Drivers of Water Balance Variability in the "Ciénega De Las Macanas" Wetland, Panama

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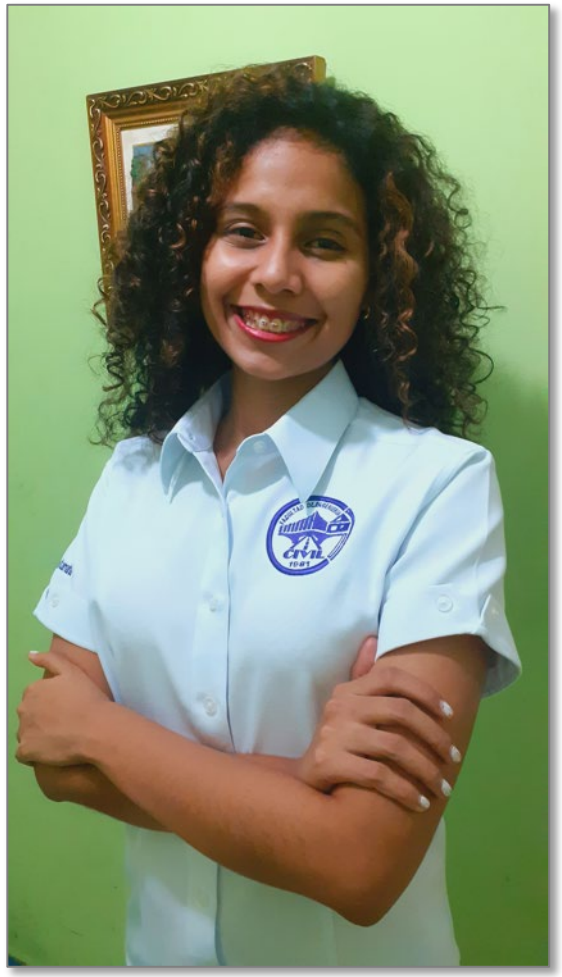
***First**: Introducing Andrea Santamaria and Yvanna Serra*



Andrea Santamaria

Yvanna Serra

*Supervised by **Dr. Jose Fabrega**, UTP Hydraulic Research Center Director*

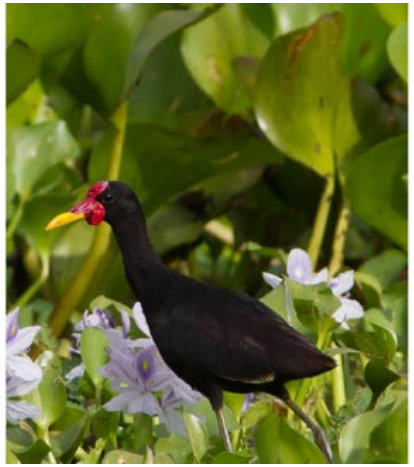
Background and Context

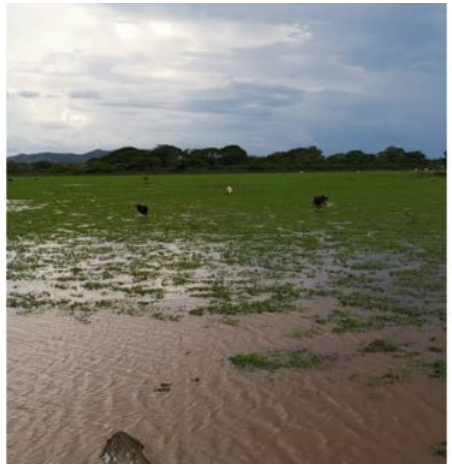
Project: Garantizando la Seguridad Hídrica en los Bosques y Humedales del Río Santa María

Guaranteeing Water Security for the Forests and Wetlands of the Santa Maria River Watershed

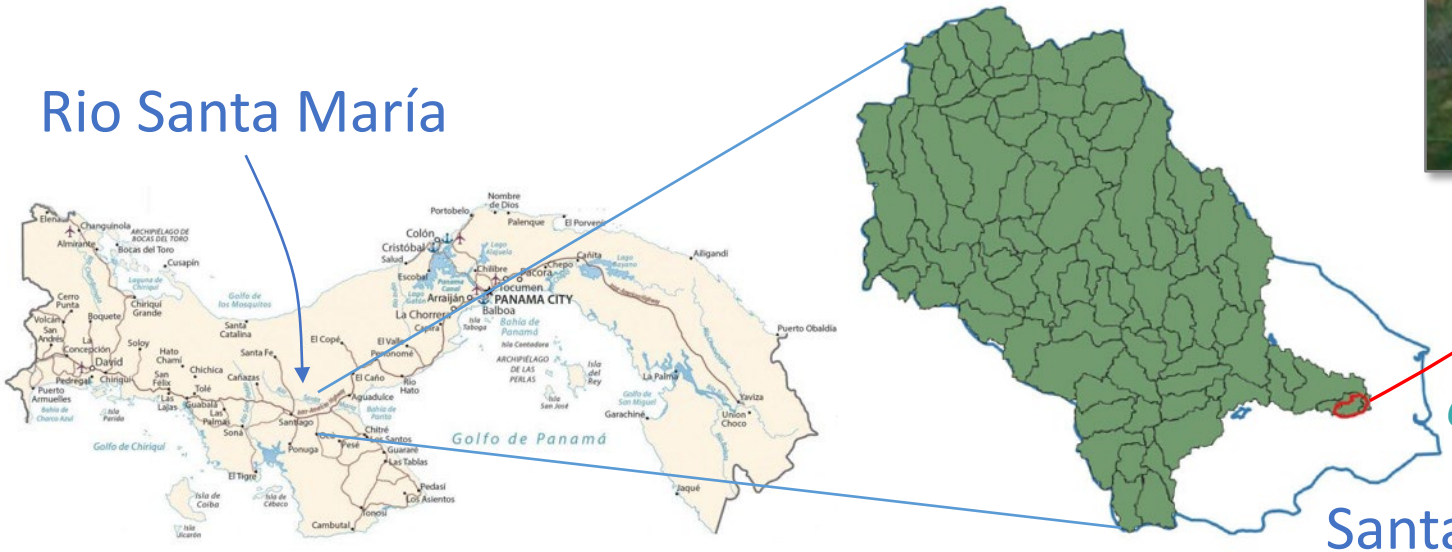
- *Obj 1: Share scientific resource management information*
- ***Obj. 2: Understand basin water availability and demand***
- *Obj. 3: Strengthen water resources governance*

***Background**: La Ciénaga de las Macanas*





Rio Santa María



Golfo de Panamá

Ciénaga de las Macanas
~2000 ha

Santa María River Basin (3326 km²)

***Background**: La Ciénaga de las Macanas*

How much water is needed to maintain a healthy wetland ecosystem?

