Impacts of Climate Change on Rice Crop Yields in Vietnam

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11 August 2017

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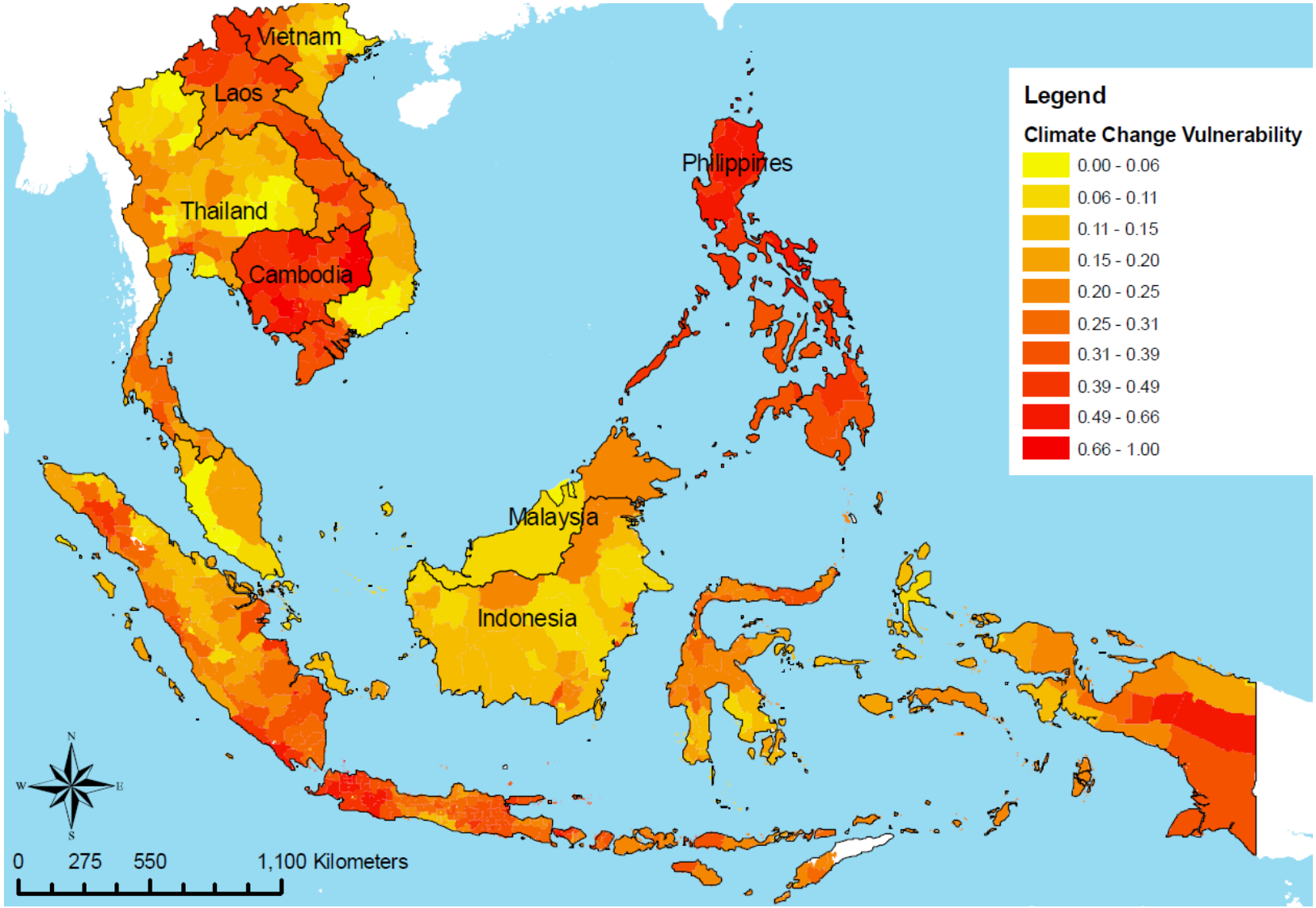
Outline

- Background of Vietnam's Rice Cultivated Areas and Yields
- Climate Model Projections
- Crop Model Calibration and Validation

  *Mekong River Delta (Hau Giang)
- Projected Crop Yield in 2020-2050 (Hau Giang)
- Conclusions (based mainly from Hau Giang; with some interpretations from other areas)

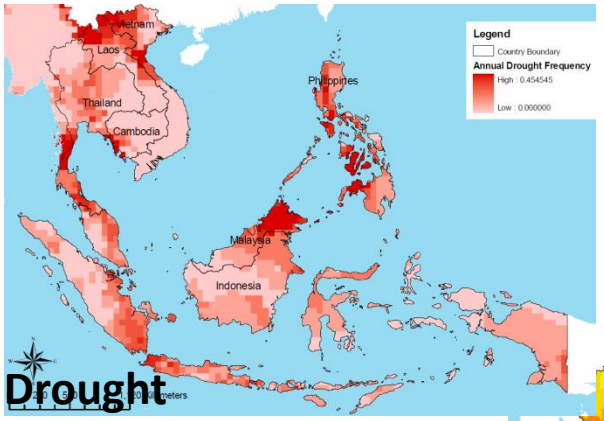
1. Background

Climate Vulnerability over Southeast Asia

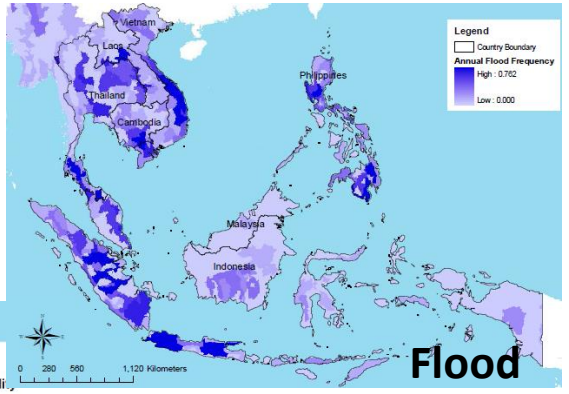


Source: EEPSEA (Economy and Environment Program for SEA)

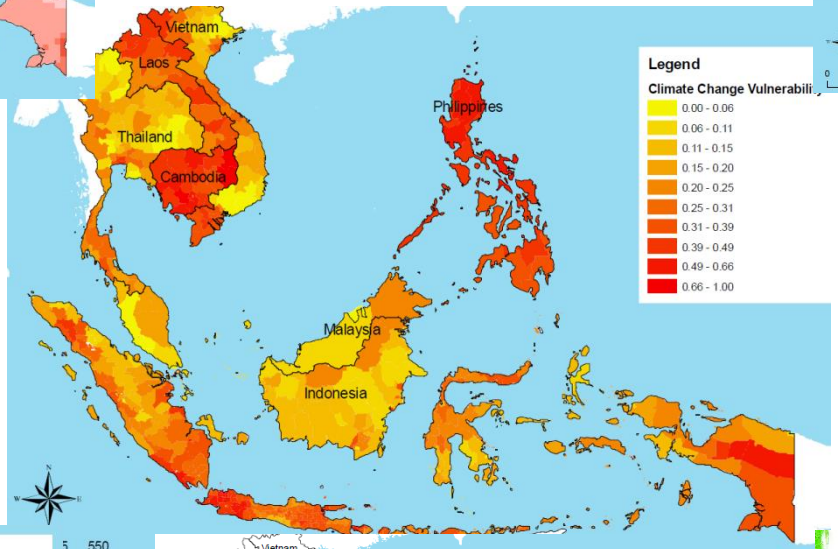
Climate change Vulnerability map over Southeast Asia

