Monitoring Sea Level Rise and Developing Conservation Strategies for Coastal Georgia: Using Estuarine Science monitoring as a predictive tool for better understanding changes in our salt marshes and human adaptation needs.

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Abstract:

Sea Level Rise is an ongoing global consequence due to a number of factors ranging from the natural transition of the earth from it's latest Pleistocene era to an increase in human created "greenhouse gases" which raise global atmospheric temperatures. Earth's polar ice caps have been experiencing reductions in spatial domain at an alarming rate over the past several decades. Due to the melting of the large bodies of stored water (ice) subsequent increases in sea level height to the continental land masses are threatening coastal habitats and human infrastructure alike. These "threats" to conservation priorities such as rare or under represented species and habitats are alarming and in need of study if we wish to retain the integrity of our coastal natural systems and it's biodiversity.Georgia's only coastal sea level monitoring gauge is located at the Ft. Pulaski National Park in Chatham County near the city of Savannah. This station is part of the National Water Leveling Observation Network (NWLON) and has a maintained a continuous 75 year record of sea level height from which many of the current local sea level rise monitoring predictions are being made. Many agencies such as the Sapelo Island National Estuarine Research Reserve (SINERR) and the Georgia Coastal Ecosystems Long-Term Ecological Initiative (GCE-LTER) are researching the effects of long-term sea level rise upon our coastal estuarine systems in Georgia.

Introduction

Sea Level Rise (SLR) has occurred in Georgia at a rate of approximately 1 foot over the past 70 years based upon the tidal gauging station located at Fort Pulaski, GA **(Figure 1).** Although this may not seem to represent an alarming rate of change it does establish a baseline of information that is of significant consequence to Georgia residents. Georgia's (South Carolina and Florida's) low sloping coastal plains will allow greater spatial impacts to our coastlines as sea level rises. This rise will affect coastal homeowners, municipalities and industries to a greater extent as compared to many other seaboard areas of the U.S. This rise in sea level will also affect our coast's natural nearshore habitats which will necessitate better conservation planning for this factor if we hope to preserve and protect our regions highly diverse wildlife and it's needed habitat. In order to better understand the effects that Sea Level Rise will have upon our natural communities scientists are developing research platforms targeting changes within biota, chiefly vegetation. Vegetation makes a good proxy as SLR will affect the salinity of coastal inland waters which will in-turn alter these habitats. The best model we have currently for the expected changes in coastal habitats due to SLR was developed by the GCE-LTER initiative **(Figure 2).** In this habitat model one can visualize the expected changes in natural communities associated with the lower Altamaha River based upon it's vegetation landscape. In order to better adjust this model for sediment erosion, accretion and subsidence (settlement) effects upon vegetation on a finer scale, smaller, site-specific scientific studies are being established in salt marsh areas such those found in the Sapelo Island NERR.

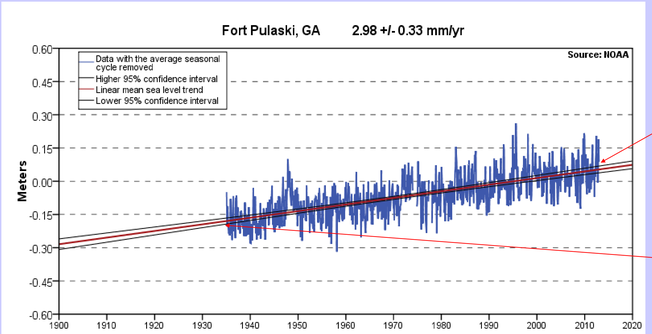

Figure 1.

Sea Level has risen about one foot over the past 75 years based upon the Ft. Pulaski tidal gauging station.

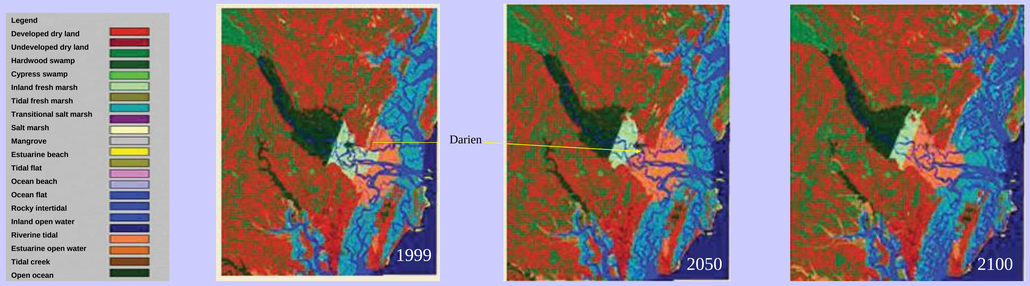

Figure 2. These spatial models (Craft et. al, 2009) illustrate expected shifts in habitats that may occur within the Altamaha River basin over the next 100 years based upon a 52 cm (approx 20 inch) increase in sea level (SLR). This trajectory shows large declines in tidal freshwater marsh (-38%) and tidal swamp (-38%). Lesser changes may occur in the extent of salt marsh (-8%) and brackish marsh (+4%) but the trend in location for all habitats is a shifting or "squeezing" up the Altamaha corridor. If the model is increased to an 82 cm rise in sea level (approx 32 inches) losses in salt marsh (- 45%) and tidal freshwater marsh (-39%) become much more extensive in the area.

