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 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

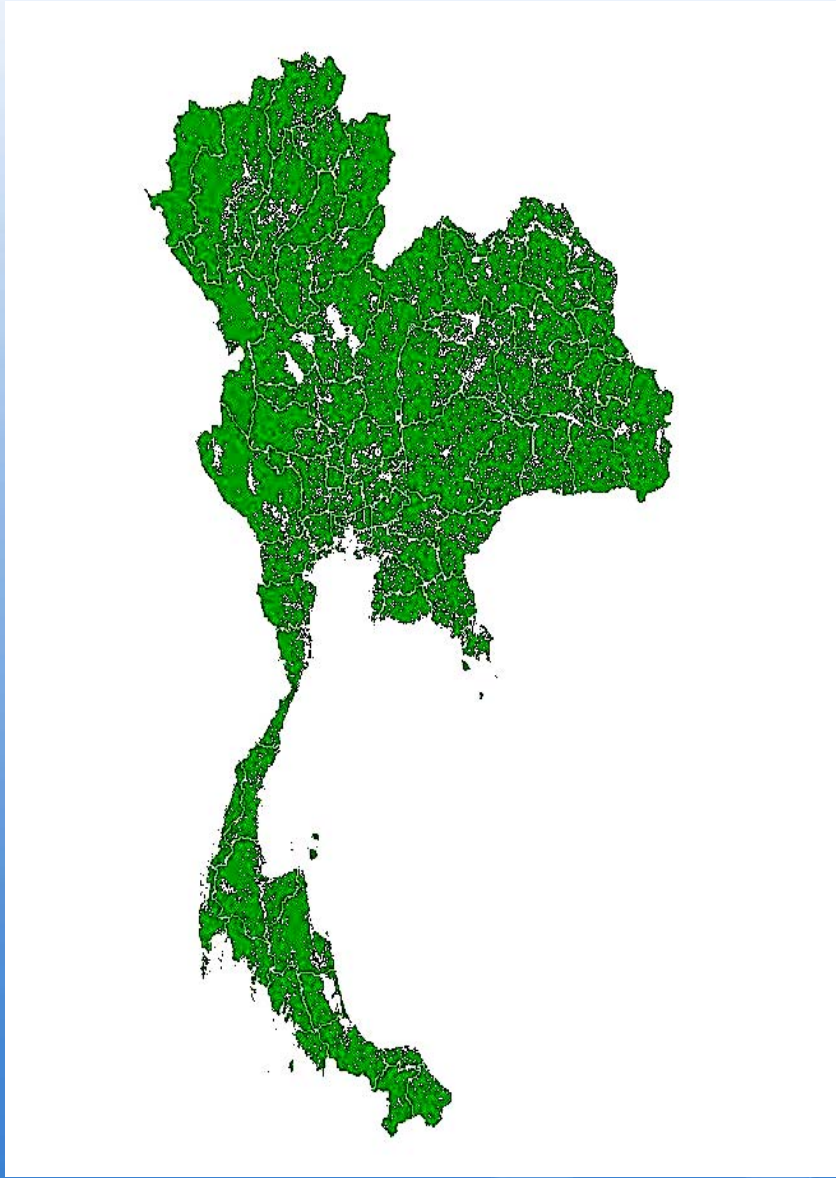
Simulation specifications

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

Procedure

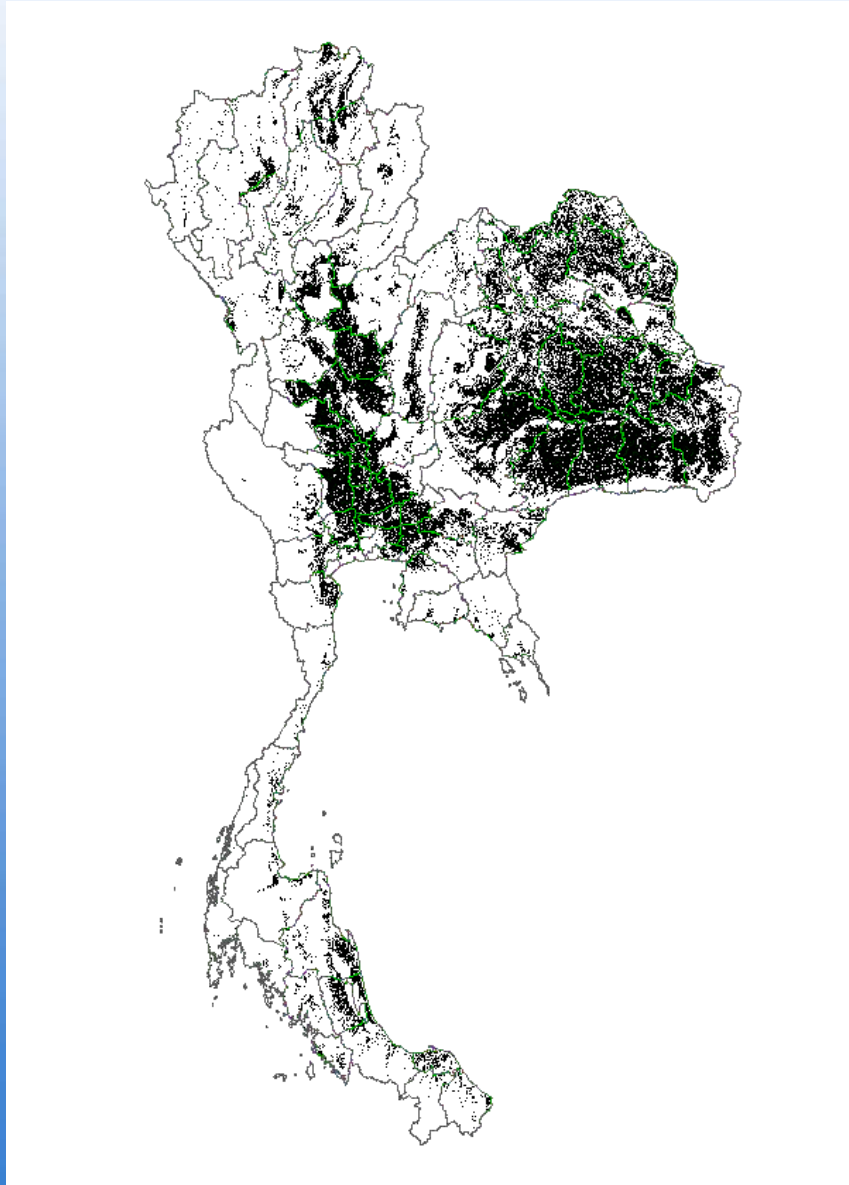
1. Defining boundary of the area planting each crop
2. Overlaying the area with soil and weather maps to obtain Simulation Mapping Units (SMU)
3. Simulate crop growth and yield in each SMU
4. Temporal and spatial analysis of the impacts