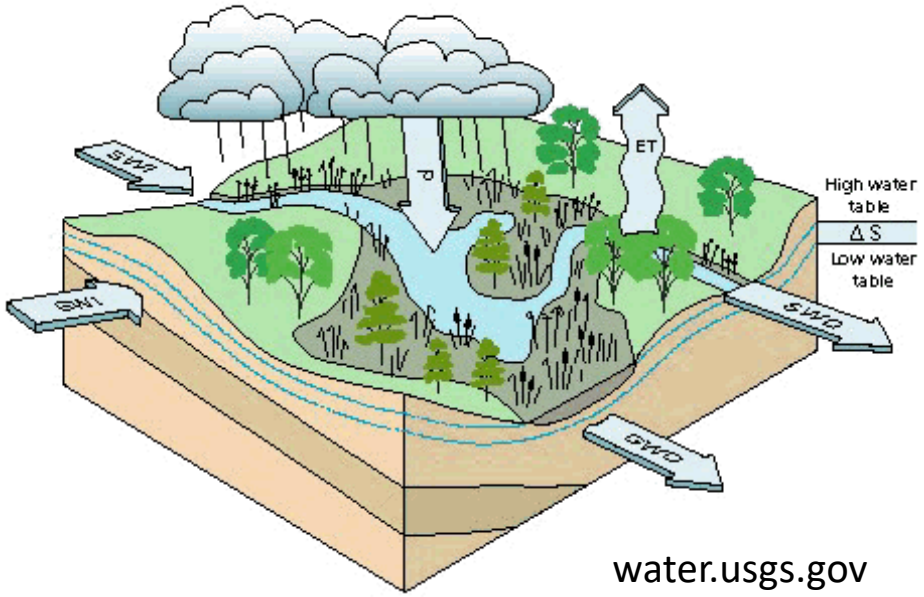
Research Questions

1. *What are the major drivers of hydrologic variation in the Ciénaga?*
2. *How has wetland area changed over time?*
3. *How do activities in the watershed likely affect wetland hydrology?*


Ciénaga de las Macanas, Panamá


Extreme dry season, 2015

Methods: *Water Balance + Remote Sensing*

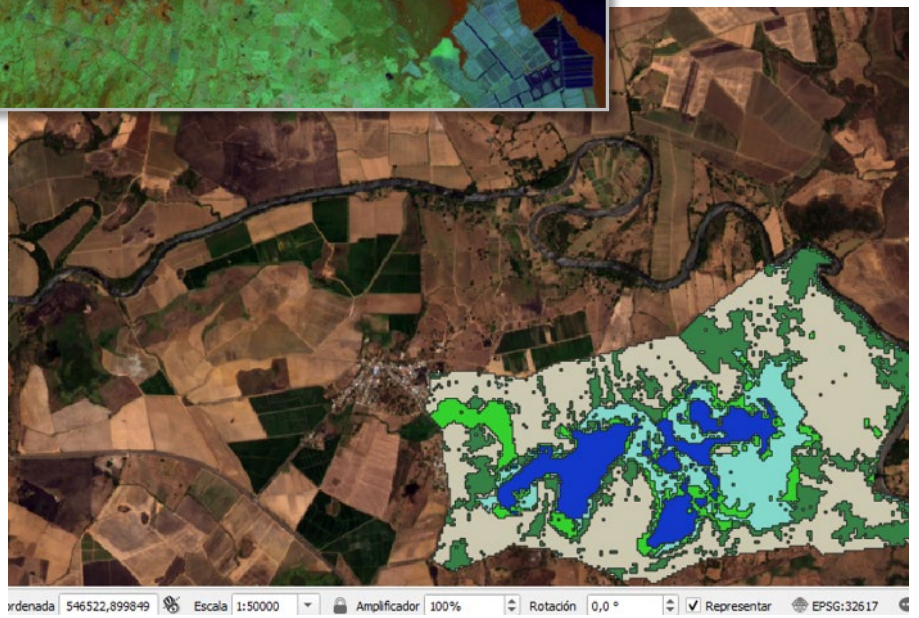


water.usgs.gov

$$\frac{\Delta S}{\Delta t} = Q_i - Q_o$$

$$Q_i = P + RO + SW_i + GW_i + A_i$$

$$Q_o = ET + SW_o + GW_o + A_o$$



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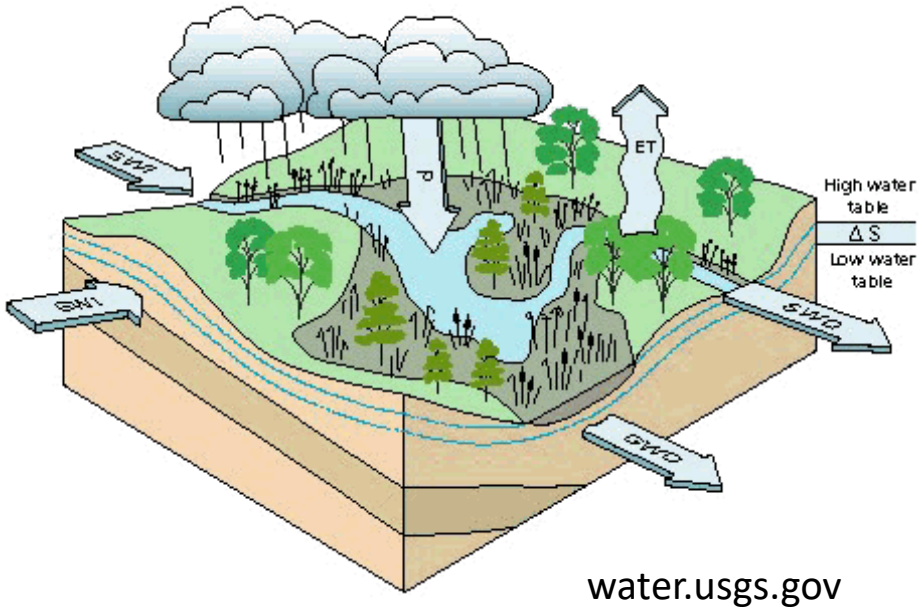

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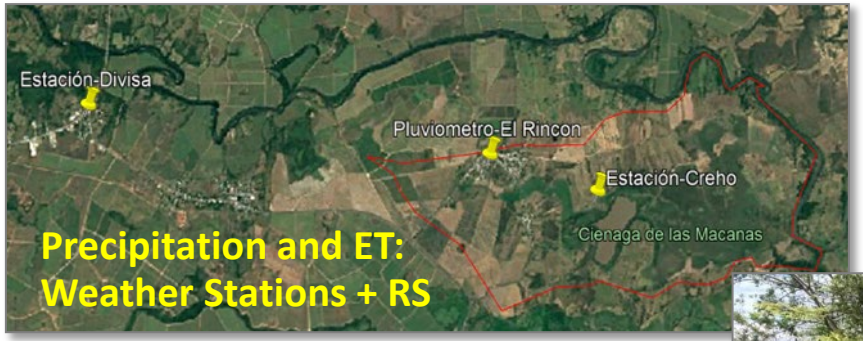
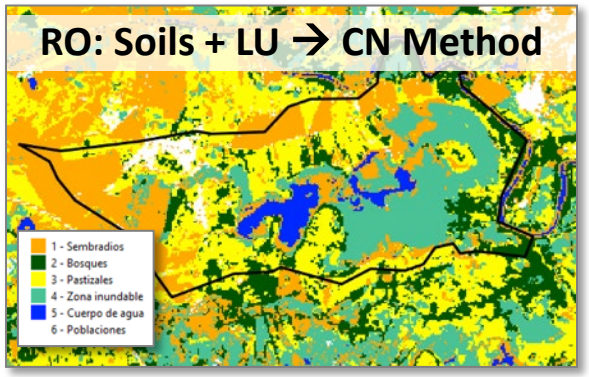
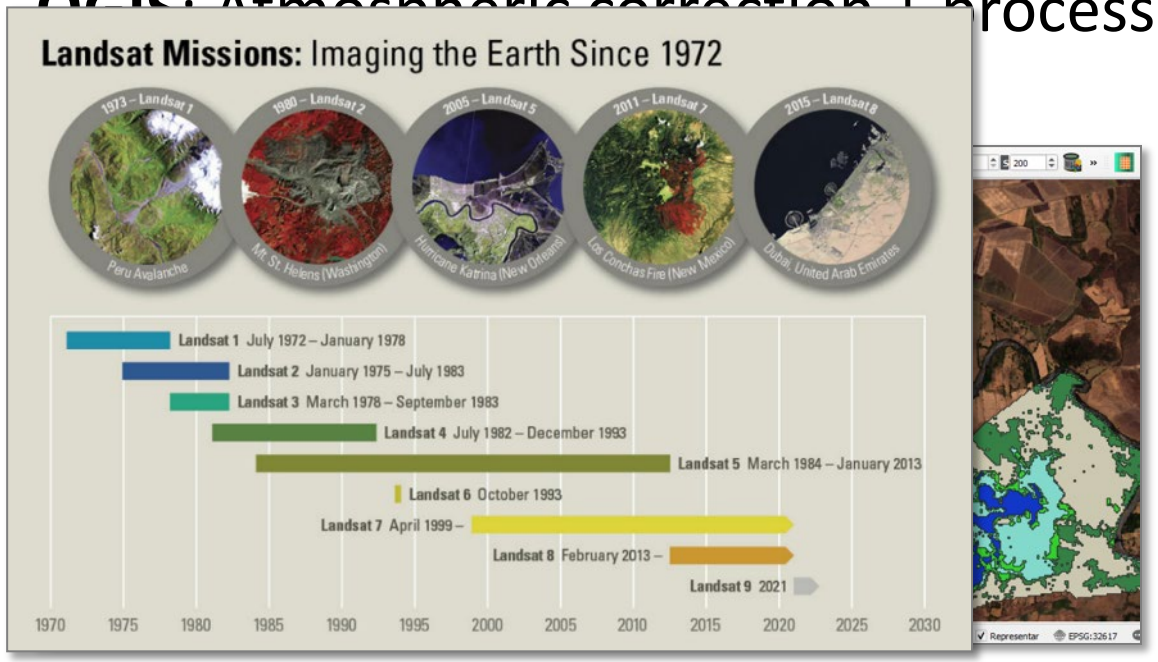