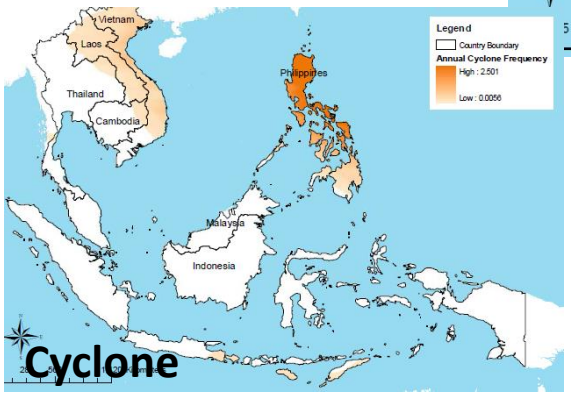


Drought



Flood





Cyclone

Sea Level Rise

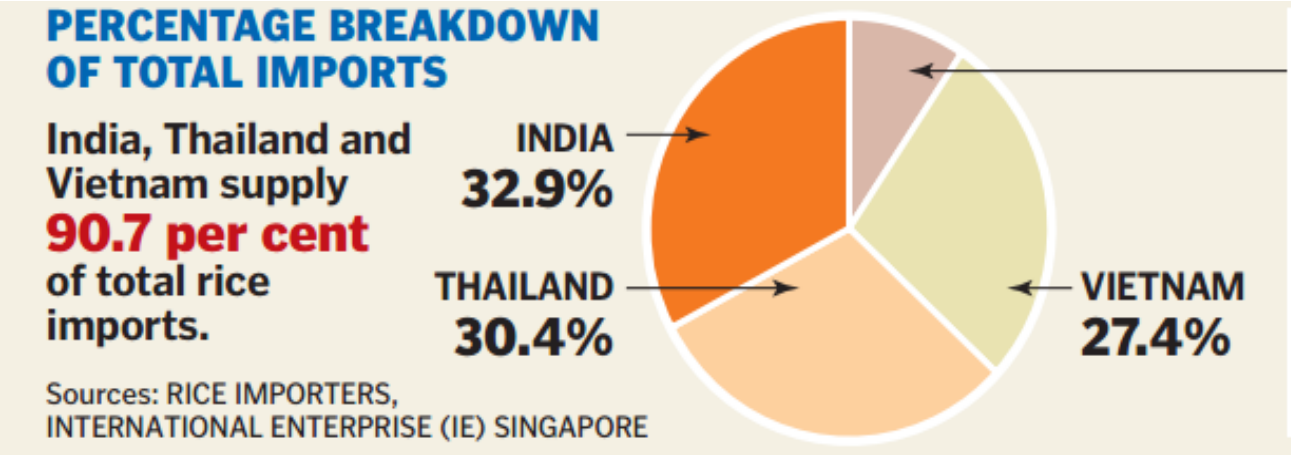
Land slide

Major Rice Cultivated Areas

Mekong River Delta: 56% of Vietnam's Rice Output

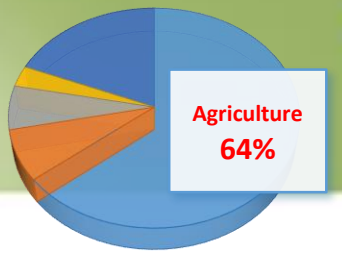
Red River Delta: 15% of Vietnam's Rice Output

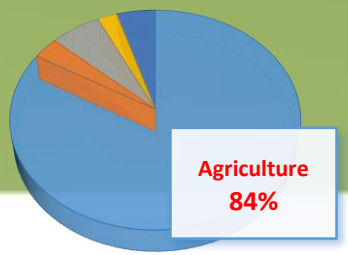
North and South Central Coasts: 15% of Vietnam's Rice Output

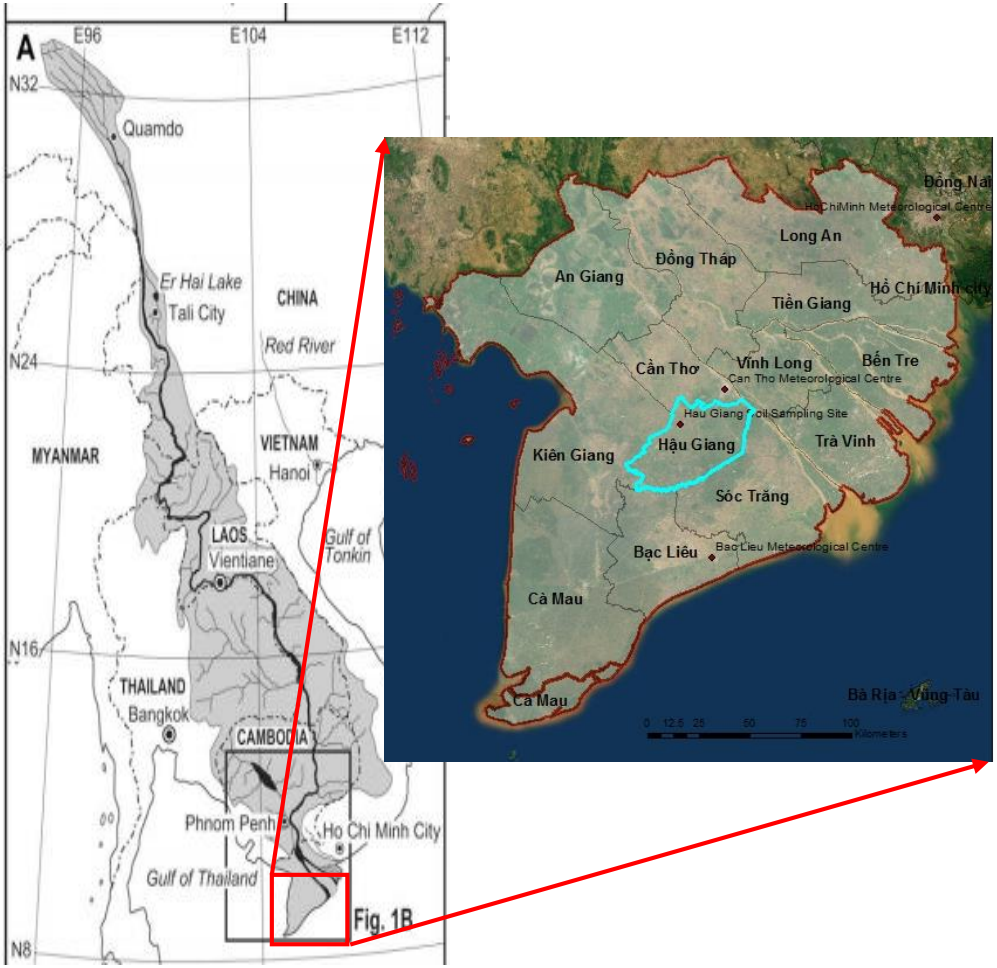


Rank	Country	Quantity (percentage of total imports)
4	Myanmar	2.5
5	Pakistan	2.4
6	US	2.2
7	Cambodia	0.9
8	Australia	0.6
	Others	0.7

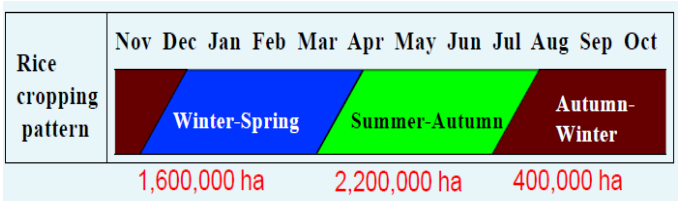
Study Area: Hau Giang







Basic Information(2014)	Mekong River Delta	Hau Giang Province
Total Area (million ha)	4.05	0.16 (4% of MRD)
Agricultural land(million ha)	**2.61**	**0.13 (5% of MRD)**
Planted Area of Rice(million ha)	4.20	0.21 (5% of MRD)
Annual Yield (t/ha)	5.94	5.85
Rice Production (million tons)	**25.24**	**1.20 (4.8% of MRD)**