Defining crop area boundary



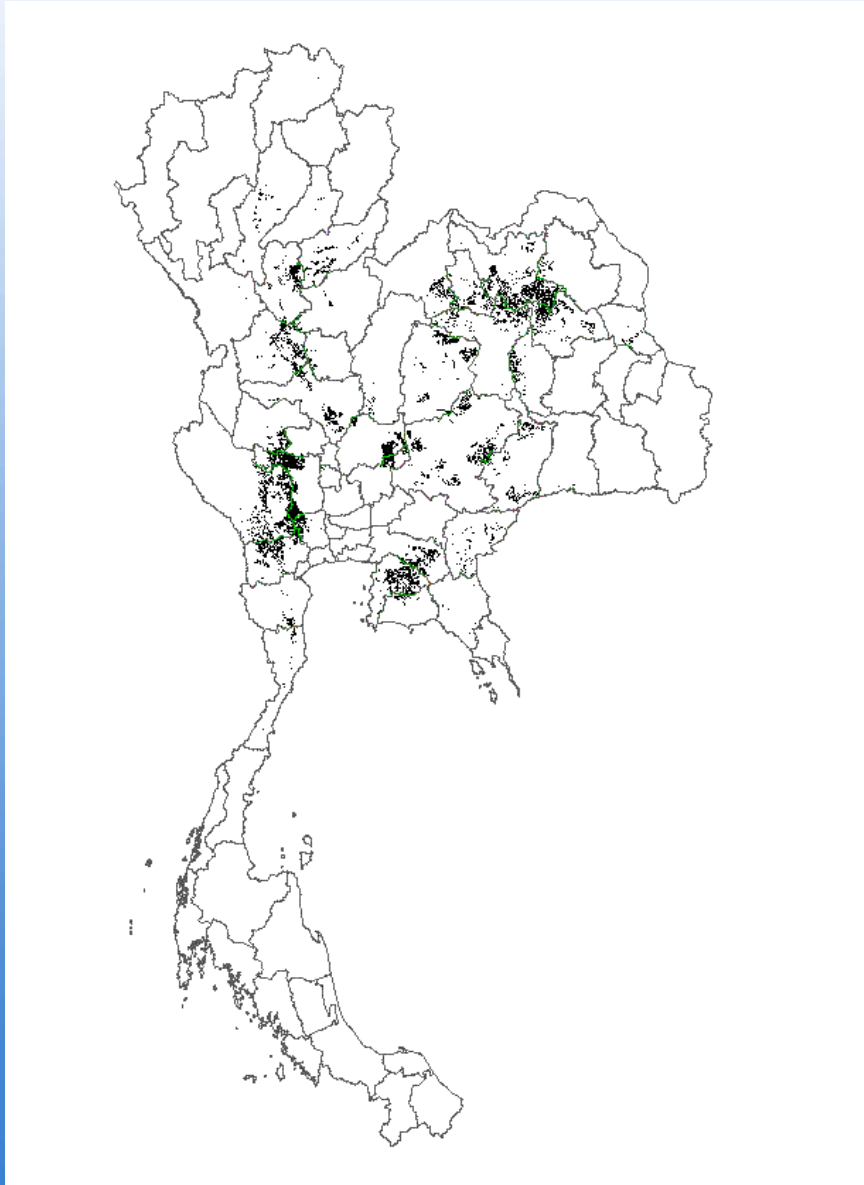
Land Use Map

Defining crop area boundary



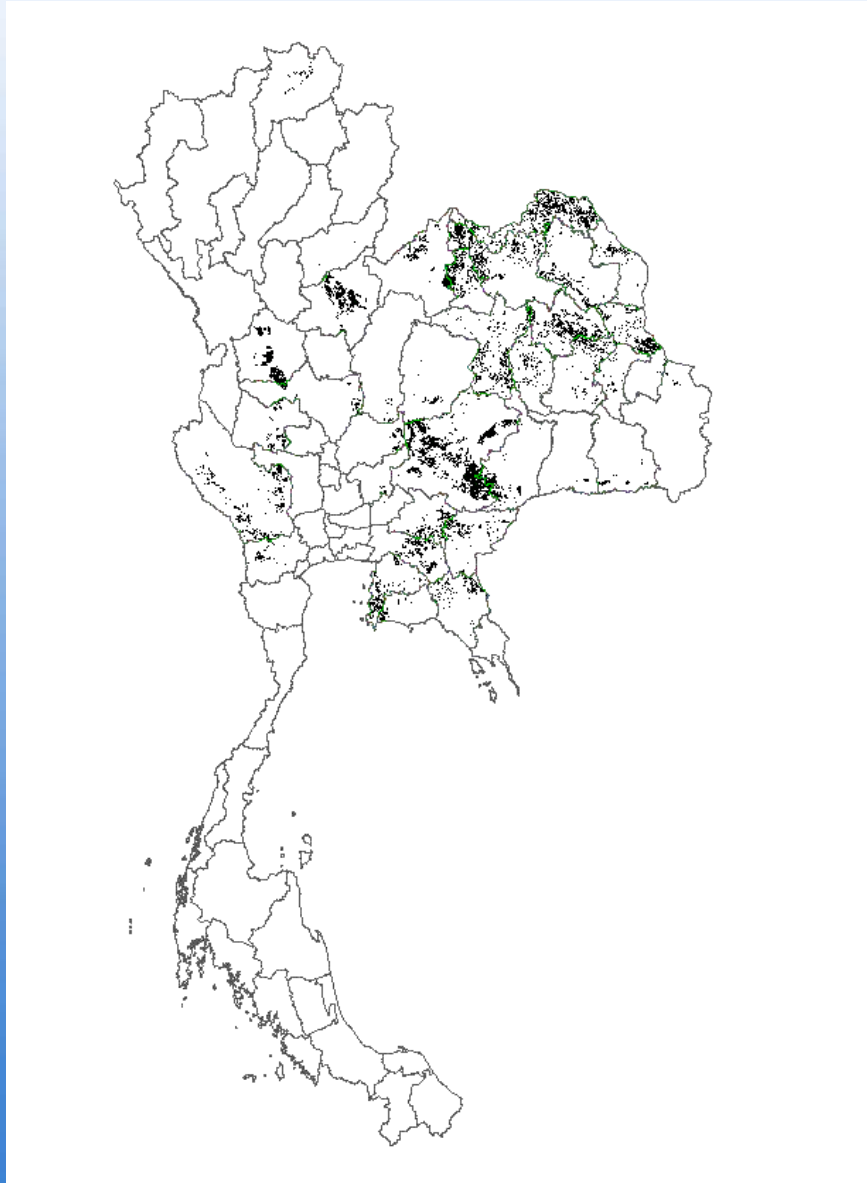
Rice growing area

Defining crop area boundary



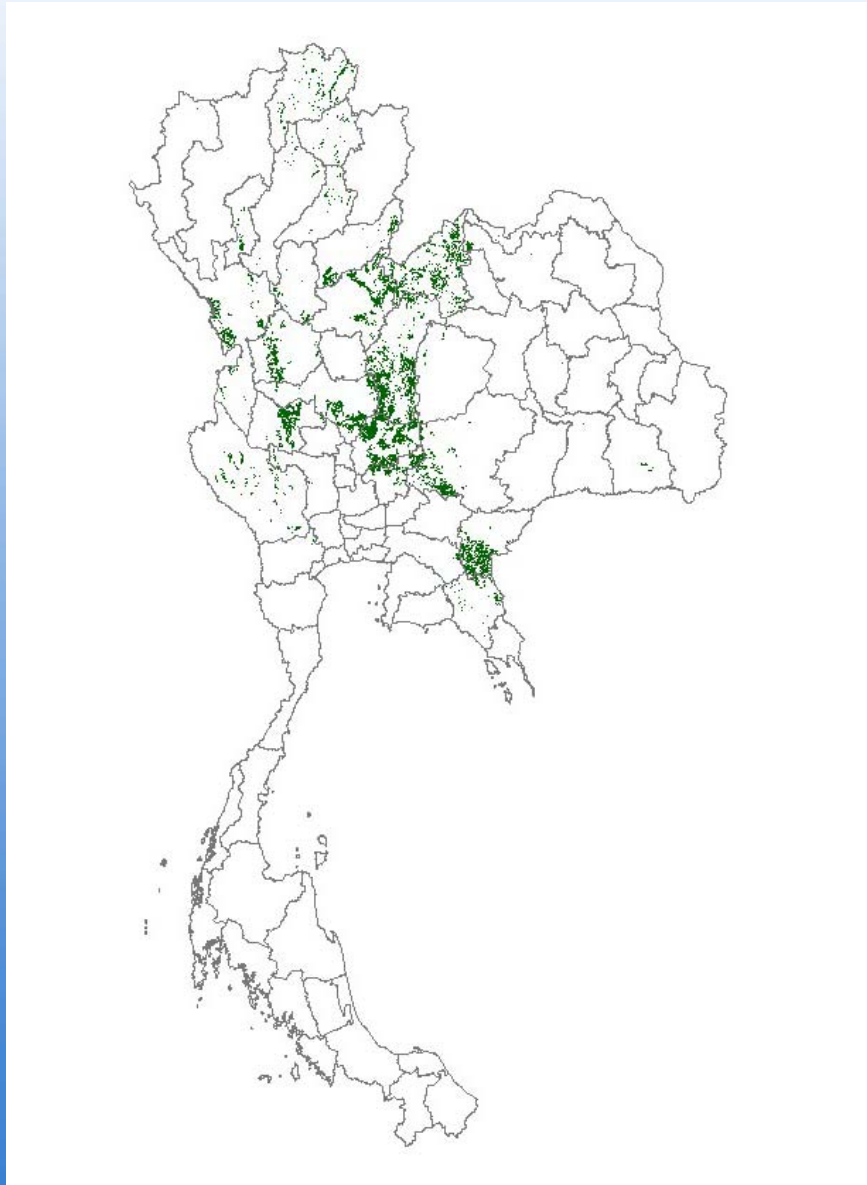
Sugarcane growing area

Defining crop area boundary

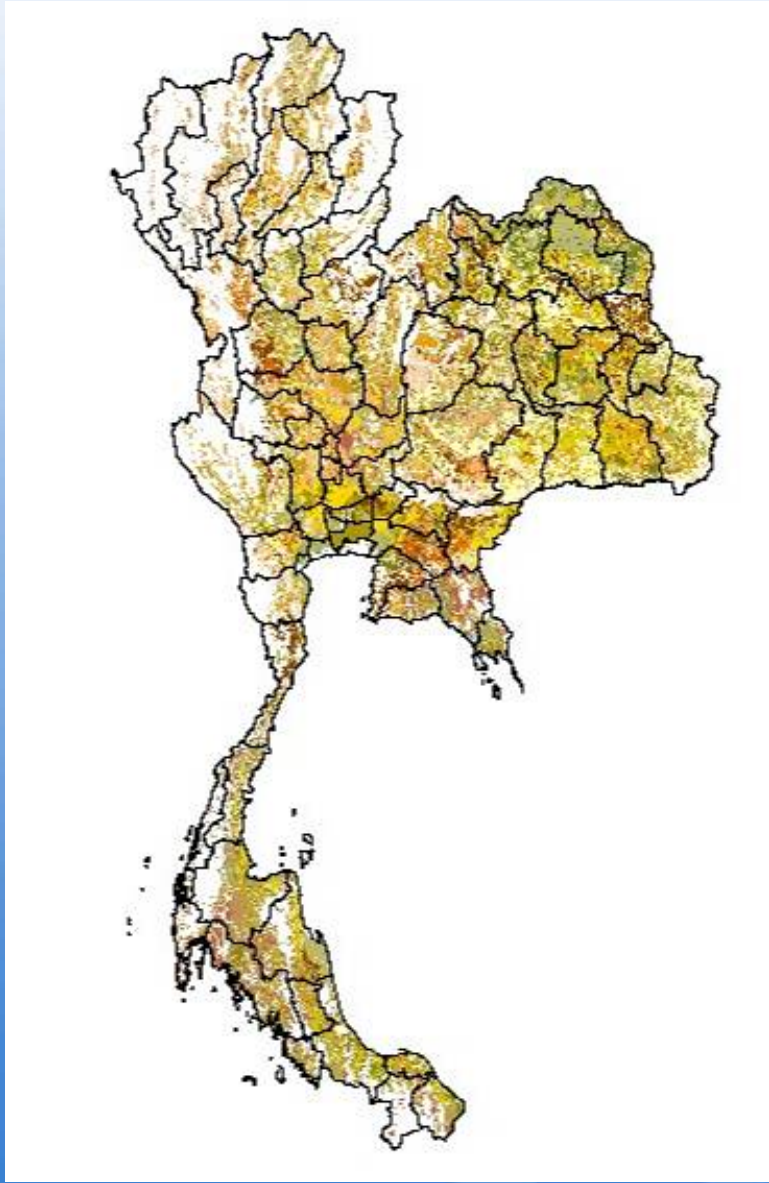


Cassava growing area

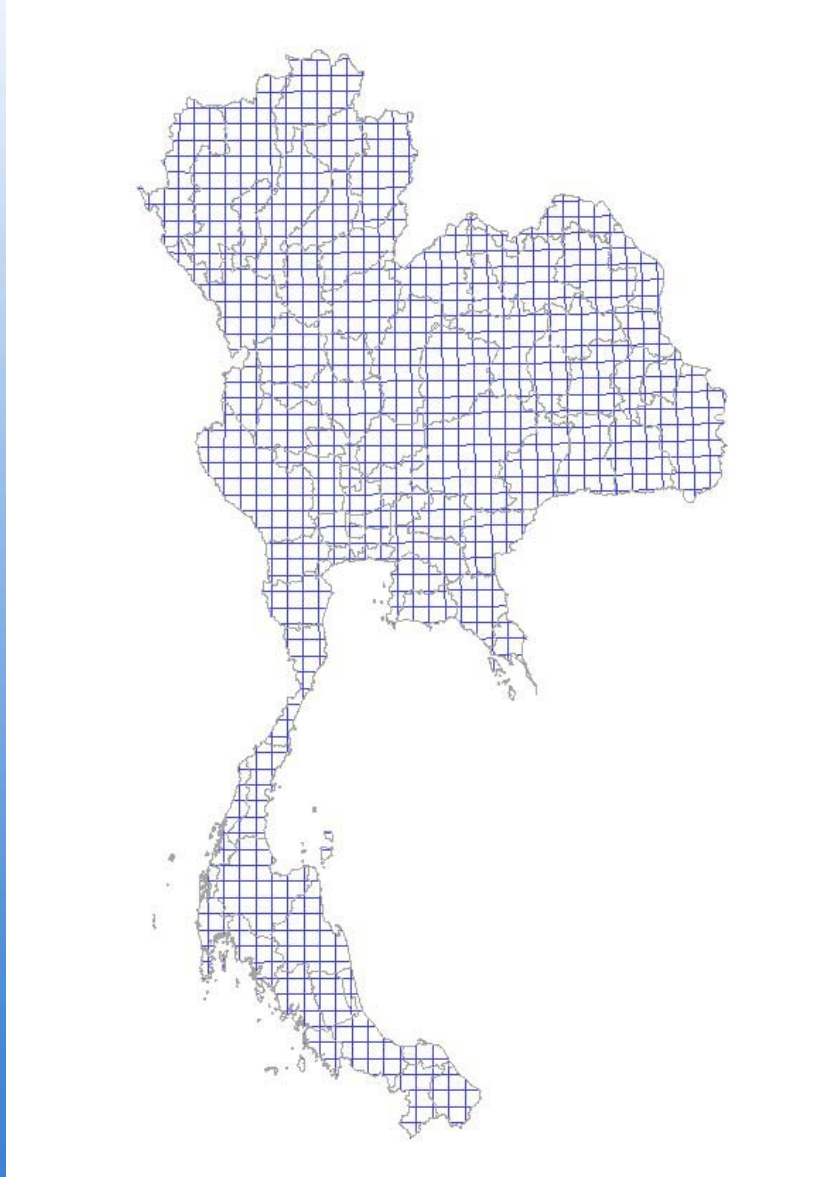
Defining crop area boundary



Maize growing area

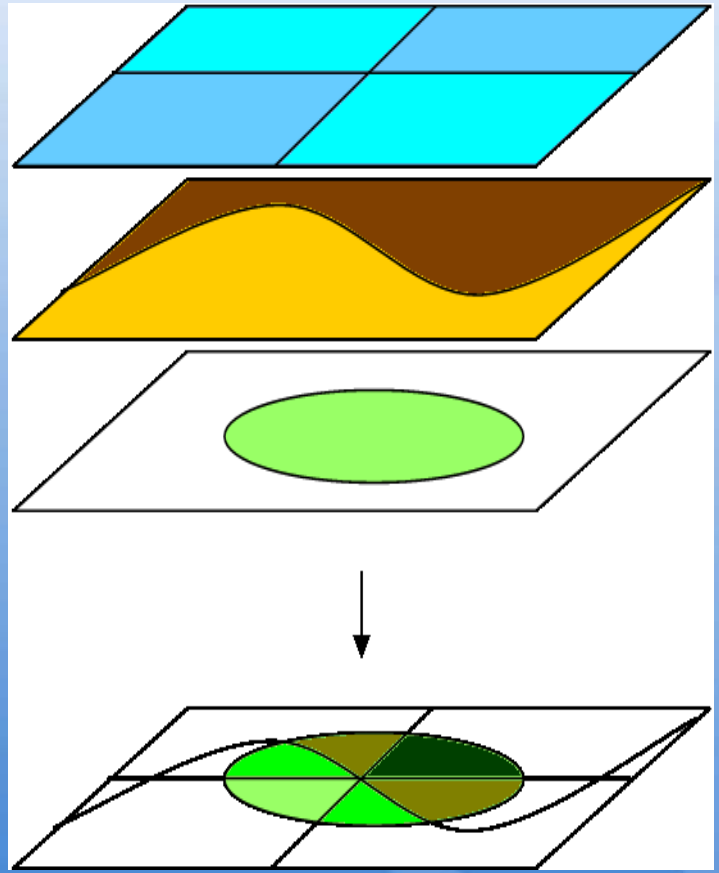


Soil group map



Weather grids 20x20 km.
ECHAM-PRECIS

Example:



