CONNECTING SEASONAL PREDICTIONS INTO DECISION-MAKING IN THE GREATER HORN OF AFRICA

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NASA - GREATER HORN OF AFRICA (GHA) PROJECT GOAL

Seasonal prediction of hydro-climatic extremes (droughts and floods) in the GHA given the challenges of an evolving climate conditions and diverse information needs to support mitigation and adaptation strategies.

NASA Theme: Understanding Earth system Vulnerabilities to Climate Extremes
Investigators

PI: T. Tadesse (National Drought Mitigation Center, UNL)
B. Zaitchik (John Hopkins University)
S. Habib (NASA Goddard Space Flight Center)
C. Funk (Climate Hazard Group, UCSB)
G. Senay (USGS Earth Resources and Observation Science Center)
T. Dinku (IRI, Columbia University)
F. Policelli (NASA Goddard Space Flight Center)
P. Block (University of Wisconsin-Madison)
G. Baigorria (SNR/Agronomy & Horticulture, UNL)
S. Beyene (Institute for Ethnic Studies, UNL)
B. Wardlow (UNL)
M. Hayes (National Drought Mitigation Center, UNL).
... and many other experts and institutes.
Project Objectives

Objective 1
Characterize and explain large-scale drivers in the ocean-atmosphere-land system associated with years of extreme flood or drought in the GHA
Lead: Ben
(Chris/Tufa/Tsegaye)

Objective 2
Evaluate the performance of state-of-the-art seasonal forecast methods for prediction of decision-relevant metrics of hydrologic extremes
Lead: Ben/Shim
(Chris/Gabriel/Shahid/Fritz/Tufa/Paul/Brian/Mike/Gul/Tsegaye)

NASA_IDS_GHA
Seasonal Prediction of Hydro-Climatic Extremes in the GHA under Evolving Climate Conditions to Support Adaptation Strategies
Lead PI: Tsegaye

Objective 3
Apply seasonal forecast systems to prediction of socially relevant impacts on crops, flood risk, and economic outcomes, and assess the value of these predictions to decision makers
Lead: Tsegaye/Shim
(Gui/Paul/fritz/Gabriel)

Objective 4
Evaluate the robustness of seasonal prediction systems to evolving climate conditions
Lead: Ben/Chris
(Tufa/Shim/Tsegaye)
Evaluation of the CHIRPS Satellite-based Rainfall Products over Eastern of Africa

Key:
- ARC: African Rainfall Climatology version 2
- TAMSAT: Tropical Applications of Meteorology using Satellite data
- CHIRP: Climate Hazards Group Infrared Precipitation
- CHIRPS: CHIRP combined with station data
- ENACTS: Enhancing National Climate Services for Africa

Results:
- both CHIRP and CHIRPS products are significantly better than both ARC and TAMSAT

(Dinku et al, 2016)
Badr et al. (2014)

Identifying Climatologically Homogeneous Regions
- A critical step for generating statistical forecast models
- Also critical for interpreting and evaluating dynamical models
- **Method:** Hierarchical Clustering in R (HiClimR)

HiClimR is an open source regionalization tool (available at https://cran.r-project.org/web/packages/HiClimR/index.html)
Evaluation of probabilistic forecast

- The Ranked Probability Skill Score (RPSS) presented here, evaluates the distance between the forecast probability and observed probability.
- The RPSS for temperature is much higher than the precipitation and greater than 0.30 RPSS is apparent over a much larger part of the domain.

A Hybrid approach

Precipitation

Temperature

Forecast lead 0 months to 5 months (Shukla et al., 2015)

(Funk et al., 2014)
Satellite-based Evapotranspiration anomaly (Satellite ETa)

\[ \text{ETa} = \text{Ks} \times \text{Kcp} \times \text{ETo} \]

(Senay et al, 2015)

http://earlywarning.usgs.gov/fews/search/Africa/EastAfrica
Figure. VegOut database, process (regression-tree rules generation), and outlook map production. (Tadesse et al., 2010, GIScience & Remote Sensing)
Schematic diagram of the project

Predicting Climatic/Hydrologic Extremes in the GHA under Evolving Climate Conditions

- Retrospective Evaluation of Drought Prediction Models
  - Statistical Methods
  - Dynamical methods
  - Statistical Projection

- Drought & Flood Forecast Systems and Indicators
  - CFS v2
  - GMAO-ESF
  - VegOut
  - CFS-Hybrid
  - Statistical Regression
  - Machine Learning

