Costa Rica Rainfall in Future Climate Change Scenarios

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Abstract

Studies of intraseasonal and annual cycles of meteorological variables, using projections of climate change, are nowadays extremely important to improve regional socio-economic planning for countries. This is particularly true in Costa Rica, as Central America has been identified as a climate change hot spot. Today many of the economic activities in the region, especially those related to agriculture, tourism and hydroelectric power generation are linked to the seasonal cycle of precipitation. Changes in rainfall (mm/day) and in the diurnal temperature range ($\^{\circ}$C) for the periods 1970-1999 and 2070-2099 were investigated using the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) constructed using the CMIP5 (Coupled Model Intercomparison Project version 5) data. Differences between the multi-model ensembles of the two prospective scenarios (RCP 4.5 and RCP 8.5) and the retrospective baseline scenario were computed. This study highlights Costa Rica as an inflexion point of the climate change in the region and also suggests an early onset of the rainy season and future drying conditions.

Costa Rica Rainfall in Future Climate Change Scenarios

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Abstract

Studies of intraseasonal and annual cycles of meteorological variables, using projections of climate change, are nowadays extremely important to improve regional socio-economic planning for countries. This is particularly true in Costa Rica, as Central America has been identified as a climate change hot spot. Today many of the economic activities in the region, especially those related to agriculture, tourism and hydroelectric power generation are linked to the seasonal cycle of precipitation. Changes in rainfall (mm/day) and in the diurnal temperature range (°C) for the periods 1970-1999 and 2070-2099 were investigated using the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) constructed using the CMIP5 (Coupled Model Intercomparison Project version 5) data. Differences between the multi-model ensembles of the two prospective scenarios (RCP 4.5 and RCP 8.5) and the retrospective baseline scenario were computed. This study highlights Costa Rica as an inflexion point of the climate change in the region and also suggests an early onset of the rainy season and future drying conditions.

Rainfall Behavior

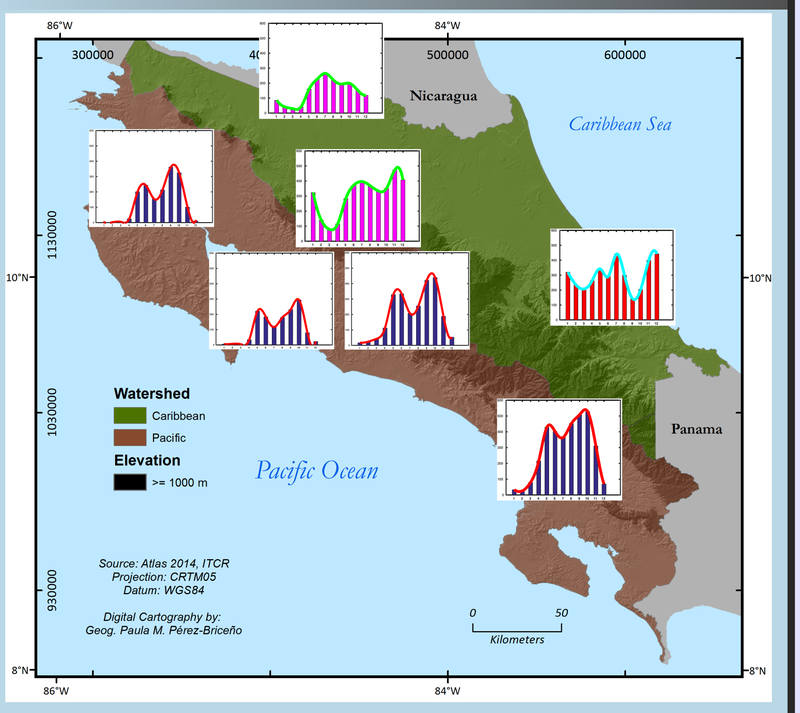

Fig. 1: Climatological Monthly Precipitation (mm/month) Distribution over Costa Rica using in-situ stations