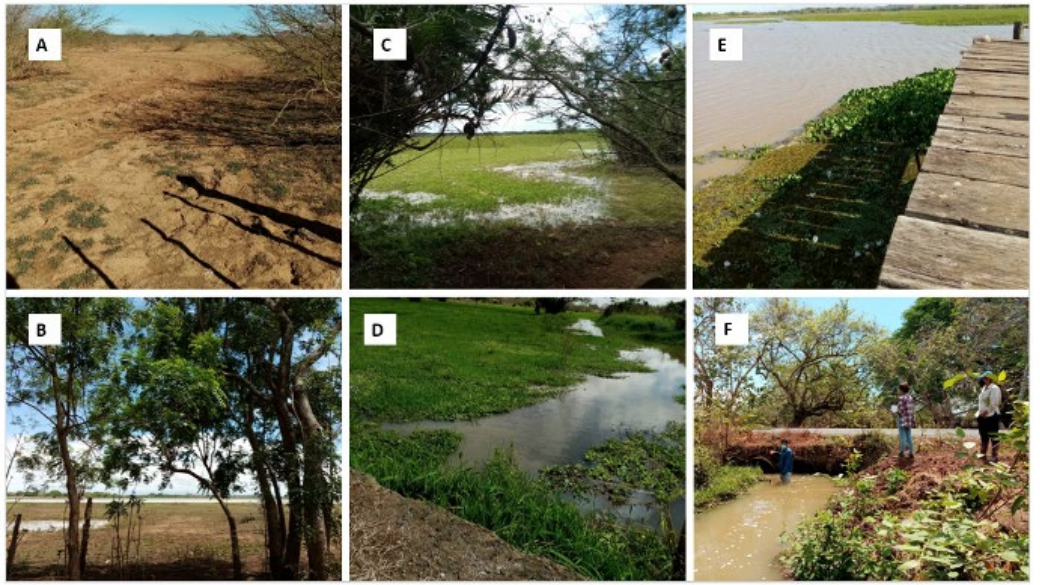
Surface inflows and outflows: field data

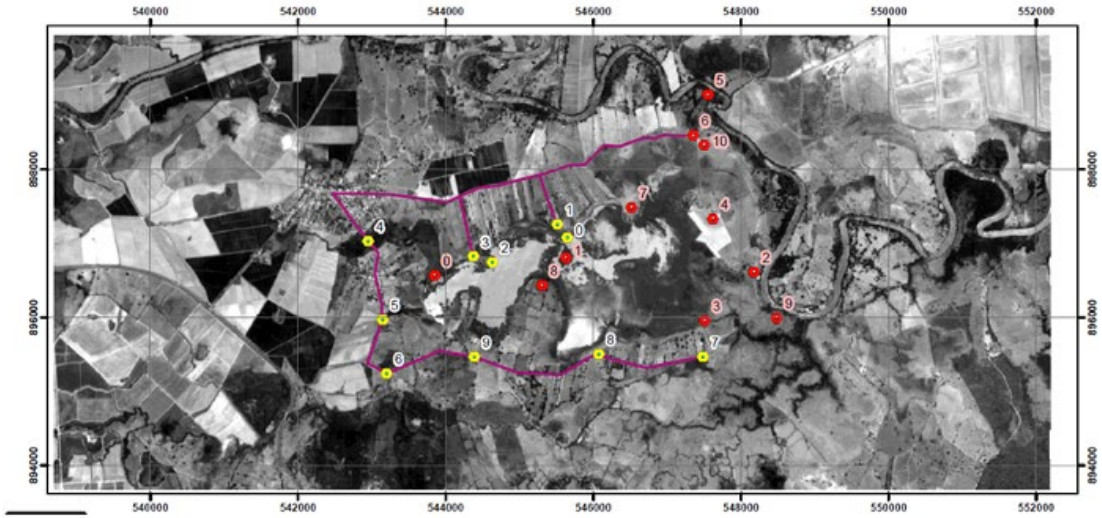


Methods: *Water Balance +* ***Remote Sensing***

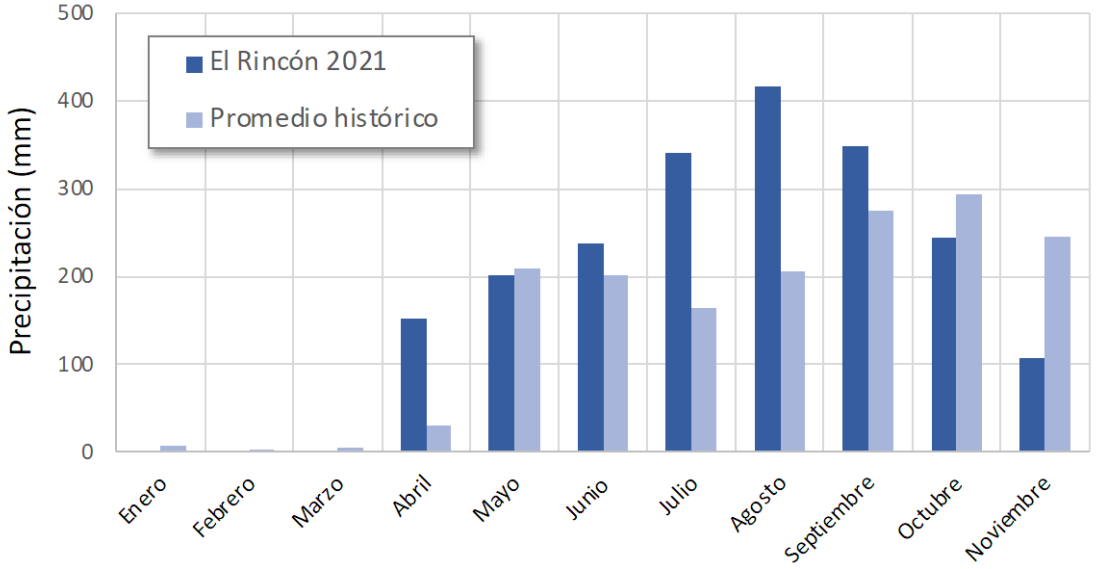
- **Supervised Classification**: **water, water w/ vegetation**, dry vegetation, dry soil, trees
- **Source**: Landsat 5 + 7 (1997-2002) and Landsat 8 (2014-2021); Collection 1, Tier 1
- **Band Combos**: R/G/B, NIR/R/G, NIR/SWIR/R
- **QGIS**: Atmospheric correction + processing