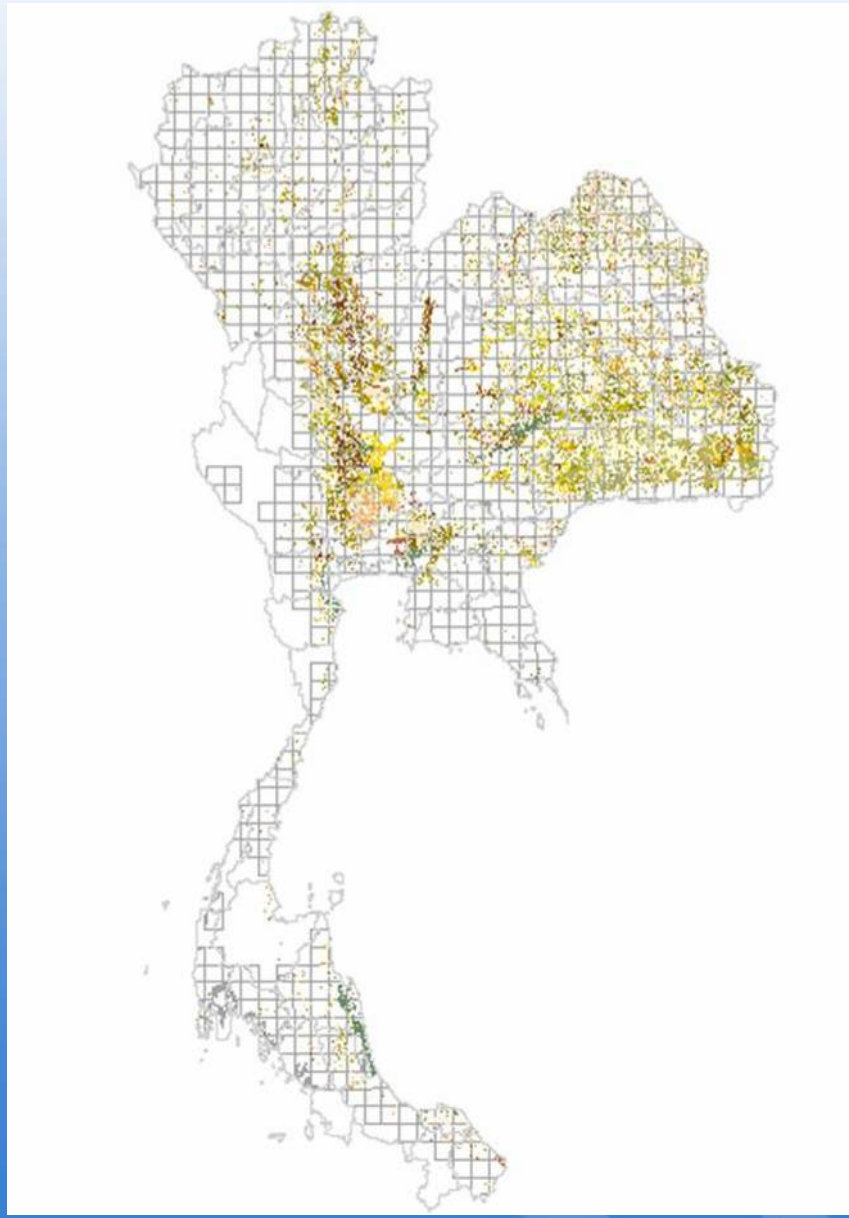
Weather: 4 units

Soil: 2 units

Crop growing area

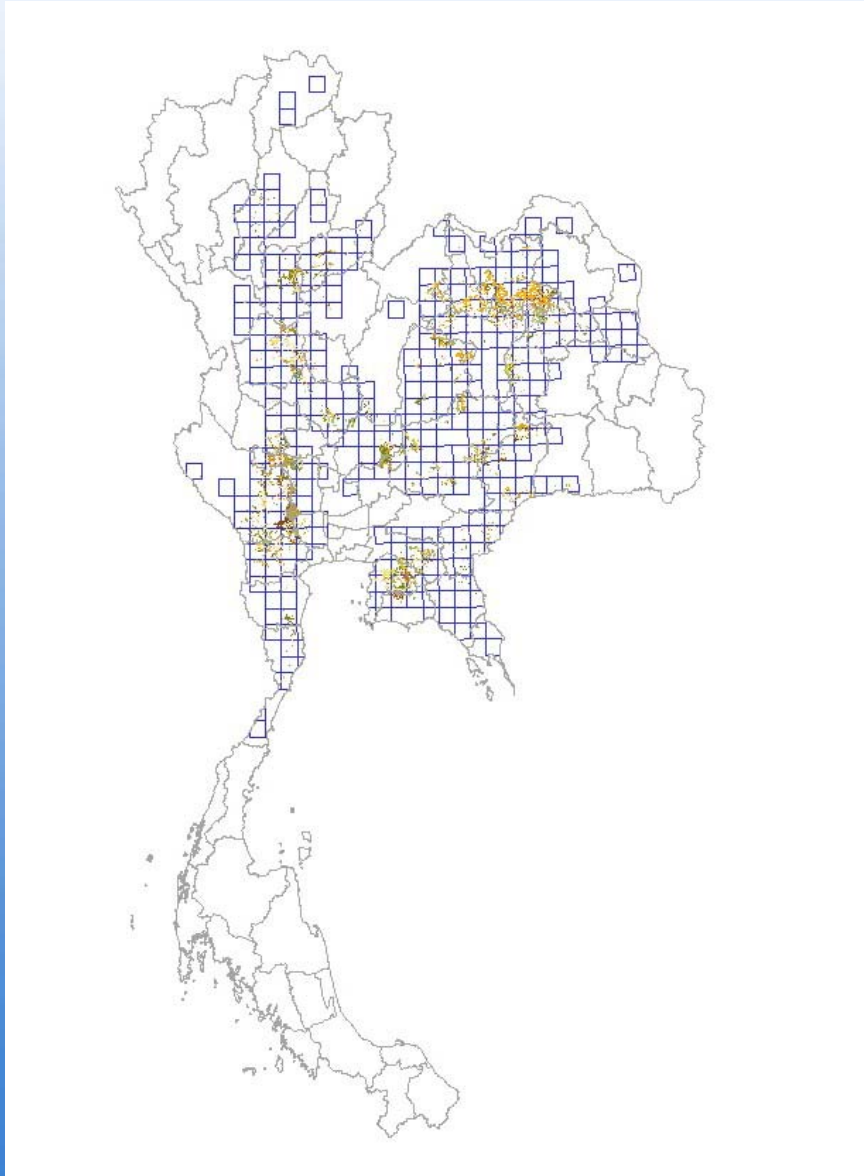
6 SMUs

Simulation Mapping Units



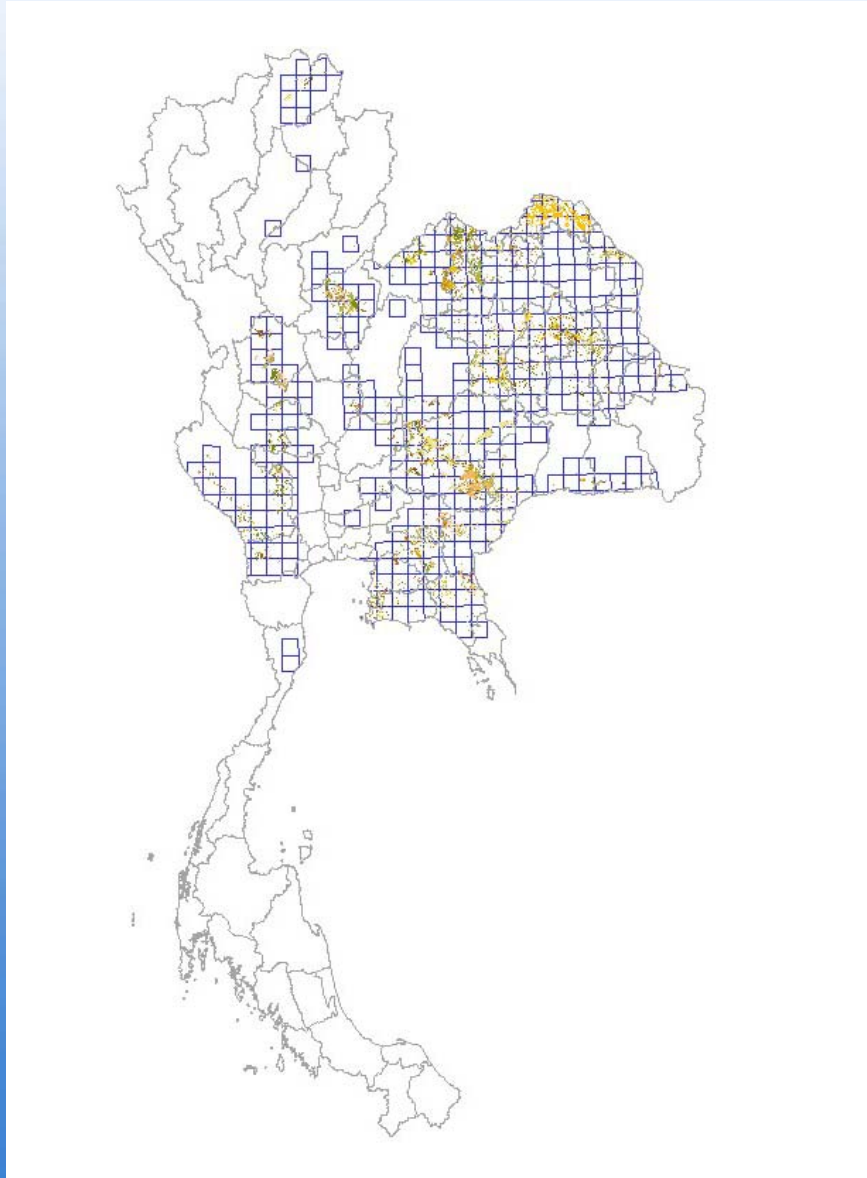
Rice SMU

Simulation Mapping Units



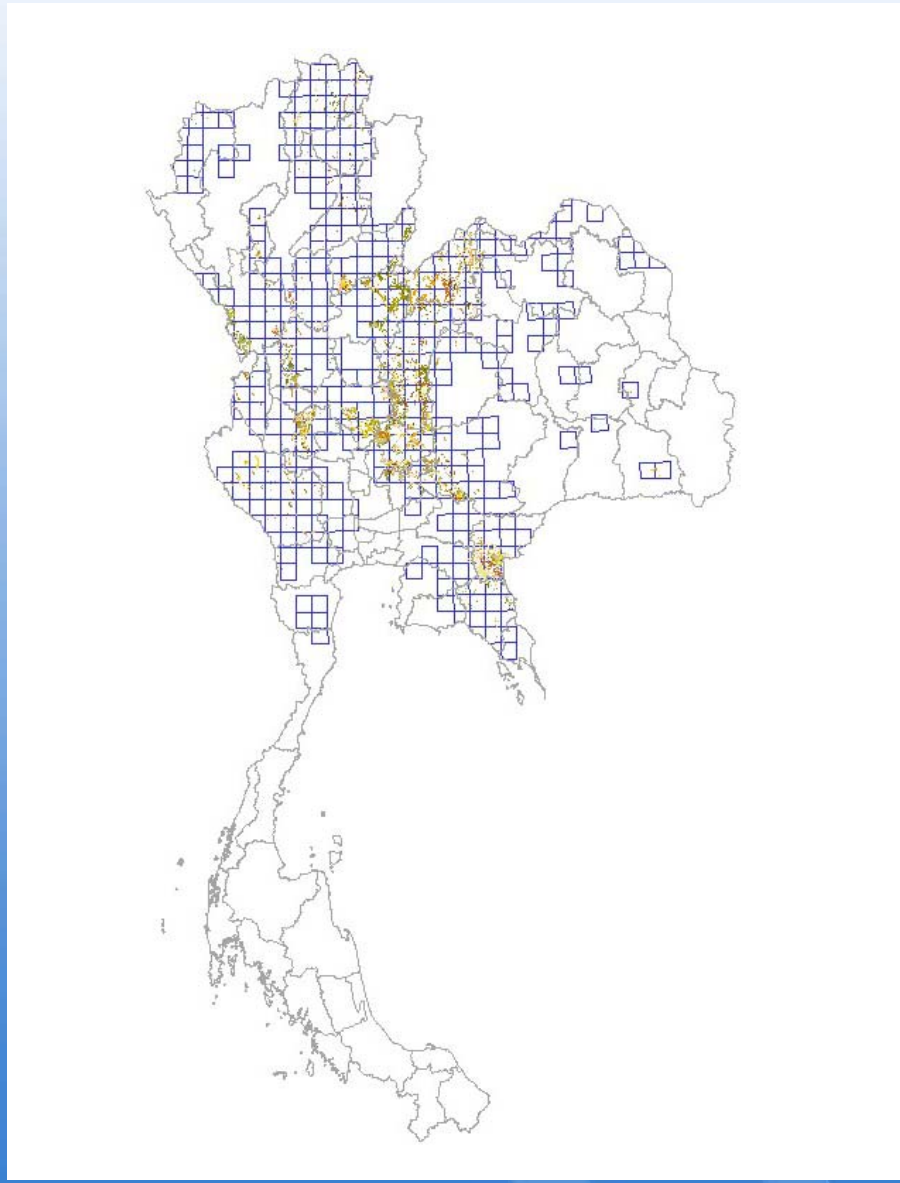
Sugarcane SMU

Simulation Mapping Units



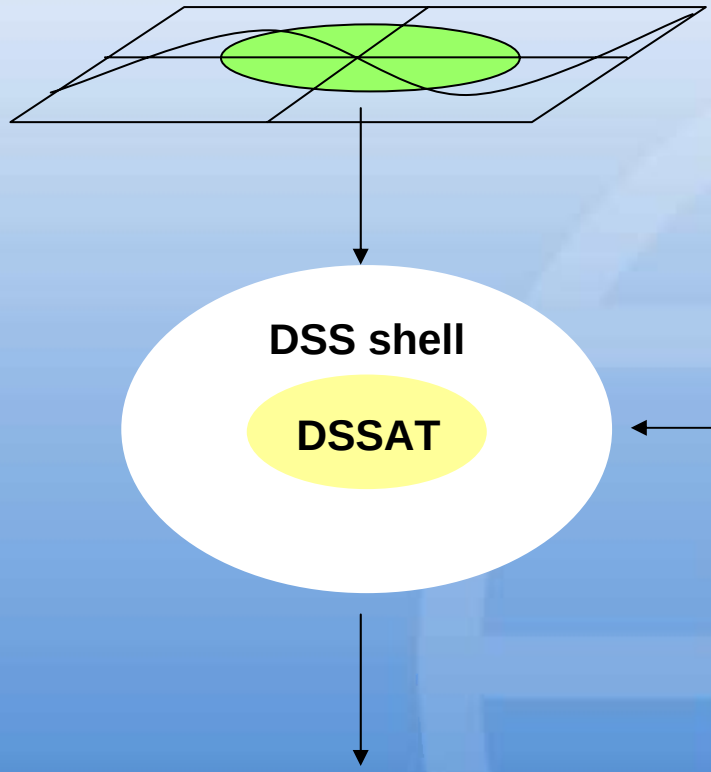