Multimodel Ensembles

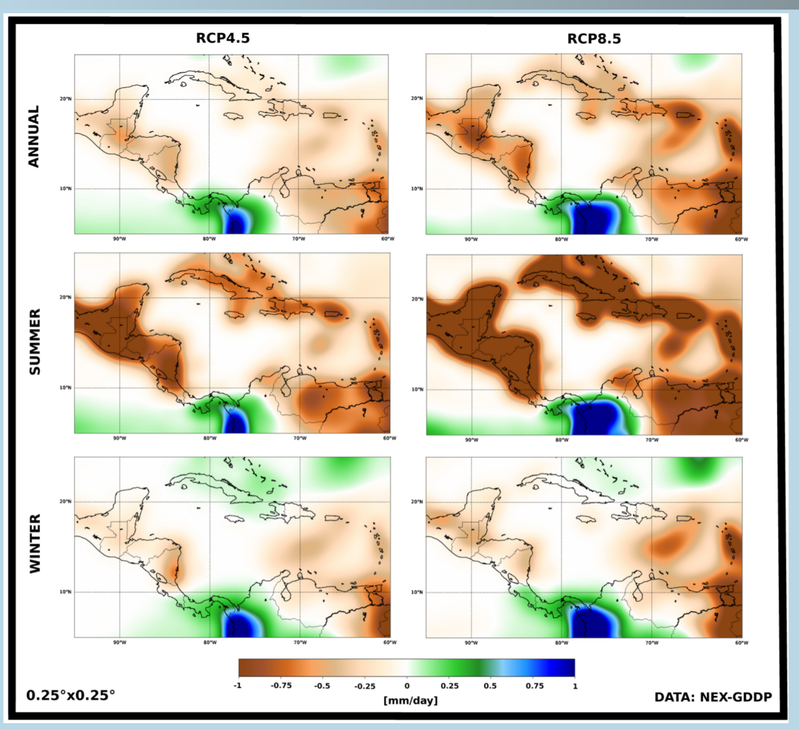

Fig. 2: CMIP5 Multimodel Ensemble Mean change in precipitation (mm/day) for 2070-2099 minus 1970-1999

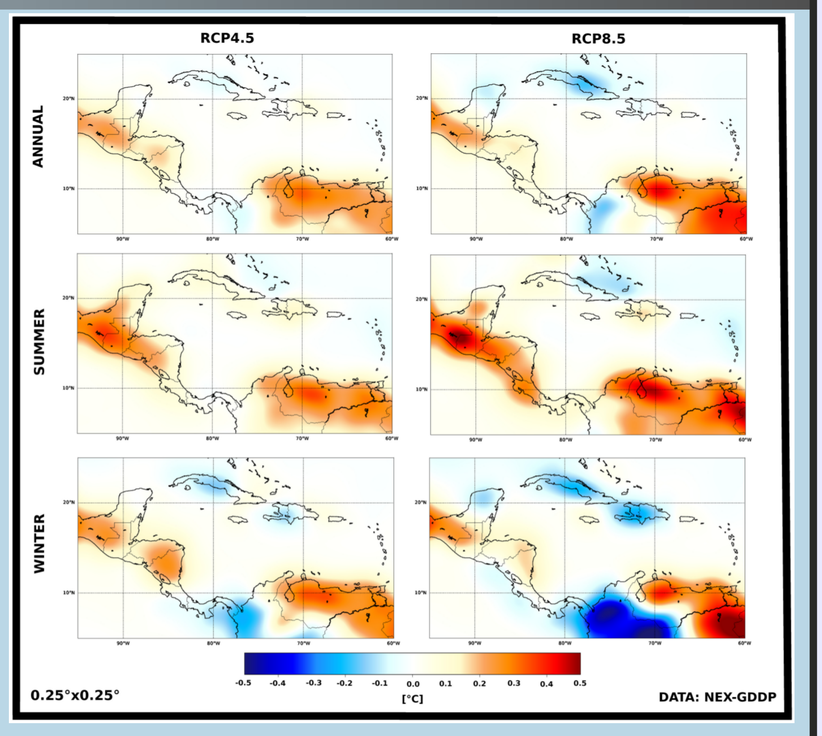

Fig. 3: CMIP5 Multimodel Ensemble Mean change in DTR (°C) for 2070-2099 minus 1970-1999

Data and Methodology

The following table summarizes the dataset specifications used in this research.

Table 1: Dataset Specifications

Dataset	NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP)
Size	12 TB
Spatial Resolution	$0.25° \times 0.25°$
Temporal Range	$1950 - 2005$ historical $2006 - 2100$ RCP (4.5 y 8.5)
Variables	*tasmin, tasmax, precipitation*
Reference	Thrasher and Nemani (2015)

The diurnal temperature range was compute as follow:

$$DTR = t_{max} - t_{min} \tag{1}$$

The multimodel ensembles of precipitation and diurnal temperature range studied in this research were perform using this equation:

$$\langle x \rangle = \frac{1}{n}\sum_{i=1}^{i=n} x_i \tag{2}$$

This study also used outliers detection in this way:

$$|x - \langle x \rangle| > 2\sigma \tag{3}$$

Costa Rican Analysis

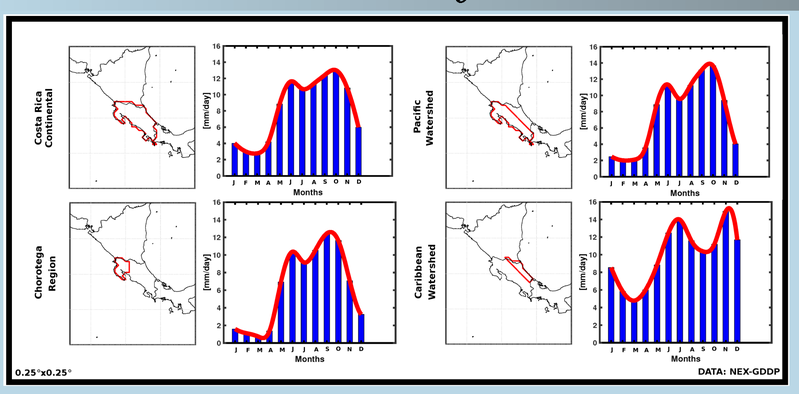

Fig. 4: CMIP5 Monthly Multimodel Ensemble Mean Precipitation (mm/day) for 1950-2005