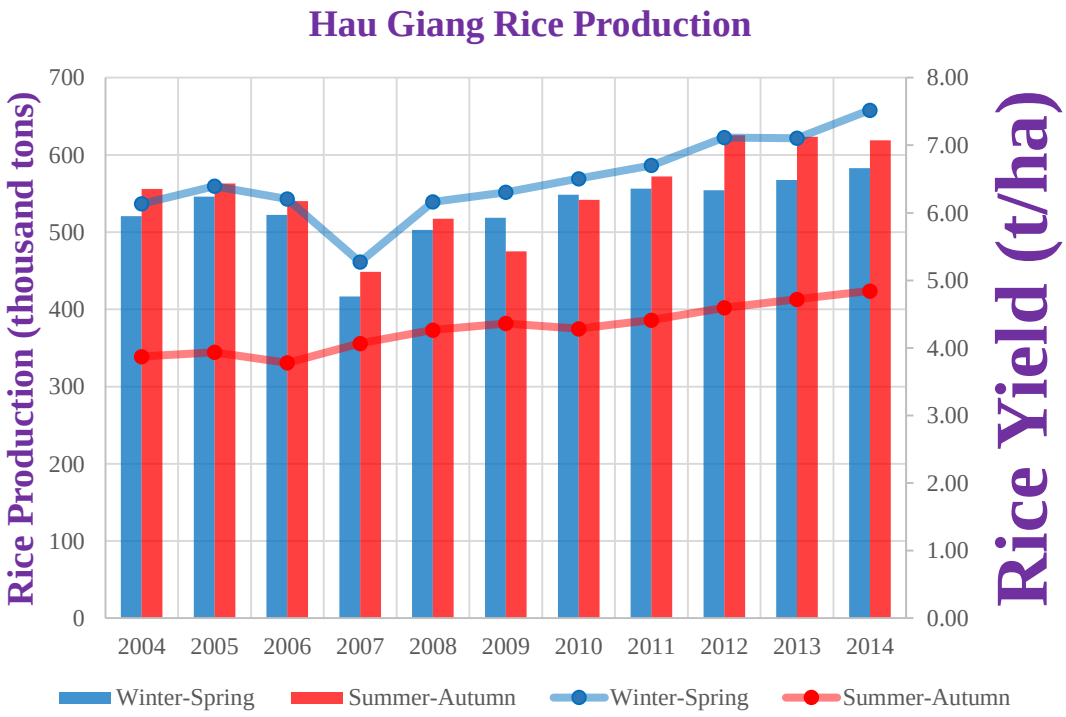


MRD: 2 or 3 crops per year

Hau Giang: 2 crops per year

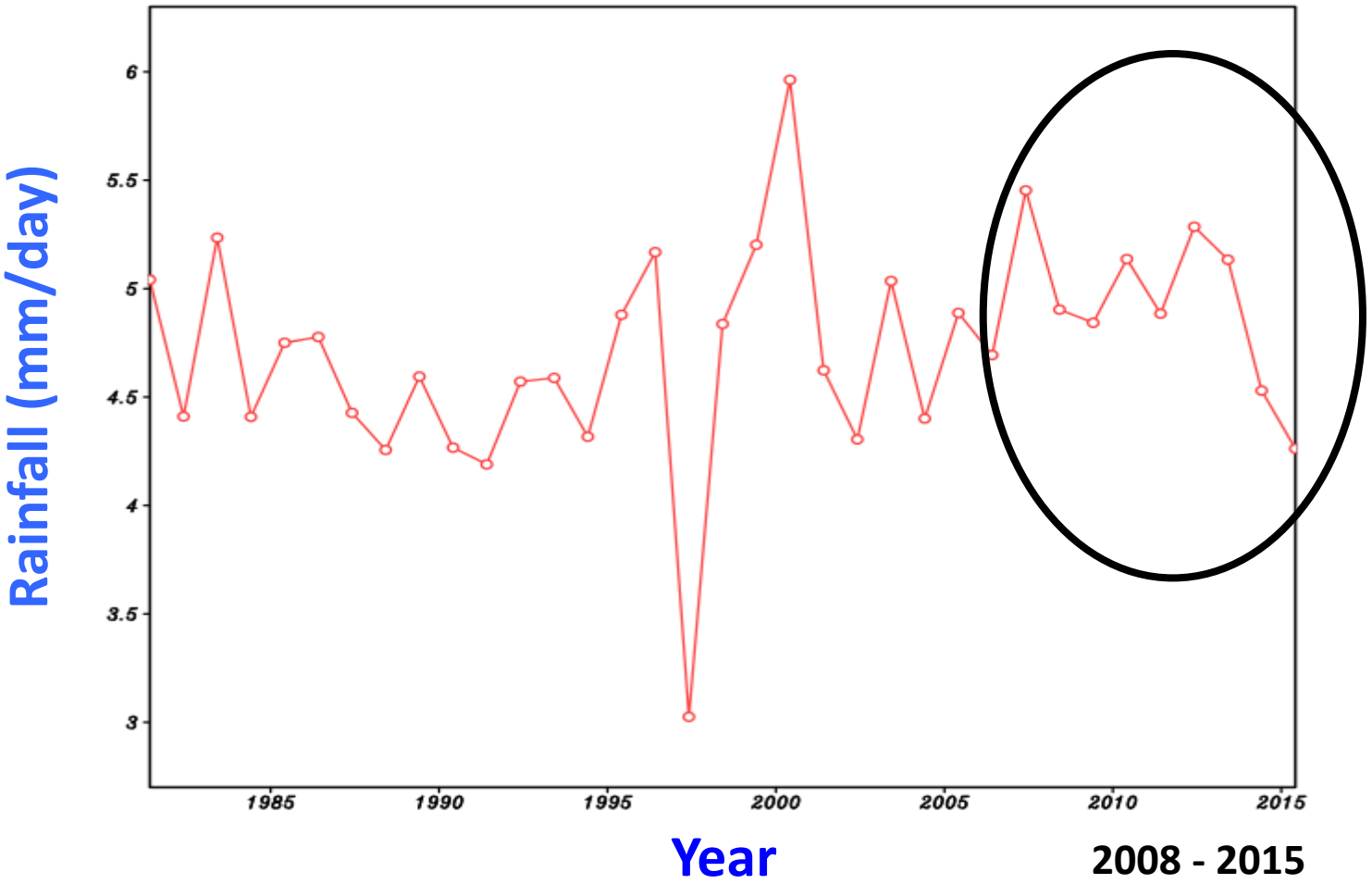
Mekong River Basin + Mekong River Delta

Rice Yield in Hau Giang (2004 – 2014)



