Assessing the impacts of extreme weather events on natural vegetation and agriculture in Belize using satellite imagery

BETSABÉ DE LA BARREDA-BAUTISTA

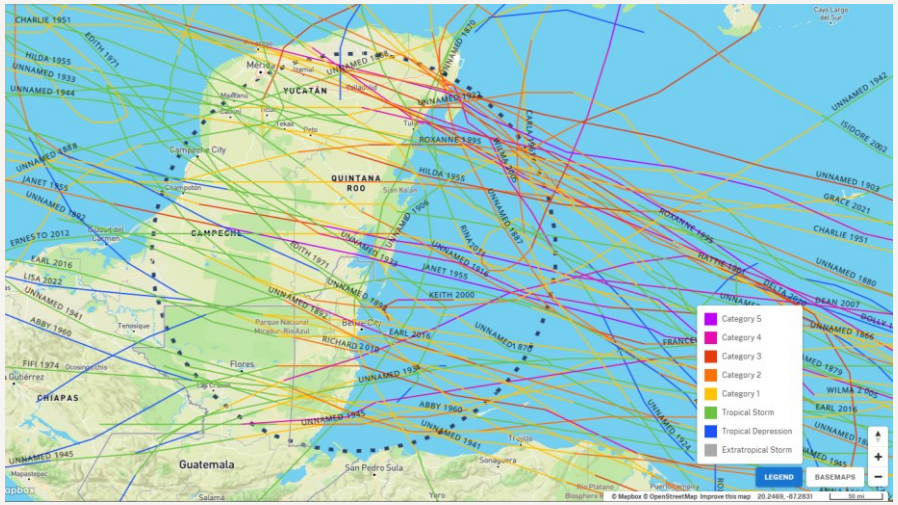
Sarah Metcalfe (PI), Georgina Endfield, Elizabeth Rushton, Franziska Schrodt, Oriol Gali, Sofia Mardero, Alec McLellan

Background

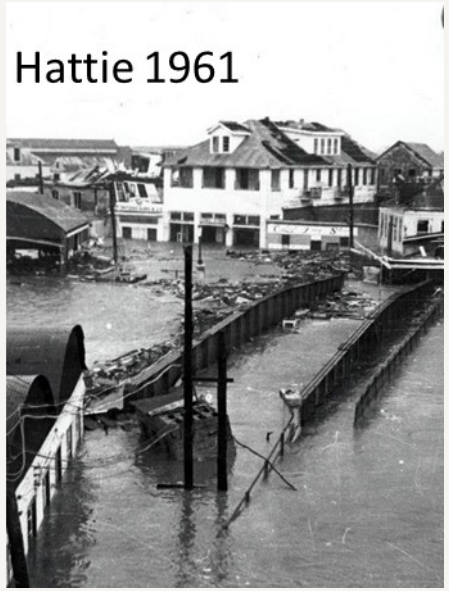
- Belize faces escalating climate risks
  - Rising temperatures, unpredictable rainfall, more intense storms, and frequent droughts

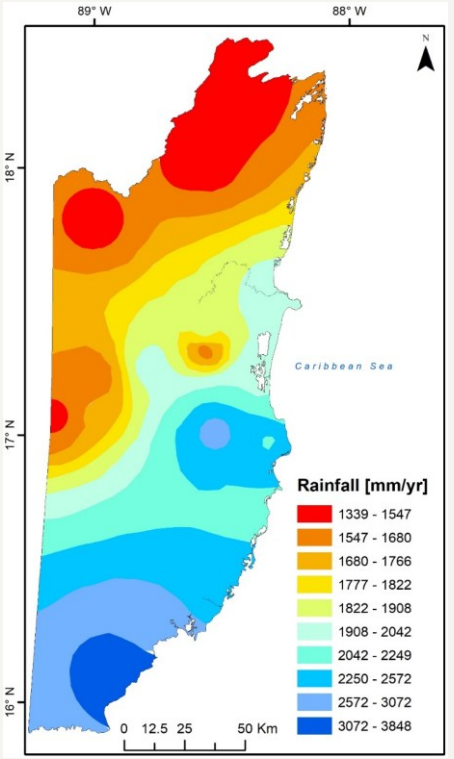
- These events pose threats to:
  - Communities and livelihoods
  - Agricultural systems
  - Ecosystems and the national economy

- ICARUS seeks to address these vulnerabilities with an interdisciplinary approach in Belize.



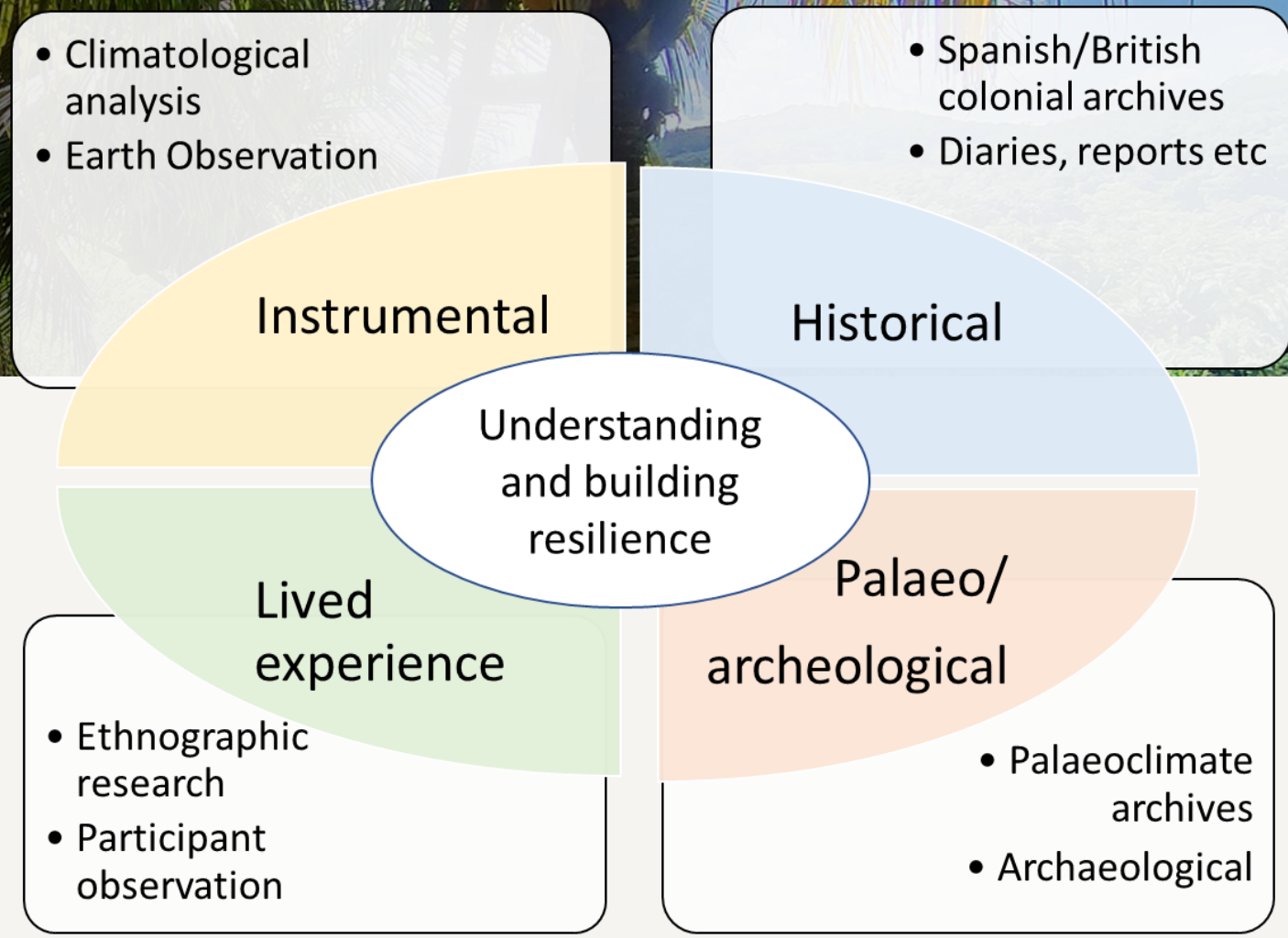
Historical Hurricane Tracks (NOAA)





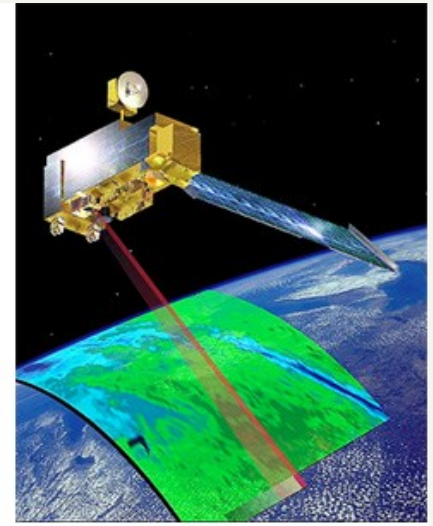
The 2019 drought caused over $38.5 million in agricultural losses.