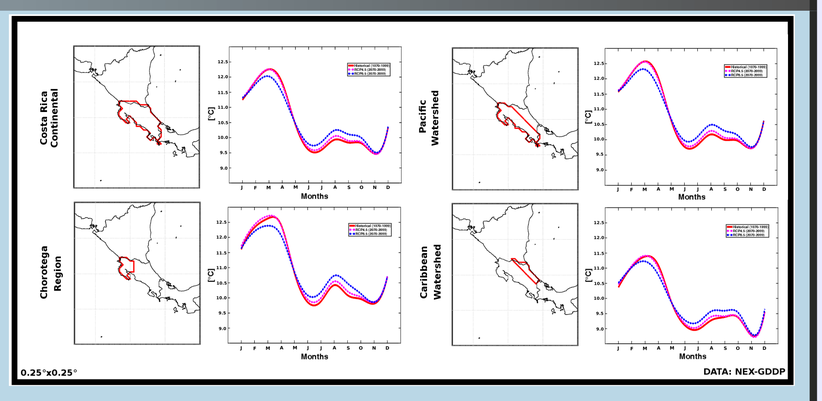

Fig. 6: CMIP5 Monthly Multimodel Ensemble Mean DTR (°C) over future scenarios

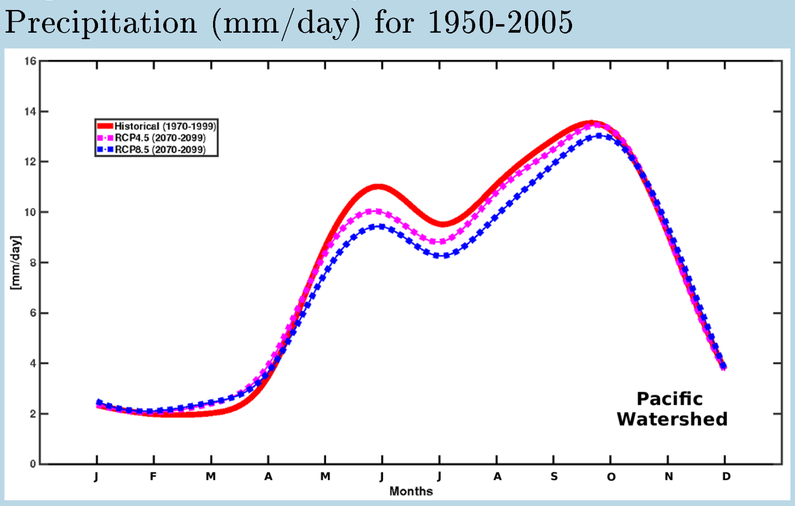

Fig. 5: CMIP5 Monthly Multimodel Ensemble Mean Precipitation (mm/day) over future scenarios

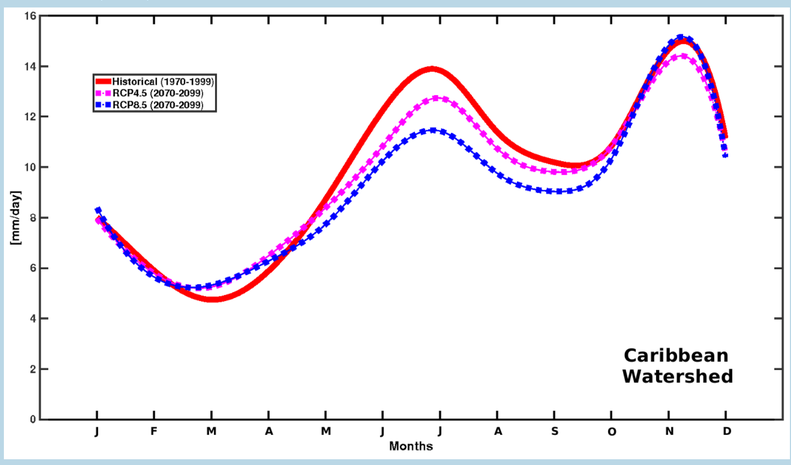

Fig. 7: CMIP5 Monthly Multimodel Ensemble Mean Precipitation (mm/day) over future scenarios

Conclusions

This work suggests that Costa Rica is the inflexion point of the climate change in the Central America region, identified as hot spot by Giorgi (2006). These results agree with those of Hidalgo et al. (2013) whose study projected climate in the 2050-2099 period to show median significant reductions in precipitation (as much as 5-10%) in northern Central America. Also the temperature pattern agrees well with their findings.

Acknowledgements

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