Sea Level Rise Impacts on Ecoregions in the Gulf of Mexico

Team SeaSense
Debasish Mishra (3rd Year PhD),
Sonali Sahani (MBA + MS Analytics)
Gulf of Mexico (GoM) of 5x global sea level rise (SLR)

Valued in the academic space:

- Average annual global SLR = ~3.6mm
- SLR in GoM >10mm
- Importance of GoM
Ecoregions on slow burner!

Challenges

• Dichotomy of beauty & terror
• More than meets the eye?
• Impact on Fragile ecosystem
• Immediate or delayed?
• TAMU - Inland vs Galvaston

• What can I do to help communities in threat?
Floods

From 2010 to 2019, more than 130 major flood disasters were declared in the United States, averaging 13 disasters per year.

Droughts

19.8 Million people in the U.S. are affected by drought this week (NOAA).
Outline

01 Modelling complexities
Understanding the mechanism to monitor and control these complexities.

02 Impact on Ecoregions
How are the impacts of Sea level changes affecting different ecoregions and its implications.

03 Stakeholder engagement
Ensuring communication of simplified science-based findings to diverse audiences.
Journey of Water Parcel

1. Sea Level gridded satellite data
2. Soil Moisture gridded satellite data

Daily, 0.25x0.25, 2010-2020 (Copernicus Climate Data Store)

(b) Anomaly Transfer Scheme (ATS)
Sea Level Fluctuations in GoM

Sea Level Anomaly (m)

Longitude

Latitude

20-year Average (1993 – 2012)
Decadal Signatures in GoM

Zonal Velocity intensification post 2015!

- What affect do these sea level and velocity fluctuations have on ecoregions?
- Can the geostrophic velocity components play dominant roles in initiating and sustaining droughts/floods?
Ecoregions in GoM

Southeastern Coastal States
(Level 3 Ecoregions from EPA)
Hydrological Regimes

Soil Moisture is the fingerprint of anomalies acting on landscapes. Gives rise to brown ocean effect!
Equilibrium State

Drought Potential

Flood Potential
Median Soil Moisture Values (m^3 m^{-3})

Can Sea Level fluctuations Influence Soil Moisture regimes in Ecoregions of GoM?
WaveNET Architecture

3-Level Wavelet Decomposition

Sea Level Anomalies
Geostrophic Velocities

Bayesian Neural Network

Vulnerability Prediction

Drought Flood

Multiresolution WAVE-NET Architecture
Multi-Resolution Analysis

Temporal Signature

Spectral Signature
Drought Vulnerability

Drying Power Of Sea
High Values Indicate Higher Controllability

- Zonal Velocity (A3): 27.5
- Sea Level Anomaly (A3): 25.0
- Zonal Velocity (A2): 22.5

1. South Central Plains
2. Mississippi Alluvial Plain
3. Piedmont
Flood Vulnerability

Wetting Power Of Sea
High Values Indicate Higher Controllability

- Meridional Velocity (A3) 26.5
- Zonal Velocity (A3) 24.0
- Sea Level Anomaly (A3) 22.5

Cross-Wavelet Power

1. East Central Texas Plains
2. South Central Plains
3. Mississippi Alluvial Plain
WaveNET Model is able to predict soil moisture conditions at minimal RMSE of 0.04 for both extremes!

70:30 Split between training-testing data (rolling forecasting origin)
Communicating to the Public
Sea level in the Gulf of Mexico has recently been experiencing a negative anomaly with higher zonal velocity fluctuation.

WaveNET (Wavelet + Bayesian Neural Net) architecture is able to capture the minute details in spectral changes in sea level in GoM.

Zonal velocity and meridional velocity components play a dominant role in controlling drought & flooding conditions respectively.

Populations in South central plains, and east central Texas plains are vulnerable to extremes due to sea level fluctuations.

THANK YOU!