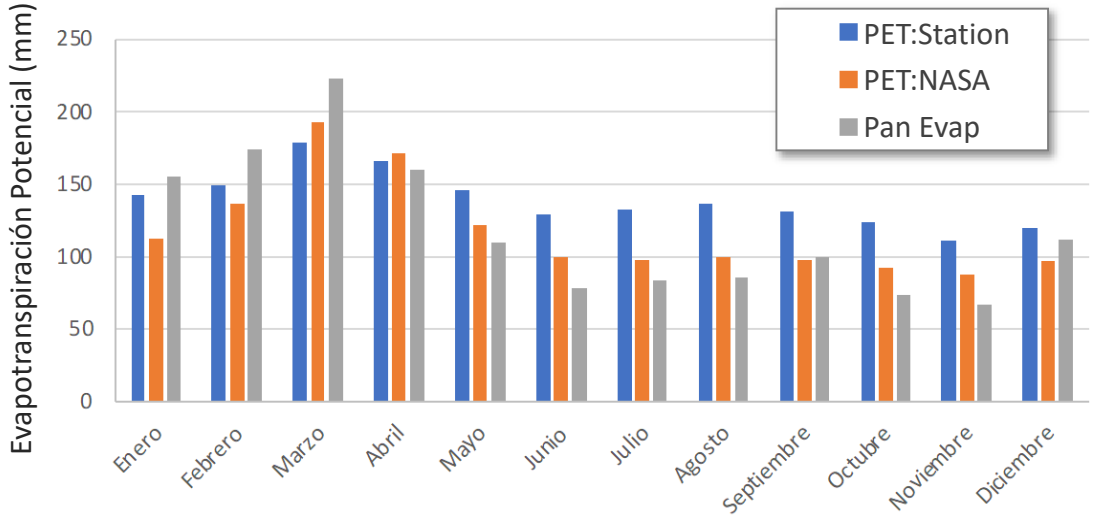


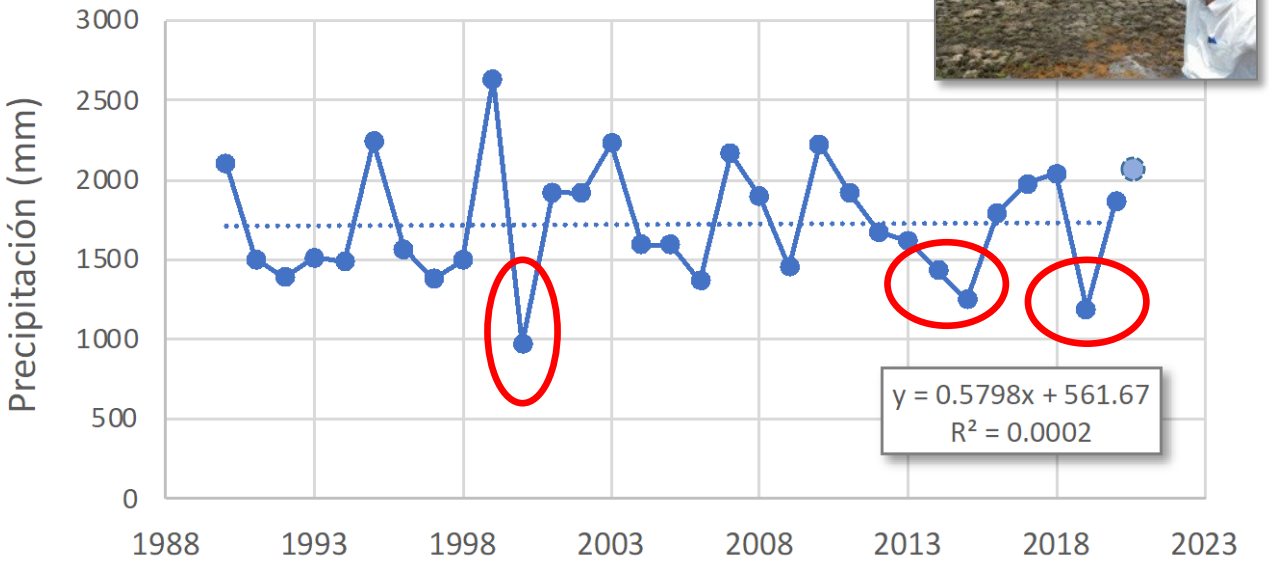


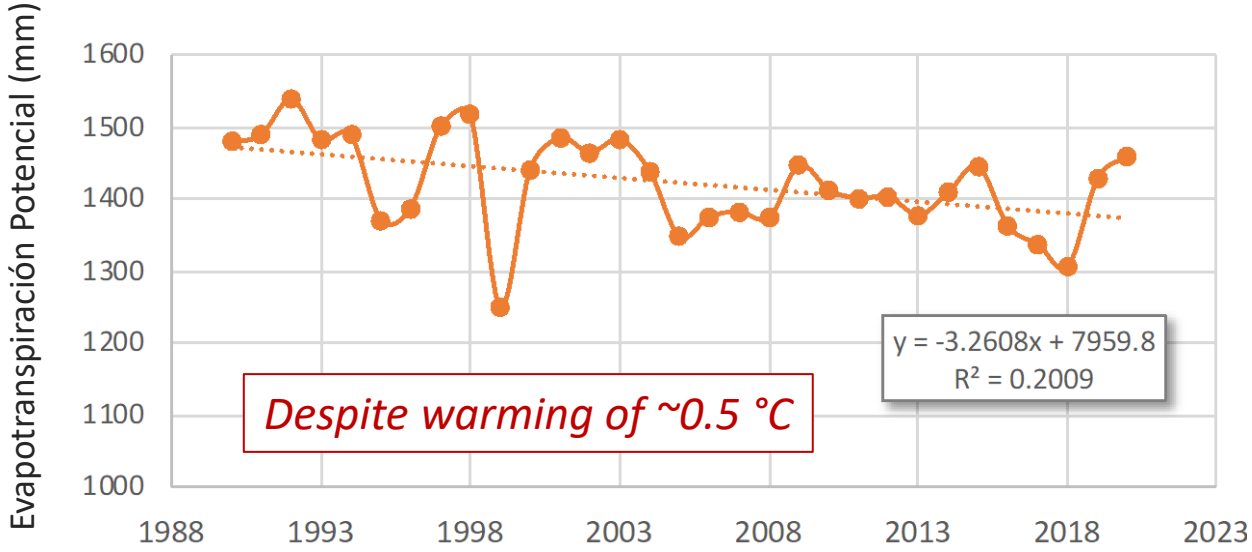


***Results**: Water Balance Components - P and ET*

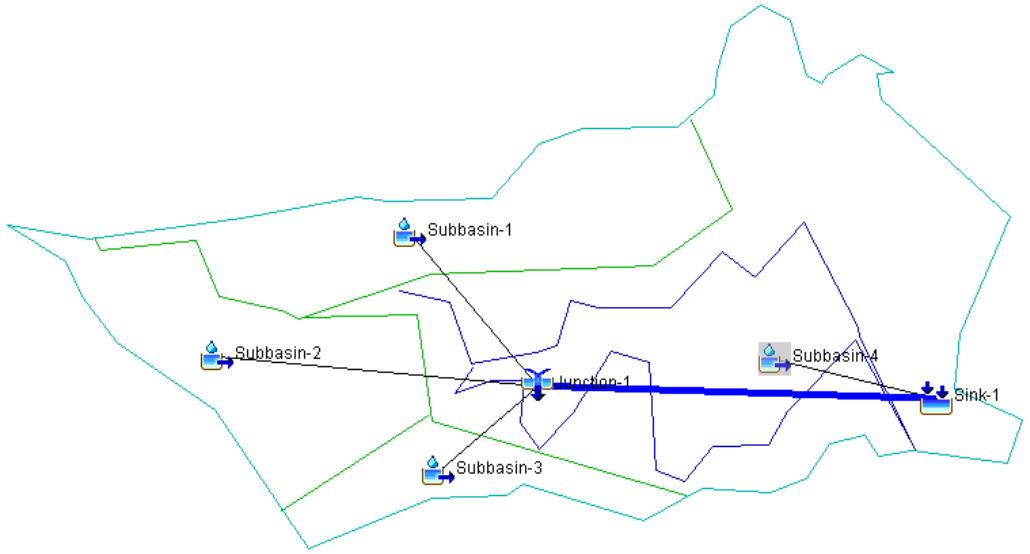


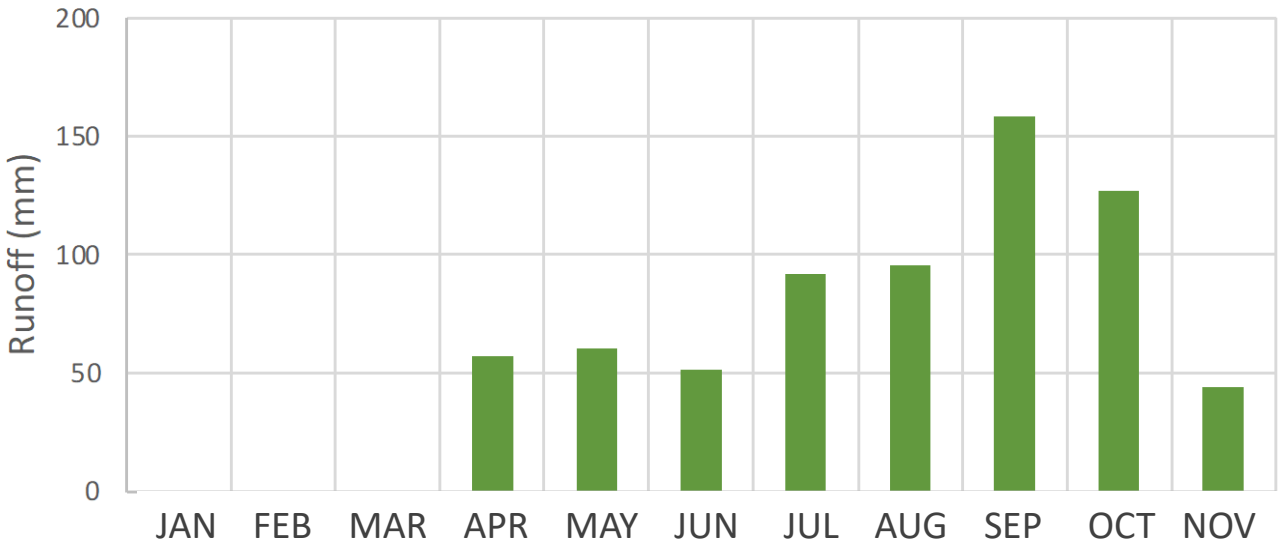


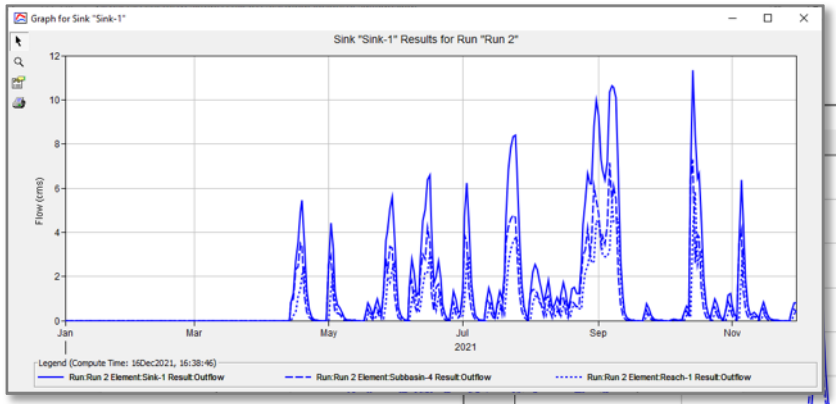


