Climate Change and the Central American Mid-summer Drought – The Importance of Changing Precipitation Patterns for Food and Water Security

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Introduction & Background:

- Much of Central America experiences a rainy season with two peaks separated by a dry period of several weeks, termed the mid-summer drought (MSD).
- Smallholder farmers' food and water security in the region is influenced by their ability to anticipate its arrival and estimate its duration.
- Using surveys of farmer experiences along with precipitation observations and projections we characterize the MSD across much of Central America
- Using established MSD metric, we estimate projected changes in MSD characteristics, including earlier MSD onset, increasing duration and intensity.
- New farmer survey results are compared to findings from our climate analysis for the historic period, are used to interpret what MSD characteristics are of greatest interest locally,
- This ongoing work will assist in the development of local adaptation strategies.

Methods, Data Sources and Study Area:

Gridded Observations:

- Gridded observed daily precipitation, prepared originally at a spatial resolution of 1.0° latitude-longitude (Sheffield et al., 2006), and later refined to 0.25° resolution (approximately 25 km).

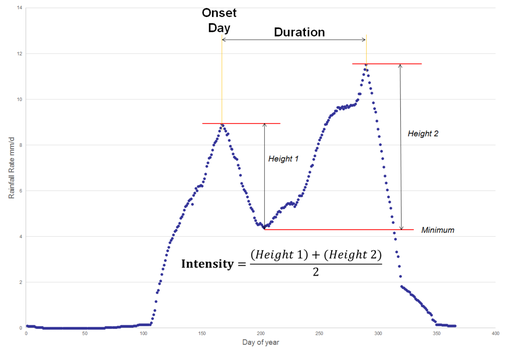
Climate Projections:

- Statistically downscaled climate projections produced by GCM runs from the 5th Coupled Model Intercomparison Project (CMIP5) .
- Use the same 0.25 ° gridded observations as baseline for bias correction/downscaling.
- BCSD method used for downscaling (Wood et al., 2004).
- 15 GCMs selected: all positively correlated with the MSD (Sheffield et al., 2013).

Case Study with Smallholders Nicaragua:

- Ethnographic research and household survey.

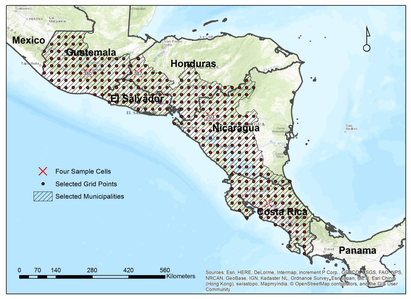
Climatological mid-summer drought definition:



- Adapts the method of Karnauskas et al. (2013), which was developed using monthly data.
- Following Alfaro (2014) triangular smoothing applied to suppress noisy daily data.
- Window of May 1 – September 30 used for analysis
  - MSD Onset set at day of peak intensity in first half of window
  - MSD end is the day of peak intensity in second half of window
- Analysis performed for 1970-99, 2040-69, 2070-99
- Statistical test for differences is Wilcoxon Signed-rank test

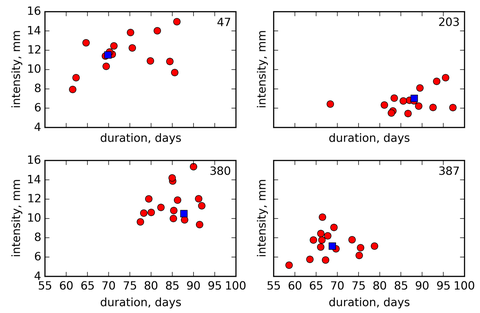
Study Area

- Central America municipalities within approximately 150 km of Pacific Coast; 303 Grid Points in 0.25° data set



