Increasing Variability of Wet and Dry Season Lengths in Southwestern Amazonia

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Introduction

- **The length of the dry season over Amazonia** is a critical factor regarding:
  - Rainforest health
  - Carbon sequestration
  - Human livelihoods
- Recent research has shown increasing dry season lengths in the region, especially over the heavily deforested southeastern Amazon basin[1]
- However, trends in dry season and precipitation across Amazonia are regionally variable[2]. More research is needed into region-specific climate dynamics and ecosystem responses
- Our research focuses on the less-studied and relatively intact Southwestern Amazon, specifically in the remote transborder region centered on Ucayali, Peru and Acre, Brazil.
- This area contains high levels of cultural and ecological diversity, and intact forest, but is also threatened by deforestation, forest degradation, agricultural expansion, and road construction.
- We combine remotely-sensed data with a network of in-situ meteorological rain gauge stations in order to address the following question:

Do we observe trends of increasing dry season length in the southwestern Amazon borderland region?

Objectives

Specifically, we sought to address:

- Has the length of the dry or the wet season changed over time?
- Has the quantity of precipitation changed in either the wet or dry season?
- To what extent do the remotely sensed data agree with observational meteorological station data in the region?

Data and Methods

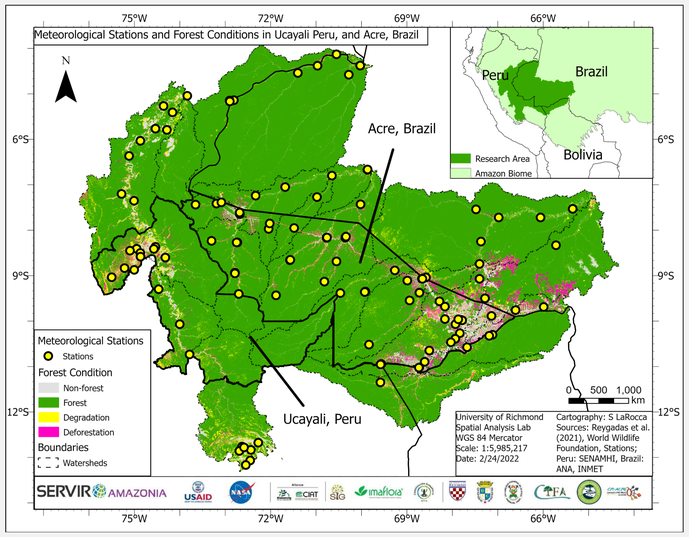

Figure 1: Region of interest including all watersheds connecting to the states of Ucayali, Peru and Acre, Brazil. Meteorological station data were sourced from Servicio Nacional De Meteorología e Hidrología del Perú (SENAMHI), Agencia Nacional de Aguas de Brasil (ANA), and the Instituto Nacional de Meteorología de Brasil (INMET). Forest conditions based on 2003-2020 forest conditions from Reygadas *et al.* (2021)[3]. Amazon biome area based on data from World Wildlife Foundation (WWF)[4].

- **Study Area:** includes all watersheds which connect to the states of Ucayali, Peru, and Acre Brazil, and timeframe as 1981-2020
- **Stations data: w**e utilized **a network of meteorological stations** with daily precipitation measurements across the study region. Of 121 stations, 90 were included in the analysis. Wet and dry season timing was defined using the Accumulation Anomaly method, based on daily precipitation quantities[5]
- **Remote sensing data:** we also used a **remotely sensed gridded dataset** of Characteristics of Rainy and Dry Seasons (RADS) calculated with precipitation from Climate Hazards Center InfraRed Precipitation with Station data (CHIRPS)[6]
- **Method:** trends in both datasets were assessed using the modified Mann-Kendall trend test[7]

Results

For annual values, no significant trends were observed in station data or remotely-sensed data for dry season length, wet season length, dry season precipitation, or wet season precipitation.

Using 30-year moving windows, no trends were observed in station data, however a **significant decrease in dry season length** (p<0.00)**, increase in wet season length** (p=0.03), and **increase in wet season precipitation** (p<0.00) was observed in remotely sensed data.

In the **30-year moving variance**, **significant positive trends** in station data for **dry season length** (p<0.00), **wet season length** (p<0.00), and **dry season precipitation** (p<0.00). For remotely sensed data, **significant positive trends were observed for all variables**; dry season length (p<0.00), wet season length (p<0.00), dry season precipitation (p<0.00), and wet season precipitation (p<0.00).

Discussion

The meteorological station data and remotely-sensed CHIRPS data were generally in agreement, however **only in the remote sensing data did we observe a significant (negative) trend in the length of dry seasons, and a (positive) trend in the length and precipitation in the wet season** using 30-year moving windows. These results contrast with recent findings of a positive trend in dry-season lengths in southeastern Amazonia (location of the arc of deforestation in Brazil) and demonstrate the value of research at regional scales within the Amazon basin.

An important result emerging from both datasets was the **increasing variance of dry and wet season lengths and precipitation**, indicating less predictable durations of rainy vs. dry seasonality. As timing of seasonality is an important factor regulating ecosystem processes, agricultural productivity, food security, and forestry activity these findings will have implications for the resilience of biotic and human systems in the region under continued climate and land use changes.

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