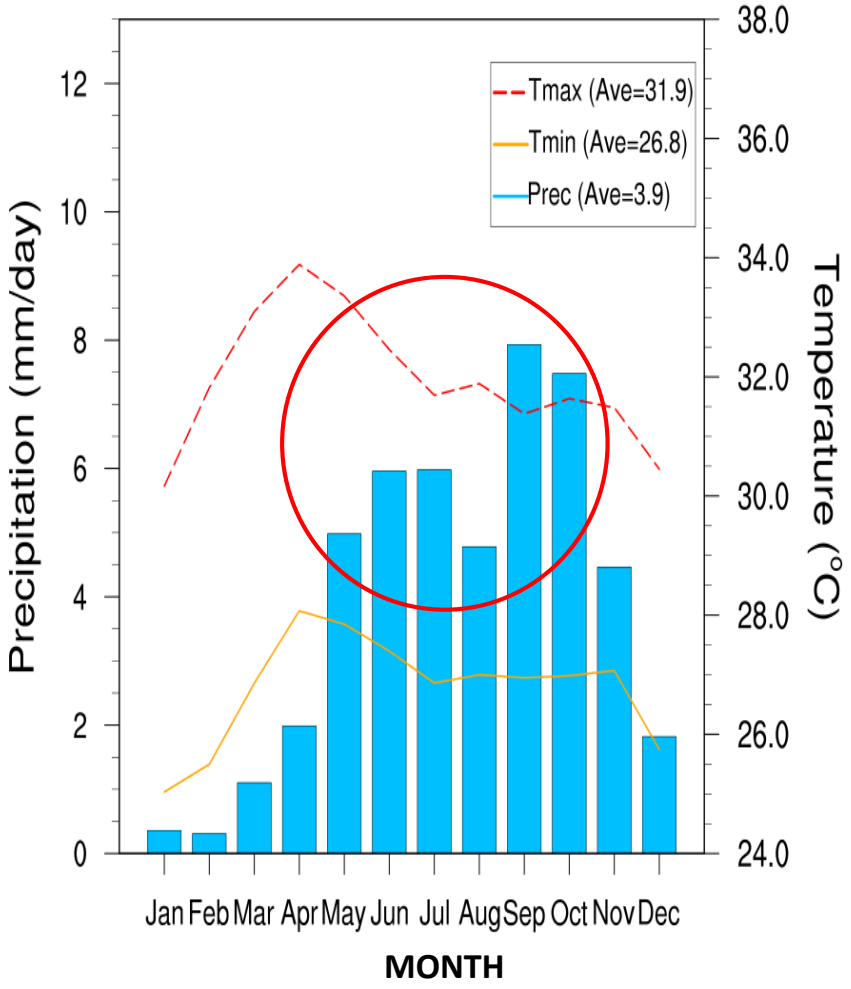
Higher productivity in Winter-Spring season ---- Less pest, less pollination failure due to less heavy rain, easier to manage due to less cultivated area

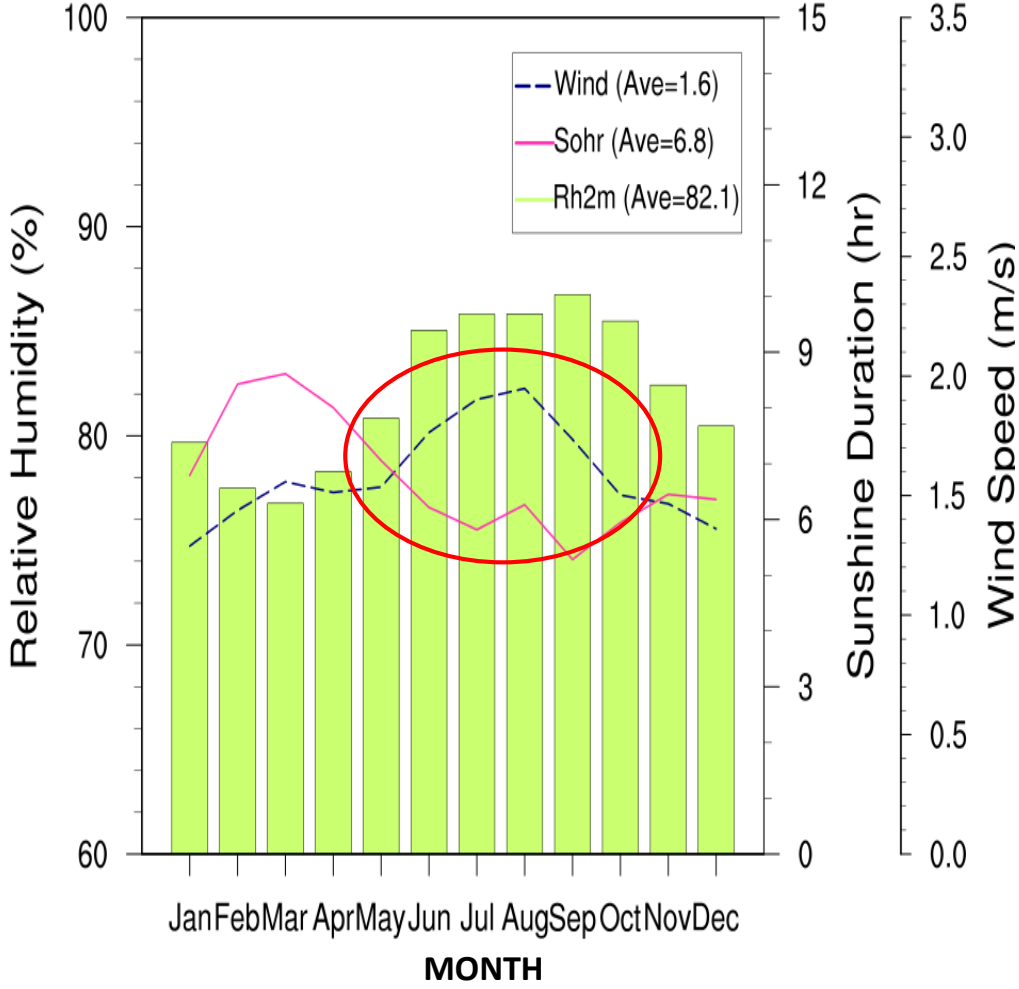
Observed Rainfall over MRD (35 Years; 1981-2015)