Cassava SMU

Simulation Mapping Units



Maize SMU

Simulation of crop growth and yield

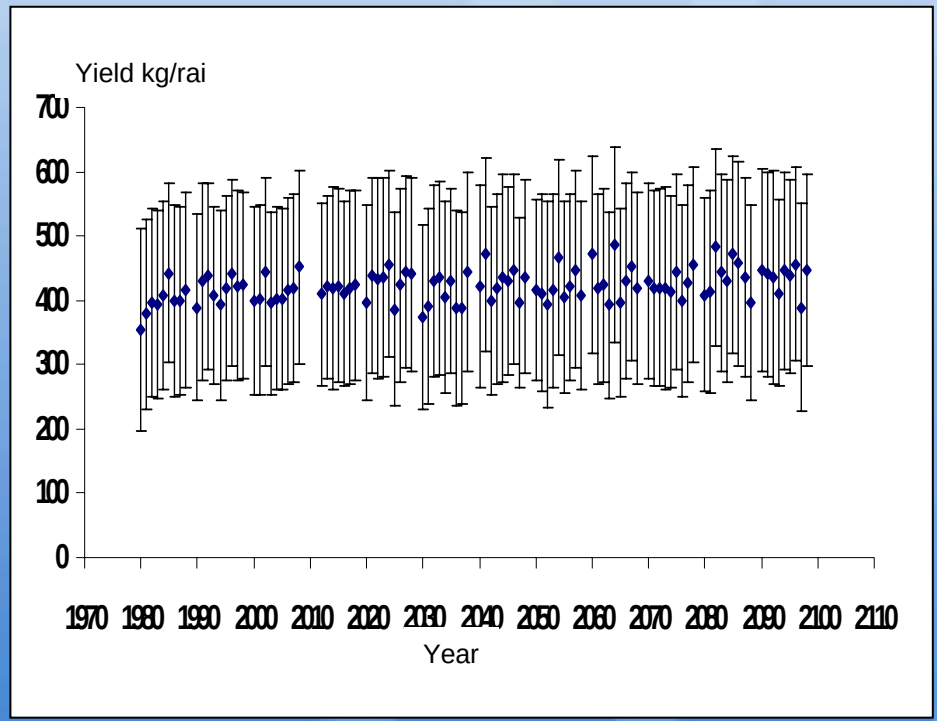


18,000 SMUs: soil-weather
120 years

Crop genetic coefficients
Crop management

Growth and yield in each SMU each year, ~2,160,000 dataset

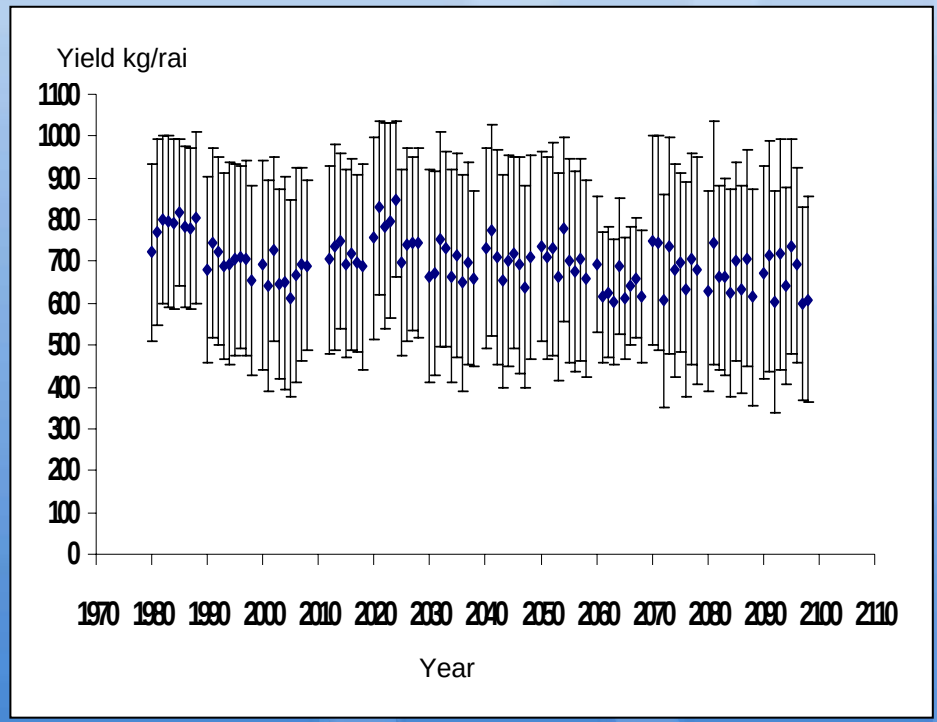
Trend and variability of rainfed lowland rice KDML105 yield