Integrated ClimAte Resilience UnderStanding (ICARUS) Belize



To build climate resilience, we must understand the past, learn from it, listen to people today, use modern technology and data science

Monitor and assess the impacts using satellite imagery



MODIS (Nasa)

2002 – Present

250m spatial resolution

16-day data

Long-term trends

Sentinel-2 (ESA)

2015 – Present

10m spatial resolution

5-day data

High-detail images

VEGETATION INDICES

Vegetation health

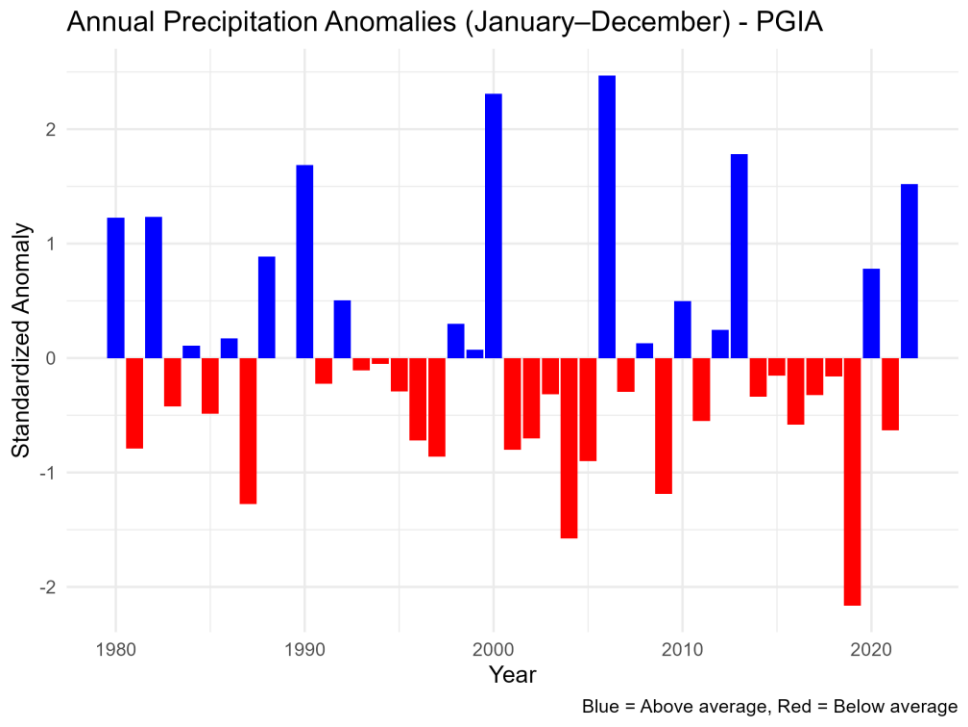
VS

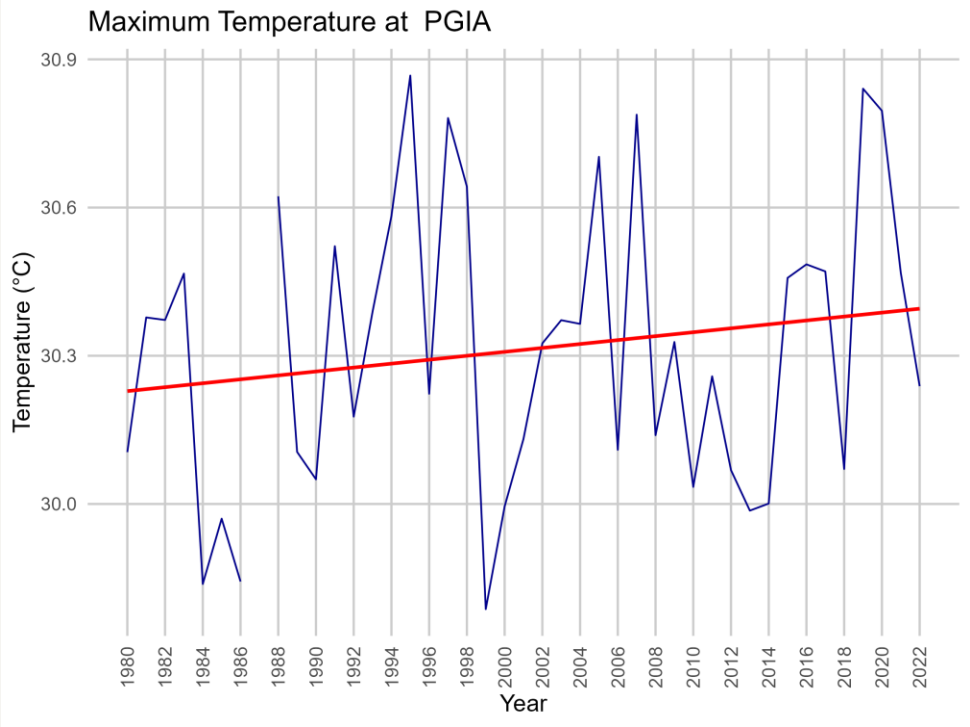
PRECIPITATION

Drought Indices

- Understand trends in productivity
- Understand correlation and causality
- The impact in different land covers
- The recovery of those

Trends: precipitation and temperature

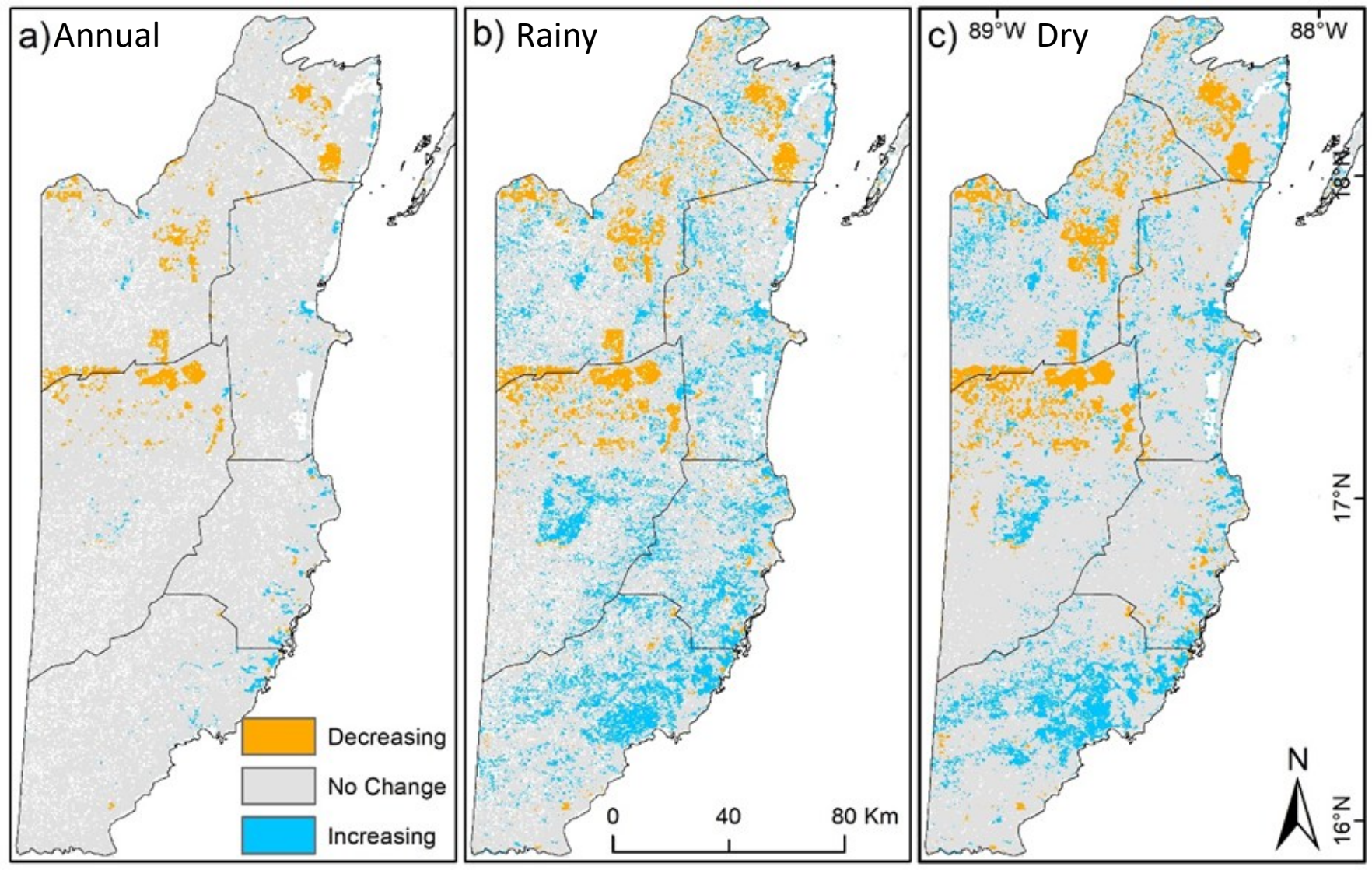




Precipitation patterns were variable across stations; central stations show declining totals and multiple dry years since 2014 with several sites recording reduced rainy-season precipitation