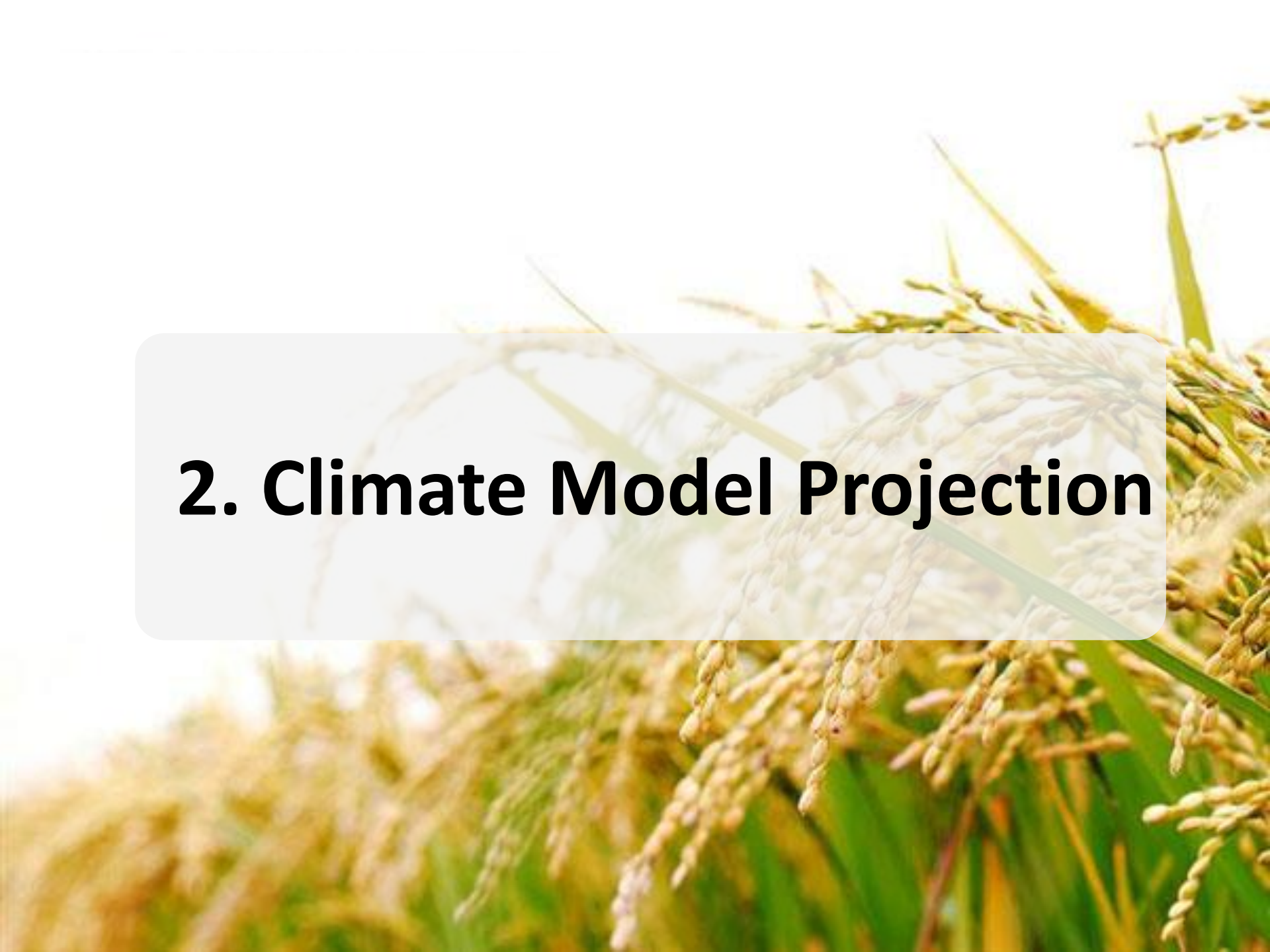


Present Climatology (2005-2014)

Two Seasons: Hot/dry; Cold/wet (southwest monsoon: May to Oct)



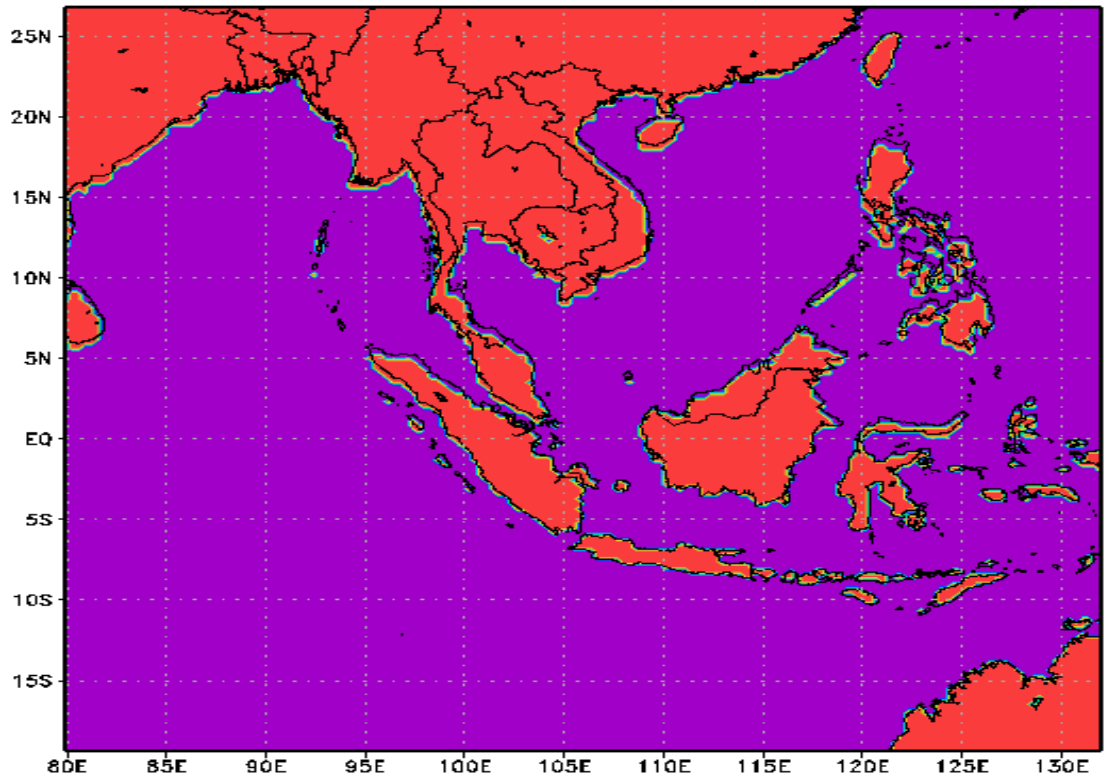




2. Climate Model Projection

Dynamical Downscaling Domain: Southeast Asia

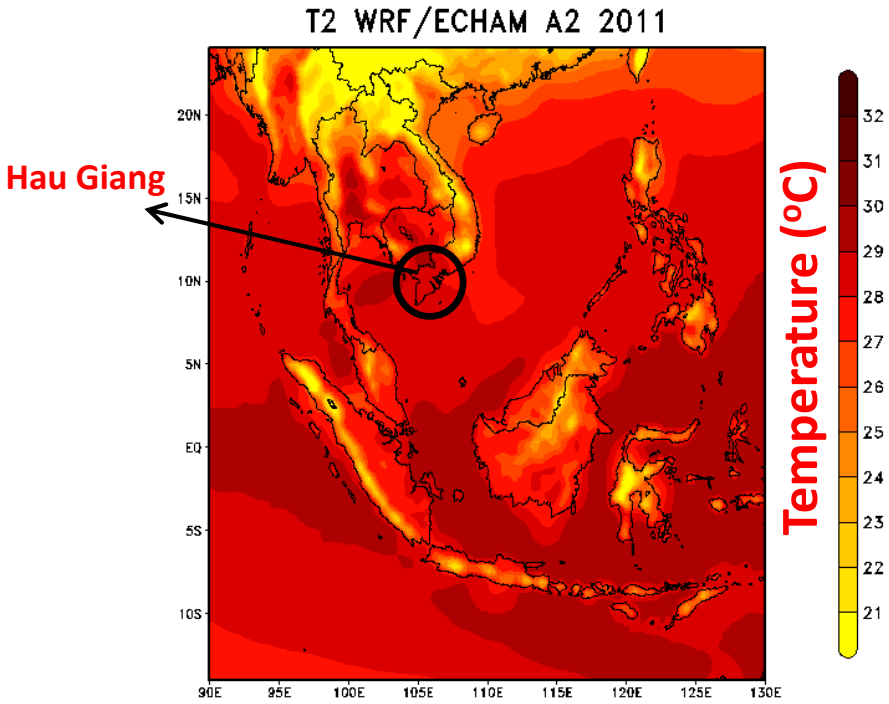
GCM	Resolution	Emission
CCSM3	1.4° x 1.4°	A1FI, **A2**, A1B
ECHAM5	1.8 ° x 1.8°	**A2**, A1B
MIROC	2.8 ° x 2.8°	**A2**, A1B



