The Use of Climate Information for Decision Making

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Simulation of 20th Century Climate Change?

IPCC PROJECTIONS SHOULD NOT BE USED BLINDLY, ESPECIALLY AT LOCAL-to-REGIONAL SCALES

(Shin and Sardeshmukh, Climate Dynamics, 2011)
Climate Variability & Change in SE South America - DJF

**Temperature**
- raw
- trend
- decadal
- interannual

**Precipitation**
- raw (mm/month)
- decadal (mm/month)
- interannual (mm/month)

- ~0%
- 17%
- 80%
- 21%
- 8%
- 69%
Necessary Elements of Useful Climate Information System for Decisions

- Informed expectations of future climate change
- Awareness of the role of decadal variability in our experience of ‘trends’
- Incorporation of reliable Seasonal Climate Forecasts
EXAMPLE: Expansion of agricultural frontier in Southeastern South America

FIGURE 1. Changes in soybean cropping area over time for Argentina. One dot = 1000 ha. Lines delimit Southeastern South America region shown in Figure 2.

... largely coincident with increases in precipitation
Observations

IPCC Models (CMIP5)
Precipitation Trends: % of total variance

20th Century Gridded Observations -- Annual Means

Climate Variability & Change in SE South America - DJF
“Learn from the Past”: Historical Analyses:

• Climate characterization: Interannual Variability, Decadal Variability, Trends
• Assess interventions with crop simulation models (e.g., combination of planting dates, crop type depending on IRI’s Seasonal Climate Forecasts/ ENSO phase)

“Present”: Environmental Monitoring:

• Test CMORPH vs. Observed Rainfall
• Vegetation Indices with MODIS
• Soil Water Balances based on Climate and Soil Types

Forecasting:

• IRI Seasonal Climate Forecasts, National SCF (Met Service + University)
• Training at Regional Level, connected to RCOFs
Severe Droughts in Uruguay

Drought 1999: Ministry and National Emergency System prioritized responses based on SCF and Monitoring

Drought 2008/09: Ministry declared Emergency in subregions based on NDVI and Soil Water Balance

Summer 2010: Minister asked parliament for emergency funds based on IRI’s SCF

Ministry of Ag Estimation of the Cost of 2008/09 Drought:
- Direct cost in Livestock production sector: US$ 300 M
- Total cost on National Economy: over US$ 1,000 M
Climate Risk Management Approach and Tools

Information and Decision Support Systems
Different Spatial Resolutions: Region → Country → Provinces, counties → Users

Different Temporal Resolutions: Seasons → Decades → Climate Change

Easily Understandable: Inform Decisions, Planning, Development
IDSS: Integrate Sciences to Inform Decisions

State of the Art Science $\rightarrow$ Understandable Products (Decisions, Policies)

**Examples “IDSS Approach”**
- Early Warning Systems
- Reservoir Optimization
- Crop Forecasts / Food Avail.
- Crop Disease/Pest Outlooks
- Climate Index Insurance
- Energy Generation (Biomass)
- Early Response to Emergencies
Need to Integrate Climate at Different scales, Agro, Policies, etc. Use Applied Systems Approach and Tools to Inform Decisions

Analyze possible impacts and responses:

Climate Information, Scenarios

Interventions
- Technologies
- Management
- Policies

Possible Outcomes

Simulation Model
(Crop, Livestock, Energy)

Analyze a wide range of alternatives and Possible impacts in different climate scenarios:

Inform Planning and Decision Making

Uncertainties?
Analyze possible impacts and responses: (Information and Decision Support Systems - IDSS)

Interventions
- Technologies
- Management
- Policies

Possible Outcomes (Probabilistic)

Climate Information, Scenarios

Simulation Model

Analyze a wide range of alternatives and possible impacts in different climate scenarios:
Inform Planning and Decision Making Including UNCERTAINTIES!
Take Away Points

1 – Climate related decisions must consider more than just climate

2 – Models contain useful information, but are not yet ready to be applied “off the shelf”

3 – In the absence of ‘accurate’ predictions, knowing the range of possibilities can support robust decision making

4 - Incorporation of reliable Seasonal Climate Forecasts is key to management of climate-related risk
Precipitation Trends: **Magnitude** of variance

20th Century Gridded Observations -- Annual Means

[Map showing precipitation trends with color-coded standard deviation values.]

