure and management capacity of dry season irrigation.
3. Influence of socio economic development on future agriculture

- Problems in food security occur at local levels due to flooding or poor road networks and post harvest infrastructure.
- Varied demographic changes take place and more are expected in terms of migration away from rural areas.
- The area planted in dry season in NE Thailand is limited by availability of labor.
- Industrialization and water pollution may have negative impacts on future agriculture.
4. Impacts of climate change in agriculture

- Analyze impact of climate change on rain-fed and irrigated rice farming in LMB based on past weather records, IPSS scenario, and MRC’s BDP scenario and hydrological models.

- Stochastic analysis of rain-fall and evapo-transpiration in LMB under climate change scenario.

- Simulation of water allocation to irrigation sector under climate change and BDP-20year plan scenario.

- Time series simulation of soil moisture and on-farm water storage at several LMB locations under climate change scenario, to analyse implication for rice farming.
SCENARIO AND MODEL

- CLIMATE & DEVELOPMENT SCENARIOS
  - BASELINE: BDP baseline scenario figures + observed weather data of 1985-2000
  - CLIMATE CHANGE: BDP 20 yr plan* + Climate change B2 (2010-2050)
    * 11 LMB mainstream dams & 30 tributary dams, irrigation & water supply

- MODEL: SWAT (Soil and Water Assessment Tool)
  IQQM (Integrated Water Quantity and Quality Model)
  ISIS (a Hydrodynamic model)

- OUTPUTS
  - Annual Rainfall, ETc & Crop Water Requirement in the LMB
  - Daily and monthly RF, ETc, & CWR at 270 sub-basins
  - Expected water allocation for irrigation schemes
MRC MODELS
CLIMATE CHANGE SCENARIO

BASIN WIDE IMPACT & ITS IMPLICATION
ANNUAL RAINFALL
Cumulative Frequency Distribution

Annual Rainfall (LMB)
ANNUAL RAINFALL

10% Exceedance* ~ Cumulative Probability 10%

* Annual rainfall value of the lowest 10% of 15 records and 40 simulated years respectively; approximation of the value for cumulative probability of 10%.
ANNUAL RAINFALL

- Changes between BL and CC-B2 is not significant.
- Standard deviation increases by 13% or 68mm.
- 10% exceedance value decreases by 8%, 87mm.
- 90% exceedance value increases by 6%, 146mm.
ANNUAL RAINFALL

- Harsher droughts and floods are expected in the future.
- Drought once in 10 years under BL will come once in 7 years under CC-B2.
- More severe flood is expected in future.
**ANNUAL ETc***
Cumulative Frequency Distribution

* ETc = ETo *Kc. ETo = PET. PET: Evapotranspiration rate calculated with Penman-Monteith Equation from solar radiation, humidity, temperature, and wind. Kc: crop coefficient

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* Clear increase
ANNUAL ETc

90% Exceedance ~ Cumulative Probability 90%
ANNUAL ETc

- Increase in average annual Etc in the whole LMB is only 6% or 93mm.
- 90% exceedance value increases by 11% or 177mm.
- More remarkable changes are found in once in 10 years drought than in average.
- Drought might damage to crops.
WATER ALLOCATION FOR IRRIGATION*
Cumulative Frequency Distribution

**Average Water Allocation at the Field Level**

![Diagram showing cumulative frequency distribution for average water allocation at the field level. The x-axis represents cumulative frequency (0% to 99%) and the y-axis represents water allocation (in mm). Two lines are shown: Baseline and CC-B2. The Baseline line is represented by a blue line, and the CC-B2 line is represented by a red line. The diagram highlights significant increase.]