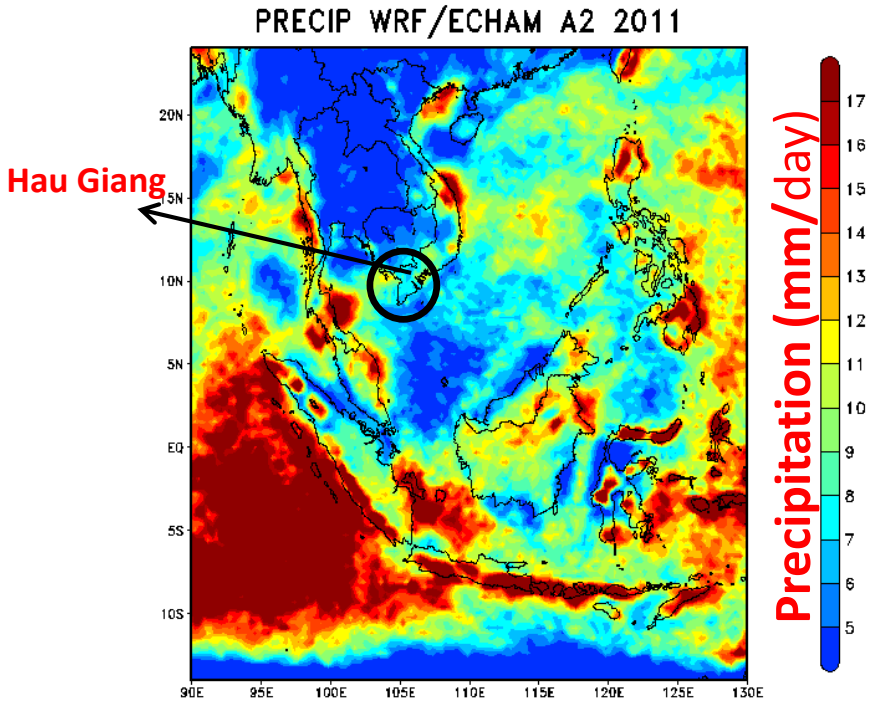
Spatial Resolution: 30 x 30 km

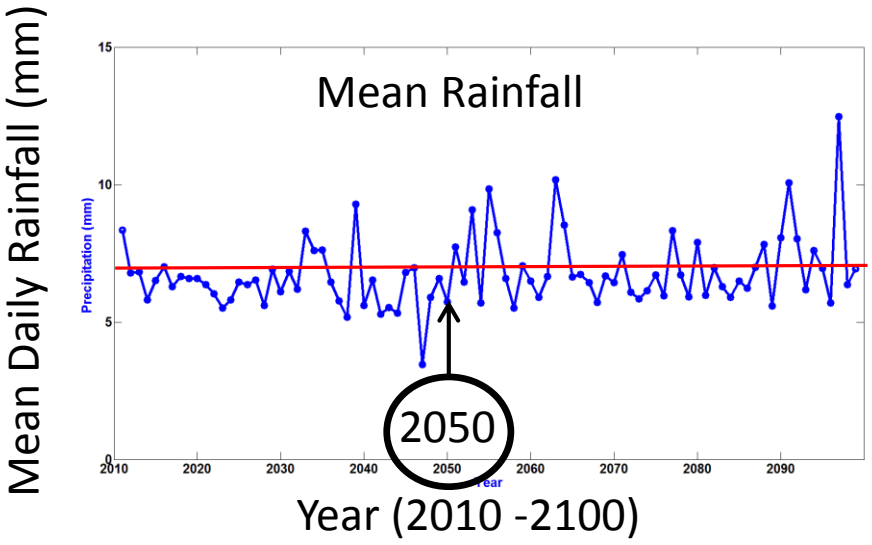
Model Used: WRF (NCAR)

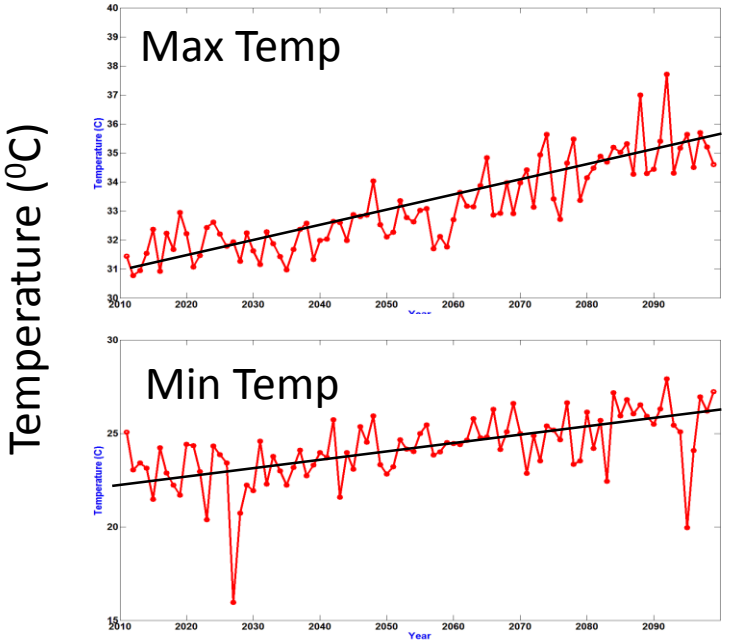
Projected Temperature



Projected Precipitation







3. Crop Model Calibration and Validation (Hau Giang)

Field Survey (Hau Giang province)

Seasonal Experiment Setup in DSSAT

		Inputs	Source/Name/Type
Present	Calibration	Weather	Observation data
		Cultivar	Fragrant Rice (OM4900)
		Soil	Riverine Fluvial Soil (Hau Gang 2015)
		Management	Constant flood depth; with fertilization
	Validation	Weather	Observation data
		Cultivar	Fragrant Rice (OM4900HG, Calibrated)
		Soil	Riverine Fluvial Soil (Hau Giang 2015)
		Management	Constant flood depth; with fertilization
Future		Weather	GCMs: CCSM, ECHAM, MIROC
		Cultivar	Fragrant Rice (OM4900HG, Calibrated)
		Soil	Riverine Fluvial Soil (Hau Giang 2015)
		Management	Constant flood depth; with fertilization

Model: DSSAT (Decision Support System for Agrotechnology Transfer)

Model Calibration and Validation

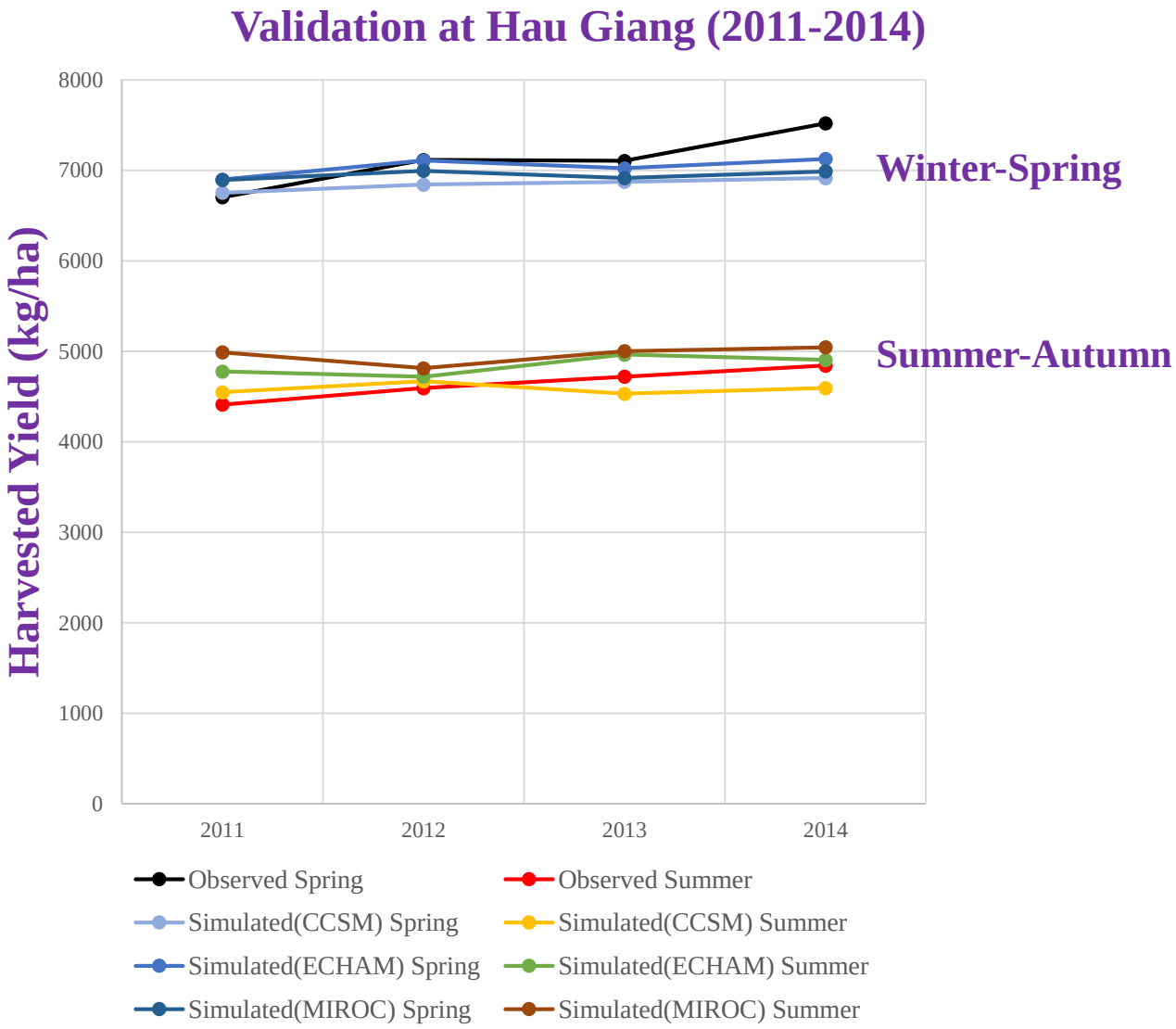
Calibrated cultivar coefficients:

Coefficient	Explanation	Unit	Initial Value	Calibrated Value
P1	Thermal time between emergence and basic vegetative phase	°C	625.5	594.2
P2R	Extent to which phasic development leading to panicle initiation is delayed (thermal time)	°C	312.6	282
P5	Thermal time between grain filling and physiological maturity	°C	393.6	499.9
P20	Critical photoperiod or longest day length at which the development occurs at maximum rate	hours	12	13.23
G1	Potential spikelet coefficient	-	55	69.3
G2	Potential single grain weight under ideal growing conditions	gram	0.0265	0.0265
G3	Tillering coefficient under ideal conditions	-	1	1
G4	Temperature tolerance coefficient	-	1	1
PHINT	Thermal time between emergence of successive leaf tips	°C	83	83

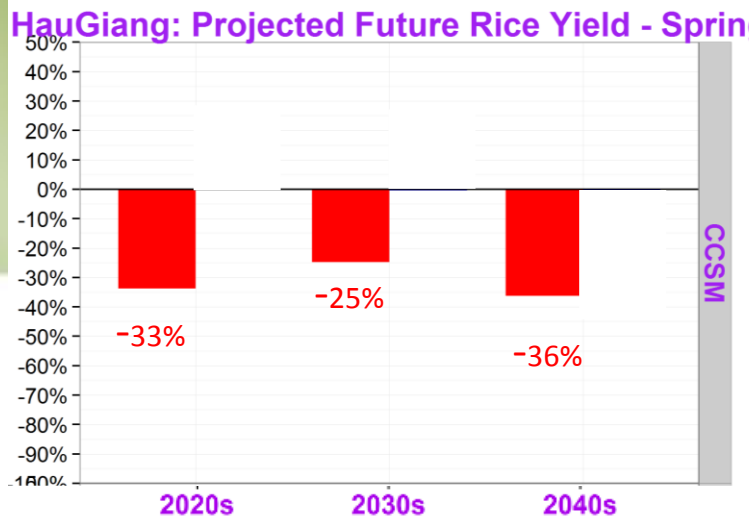
	Calibration		Validation	
Main growth and development variables	**SIMULATED**	**MEASURED**	**SIMULATED**	**MEASURED**
Anthesis day (dap)	62	62	63	60
Physiological maturity day (dap)	95	95	95	95
Yield at harvest maturity (kg [dm]/ha)	5824	5827	5573	5490
Unit weight at maturity (g [dm]/unit)	0.0265	0.026	0.0265	0.026

4. Projected Crop Yield in 2020-2050 (Hau Giang)

Model Validation



Projected Future Rice Yield (2020-2050)



Winter-Spring Season

Projected changes in potential yields relative to 2004-2014 mean(%)

Rainfed Crop Yield: About 24% REDUCTION!

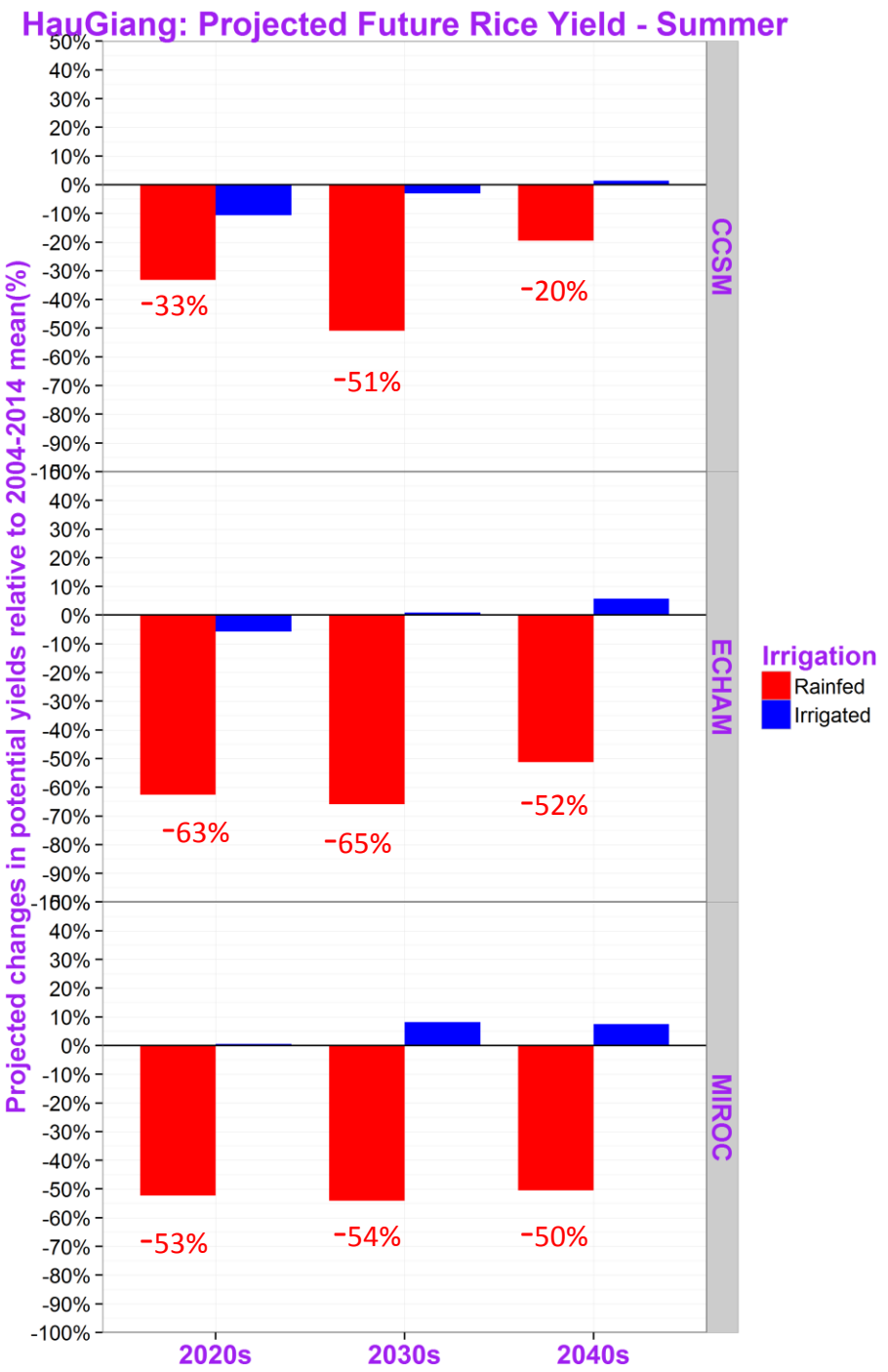
Projected Future Rice Yield (2020-2050)

Summer-Autumn Season

Projected changes in potential yields, relative to 2004-2014 mean(%)

Rainfed Crop Yield: About 49% REDUCTION!