Conclusions

- Trend 9% increases
- Temporal variation CV 14%
- Spatial variation CV 33%

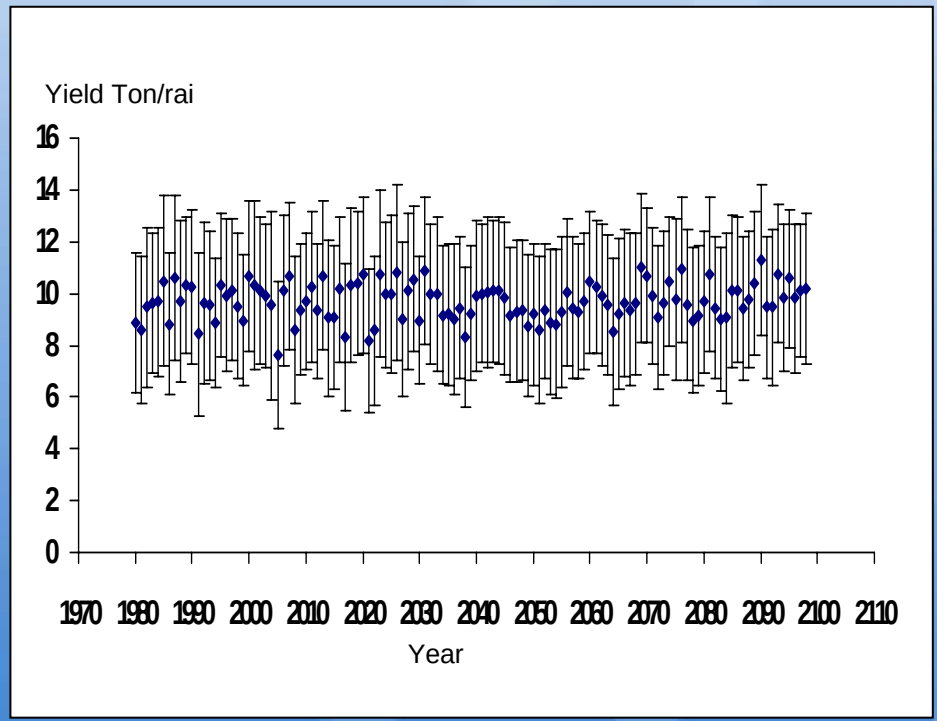
Trend and variability of irrigated rice Suphanburi 1 yield



Conclusions

- Trend 12% decreases
- Temporal variation CV 14%
- Spatial variation CV 33%

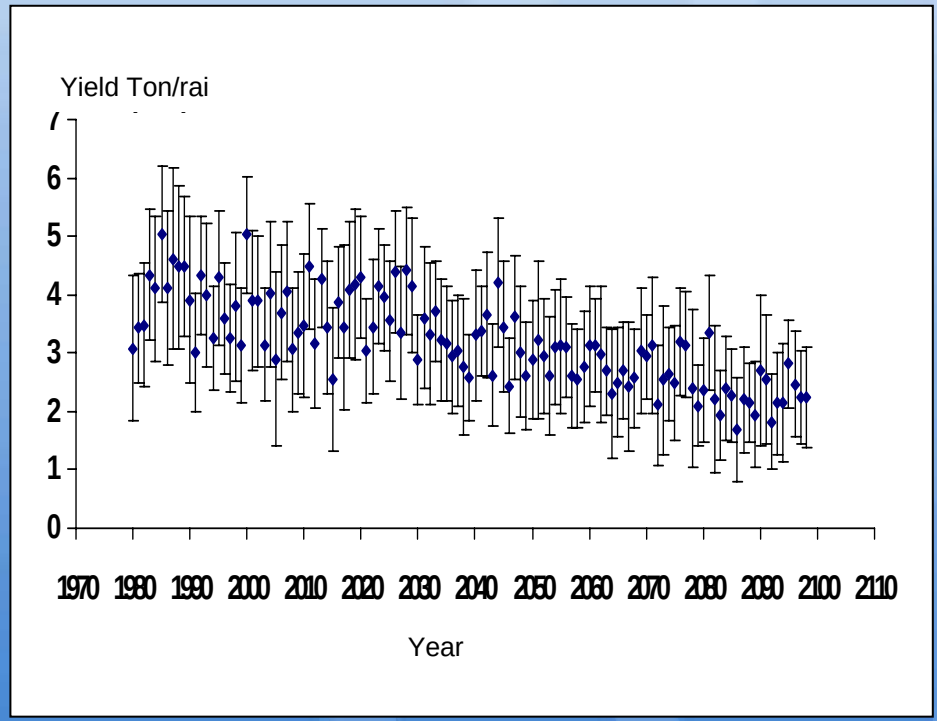
Trend and variability of rainfed sugarcane K84-200 yield



Conclusions

- Trend 6% increases
- Temporal variation CV 18%
- Spatial variation CV 23%

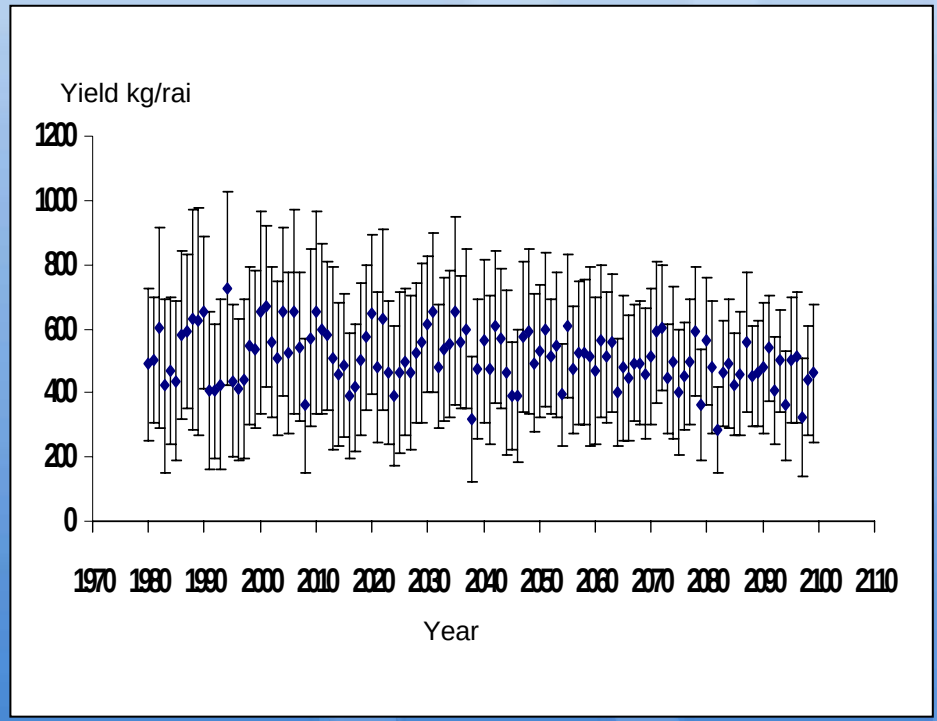
Trend and variability of rainfed cassava Kasetsart 50 yield



Conclusions

- Trend 43% decreases
- Temporal variation CV 34%
- Spatial variation CV 33%

Trend and variability of rainfed maize Suwan 1 yield



Conclusions

- Trend 15% decreases
- Temporal variation CV 41%
- Spatial variation CV 45%

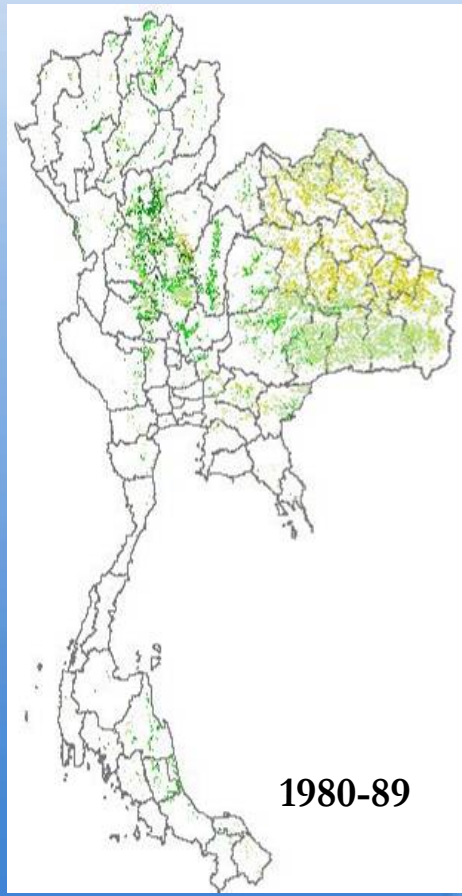
Consequences of CC on crop production

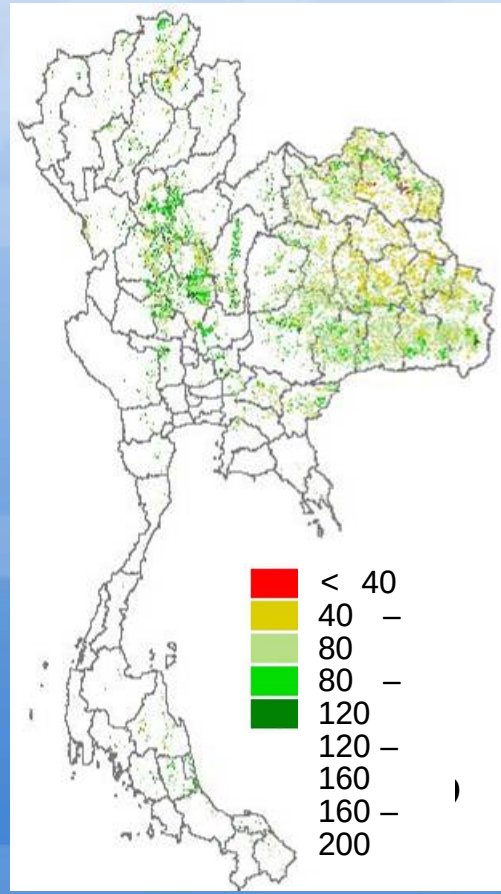
- Long term trend of change in yield due to CO_2 and T is small, except cassava
- Temporal variability of yield due to weather extremes is obvious with cassava and maize
- Spatial variability is large and greater than temporal