- Droughts and Floods Frequency, Severity, Forecasts, and Impact Models/Products

- Decision Makers/Users

- Climate Model Projections
  - CMIP5

- Drought & Flood Impact Analysis and Crop Model
  - CSM-DSSAT
  - CREST
  - EMM
  - FEWS NET Food Security Maps
  - Crop Calendar
  - Others

Participatory System Design and Evaluation

- Objective Regionalization of Distinct GHA Climatic Subregions
  - Hierarchical Clustering based on precipitation reanalysis using
    - CRU data
    - FEWS data
    - NMA Merged satellite data

- Analysis of Large-scale Drivers
  - Ocean-Atmosphere-Land system

- Evaluation of Forecast Methods
  - Retrospective Forecast Experiments

Apply Seasonal Forecast System to Prediction of Socially-relevant Impacts on Crops, Flood Risk, and Economic Outcomes
Drought monitoring and Early Warning Systems

Improved EWS:
- Allows for early detection of drought and floods
- Helps in decision making for preparedness, mitigation, and adaptation
- Provides actionable information for decision makers
A General Framework to Link Seasonal Predictions into Decision-making and Disaster Management in the Greater Horn of Africa

(Tadesse et al. 2015)
Two Participatory Research Workshops conducted:
- 11-12 August, 2014 and 28-29 July, 2015, Addis Ababa, Ethiopia

Participants include from: international organizations, development NGOs, national agencies and universities in Ethiopia, Kenya, and South Sudan, Tanzania, Somalia, and South Africa

Objective: Characterize the value of existing systems and identify key time horizons, prediction targets, and uncertainties relevant to decision makers

The iterative nature of action research (Source: Damme 1998)

Source: http://www.agrotechconsult.com/what-we-do/field-surveys-/Source: and-participatory-research
Engagement Methods - Tools for Analysis

- Qualtrics Survey Software
- Sticky Wall
- Clickers
- Adobe Connect-Webinars
- Small groups (World Café)
- Logic Models
  - Resources-Activities-Outputs-Outcomes (short- & long-term)
- Community Capital Framework Model with Appreciative Inquiry technique
The Community Capitals Framework

Involves framing community capacity in terms of seven types of capitals (resources or assets)

- Offers a practical framework for researchers, practitioners, and local stakeholders to engage in dialogue about how to effectively build community resilience and reduce vulnerability to impacts, such as climate change

- **Built Capital**
- **Natural Capital**
- **Cultural Capital**
- **Human Capital**
- **Social Capital**
- **Political Capital**
- **Financial Capital**

- Economic Security
- Healthy Ecosystem
- Social Inclusion

(From Flora, 2004)
# The Community Capitals

<table>
<thead>
<tr>
<th>Capital</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>Includes air, water, soil, wildlife, and weather that surround a community. Forms the basis for all capitals.</td>
</tr>
<tr>
<td>Built</td>
<td>Human constructed infrastructure that facilitates the livelihood or well-being of a community. Includes technology, bridges, roads, and buildings.</td>
</tr>
<tr>
<td>Financial</td>
<td>The financial resources available to invest in a community for capacity building. Includes income generation, foreign aid, and changes in poverty.</td>
</tr>
<tr>
<td>Political</td>
<td>The ability of a community to turn norms and values into standards, rules, regulations, and whether or not they are enforcement.</td>
</tr>
<tr>
<td>Human</td>
<td>The capabilities and potential of individuals. Includes people’s health, knowledge, skills, and motivation.</td>
</tr>
<tr>
<td>Social</td>
<td>Reflects the connections among people and organizations. Consists of interactions within a specific group or community.</td>
</tr>
<tr>
<td>Cultural</td>
<td>Determines a group’s worldview, how it sees the world, what is often taken for granted and what is valued.</td>
</tr>
</tbody>
</table>

(Flora, 2004)
Survey Development

- Short Time Frame

- Survey was created for the NASA IDS workshop and approved by the UNL Institutional Review Board.

- Pre-Survey: demographics and perceptions of climate change impacts


Survey Results

Top TWO community assets with the highest response rate per capital.

- **Political**
  - Climate adaptation strategies or policies
  - Political or water-use conflict

- **Natural**
  - Plant and animal diversity
  - Water quantity

- **Human**
  - Health and disease
  - Quality of life

- **Built**
  - Water wells - number and capacity
  - Energy Projects

- **Social**
  - Population migration
  - Social networks and organizations

- **Financial**
  - Agricultural productivity
  - Number of people in poverty

- **Cultural**
  - Sustainability practices
  - Gender and/or age-based roles
Survey Results

In your country, have you seen or heard about changes (either positive or negative) in any of the following, because of climate extremes (such as flooding or drought)?

