Leaning into La Encrucijada Chiapas mangroves': NPP from ground measurements and MODIS

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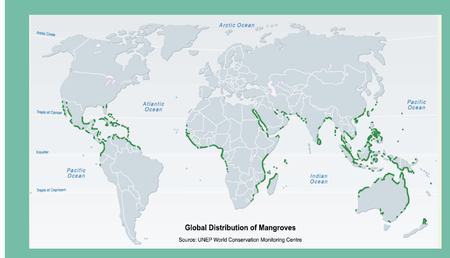
1. Introduction

Ecoystems such as MANGROVES play an important ecohydrological role as costal marine wetlands. In which ocean-land-atmosphere interactions influence processes, mechanisms, and feedbacks. Coastal marine wetlands are known as BLUE CARBON, however the mechanisms that make this system a source or sink of CARBON, and potential drivers are yet to be better understood.



Mangroves in low and mid latitudes cover approximately 18 million ha. (0.7%) of the worlds tropical forest (Giri et al. 2011). Despite its coverage the importance of mangroves in the carbon cycle (CC) is above (**sequestration**) and below (**storage**) ground.

Like other tropical forests, mangroves provide many services. They are also threatened by anthropogenic activities (i.e. shrimp farming), and climate change. There is a need to improve our understanding of its role in the CC and communicate that to policy makers and resource managers.

2. Objective and hypothesis

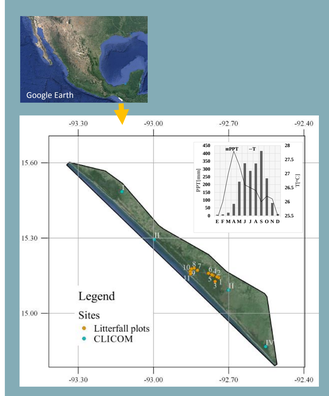
Here we analyze 3 different DATASETS to better understand Net Primary Productivity (NPP) via ground and remote sensing data for a mid-latitude tropical mangrove. We hypothesize:

H1: Litterfall production is influenced by a gradient from inland towards the ocean.

H2: Linear relationships can be established between NPP components (i.e. litterfall, NDVI) and environmental parameters (i.e. temperature, precipitation, salinity)

H3: A multivariate approach and empirical modeling using timeseries could improve how we assess NPP.

3. La Encrucijada Biosphere Reserve (EBR)



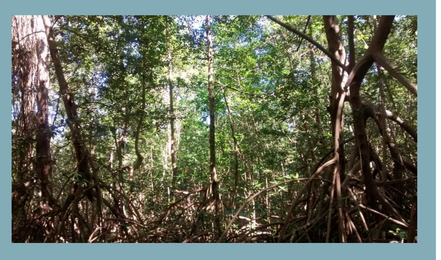
The EBR is influenced by a cluster of watersheds corresponding to 8 municipalities and its feed by 13 rivers.

Mostly the reserve has tropical wet-and-dry climate (Aw2, 93.5% of area) (García 1988), with mean annual temperature of 22ºC and maximum precipitation during September.

Over 70% of the soil type is dominated by Solonchak (50.5%) and Regosol (25.7%).

Mangrove covers about 275.19 km² of the EBR (ASERCA-CONABIO, 2006) , of which:

- *Rhizophora mangle* (red mangrove/mangle rojo) is the dominant species (Importance Value= 67.3 %) with a mean canopy height that varies from 22 to 27.6 m
- Remaining include: *Avicennia germinans* (black mangrove/mangle negro), *Laguncularia racemosa* (white mangrove/mangle blanco), and *Conocarpus erectus* (buttonwood/botoncillo).



4. Data and analysis

Data available

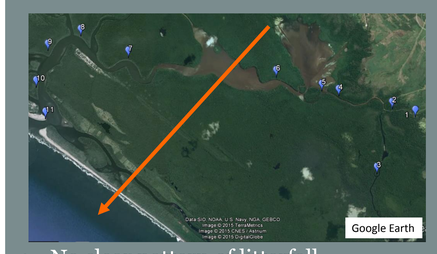
	Ground Data	Climate	Remote Sensing
Product	database	database	MODIS MOD13Q1-NDVI
Period	1999-2003	Station number: 7380: 2000-2010 7344: 1982-2010 7320: 1978-2010 7370: 1984-2010	2000-2006
Temporal resolution	Monthly	Daily	16 days-composite Daily interpolation
Spatial resolution	11 sites (Point)	4 stations (Point)	Pixel (250 m)
Data manager	ECOSUR	CONAGUA-DGE	NASA

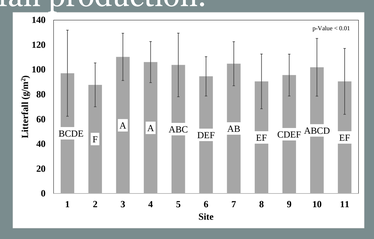
Analysis

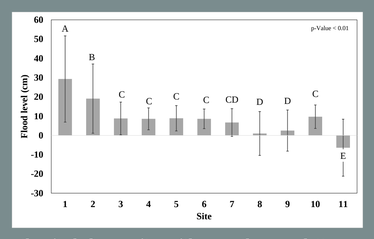
a) Statistical analysis: ANOVA and comparison of means Student's t
b) Linear regression
c) PCA and Surface trend analysis
d) Image Processing based on Colditz et al., 2008 and Colditz, 2014 .

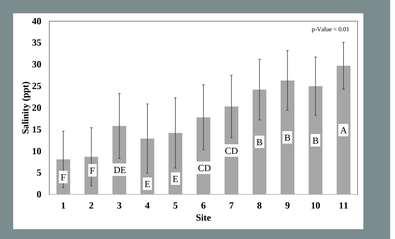
5. Results

H1: Gradient influence on litterfall production.