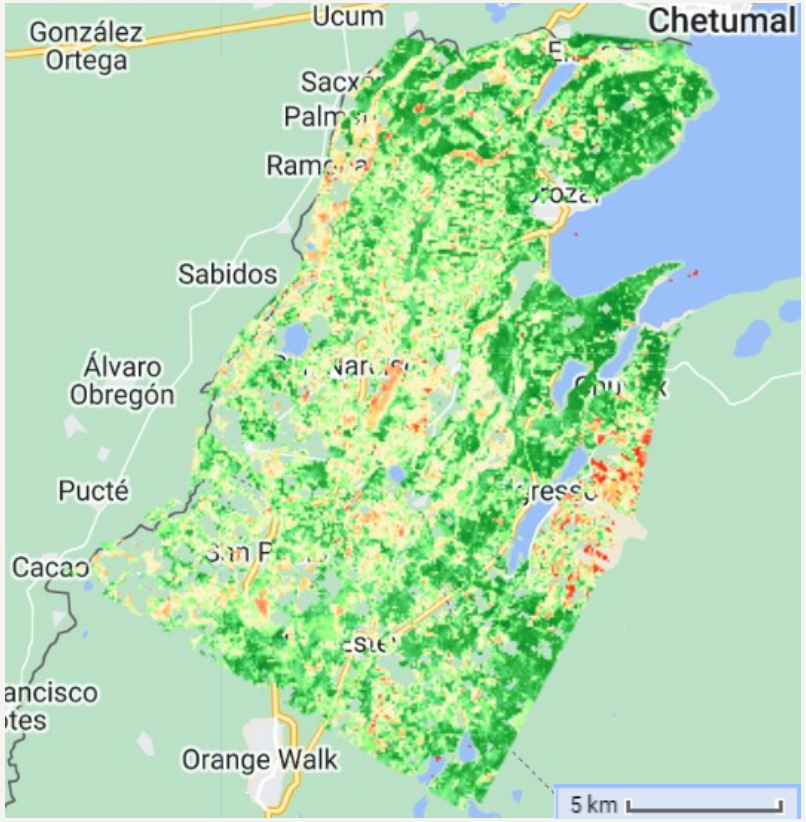
Across Belize, maximum temperatures, have consistently increased, aligning with stakeholder perceptions.

Trends: vegetation indices (2002 – 2022)