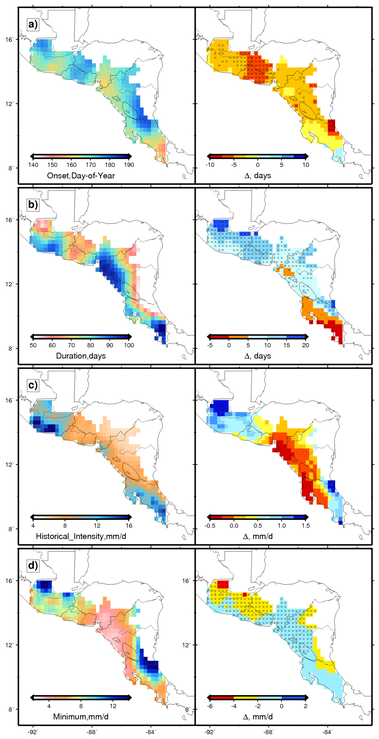
Downscaled GCMs simulate MSD metrics well

MSD mean duration and intensity at 4 points for 1970-99. Red=GCMs, Blue=Observations. Location number identified on map to left.



Projected changes: 2070-2099 minus 1970-1999

Multi-model ensemble mean historical values (left) and mean projected changes (right) for four statistics. Changes with an 'x' are statistically significant at α=0.05.



Onset Day

- Onset Day projected to occur earlier for most of domain
- Statistically significant changes across Northern areas.
- El Salvador and Honduras see about 1 week earlier MSD onset

Duration

- As with Onset Date, most significant changes in Northern areas
- Duration increases by 5-15 days in North
- Areas with decreasing duration are insignificant.

Intensity

- Varying changes in intensity across Central America
- Nearly all changes are not significant

Minimum

- Minimum value is projected to decrease across domain, averaging 26% decline
- Almost all changes statistically significant
- With little change in intensity, this suggests peaks decline along with minimum.
- Consistent with average precipitation decrease of 9.6%

Summary:

- Most significant impacts to MSD are in northern Central America
- Onset of MSD is projected to occur earlier
- Minimum intensity of MSD decreases by end of century, reflecting overall precipitation decline.
- These risks threaten rural livelihoods and food security, suggesting the need for adaptive action.

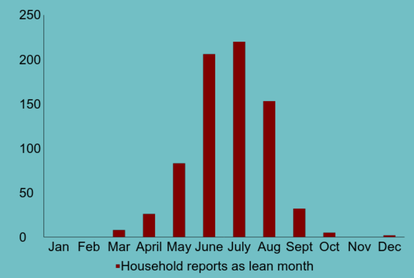
Spatial average results

Statistic	Historical Average Value (1970-99)	RCP 4.5: Average Change by 2040-2069	RCP 4.5: Average Change by 2070-2099	RCP 8.5: Average Change by 2040-2069	RCP 8.5: Average Change by 2070-2099
Intensity, mm/d	9.3	+0.6 (26%)	+0.3 (7%)	+0.7 (29%)	+0.4 (3%)
Duration, d	76.3	+5.6 (45%)	+4.5 (29%)	+5 (34%)	+8.4 (61%)
Date of Onset, day of year (date)	167 (June 16)	-2.0 (19%)	-1.9 (6%)	-2.0 (10%)	-3.6 (33%)
Minimum, mm/d	6.8	-1.1 (67%)	-1.1 (61%)	-1.3 (65%)	-1.8 (71%)

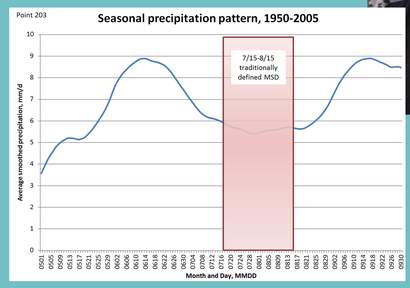
A Bottom-Up Recasting of the MSD Analysis

Adapt the **Participatory Action Research (PAR)** Approach (Minkler, 2000)

The MSD coincides with seasonal hunger



- This is related to the lack of other livelihood options, food prices, and crop failure risks, according to 368 household surveys conducted in 2014.
- Additional ethnographic research conducted in 2016 confirmed that farmers consider the MSD to be from July 15- Aug 15.



- Climatological peak-to-peak definition does not match farmers' concerns.
- New metrics are needed that capture this period, so projected changes can be anticipated.

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