Since spatial variation is large, questions

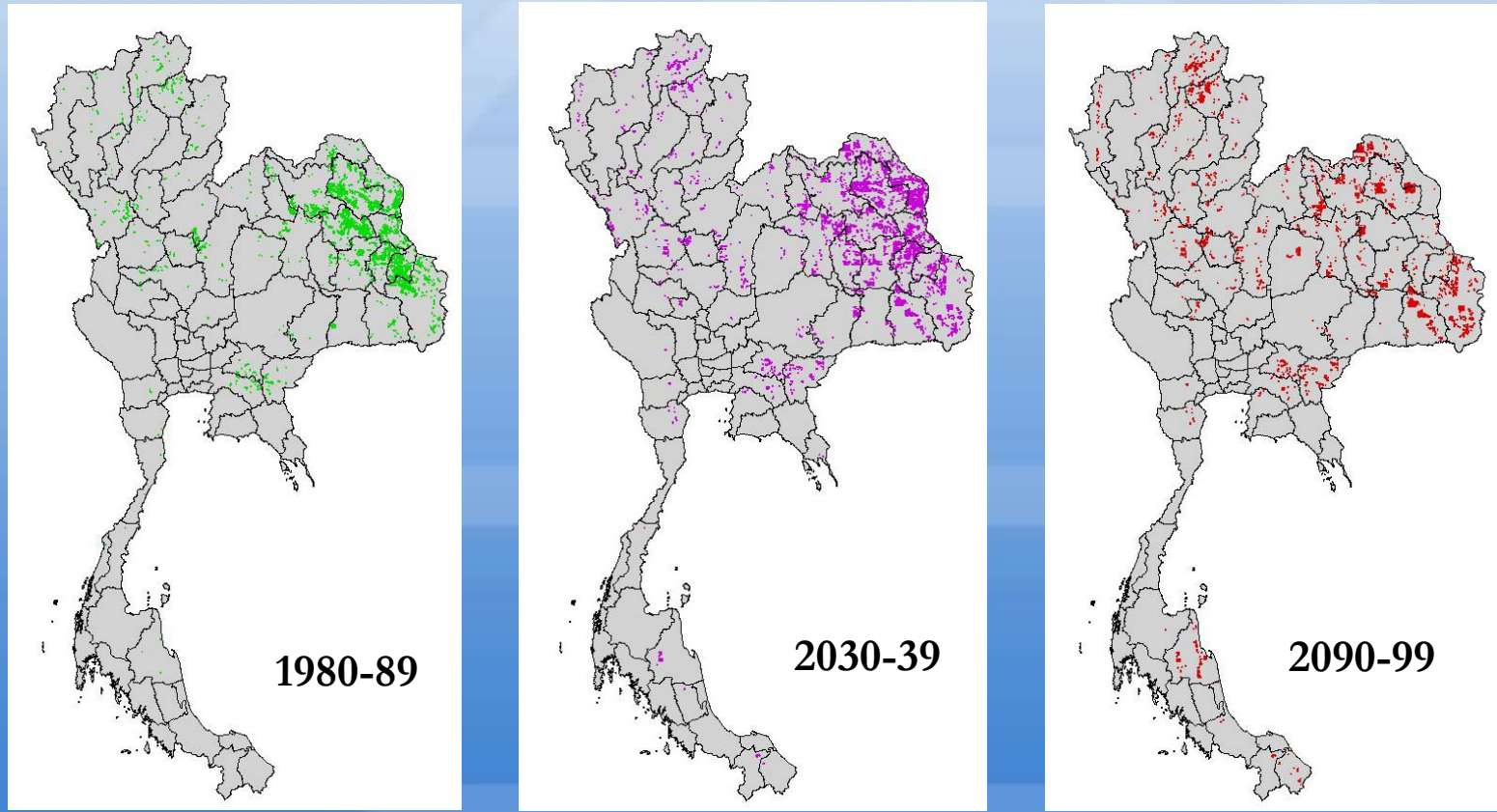
- Where are those hard hit areas by CC
- Timing and duration of the impacts
- How the areas change/displace with time

Relative rainfed rice yield to the mean of the country 1980-89

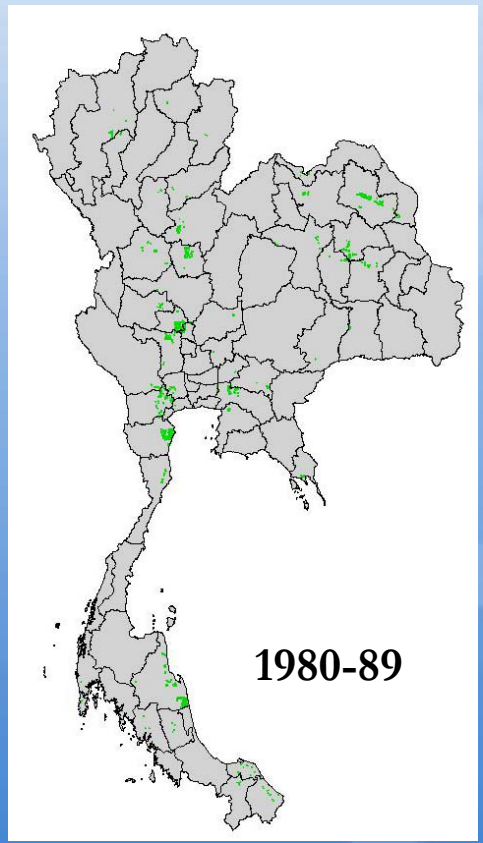


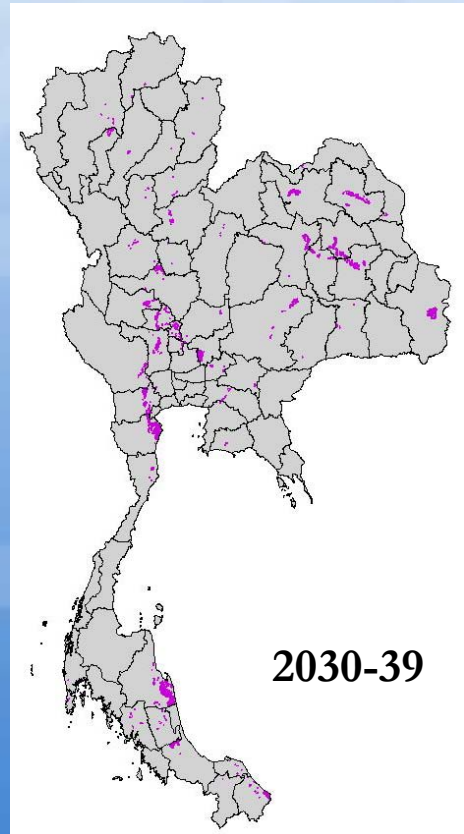


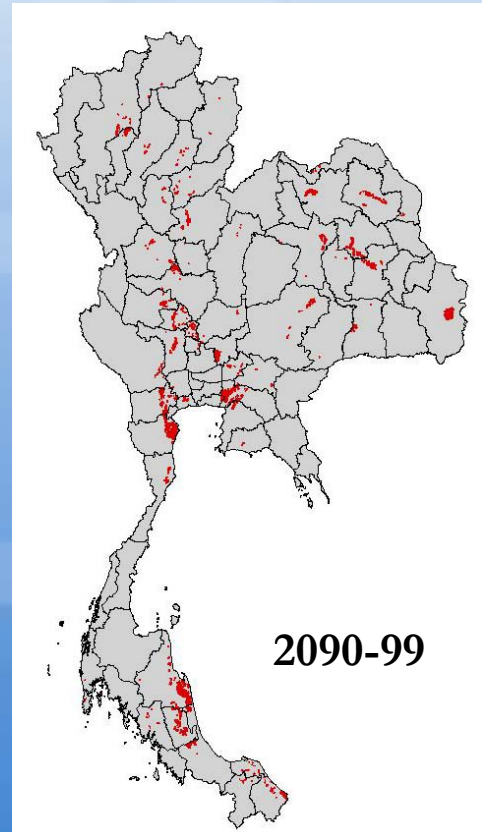
Rainfed rice where yield < 70% of the base year mean



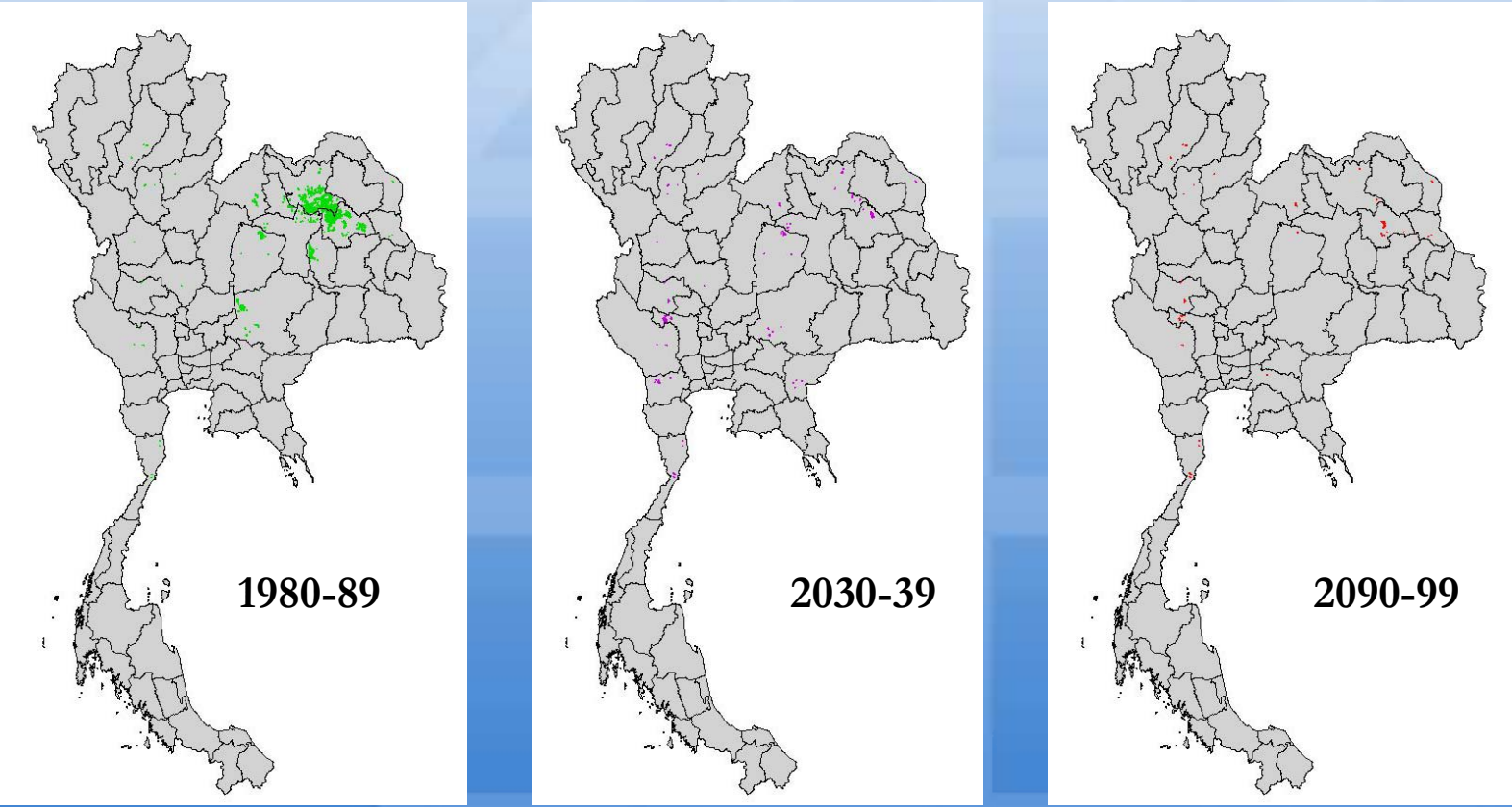
Irrigated rice where yield < 70% of the base year mean



