Short introduction to WP1:
“Climate variability and seasonal prediction”

Patrick Laux
Overview of envisaged working tasks

**WT1.1:** Quantification and predictability of climatic parameters affecting rice growth at sensitive development stages

**WT1.2:** Long term regional climate simulations to study the impact of LUC/LCC on climate

**WT1.3:** Quantification of climate induced uncertainties for future rice production in EA
Seasonal climate predictions: State-of-the-art

Problems for end-users:

- Sensitivity of crops to climatic variability is modulated at intraseasonal time scale and farmers mostly depend on local-scale climatic variability

- Tercile information not sufficient and no answers to intraseasonal issues

- Limited predictive skill: almost no skill for JFM/AMJ, and moderate skill for OND seasonal resolution may mask predictability if intraseasonal rainfall not matched the modulation of predictability
WT 1.1: Specific Objectives

- To analyze the intraseasonal modulation of predictable signals of rainfall jointly with the spatial coherency of the predictable signal (prerequisite for seasonal prediction)

- To quantify the predictability of extreme events which severely affect rice growth

- To analyze the predictability crucial intraseasonal features for different rice varieties at different spatiotemporal scales
  - Start of wet season to determine suitable planting windows for rice
  - Intraseasonal probabilities of dry spells
  - etc.
Methods

- 2-tiered forecast system (at IRI):
  - Forecasts of global tropical SSTs
  - Application for the suite of atmospheric models that respond to SST forcing
    → surface temperature and precipitation anomaly patterns

- Predictor screening (other than SST) for model improvement

- Statistical analysis to assess the level of predictability of predictand (jointly with coherency of the predictand)
Milestone: A prediction system …

Current Seasonal Predictions

Regional to global / Seasonal

End users

Local scales / Daily

NOISE

Improved Intraseasonal Predictions

RICE-EA Workshop Garmisch-Partenkirchen 13.-15. June 2012
Milestone: ... accounting for vulnerability of rice (varieties) during development

Critical temperatures for the development of rice plant at different growth stages

<table>
<thead>
<tr>
<th>Growth stages</th>
<th>Critical temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Germination</td>
<td>16–19</td>
</tr>
<tr>
<td>Seedling emergence</td>
<td>16</td>
</tr>
<tr>
<td>Rooting</td>
<td>7–12</td>
</tr>
<tr>
<td>Leaf elongation</td>
<td>9–16</td>
</tr>
<tr>
<td>Tillering</td>
<td>15</td>
</tr>
<tr>
<td>Initiation of panicle</td>
<td>-</td>
</tr>
<tr>
<td>primordia</td>
<td>-</td>
</tr>
<tr>
<td>Panicle differentiation</td>
<td>15–20</td>
</tr>
<tr>
<td><strong>Anthesis</strong></td>
<td>22</td>
</tr>
<tr>
<td>Ripening</td>
<td>12–18</td>
</tr>
</tbody>
</table>

Vulnerability: 1-2 hours of high T at anthesis result in large fraction of grain sterility!

Overall objectives:
Optimize planting dates of rice (varieties) to avoid crop failure & stabilize food security!

Assessing vulnerability also for water availability, radiation, ...

Yoshida, 1978
Overview of envisaged working tasks

WT1.1: Quantification and predictability of climatic parameters affecting rice growth at sensitive development stages

WT1.2: Long term regional climate simulations to study the impact of LUC/LCC on climate

WT1.3: Quantification of climate induced uncertainties for future rice production in EA
Regional climate predictions: State-of-the-art

Rationale: High spatiotemporal resolution climate information required for agricultural impact studies (e.g. future rice productivity, future suitability areas for rice growing)

Problems for CC impact modelers:

- Description of the land surface not sufficient usually time-invariant, i.e. static LU maps

- Poor representation of lateral (subsurface and overland) fluxes: the process formulations of land surface schemes describe the vertical exchange of energy and water fluxes but no lateral transport is possible

Purely scientifically issue: RCMs do not explicitly account for the effects of the mixing ratios of greenhouse gases (GHGs) other than CO₂
WT 1.2: Specific Objectives

- To identify the spatial “target” resolution, i.e. to which resolution is DSS giving additional information for impact studies?