In the above three sets of figures capital letters refer to the group the site belongs, sites with more than one letter are not significantly different from each other.

- No clear pattern of litterfall productivity following a gradient away from inland.
- Environmental parameters such as flood and salinity show a gradient away from inland.

- Despite a clear pattern of litterfall productivity sites 3 and 4 have the most productivity and are related to low salinity and consistent flooding.
- Site 11 has low productivity associated with low flood and high salinity.

- Flood level is highest in sites 1 and 2, and lowest in site ll.
- Beyond the gradient, sites closer to the river 3-6 and 10 have consistent and less variable flooding compared to distant sites 8,9,11.

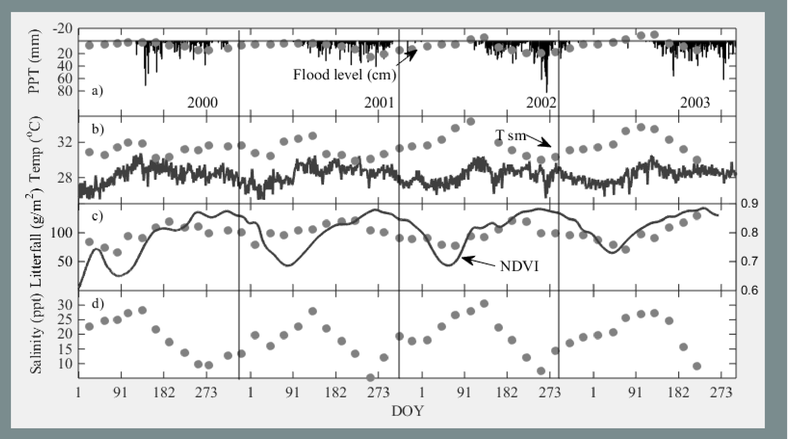
- Salinity is highest in sites closer to the ocean 8-11.
- Seasonal and tide effects of fresh and salt water mixing are observed in the variability for each site.

H2: Environmental influence on litterfall and NDVI

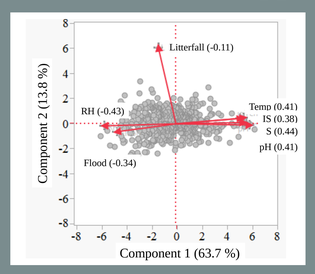
	Litter		NDVI	
	slope	r^2	slope	r^2
Flood level	+	0.15	+	0.36
Interstitial Salinity	-	0.03	-	0.28
PPT metstation	+	0.16	+	0.01
Relative humidity	+	0.19	+	0.26
Salinity	-	0.23	-	0.53
Temp metsation	+	0.23	-	0.04
Temp site	-	0.15	-	0.24

- Salinity correlates negatively to litterfall and NDVI, this relationship is stronger with NDVI.
- Temp measured at the site (Tsm) at 1.5 m above the soil shows a negative correlation with both litterfall and NDVI
- Met station T shows positive correlation with litterfall and negative with NDVI, potentially reflecting the complex intercanopy interactions, and scale issues.

- Litterfall production is weakly positively correlated to NDVI, potentially because of difference in scale. In c) general trend is similar although in occasions a lag is observed.
- NDVI is lower with little precipitation and high salinity, litterfall follows this trend.
- Mean temperature from met stations is lower than measured at the site, this is related to time during ground measurement.



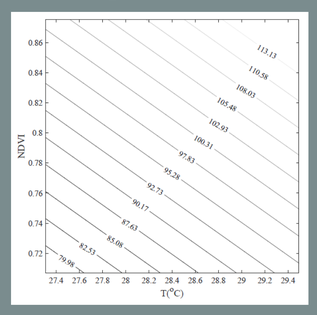
H3: Multivariate approach and modeling



- From ground measurements we detect that >50% variability in litterfall is influenced by salinity, temp, pH, and interstitial salinity.

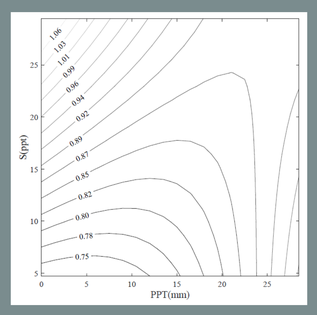
- We performed the PCA analysis to select the variables that are used in our empirical modeling .
- We select variables that are available from meteorological stations and/or remote sensing to generate our empirical model to calculate NPP components.

Litterfall Model (g/m²)
f (Temperature, NDVI)



- Temperature from meteorological station and NDVI interpolated to daily resolution.
- First order polynomial with a r^2=0.73

NDVI Model
f (PPT, Salinity)



- Precipitation from meteorological station and salinity from data collected in the field
- Second order polynomial with a r^2=0.85

6. Take home message

- Litterfall production is driven by more than one environmental variable. In this particular mangrove forest salinity, temperature, and flood level affect NPP. However this does not necessary follow a land-ocean gradient from inland out such as the environmental parameters. In the transitional zone other hydrological (i.e. lateral flow), soil (i.e. biogeochemistry), and atmospheric (i.e wind speed) variables likely play an important role in litterfall production.
- Understanding which variables are important and identifying some that have been measured continuously (i.e. meteorological stations and remote sensing) contribute to an important piece in the carbon cycle science.
- It is important to consider the difference in scale, e.g. comparing litterfall as sampled on the ground with NDVI derived by 250m satellite images. In this study we could not establish a linear relationships between them, likely because of the scale , and time lag between events.

7. Acknowledgement

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