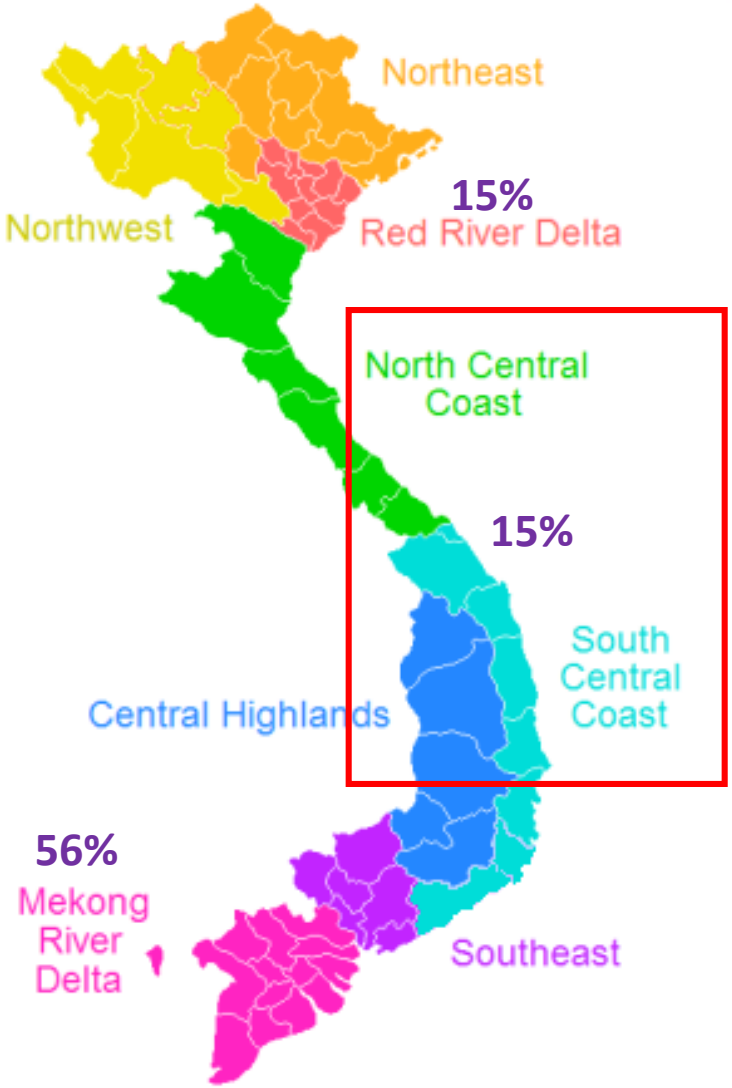
AVERAGE from both Seasons: ~35%



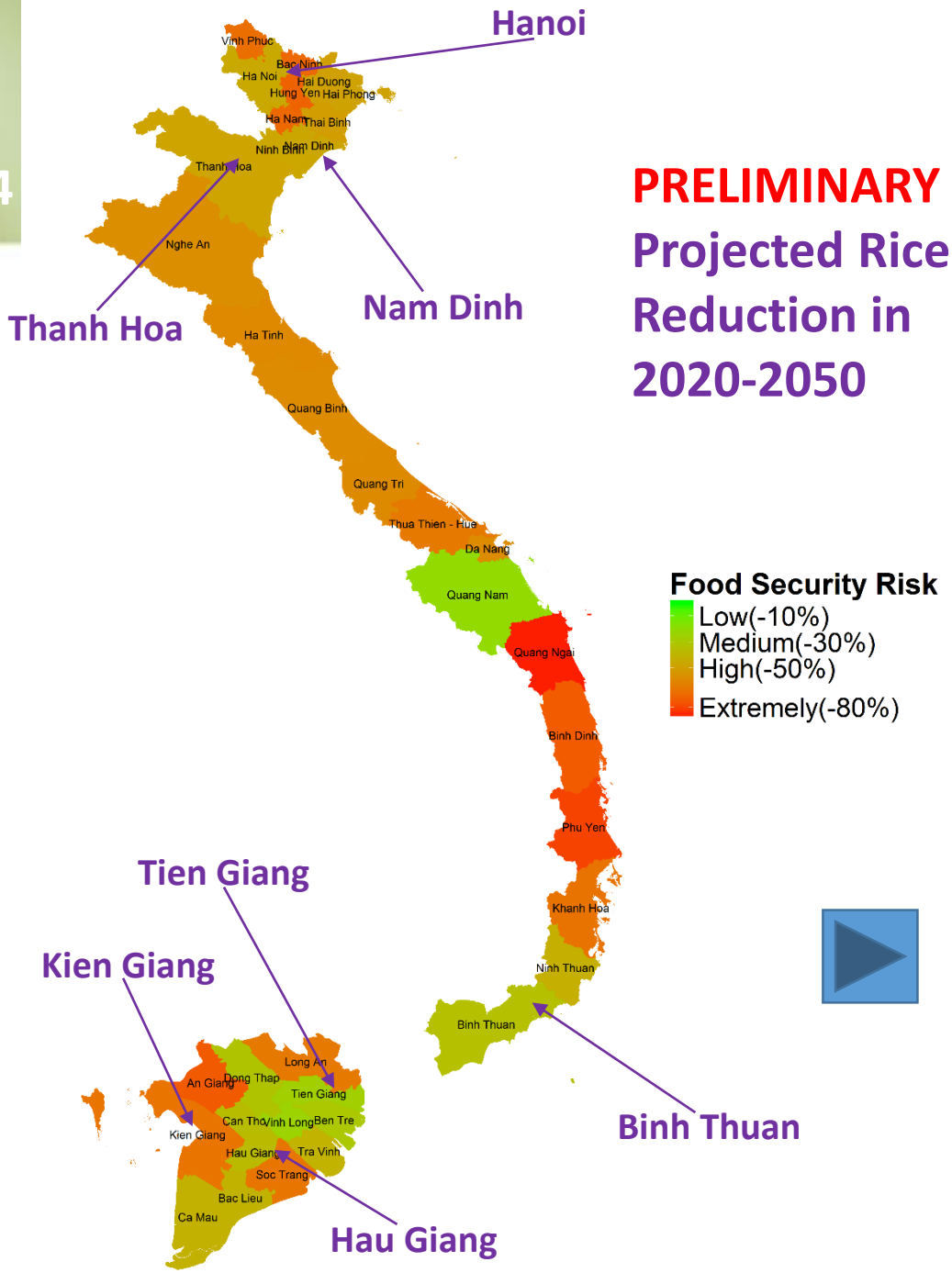
Results from other study areas?

Food Security Risk

Share of Paddy Production in 2014



PRELIMINARY
Projected Rice Reduction in 2020-2050



Source: Figure from Wikipedia and Data from General Statistics Office of Vietnam

5. Conclusions

Conclusions (based on Hau Giang's study only)

- **Significant rice production reduction of about 35% is projected in 2020-2050 period --- as rainfall amount is projected to decrease.**
- **Irrigation could significantly improve crop yield. However, the challenge is to find water sources.**
- **Planting&Growing seasons may have to shift following the changing rainfall periods.**
- **To consider new breed of rice cultivars which require less water consumption.**
- **With (1) 90% of rice export from Vietnam originated from MRD; (2) Singapore's total rice import from Vietnam is about 30%; AND (3) rice yield is expected to reduce by 35% in 2020-2050 → essential information for Singapore's policy makers in their strategic planning (Price increase and Food Security)**

Acknowledgements

"This research is supported by the National Research Foundation Singapore under its Campus for Research Excellence and Technological Enterprise programme. The Center for Environmental Sensing and Modeling is an interdisciplinary research group of the Singapore MIT Alliance for Research and Technology."

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Thank You.