Materials and Methods

The Sapelo Island NERR is currently conducting long-term SLR vegetation and sediment monitoring within a salt marsh. The developing scientific platform is focused on how high-marsh vegetation communities will shift in spatial domain, species abundance and location along (up) a tidal gradient with advances in sea level. High resolution Real- Time Kinematic (RTK, **Figure 3**) surveys will be conducted upon established deep rod Sediment Elevation Tables (SET's; **Figure 4**) and salt marsh transects (6 transects of 7 replicates each; n = 42; **Figure 5**) along the elevation gradient in which all are located. Currently quarterly (seasonal) assessments are made on SETs with an annual peak biomass (mid-October) assessment on adjacent vegetation. This information will be used to improve future spatial modeling (**Figure 2**) and fill needed data gaps related to both effects and processes involved in Sea Level Rise.

Figure 3.Real Time Kinematic marsh monitoring allows for very high vertical (topographical) resolution readings which are then infused and translated into a Sea Level Rise monitoring platform.

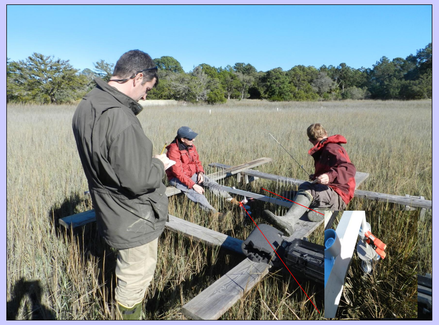

Figure 4. Sediment Elevation Tables (SET) monitoring allows scientists to understand sediment accretion, erosion and subsidence rates in a salt marsh based upon current sea level and it's predicted rise.

Figure 5. Monitoring current vegetation and tracking its changes directly beside SETs allows scientists an understanding of how sea level changes affects the distribution and species composition of the natural communities and habitats.

Results and Discussion

Large spatial scale, long-term SLR monitoring is under development for the entire coast of Georgia. Coastal Resources Division (CRD) in conjunction with Wildlife Resources Non-Game Section are monitoring the effects of SLR on a statewide basis. (**Figure 6**.). The objectives of this monitoring include acquiring information that will be important for balancing human community growth with ecological needs. Likewise, organizations such as The Nature Conservancy (TNC) are placing great emphasis upon characterizing coastal habitats and protecting our nations coastal conservation legacy. In order to preserve these habitats TNC uses tools such as conservation easements and direct acquisitions tailored to protect the long-term needs of living resources that are threatened by changes in environment and habitats due to SLR and development (**Figure 7.**). Strategic TNC conservation targets in coastal Georgia include fauna such as loggerhead sea turtles, indigo snakes, red knots and American oystercatchers.

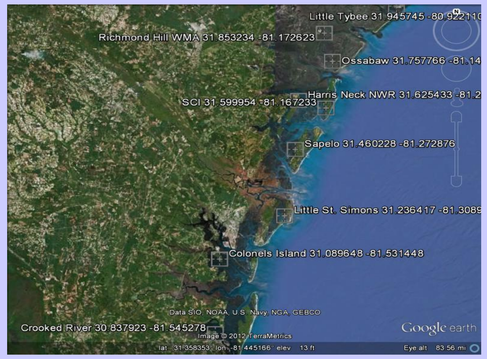

Figure 6. Locations of Coastal Resources Division (CRD) long-term sea level rise monitoring sites along the Georgia coast. This coast-wide vegetation monitoring also includes a human community component for applications related to developments near marsh areas.

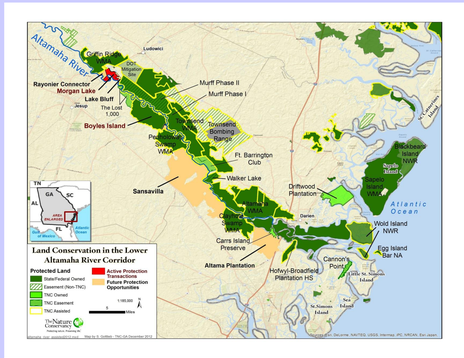

Figure 7. Map showing the location and extent of properties protected by TNC and found within Georgia's coastal plain. These areas are strategically acquired for protection of critically important habitats which in-turn allow for the maintenance of our states coastal and riparian biodiversity.

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Literature Cited

Craft, C., J. Clough, J. Ehman, S. Joye, R. Park, S. Pennings, H. Guo, and M. Machmuller. 2009. Forecasting the effects of accelerated sea-level rise on tidal marsh ecosystem services. Frontiers in Ecology and the Environment 7:73–78.