Agricultural Decision-Making in Indonesia with ENSO Variability: Integrating Climate Science, Risk Assessment and Policy Analysis

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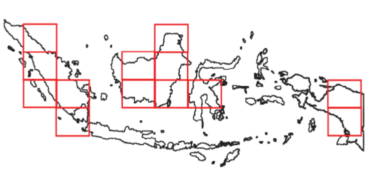
Context

The combined forces of El Nino-Southern Oscillation (ENSO) events and global warming are likely to have dramatic effects on future crop production and food security in Indonesia and other tropical countries. Indonesia consistently experiences dry climatic conditions and droughts during El Nino events, resulting in delayed production of rice—the country's primary food staple—and exacerbated problems of food insecurity among the poor.

Our preliminary analysis suggests that global climate change could cause Indonesia's "normal" climate state to be similar to an El Nino state currently. Unfortunately, global climate models (GCMs) link poorly to regional hydrologic conditions in the tropics, and have limited coverage of the Indonesian archipelago, excluding areas representing 75% of the population and 66% of the rice production (**Figure 1**). Therefore results from the GCM need to be further "downscaled" to understand the effects of global climate change on Indonesian hydrology and agriculture.

Figure 1. GCM Coverage of Indonesia



Project Objectives

- To build empirical downscaling models (EDMs) that link output from GCMs with regional-scale precipitation for Indonesia
- To estimate statistical relationships between downscaled rainfall patterns and crop production in Indonesia
- To construct a risk-assessment framework for analyzing critical thresholds of climate impact and adaptation strategies for coping with changed climate conditions in the agricultural sector

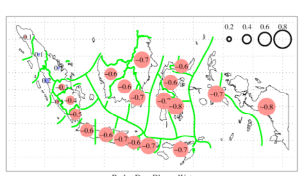
Downscaling

Our results show that the EDMs are:

• Skillful in predicting precipitation during the dry season (May-August) and during monsoon onset (September-December) (**Figure 2**)

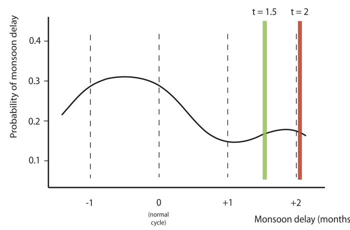
• Less skillful during the wet season and monsoon withdrawal (January-April).

Figure 2. Correlation Between Precipitation and ENSO, Sept-Dec.



Defining Critical Thresholds

Figure 3. Delay in Monsoon Onset and Rice Production



Effect of Monsoon Delay Onset on Rice Production*

Production period	Threshold value +1.5	Threshold value +2
Sep. - Dec.	-11%	-14%
Jan. - Apr.	- 9%	-12%
May - Aug.	+ 6%	+ 8%

*Based on the equation detrended production = α + β (months delay) for the period 1971-2004. All production effects significant at the 95% level.

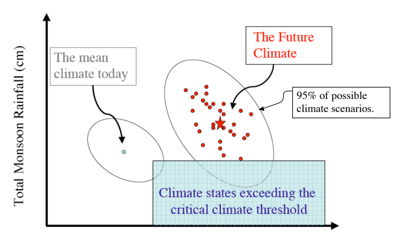
We have also been assessing various critical threshold indicators for future climate impacts on rice production and food security. Candidates include the duration of the monsoon, the percentage of "normal" rainfall in the wet season, and the delay in rainfall onset in the wet season. A late monsoon causes delay in planting and harvesting of rice, which prolongs the "hungry season" and can lead to rice price increases, with serious consequences for the poor. **Figure 3** shows the impacts on rice production at certain thresholds of delayed monsoon onset, based on rainfall data from 1971-2001.

Uncertainty

We will quantify the propagation of uncertainty throughout the analysis, including the effect of natural climate variability and uncertainties in the climate models and emission scenarios.

Figure 4: Probability distribution of monsoon rainfall and delay under current and future climate scenarios, and correspondence with critical thresholds.

Figure 4. Probability Distributions of Current and Future Climates



Year Two

• Estimate future (large-scale) climate using output from 20 GCMs used in the fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC).

•Construct EDMs to map large-scale circulation to regional precipitation in *both* today's climate and in a warmer world.

• Identify other critical threshold indicators for our risk assessment framework.
• Characterize the main patterns of uncertainty in the IPCC AR4 model simulations via principal components (PC) analysis.
• Explore the potential role of adaptation measures in promoting future food security in Indonesia.

Project website: http://fsi.stanford.edu/research/2007/