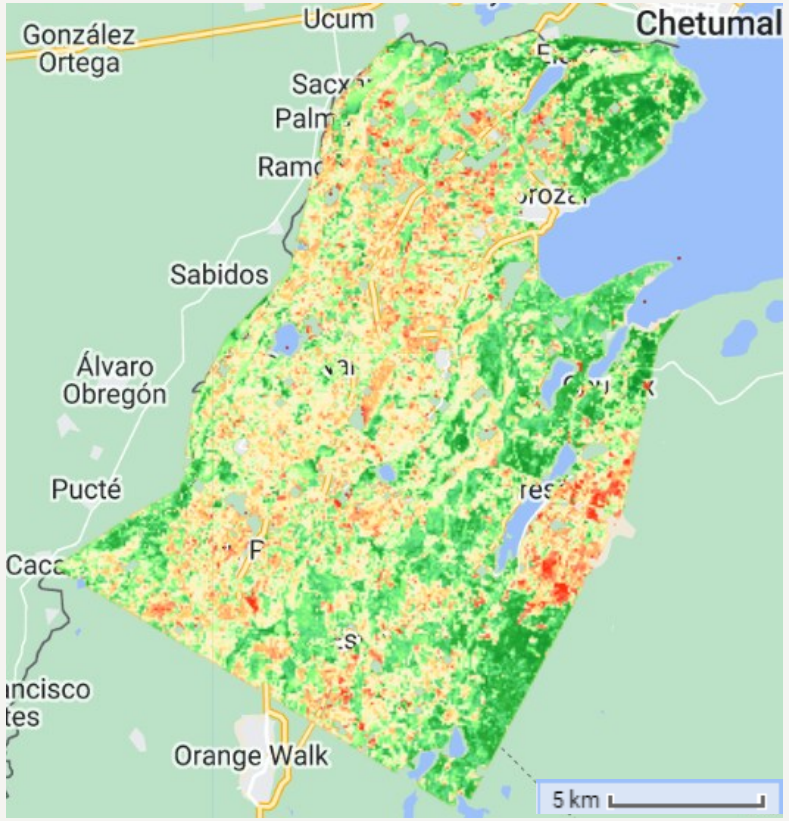


Impacts of drought 2019

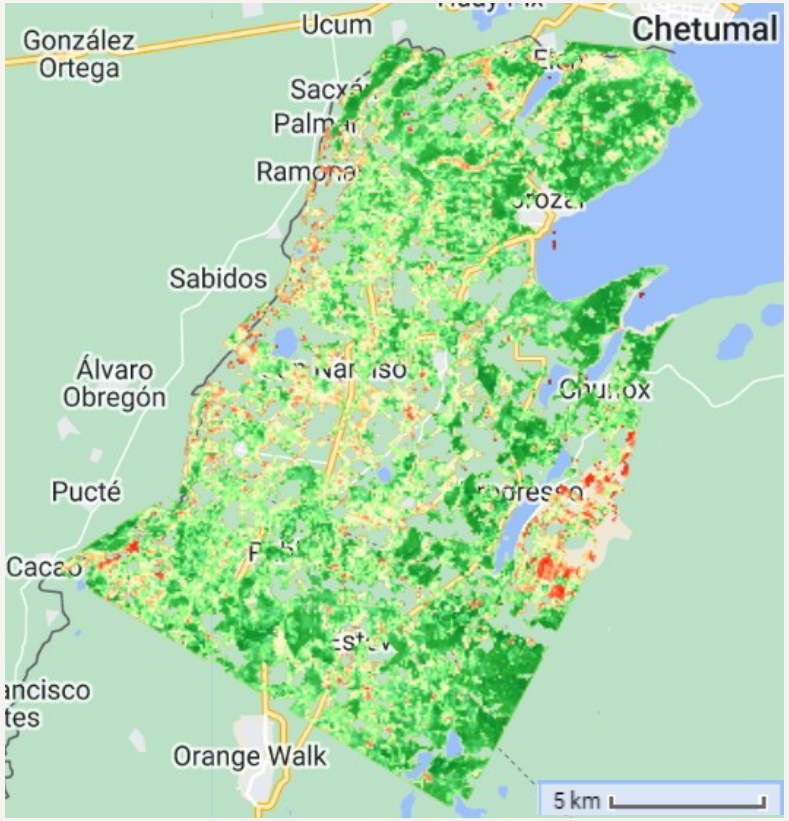
2018



2019

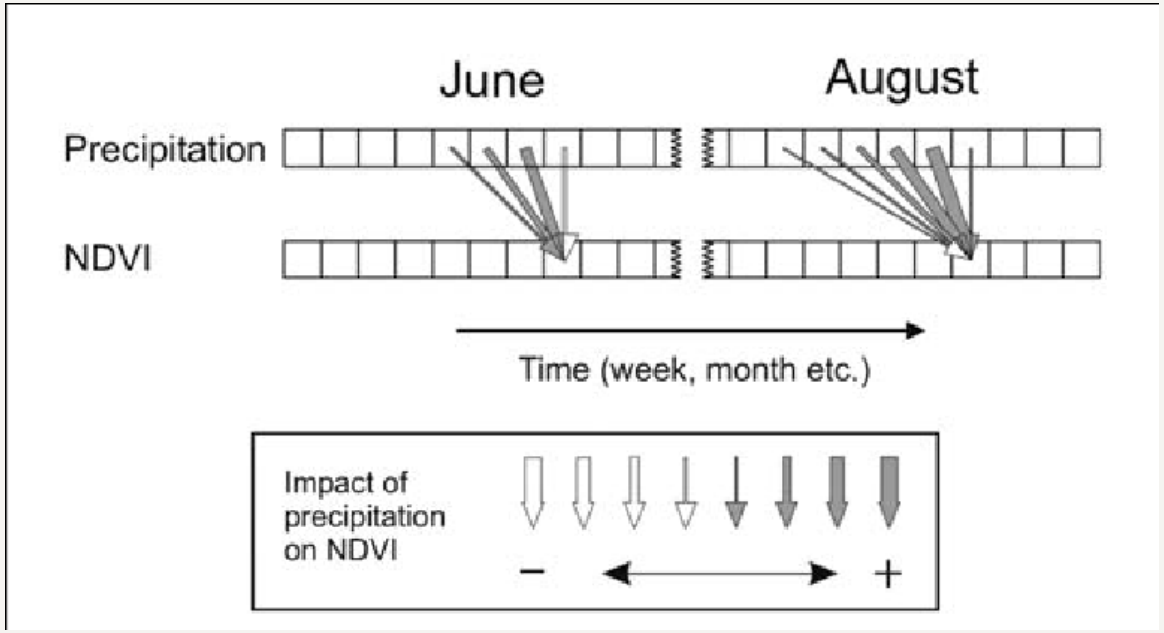


2020

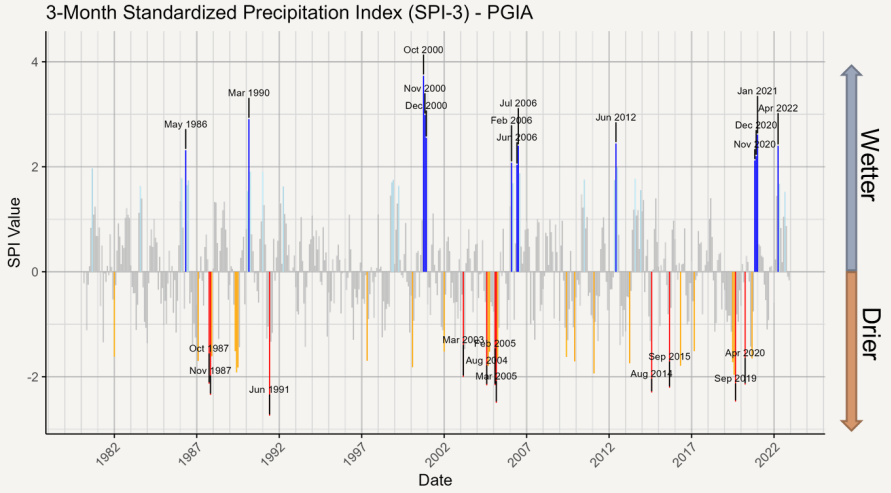


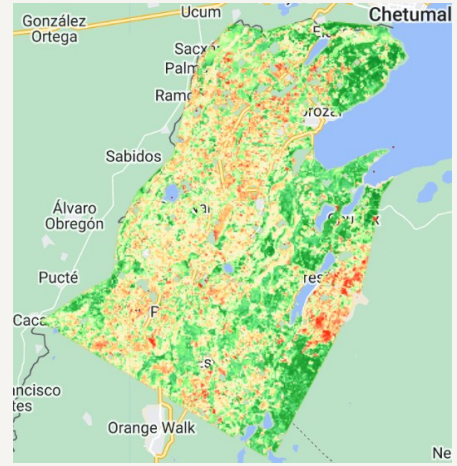
- S2 images from July and August

Rainfall – vegetation link



- Understand relationship and causation
- Analyse different land covers in different regions
- Knowing when and how vegetation responds to rain pinpoints the ecosystems/crops most vulnerable to drought
    - Climate-smart management



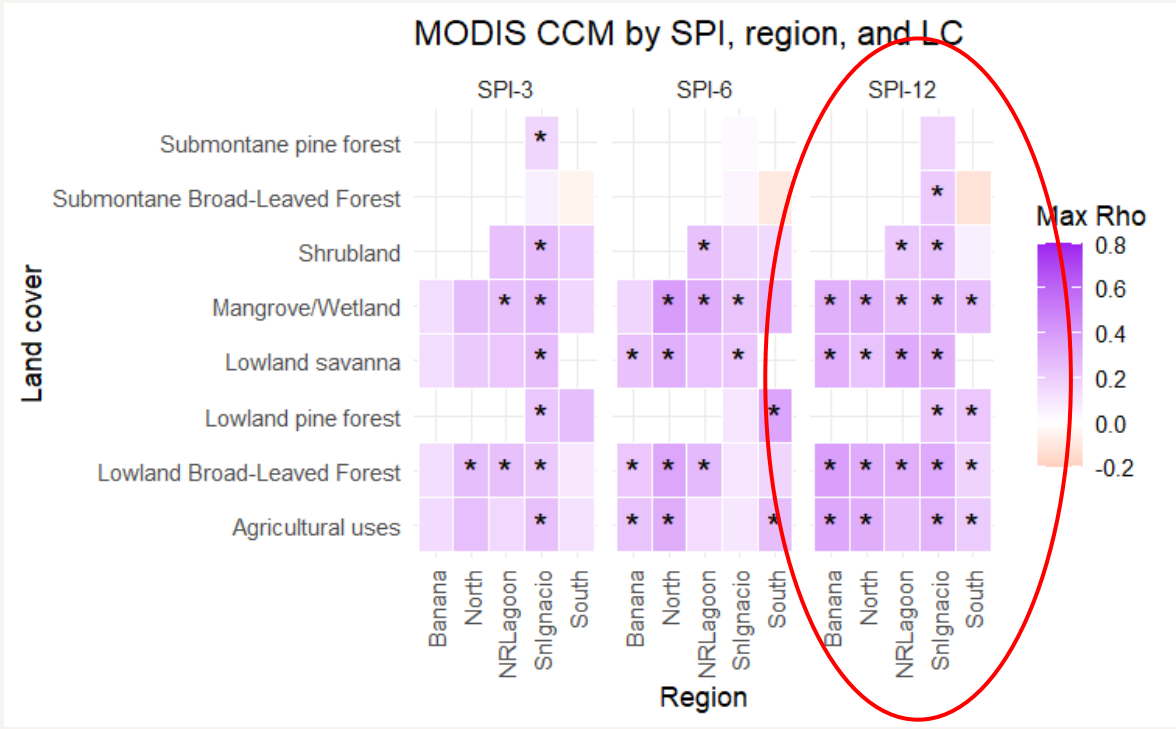


Rainfall – vegetation link – causality

Raw relationship

Land Cover	North	NRLagoon	San Ignacio	South	Banana
Agricultural uses	Lag 0 Rho = 0.71 **Strong** *	Lag 1 Rho = 0.67 Moderate *	Lag 0 Rho = 0.55 Moderate *	Lag 0 Rho = 0.42 Weak *	Lag 6 Rho = 0.63, Moderate *
Lowland Broad-Leaved Forest	Lag 1 Rho = 0.74 **Strong** *	Lag 1 Rho = 0.67 Moderate *	Lag 0 Rho = 0.57 Moderate *	Lag 0 Rho = 0.39 Weak *	Lag 6 Rho = 0.69 Moderate *
Lowland savanna	Lag 1 Rho = 0.66 Moderate *	Lag 6 Rho = 0.74 **Strong** *	Lag 2 Rho = 0.64 Moderate *	NA	Lag 0 Rho = 0.72 **Strong** *
Mangrove/Wetland	Lag 2 Rho = 0.75 **Strong** *	Lag 6 Rho = 0.56 Moderate *	Lag 4 Rho = 0.46 Weak, *	Lag 0 Rho = 0.44 Weak *	Lag 4 Rho = 0.71 **Strong** *