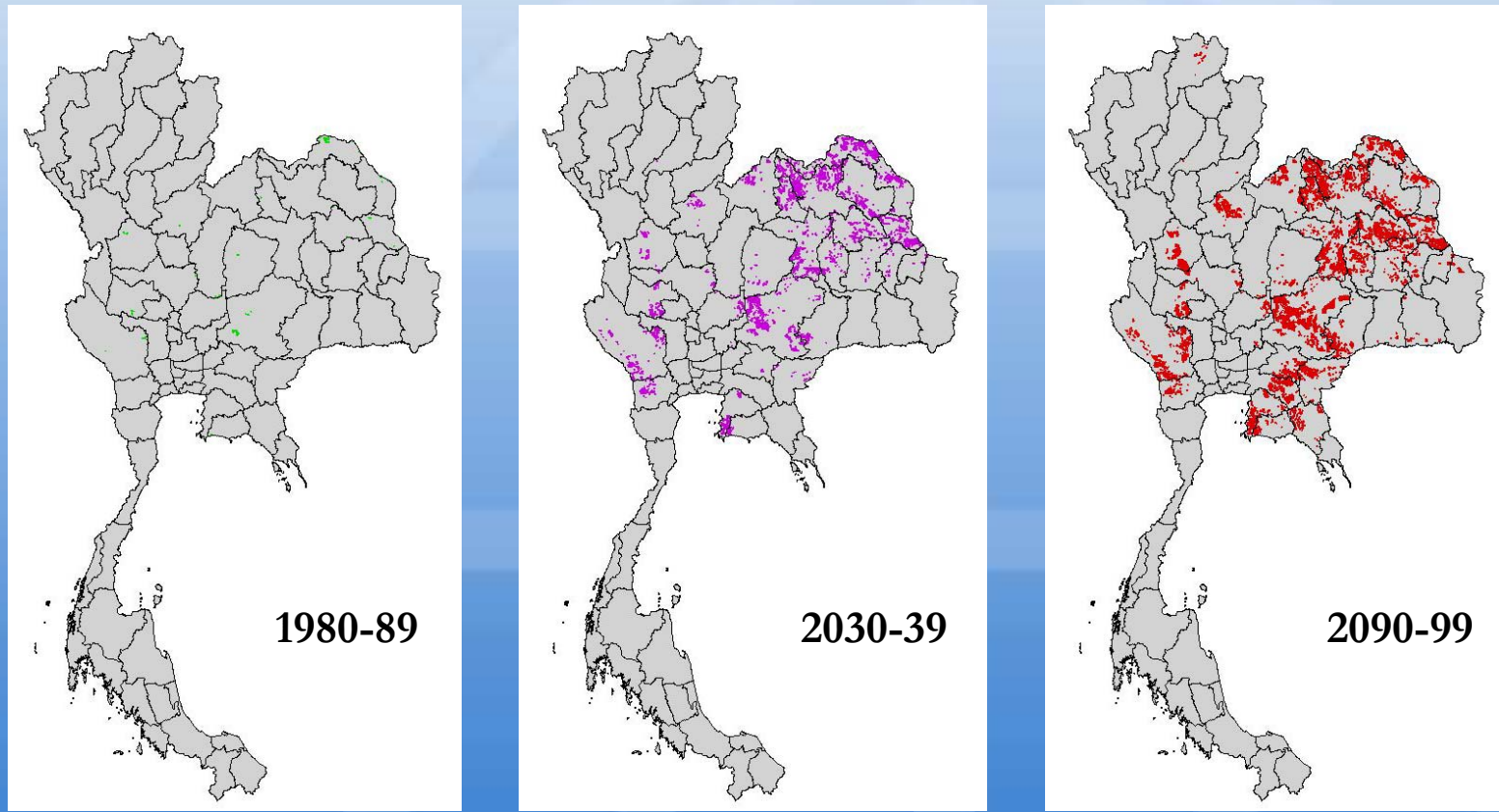




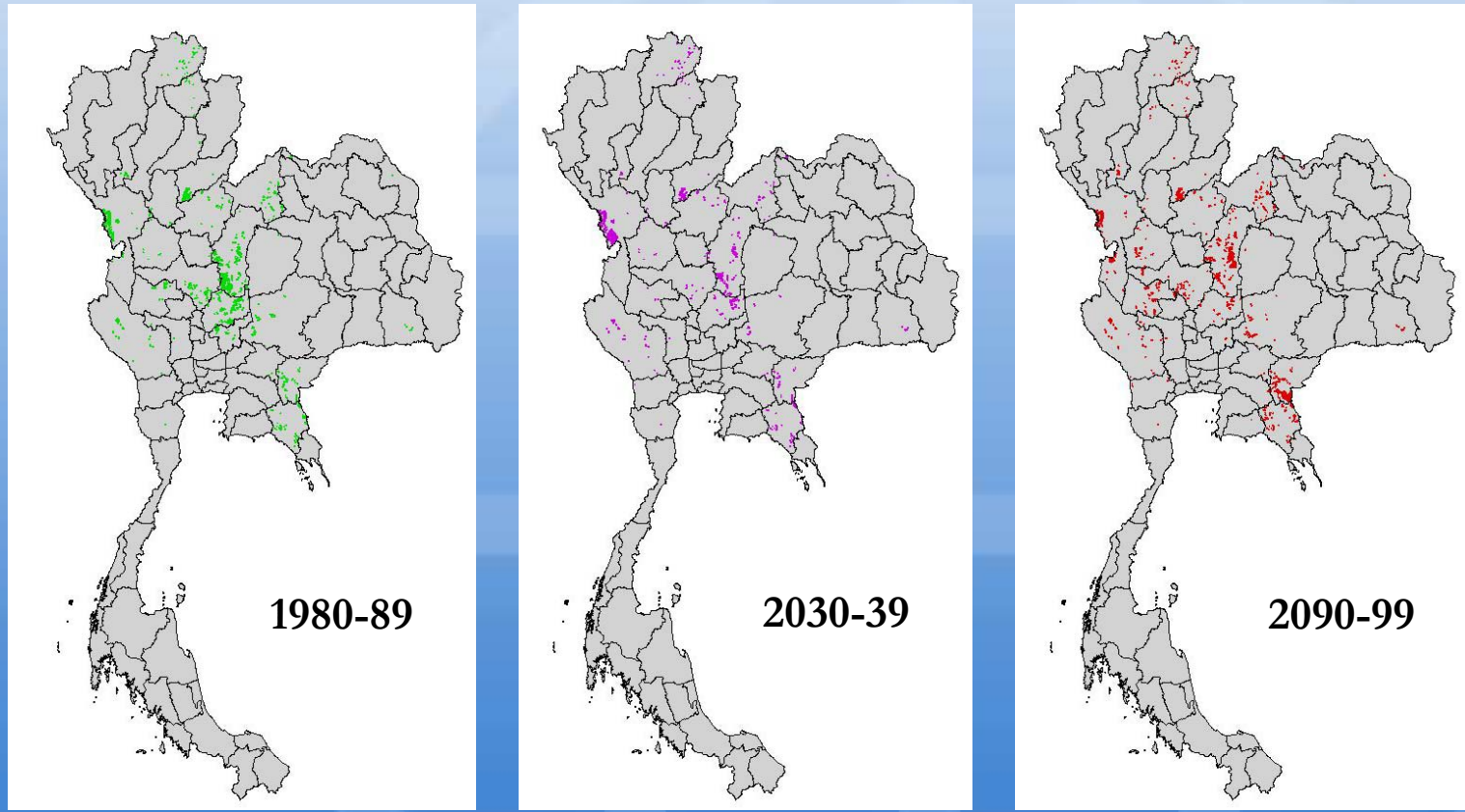
Sugarcane where yield < 70% of the base year mean



Cassava where yield < 70% of the base year mean



Maize where yield < 70% of the base year mean



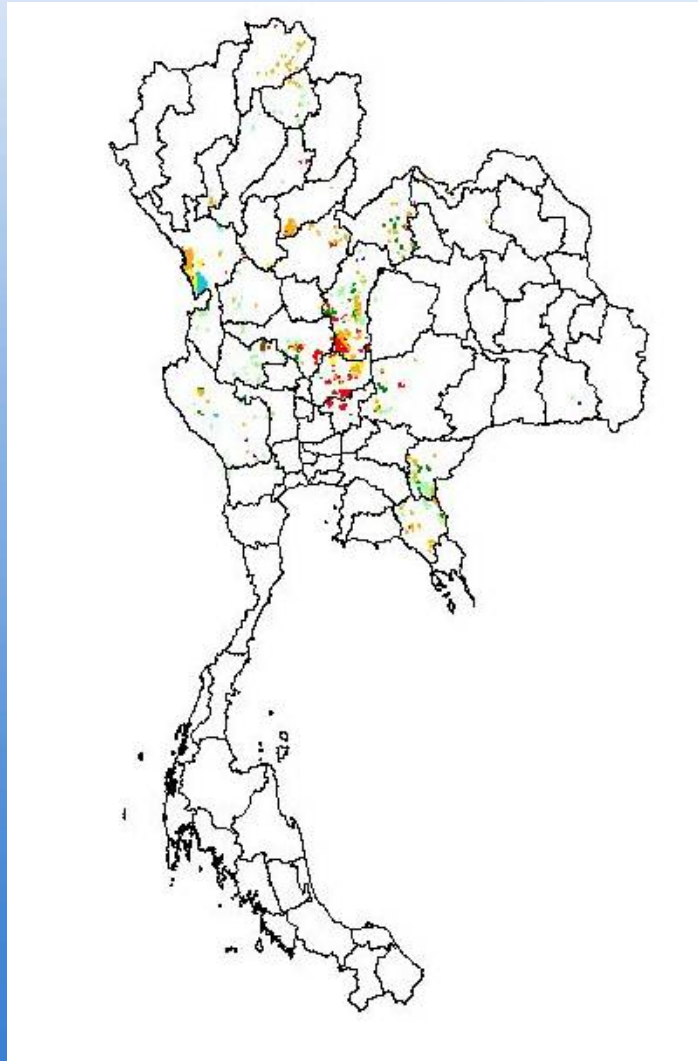
To identify the timing of occurrence and duration, time series maps of affected area are overlaid