*Estimated amount of water allocated to irrigated fields in the IQQM scenario analysis shown in mm.*

**Graphical Notes:**
- Significant increase!
- Is higher CWR met in current schemes??
- Do all projects in BDP20YDEV receive enough water??
WATER ALLOCATION FOR IRRIGATION

90% Exceedance ~ Cumulative Probability 90%
Difference between Baseline and Climate Change Scenarios

Agricultural Water Use in the LMB (a)

The Day Accumulated rainfall >500mm
Change, Baseline vs CC-B2

average

90% exceedance
WATER ALLOCATION FOR IRRIGATION

- Water allocation for irrigation increased by 12% or 113mm.
- 90% exceedance is also increased by 8% or 187mm.
- Irrigation systems will be forced to supply more water.
- Operation costs, particularly, for pumping irrigation schemes may increase.
- Increased irrigation demand results in water shortage.
- Decline in reliability of irrigation systems, inducing farmers’ uncontrolled water intake or refusal of irrigation fee payment.
SIMULATIONS AT SELECTED SUB-BASINS

IMPACT ON ON-FARM WATER MGMT
# SELECTED SUB BASINS

<table>
<thead>
<tr>
<th>sub-Basin</th>
<th>Province</th>
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<tbody>
<tr>
<td>213</td>
<td>Chiang Rai</td>
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<td>427</td>
<td>Vientiane</td>
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<td>411</td>
<td>Khammuane</td>
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<tr>
<td>713</td>
<td>Khon Kean</td>
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<tr>
<td>604</td>
<td>Stung Treang/Champasak</td>
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<td>913</td>
<td>Kampong Chhnang</td>
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<td>Dac Lak</td>
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<td>1018</td>
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MODELING OF ON-FARM STORAGE

\[
OFS(i) = OFS(i-1) - ETo(i) \times Kc - S(i) + R(i)
\]

Where:
- \( OFS \): On Farm Storage (mm),
  - \( 0 < OFS < 200 \text{mm} \),
- \( ETo \): Evapo-transpiration (mm/day)
- \( Kc \): Crop factor for rice
- \( R \): Rainfall (mm)
- \( S \): Seepage, (2 mm/day)
## SELECTION OF REFERENCE YEAR

- Equivalent to 10 yr Return Period -

<table>
<thead>
<tr>
<th>Sub Basin</th>
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<tbody>
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<td>Max DS</td>
<td>ET</td>
<td>Crop Req</td>
<td>Rain</td>
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<td>13</td>
<td>453</td>
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Number of Days OFS < 0mm

Chieng Lai (#213)
Period: June to Sep

Chieng Lai (#213)
Baseline (1990)

Chieng Lai (#213)
CC-B2 (2027)

Mekong River Commission
2nd Mekong Climate Change Forum
6 – 8 October 2014
Siem Reap, Cambodia
FINDINGS

- Changes in average rainfall is small, but annual deviation becomes larger, which causes water shortage in reservoirs and tributaries more often.

- ET will increase in both average and 90% cumulative probability, which raises irrigation demand.

- Higher irrigation demand will increase operation costs in such irrigation systems that depend on pumps.

- The irrigation systems that depend on tributaries and reservoirs may face shortage in water resources due to higher irrigation demand and occasionally lesser available water in rivers and reservoirs.

- Dates for planting rain-fed rice tend to be delayed.

- Longer dry spells during the wet season will raise the risk of drought damage in rain-fed rice.
RICE SUPPY AND DEMAND ANALYSIS

- Climate change will depress wet season rice production in Cambodia and the Delta.
- Climate change will depress dry season rice in the Delta and NE Thailand.
- Climate change is expected to increase farm prices of rice in Cambodia, Viet Nam, and Thailand.
- Climate change will weigh on livelihood of rice consumers, especially poor rural populations.
5. Possible adaptation measures in agriculture

- **Where Rainfall > ET**
  - Develop and select such varieties that grow in a shorter period and are resistant against both inundation and longer dry spells
  - Adjust the planting day
  - Increase the height of paddy levees to store more rainfall

- **Where Rainfall < ET**
  - Develop supplementary irrigation systems where currently no irrigation service is available despite the potential for water resources development
  - Improve irrigation efficiency where currently irrigated
  - Diversify from rice to other crops that require less water and have higher value
Thank you