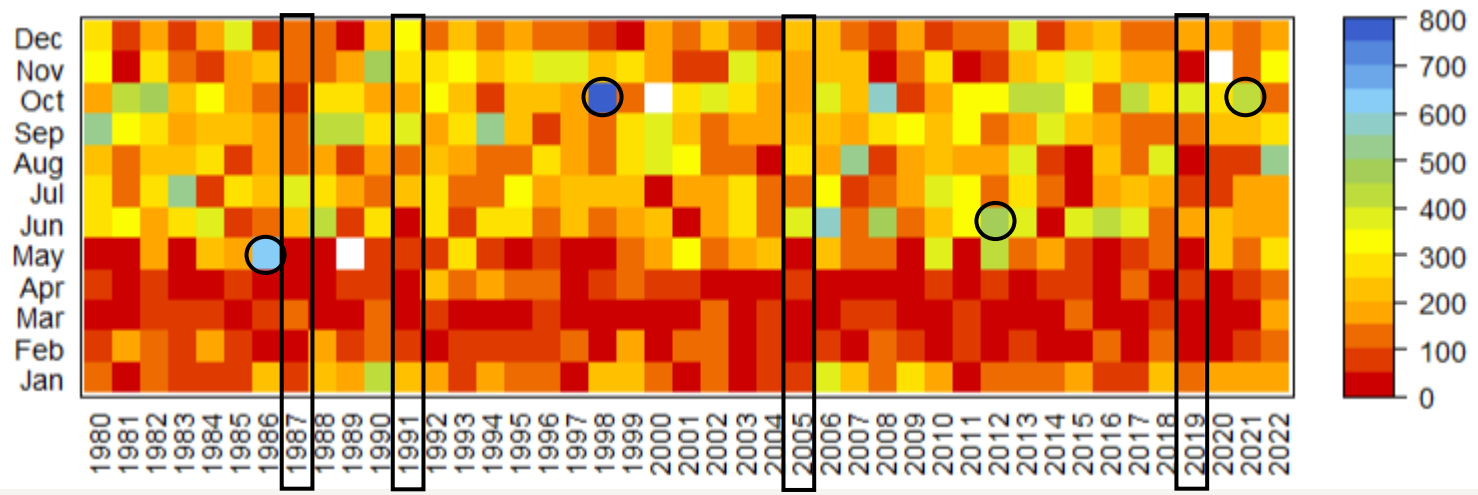
Extremes relationship

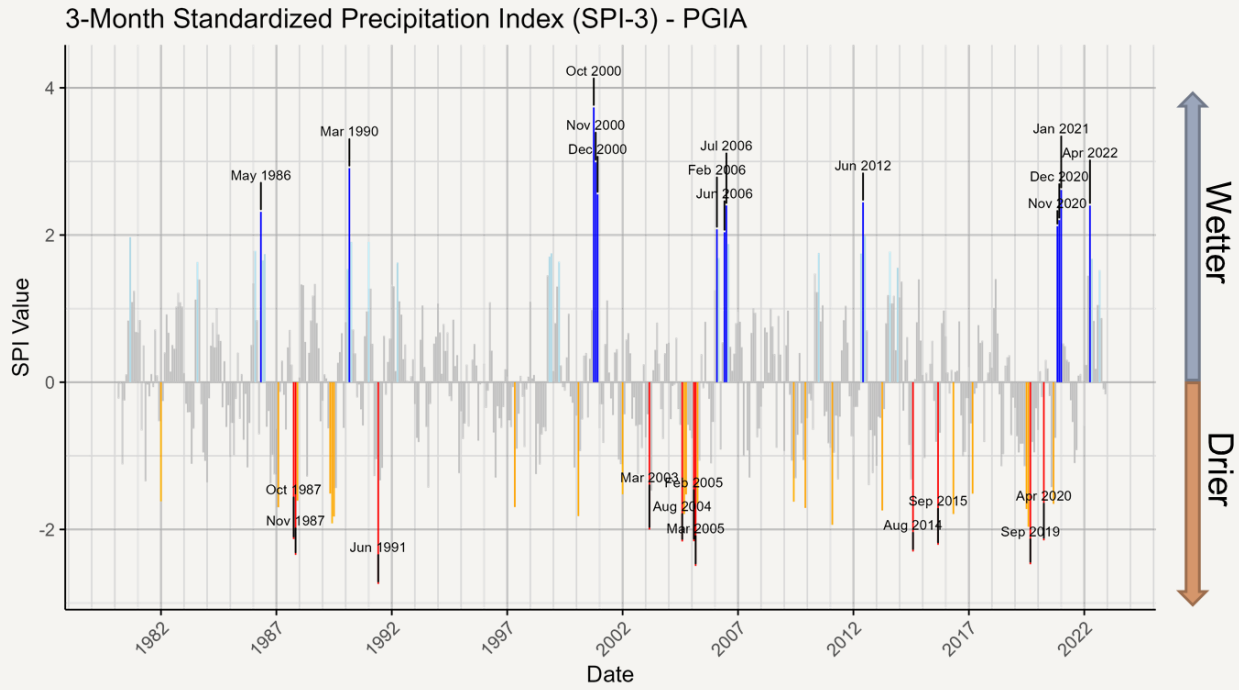


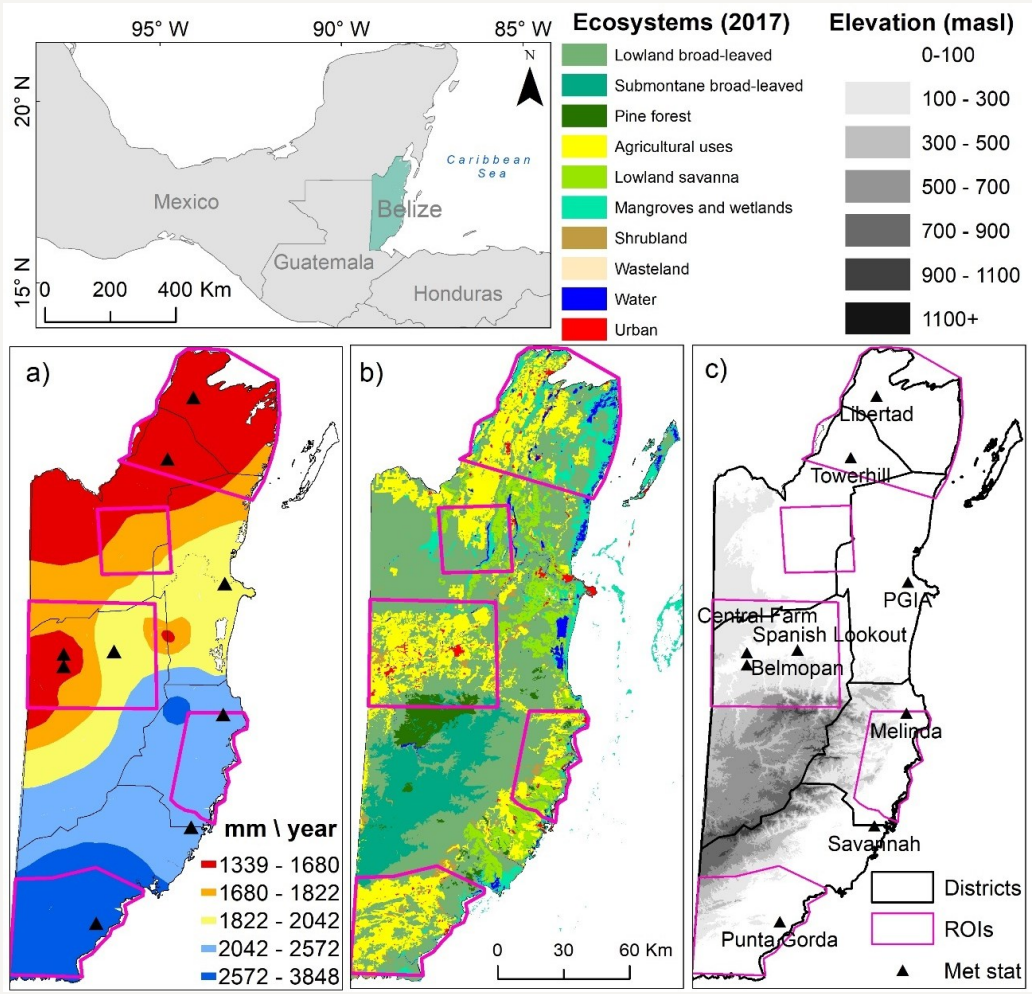
- Rainfall vs VI → Strong causal relationship
- SPI vs VI anomaly → Stronger with SPI-12