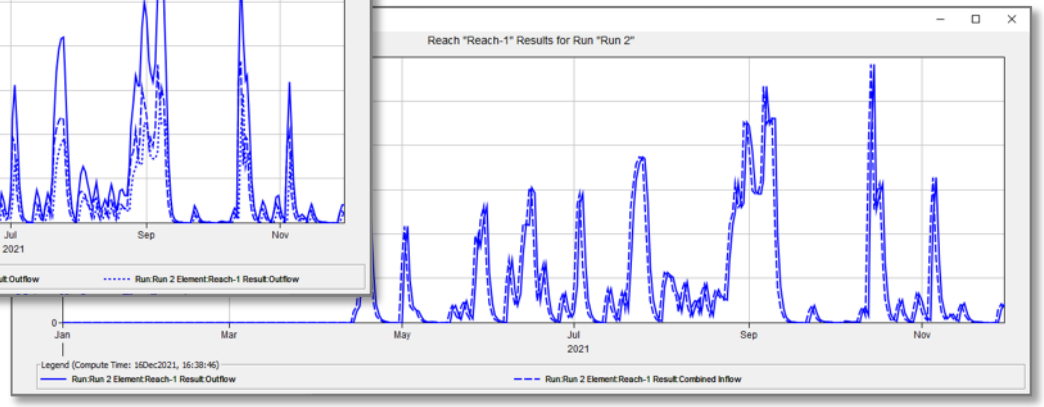


***Results**: Water Balance Components - Runoff*



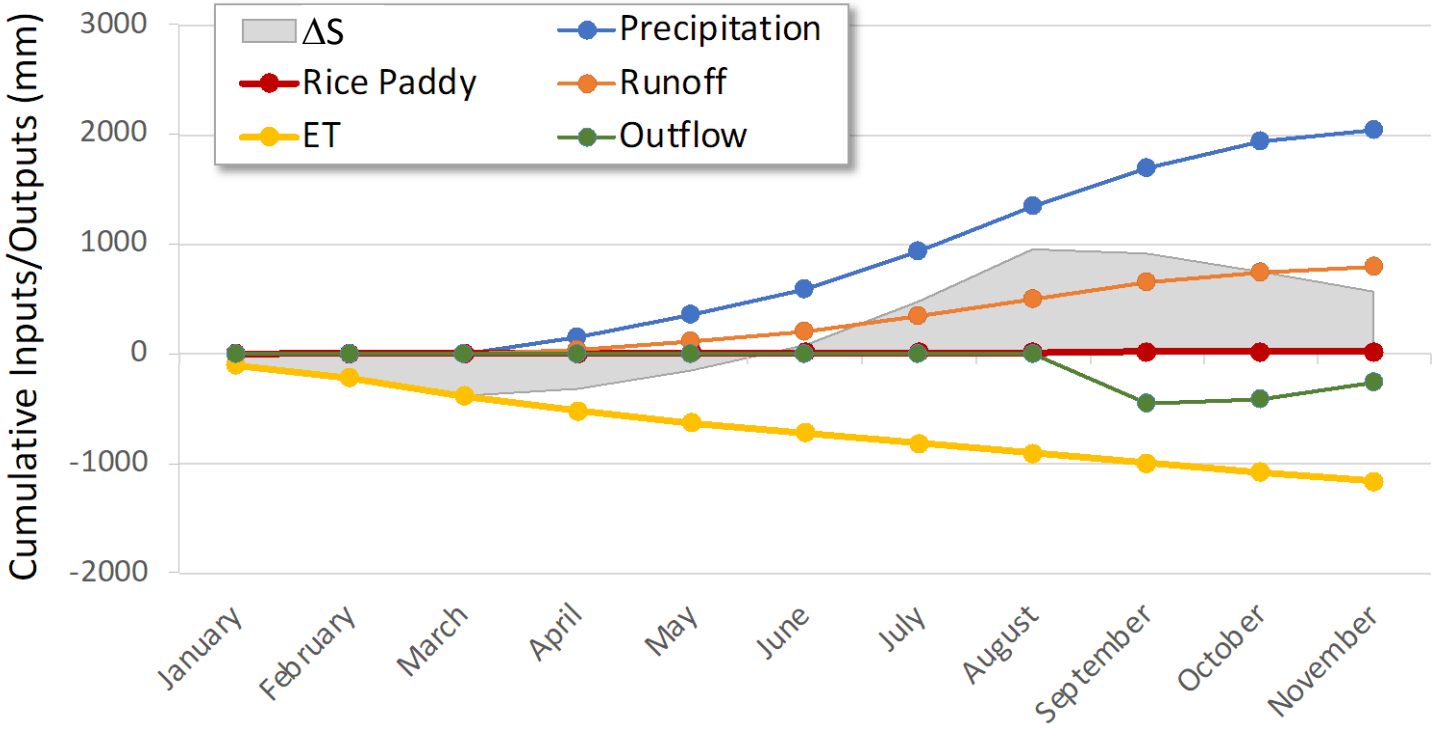


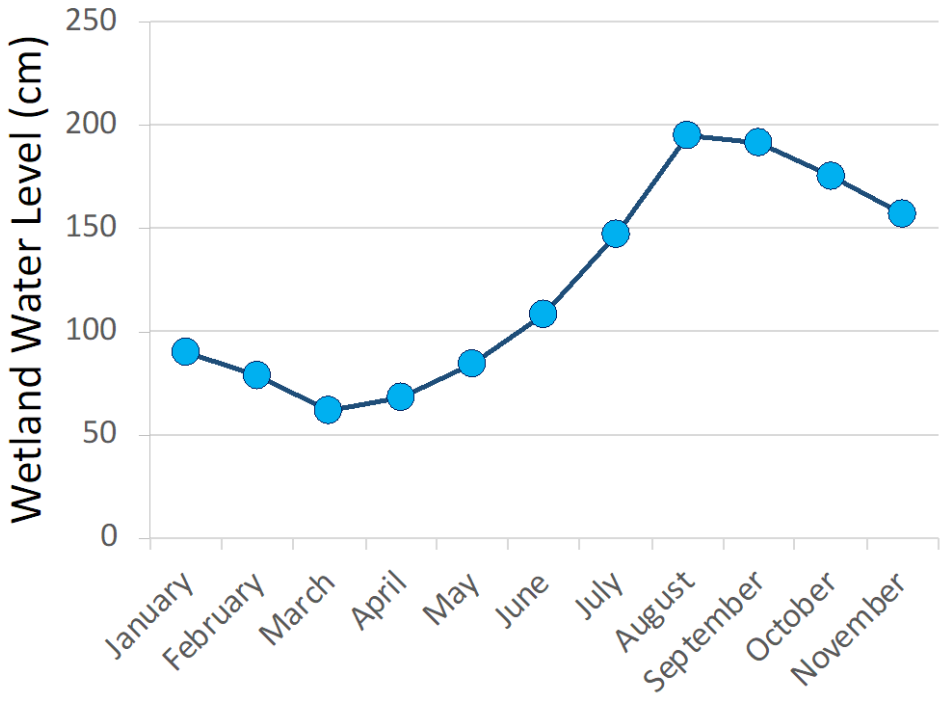




- Minor canal inflows from irrigated rice (<5 mm)
- ***Net groundwater assumed ~0***
- ***Variable inflows/outflows to Santa Maria River <u>estimated</u>***

