Impacts of climate change on rice, sugarcane, cassava and maize production in Thailand

by

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Consequences of CC on crop production

- Long term change in yield due to $\text{CO}_2$ and $T$
- Variability of yield due to climate extremes
Tools to derive the necessary information

- Crop model
  - Mechanistic and dynamic with 1 day time step
  - Input:
    Driving variables: daily weather
    System parameters: crop, soil and management

- GIS

Simulation specifications

- No pests and weeds
- Crop management as recommended by MOAC
Procedure

1. Defining boundary of the area planting each crop
2. Overlaying the area with soil and weather maps to obtain Simulation Mapping Units (SMU)
3. Simulate crop growth and yield in each SMU
4. Temporal and spatial analysis of the impacts
Defining crop area boundary

Rice growing area
Defining crop area boundary

Sugarcane growing area
Defining crop area boundary

Cassava growing area
Defining crop area boundary

Maize growing area
Soil group map
Weather grids 20x20 km.
ECHAM-PRECIS
Example:

Weather: 4 units

Soil: 2 units

Crop growing area

6 SMUs
Simulation Mapping Units

Rice SMU
Simulation Mapping Units

Sugarcane SMU
Simulation Mapping Units

Cassava SMU
Simulation Mapping Units

Maize SMU
Simulation of crop growth and yield

18,000 SMUs: soil-weather
120 years

Crop genetic coefficients
Crop management

Growth and yield in each SMU each year, ~2,160,000 dataset
Trend and variability of rainfed lowland rice KDML105 yield

Conclusions
- Trend 9% increases
- Temporal variation CV 14%
- Spatial variation CV 33%
Trend and variability of irrigated rice Suphanburi 1 yield

Conclusions
- Trend 12% decreases
- Temporal variation CV 14%
- Spatial variation CV 33%
Trend and variability of rainfed sugarcane K84-200 yield

Conclusions
- Trend 6% increases
- Temporal variation CV 18%
- Spatial variation CV 23%
Trend and variability of rainfed cassava Kasetsart 50 yield

Conclusions
- Trend 43% decreases
- Temporal variation CV 34%
- Spatial variation CV 33%
Simulation of crop growth and yield

Trend and variability of rainfed maize Suwan 1 yield

Conclusions
- Trend 15% decreases
- Temporal variation CV 41%
- Spatial variation CV 45%
Consequences of CC on crop production

- Long term trend of change in yield due to CO₂ and T is small, except cassava
- Temporal variability of yield due to weather extremes is obvious with cassava and maize
- Spatial variability is large and greater than temporal
Since spatial variation is large, questions

- Where are those hard hit areas by CC
- Timing and duration of the impacts
- How the areas change/displace with time
Information needed for adaptation

Relative rainfed rice yield to the mean of the country 1980-89
Rainfed rice where yield < 70% of the base year mean
Information needed for adaptation

Irrigated rice where yield < 70% of the base year mean

1980-89

2030-39

2090-99
Information needed for adaptation

Sugarcane where yield < 70% of the base year mean

1980-89

2030-39

2090-99
Information needed for adaptation

Cassava where yield < 70% of the base year mean

1980-89

2030-39

2090-99
Information needed for adaptation

Maize where yield < 70% of the base year mean

1980-89  
2030-39  
2090-99
To identify the timing of occurrence and duration, time series maps of affected area are overlaid.

3 maps yield 8 classes of the affected area:

Classes of impact $= 2^{\text{No. of maps}}$
Information needed for adaptation

Classes of the maize affected areas
Assessment of the CC impacts: Impact Factor

- magnitude
- area
- duration/frequency
- time of occurrence

Impact Factor = magnitude x affected area x duration x timing
## Impact Factor assessment of the rainfed rice area

<table>
<thead>
<tr>
<th>Class</th>
<th>% of total area</th>
<th>duration</th>
<th>Timing inverse of order</th>
<th>Impact Factor</th>
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</tr>
</tbody>
</table>

### Class 6: yield < 70% of mean, duration 20 years 2030-39 & 2090-99
Map of the class 6 of the affected rainfed rice area

Class 6
- yield < 70% of mean
- area 4%
- duration 20 years
- from 2030-39 & 2090-99
Information needed for adaptation

Map of the affected irrigated rice area with highest IF

Class 6
- yield < 70% of mean
- area 14%
- duration 20 years
- from 2030-39 & 2090-99
Information needed for adaptation

Map of the affected sugarcane area with highest IF

Class 2
- yield < 70% of mean
- area 12%
- duration 10 years
- From Present - 2029
Information needed for adaptation

Map of the affected cassava area with highest IF

Class 6
- yield < 70% of mean
- area 37%
- duration 20 years
- from 2030-39 & 2090-99
Information needed for adaptation

Map of the affected maize area with highest IF

Class 8
- yield < 70% of mean
- area 5%
- duration 30 years
- from present & 2090-99
Next steps

- casual analysis of the CC impact
- options for adaptation
Thank you