Identification of extreme weather events

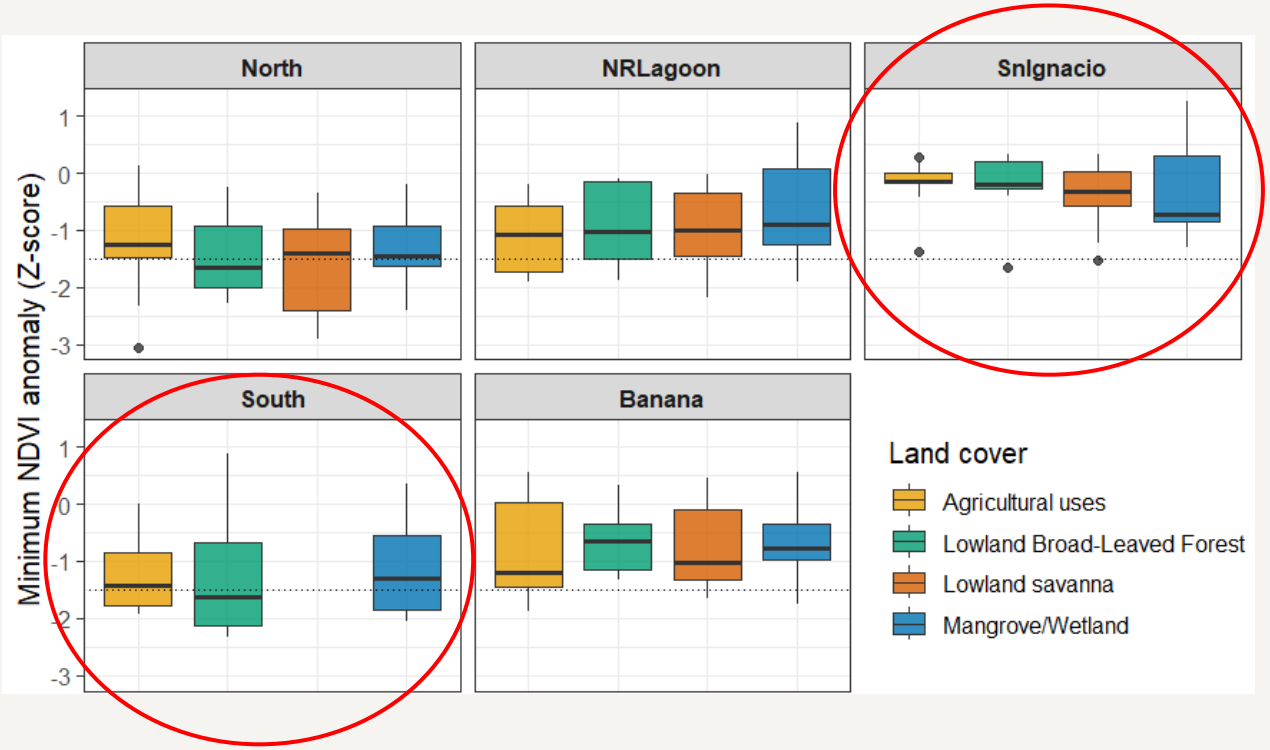
Monthly precipitation at PGIA [mm/month]







How different land cover respond

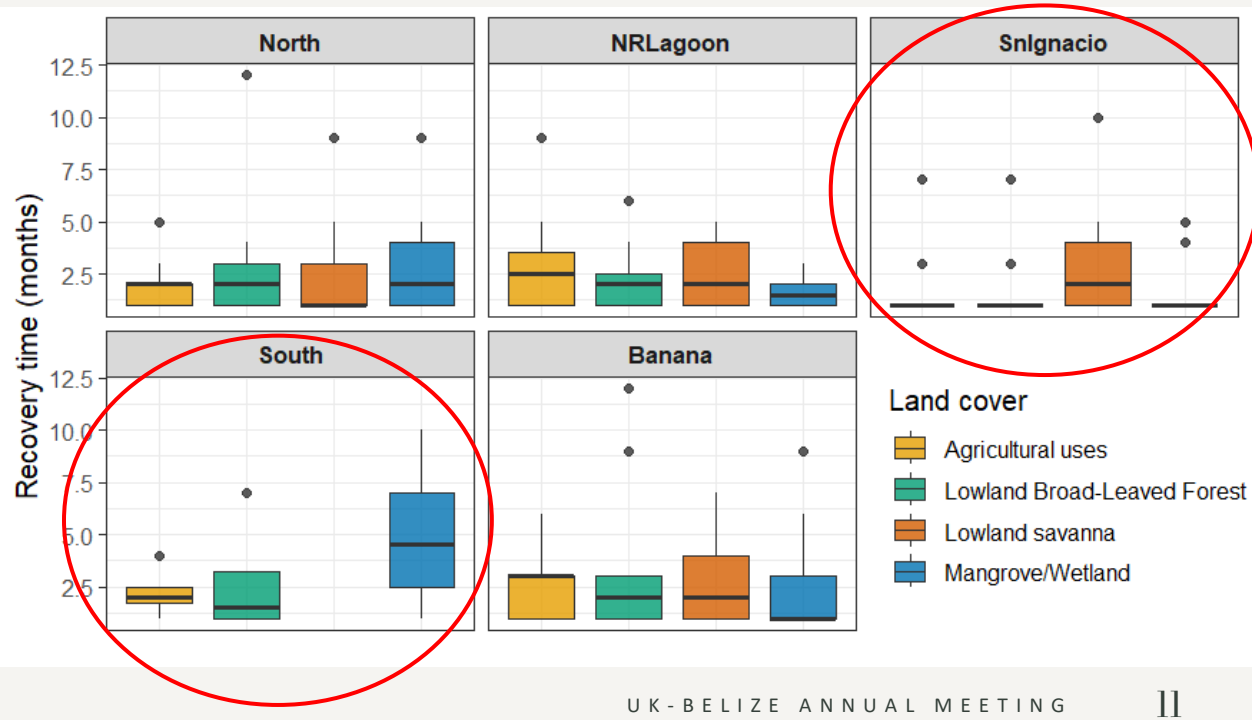


Drought impact / Resistance

- Most affected: agriculture and savannas
- Least affected: forests
- Region with highest resistance: San Ignacio and Banana