***Results**: Overall Water Balance*





- Inflows dominated by direct precipitation, then runoff
- Outflows dominated by ET, then outflow to Santa Maria River*
- Seasonal changes in storage → water level variation (needs validation w/ wetland data)

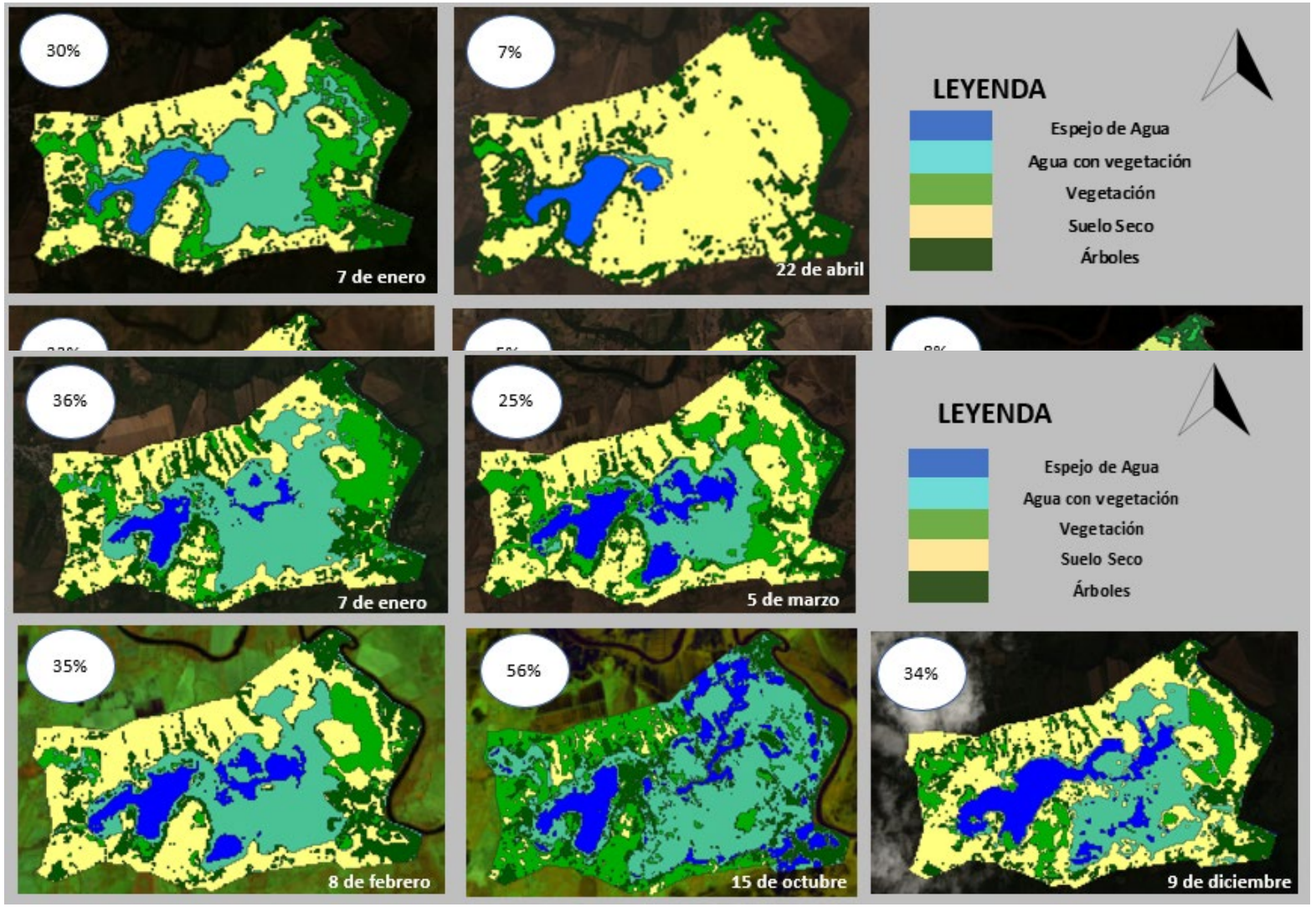
***Results**: Remote Sensing - Extreme Years*