	Period		
class	1980-89	2030-39	2090-99
1	0	0	0
2	1	0	0
3	0	1	0
4	0	0	1
5	1	1	0
6	0	1	1
7	1	0	1
8	1	1	1

3 maps yield 8 classes of the affected area:

Classes of impact = $2^{\text{No. of maps}}$

Classes of the maize affected areas



Assessment of the CC impacts: Impact Factor

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

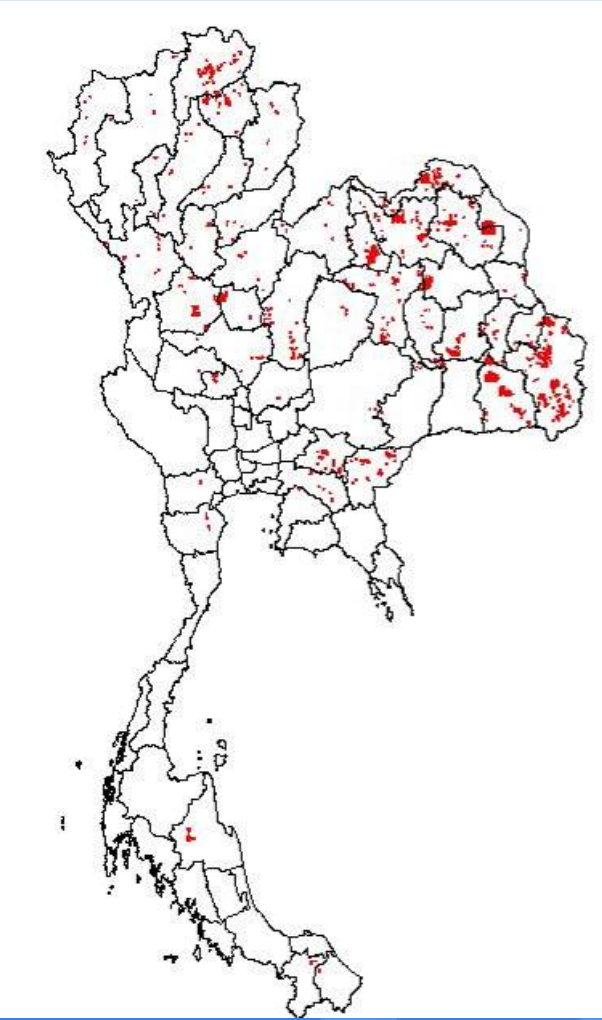
Impact Factor = magnitude x affected area x duration x timing

Impact Factor assessment of the rainfed rice area

Class	% of total area	duration	Timing inverse of order	Impact Factor
1	85.1	0	0.0	0
2	4.3	10	1.0	0.0142511
3	3.0	10	0.5	0.0050299
4	1.3	10	0.3	0.0014063
5	1.4	20	1.0	0.0093843
6	4.4	20	0.5	0.0145675
7	0.1	20	1.0	0.0004211
8	0.5	30	1.0	0.0053479

Class 6: yield < 70% of mean, duration 20 years 2030-39 & 2090-99

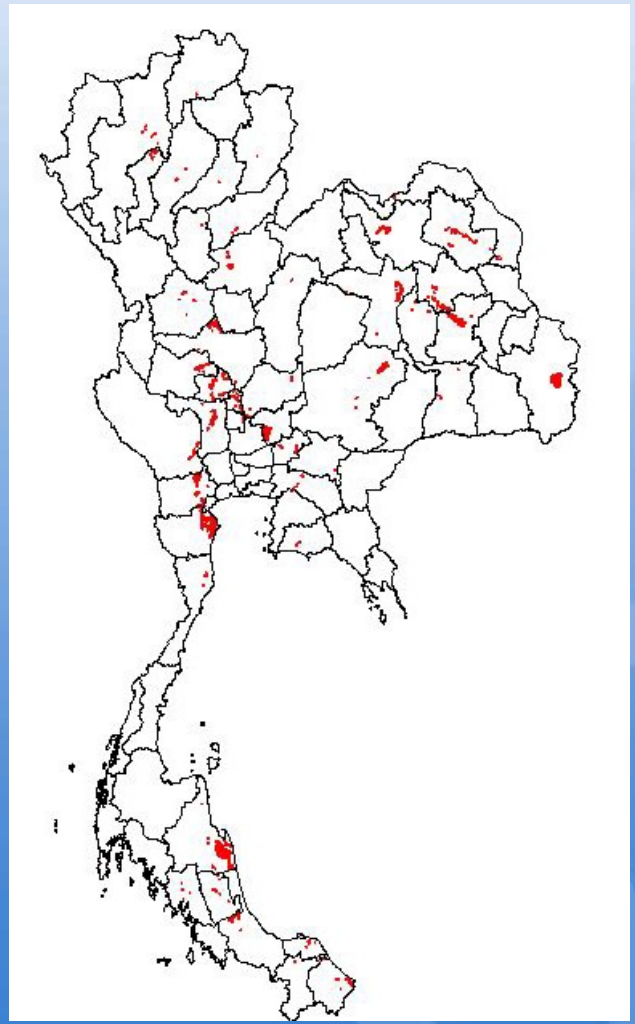
Map of the class 6 of the affected rainfed rice area



Class 6

- yield < 70% of mean
- area 4%
- duration 20 years
- from 2030-39 & 2090-99

Map of the affected irrigated rice area with highest IF



Class 6

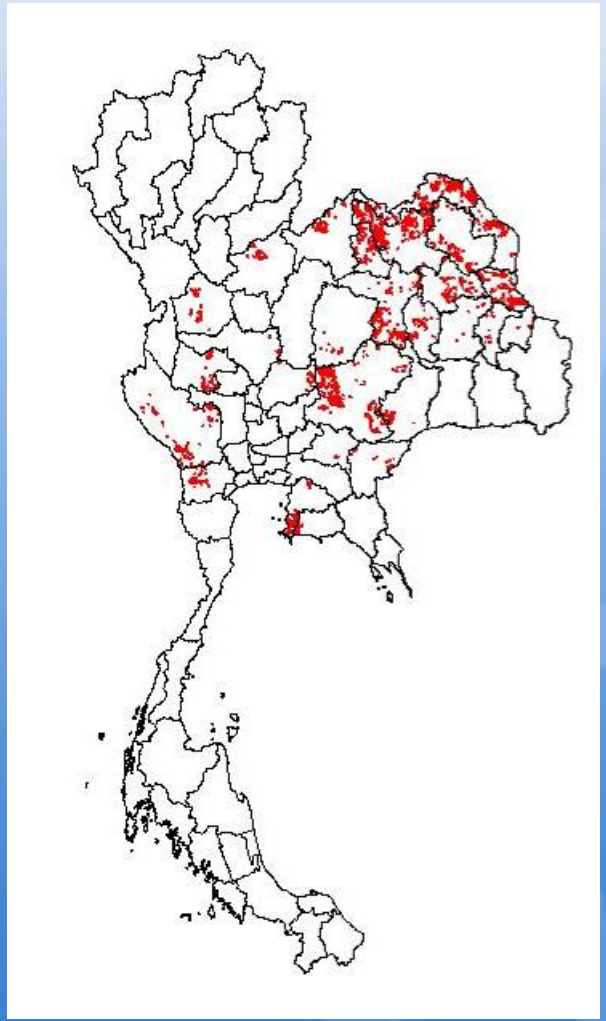
- yield < 70% of mean
- area 14%
- duration 20 years
- from 2030-39 & 2090-99

Map of the affected sugarcane area with highest IF

Class 2

- yield < 70% of mean
- area 12%
- duration 10 years
- From Present - 2029

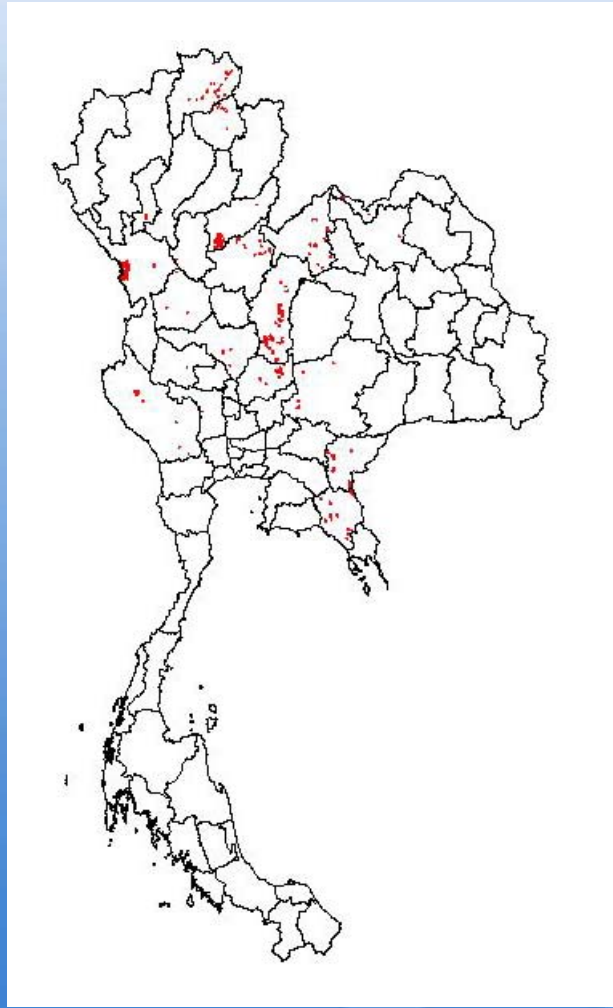
Map of the affected cassava area with highest IF



Class 6

- yield < 70% of mean
- area 37%
- duration 20 years
- from 2030-39 & 2090-99

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