- Natural
- Built
- Financial
- Political
- Social
- Human
- Cultural

<table>
<thead>
<tr>
<th>Category</th>
<th>Yes</th>
<th>No</th>
<th>I Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>84%</td>
<td>13%</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>Built</td>
<td>81%</td>
<td>15%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Financial</td>
<td>79%</td>
<td>15%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Political</td>
<td>73%</td>
<td>24%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Social</td>
<td>69%</td>
<td>29%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Human</td>
<td>67%</td>
<td>31%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Cultural</td>
<td>59%</td>
<td>34%</td>
<td>7%</td>
<td>2%</td>
</tr>
</tbody>
</table>
Second Participatory Research Workshop on Seasonal Prediction of Hydro-climatic Extremes in the Greater Horn of Africa

- Linking seasonal prediction products to decision-makers and users through small group discussions on agriculture (both crop and livestock production systems), water resources, and disaster management.
- Seventy six participants, including experts from seven countries from the Greater Horn of Africa (GHA) and project co-investigators from the USA attended the workshop.
- Experimental seasonal prediction models were tested at the GHA, engage decision-makers and users in the assessment of hydro-climatic information needs, and use feedback to build a framework to support decision-making and disaster management. In pre- and post-workshop surveys, workshop participants were asked how the utility of forecasts to decision makers might be improved. Their recommendations are presented.

28-29 July 2015
Addis Ababa, Ethiopia

(Tadesse et al., 2016 - BAMS)
## Preliminary Results of the Survey

<table>
<thead>
<tr>
<th>Seasonal Forecast Tool</th>
<th>Easy/Very easy</th>
<th>Percent of participants that would use it</th>
<th>Months the Tool Most Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seasonal Precipitation Prediction for climatically homogeneous region across the Greater Horn of Africa</td>
<td>88</td>
<td>64</td>
<td>June-August</td>
</tr>
<tr>
<td>Satellite-based Evapotranspiration anomaly (Satellite ETa)</td>
<td>77</td>
<td>72</td>
<td>March-October</td>
</tr>
<tr>
<td>Seasonal hybrid (integrated climate-, satellite-, environmental-based) vegetation outlook (VegOut)</td>
<td>57</td>
<td>54</td>
<td>June-October</td>
</tr>
<tr>
<td>Corn Yield Estimate Tool [using “Decision Support Systems for Agrotechnology Transfer (DSSAT v.4.5) software]</td>
<td>85</td>
<td>53</td>
<td>April-September</td>
</tr>
</tbody>
</table>

(Tadesse et al., 2016 - BAMS)
Farmer Focus Group

- 2-hour focus group with approximately 10 farmers.
- The focus group interview at a farm located near Debre Zeit, in the Ada’a woreda of East Shewa District, Ethiopia.
- The interview was conducted in Amharic by Dr. Girma Mamo and translated by Andualem S. Shiferaw

East Shewa
Knowing when Rains will Start

- Traditional knowledge and experience
  - Shifts in the direction of the wind in mid- to late-June
  - Movement of clouds from higher to lower altitudes.
  - Expect a dry season every 4 years.
- Farmers would like better information about the onset and cessation dates of the main rainy season.

Knowing when Rains will End

- Tef and wheat harvest usually takes place in October, and lentils and chickpeas are harvested later than that.
- Farmers traditionally know when the crop are ripe for harvest, but would like information about any unseasonal rains at the end of the growing season.
- Unseasonal rainfall usually results in loss of seed quality.
- Too wet at the end of the season causes damage and yield loss to their chickpea crop.

(Haigh et al., 2015)
Linking Climate Info with Farm Decisions

• Food production - regionally-specific adaptations to annual patterns of temperature and precipitation

• Patterns of precipitation and temperatures are changing

• Drought and flooding - challenges to food security in East Africa.

• Climate information can inform adaptation and decision-making.

• But unless the climate info providers understand the decision-making context of farmers, the information provided is unlikely to be used to its potential.

• Future Research
  • Decisions driven by data vs cultural norms or traditions.
  • Better understand economic, social, and cultural implications of changing agricultural practices to adapt to climate variability or change.
  • Research informs development of higher quality climate information provision, as well as for informing research into agricultural adaptation to climate variability and change.
Conclusion

- The necessity in changing the paradigm shift from crisis to risk management.
- Improving drought monitoring and early warning systems in Africa is essential for food security and sustainable development.
- Need for improved or new seasonal prediction tools and products.
- Engaging decision makers in developing forecasting tool is efficient.
- Decisions calendars driven by data vs cultural norms or traditions.
- Better understand economic, social, and cultural implications of changing agricultural practices to adapt to climate variability or change.
Thank you for listening. Questions?