- To analyze the impact of GHG induced changes, separately for different greenhouse gases, and the impacts induced by LUC/LCC on climate

- To analyze the impacts of small scale lateral water fluxes at surface and subsurface on atmosphere, and thus, to analyze the feedback of LUC/LCC on precipitation patterns
Methods

1.) Regional Climate Modeling (WRF) to provide input e.g. for hydrological and agricultural impact studies

- P, T, RH, v, \( R_n \)

Hydrology
\( \Delta x \approx 1\text{km}...100\text{m} \)

GCMs
Atmosphere & Ocean
\( \Delta x \approx 300...100\text{km} \)

RCMs
\( \Delta x \approx 50...10\text{km} \)

2.) Model improvement (lateral water and energy fluxes)

- Explicit saturated subsurface flow
  \( \Delta t \approx 6\text{sec} \) for
  \( \Delta x \approx 100\text{m} \)

- Explicit diffusive wave overland flow

3.) Implementation dynamic LUC/LCC

- Supervised/unsupervised classification of RS imagery
- LUC/LCC scenarios
Milestone:

RCM simulations for EA with improved model compartments
30-year time slice from 1971-2000 (baseline) & two future periods (2021-2050, 2071-2100)
→ using identified target resolution
→ accounting for LUC/LCC & GHG induced changes
→ accounting for lateral water and energy fluxes

Overall objectives:

Improved high resolution climate data for EA to provide more accurate data for RICE-EA impact modelers (hydrological and crop yield modelers)
Overview of envisaged working tasks

**WT1.1:** Quantification and predictability of climatic parameters affecting rice growth at sensitive development stages

**WT1.2:** Long term regional climate simulations to study the impact of LUC/LCC on climate

**WT1.3:** Quantification of climate induced uncertainties for future rice production in EA
CC/CV uncertainty estimation: State-of-the-art

Problems for end-users:

- DDS very expensive (computing resources) → Usually: 1 GHG scenario, 1 GCMs, 1 RCM
- Uncertainties increase with increasing modeling chain (GHG scenario, GCM, RCM, etc.)
WT 1.3: Specific Objectives

- Statistically downscale meteorological variables (P, T, R) using a *multi-model & multi scenario* approach

- To quantify uncertainties in deriving hydrometeorological variables important for rice production in EA arising from different GCMs, emission scenarios, and ESDS approaches

- To judge the probability of the RCM projection derived in WT1.2
Methods

- Different ESDS methods:
  - *Expanded Downscaling* (XDS, e.g. Bürger 1996, 2002)
  - *Multi-Objective Fuzzy Rule-Based Classification* (MOFRBC, Bárdossy, 1995)

- Statistical analysis of the ESDS results to derive PDFs of crucial variables for rice growth in EA for the past and future time slices

- EV Theory to assess probability (change) of rare events

![Graphs showing probability of occurrence and changes in mean, mean and variance, and variance](image)
Milestone:
Derive & provide RICE-EA partners with PDFs of crucial variables for rice growing in EA to be used for CC impact analysis

Overall objectives:
Quantification of uncertainties for future rice production in EA related to the climate drivers
To be discussed

- Centralized Database for RICE-EA consortium
- Missing partner for supervised/unsupervised classification of RS imagery to derive LUC/LCC scenarios
- Suggestions for RCM simulations (GCM, GHG scenario, which time slices, etc.?)
THANK YOU FOR YOUR ATTENTION
Global CO₂ emissions

Atmospheric CO₂ concentrations

Global warming

Regional temperature and rainfall changes

System responses to combined CO₂, temperature, rainfall and management changes