2015 - Extreme Drought

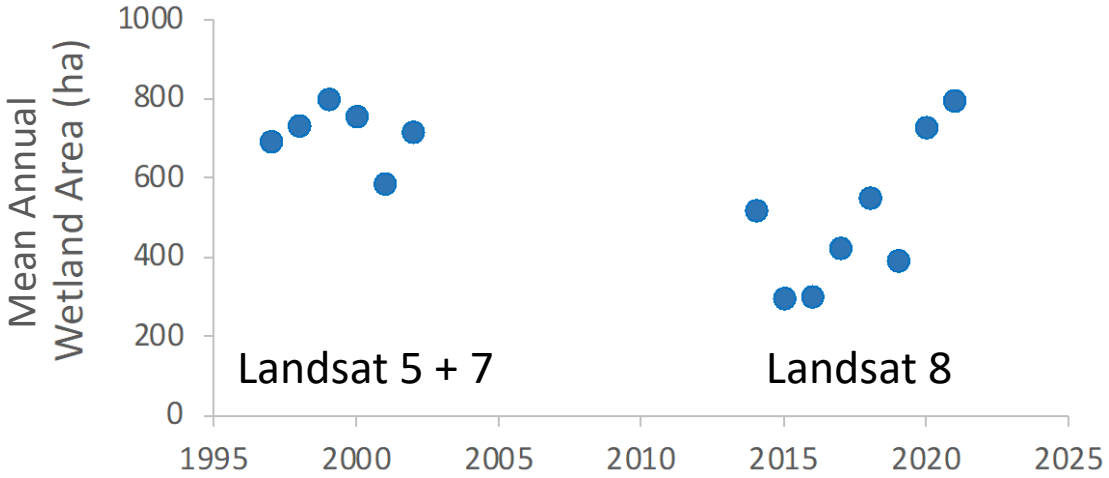
- 8 images
- 5-33% wetland cover
- Average: 16.5%

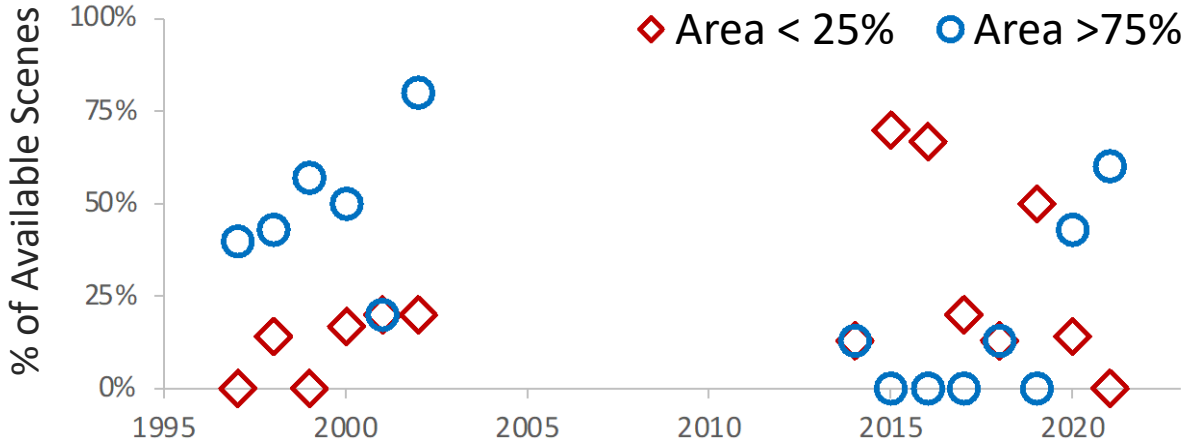
2021 - Extreme Floods

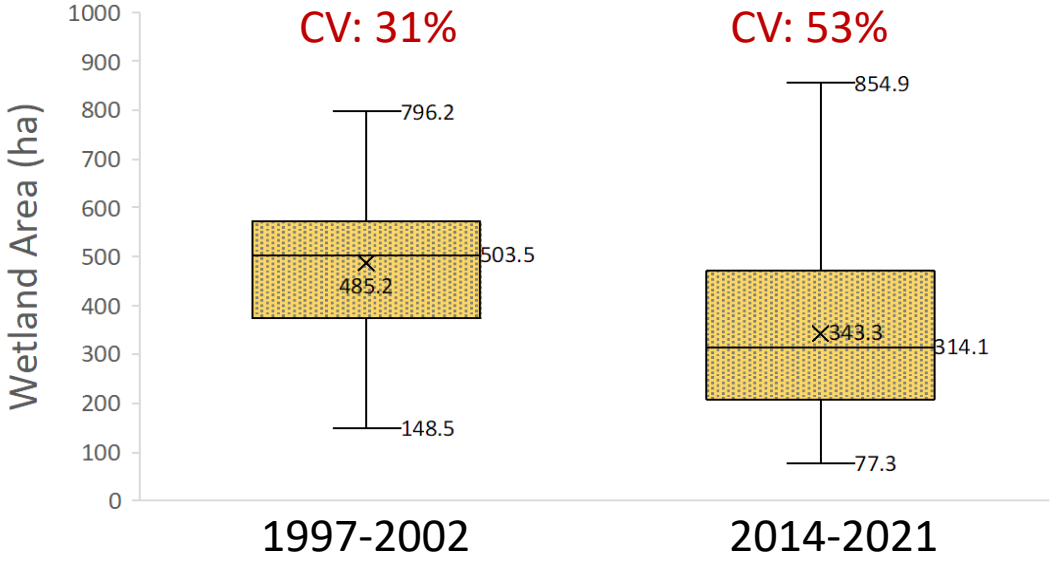
- 5 images
- 34-56% wetland cover
- Average: 37.2%