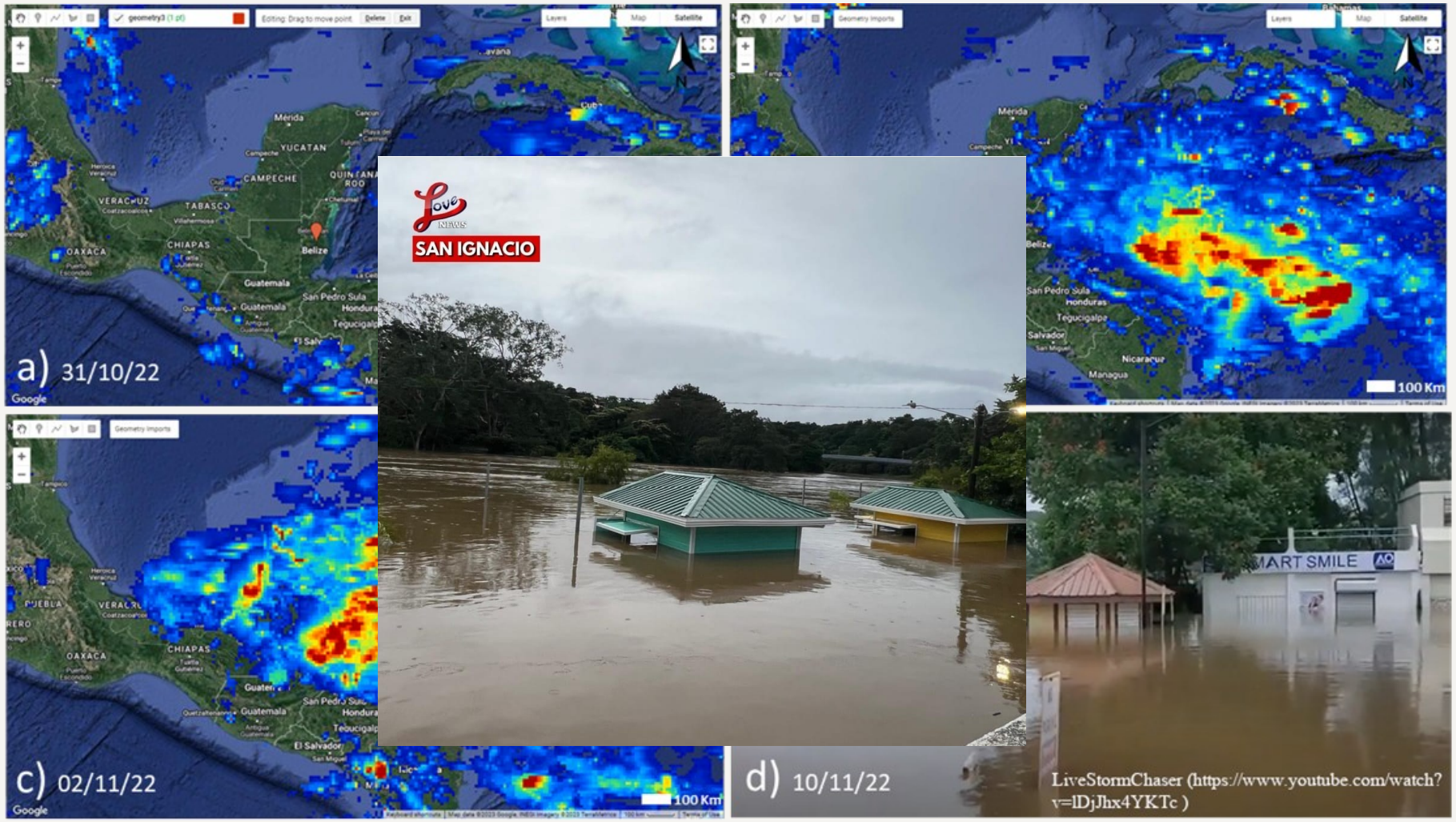
Recovery / Resilience

- Fastest recovery: Agriculture
  - ~2-4 months
  - Irrigation



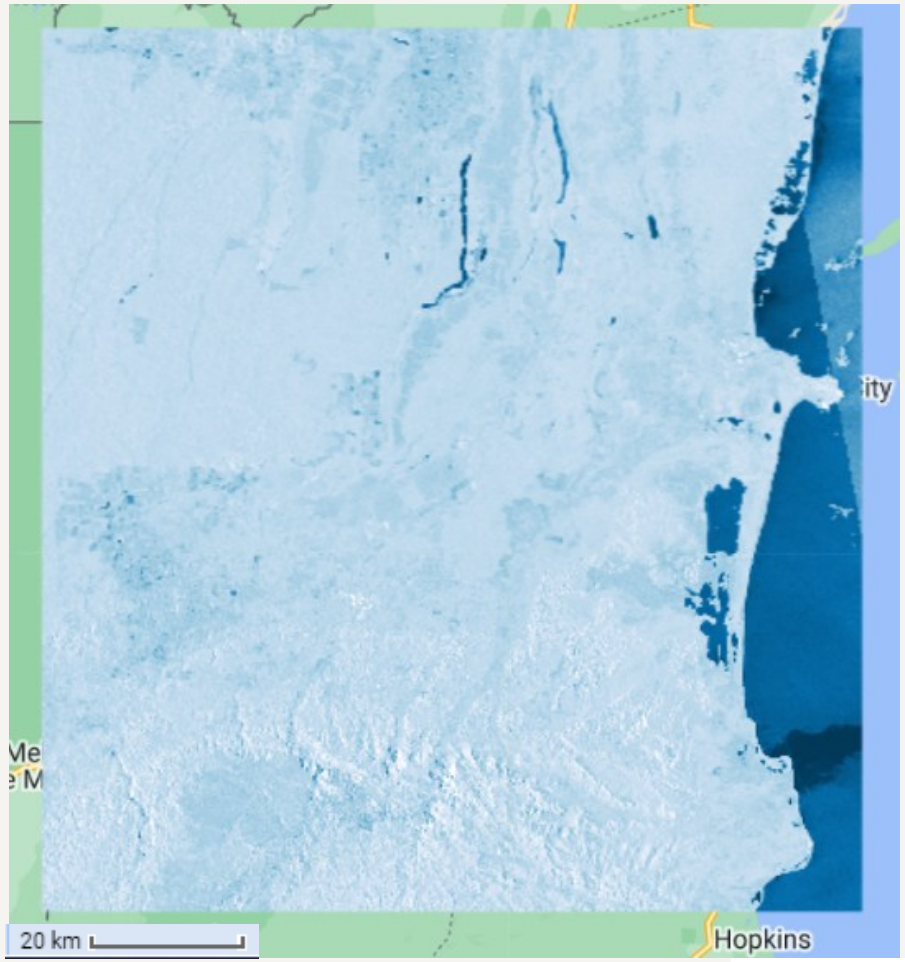
Assessing and mapping the impacts

Hurricane *Lisa*'s track

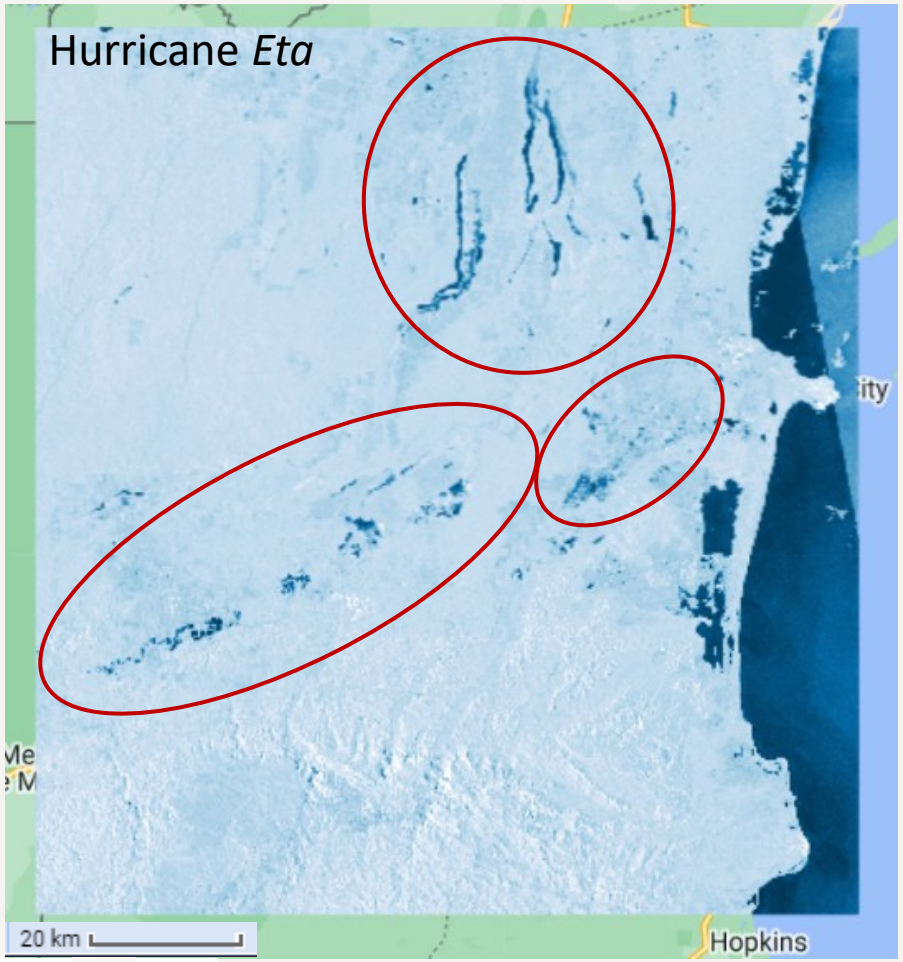


Assessing and mapping the impacts

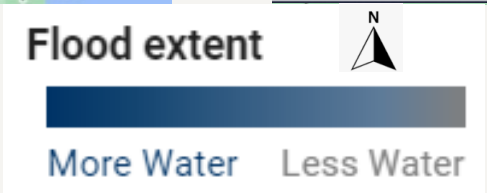
Oct 25-31, 2020

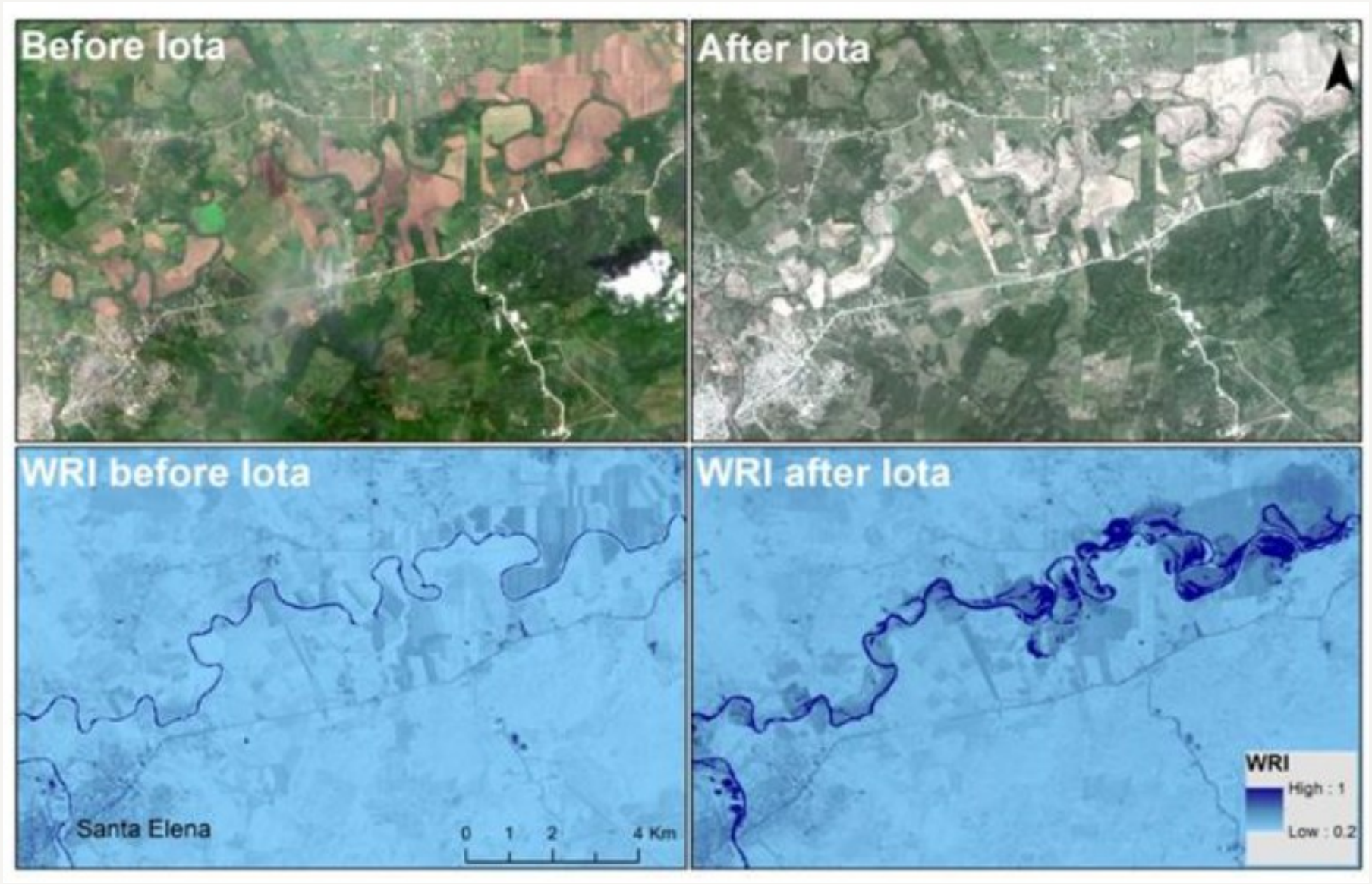


Nov 4-10, 2020

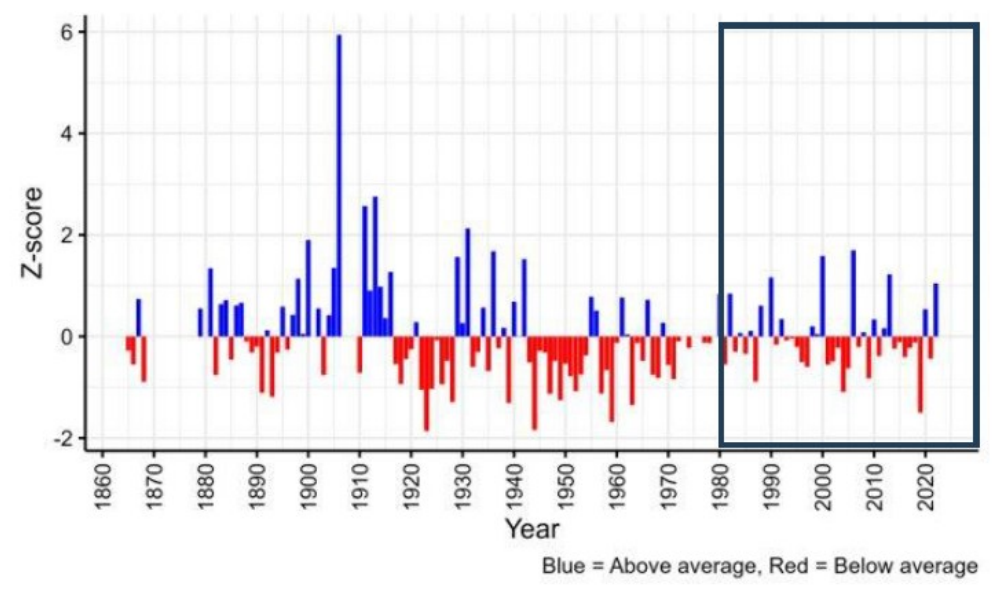


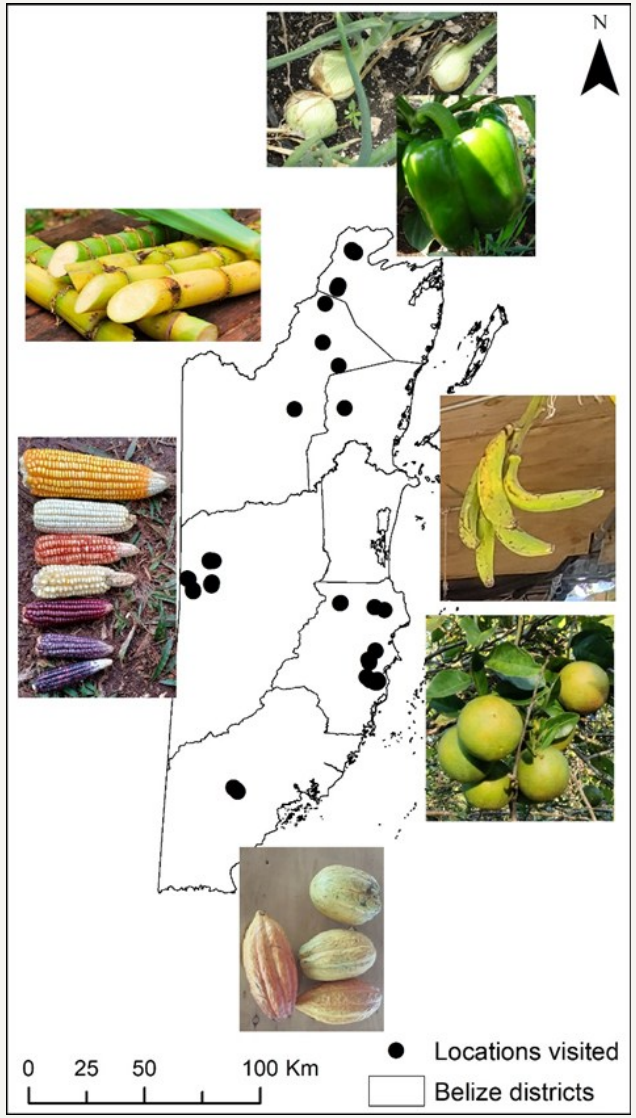
- S1 images




Before Iota
After Iota
WRI before Iota
WRI after Iota
Santa Elena
0 1 2 4 Km
WRI
High : 1
Low : 0.2

Connecting data to live experiences and past





Key findings

- Extreme climate events documented from the 18th century until now
- Drought effects differ across regions and land covers.
- Agroforestry and mixed systems in the south show more resilience.
- Remote sensing can reveal where systems are most at risk.
- Farmers adaptations practices:

- Crop diversification

- Adoption of irrigation systems

- Adjusted crop calendars

Thanks!

EMAIL: BETSABE.DELABARREDA@NOTTINGHAM.AC.UK

Collaborators:
Dr Donneil Cain (Caribbean Community Climate Change Centre)
Christina Garcia (Ya'axche Conservation Trust, Belize)
Dr Julie Hoggarth (Baylor University, USA)
Ina Iris Sanchez (Ministry of Agriculture, Belize)
Dr Birgit Schmook (ECOSUR, Mexico)
Dr Bronwen Whitney (Northumbria University, UK)

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