Temperature Trends: Percent of total variance

20th Century Gridded Observations -- Annual Means
Precipitation Decadal Variability: % of variance

20th Century Gridded Observations -- Annual Means

http://iridl.ldeo.columbia.edu/maproom/./Global/./Time_Scales/
Climate Variability & Change Globally

Annual Mean Temperature

- 65%
- 13%
- 21%

(Greene, Goddard & Cousin, EOS, 2010)
Climate Variability & Change in South Africa – Annual Mean

**STOCHASTIC SIMULATIONS: 2 Ensemble Members**

Example from South Africa, Western Cape

(Greene & Co-authors, Climate Dynamics, 2012)
Decadal Prediction?
Precipitation Correlations
- data smoothed to 5x5 deg
- Annual Mean data
- 2-9 year lead

Context
Agricultural Decisions
Climate Trend
Variability Wx
### Attribution of Precipitation Trends (1960-99) over Southeastern South America

#### Context

**Agricultural Decisions**

**Climate**

**Trend**

**Variability**

**Wx**

#### Summary

<table>
<thead>
<tr>
<th>Change [mm/month]</th>
<th>GPCC (Obs)</th>
<th>ozone-only AGCM (1)</th>
<th>ozone-only CGCM (3)</th>
<th>all forcings (1)</th>
<th>all forcings (40)</th>
<th>GHG-only (3)</th>
<th>ozone-only (3)</th>
<th>all forcings (Obs. SST) (3)</th>
<th>all forcings (CGCM) (3)</th>
<th>GHG-only (1)</th>
<th>ozone-only (1)</th>
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#### Time-slice integrations

- CMAM
- CAM3

#### CAM3 (LDEO) historical

#### CCSM4 CMIP5 historical single-forcing

#### CCMVal2 historical integrations

- WACCM
- CMAM
CORRECTING PATTERNS of 20TH C TRENDS for application to 21ST C PROJECTIONS

Temperature Trend DJF 1949–2000, UEA Observations

Temperature Trend DJF 1949–2000, IPCC Run 1

Temperature Trend DJF 1949–2000, IPCC Ensemble Mean

Temperature Trend DJF 1949–2000, IPCC Run 3

Temperature Trend DJF 1949–2000, CPT Run 1

Temperature Trend DJF 1949–2000, Mean of CPT Runs 1–3

Temperature Trend DJF 1949–2000, CPT Run 3

Observed (CRU TS2.1) TEMPERATURE Linear Trend 1949–2000

IPCC Model (Raw)

IPCC Model (+CPT)

r = 0.53

r = 0.91

r = 0.46

r = 0.89
Example

Expected Changes in Climate versus Expected Changes in Crop Prices

• Decisions on Policy (e.g., Ministries of Agriculture, Development Agencies)

• Decisions on Management (e.g., Farmer advisers, Farmers, Agribusinesses)
Increased demand: China, India

Price increase 2000 to 2009:

- Soybeans: 108% (2012 = >640 US$/Ton)
- Rice: 154%
- Maize: 100%
- Meat: 17%
Soybeans: Sown Area in SE South America

Argentina

Paraguay

Price increase 2000 to 2009: 108%

Area increase 2000 to 2010: AR = 110%, BR = 71%, PY = 127%, UY = 100 fold

Brazil

Uruguay
Science and Society: Information Networks

(Very) Simplified Example in Agriculture

- Understand the Network (links, processes)
- Define priorities
- “Target” users (problems/demands)
- Strengthen links, communication