***Results**: Remote Sensing - Wetland Area Change*

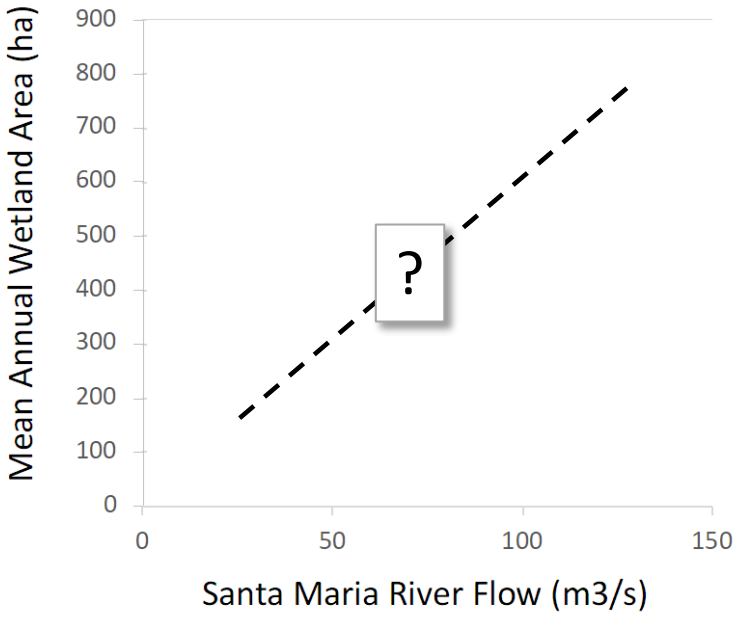


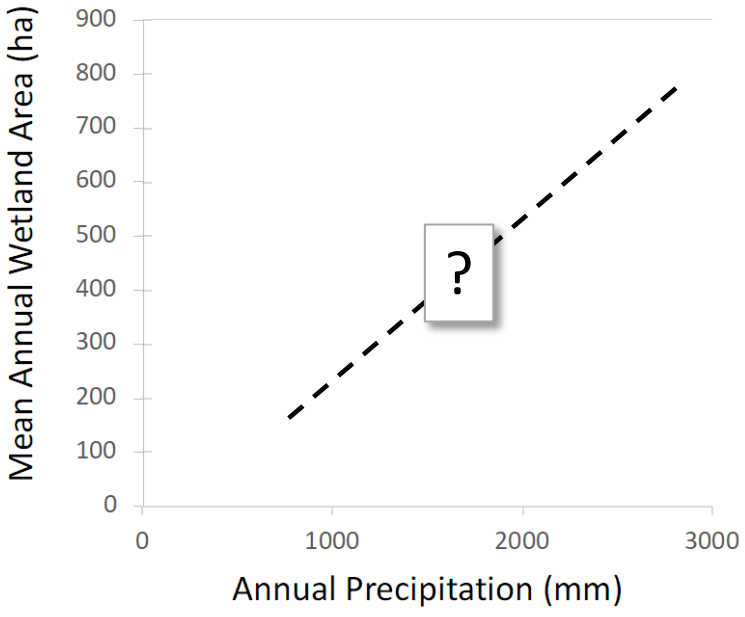


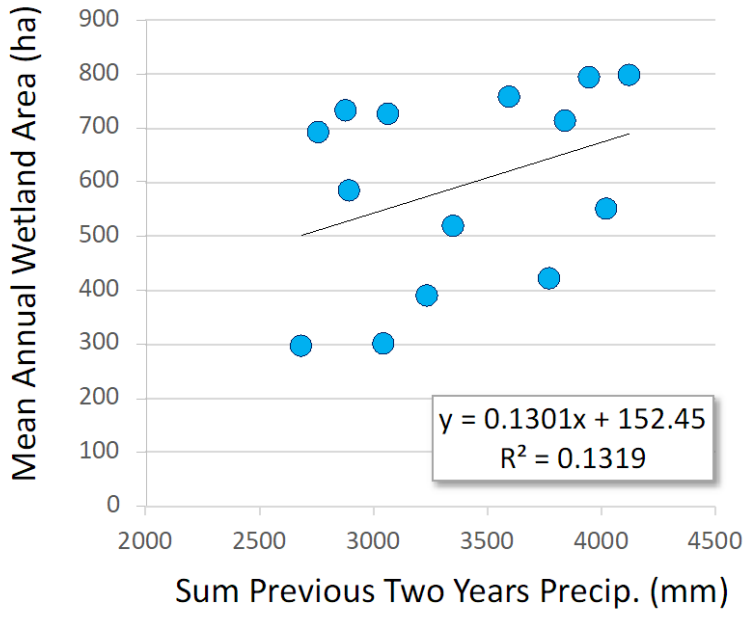


- Wetland area reduced ~50% in 2014-2019
- Recovery in 2020 and 2021
- Overall reduction in years w/ large inundated area, increase in years w/ small inundated area, and increased variability

Synthesis: *Hydrologic Drivers ~ Wetland Cover?*







vith Sta. Maria River flow

ear precipitation

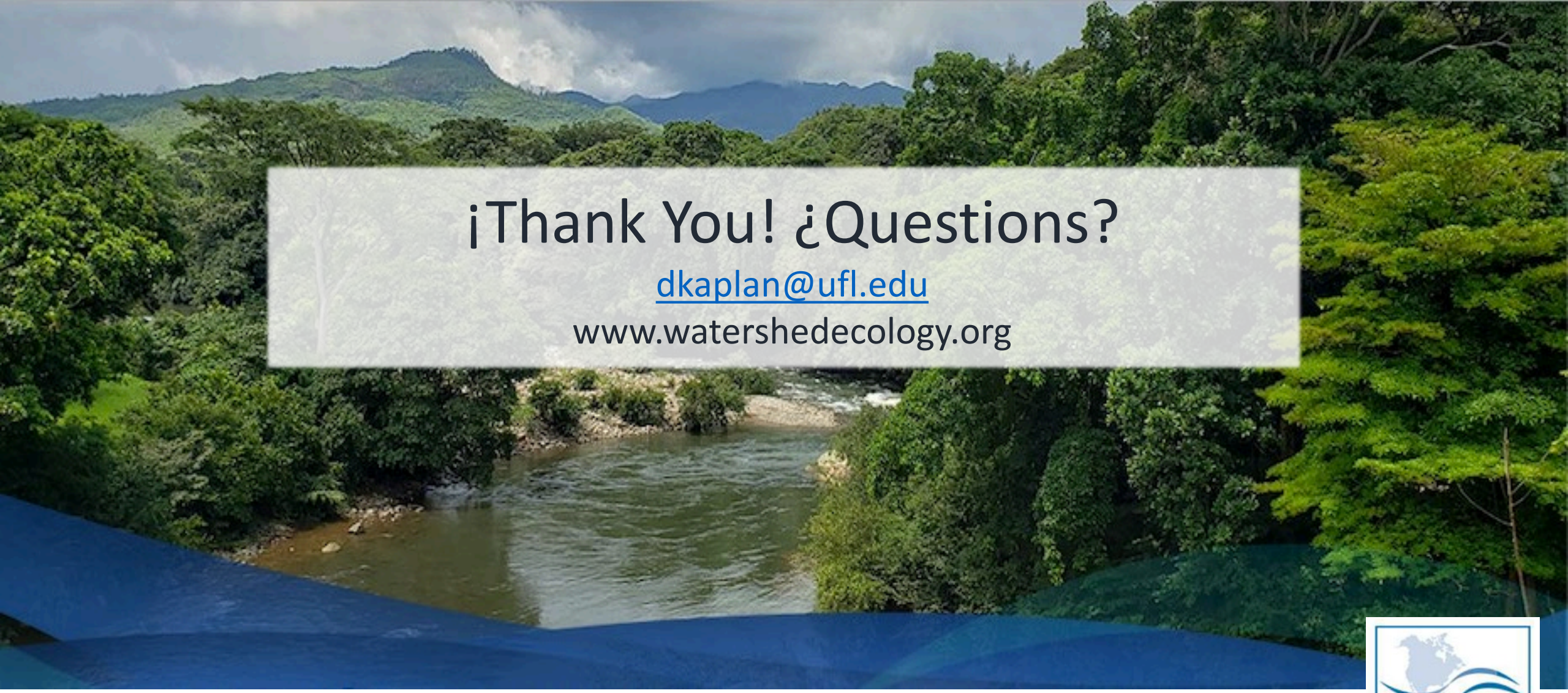
cipitation history

Conclusions and Future Work

- Water balance in Cienega de las Macanas dominated by precipitation (+) and evapotranspiration (-)
- Minimal inflows from rice agriculture (nutrients?)
- Reduction in wetland & open water areas (recent recovery + variability)
- Little association with river flow, local precipitation more important
- **Future work**: field validation and hindcast
- **Looming issue**: climate variation and change

Macanas?

Synbranchus marmoratus, marbled swamp eel



¡Thank You! ¿Questions?

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