NOVEMBER 2022

SALTWATER INTRUSION IN THE NORTHERN GULF OF MEXICO

A BRIEF SUMMARY OF REGIONAL MONITORING AND IMPACTS TO COASTAL HABITATS

ABOUT THIS REPORT

This report serves to summarize current understanding and monitoring around saltwater intrusion in the northern Gulf of Mexico region in an easy to understand and digestible way. Hopefully, this will serve as a starting point for more conversations on how to approach the increasing threat of saltwater intrusion associated with sea-level rise in our region.

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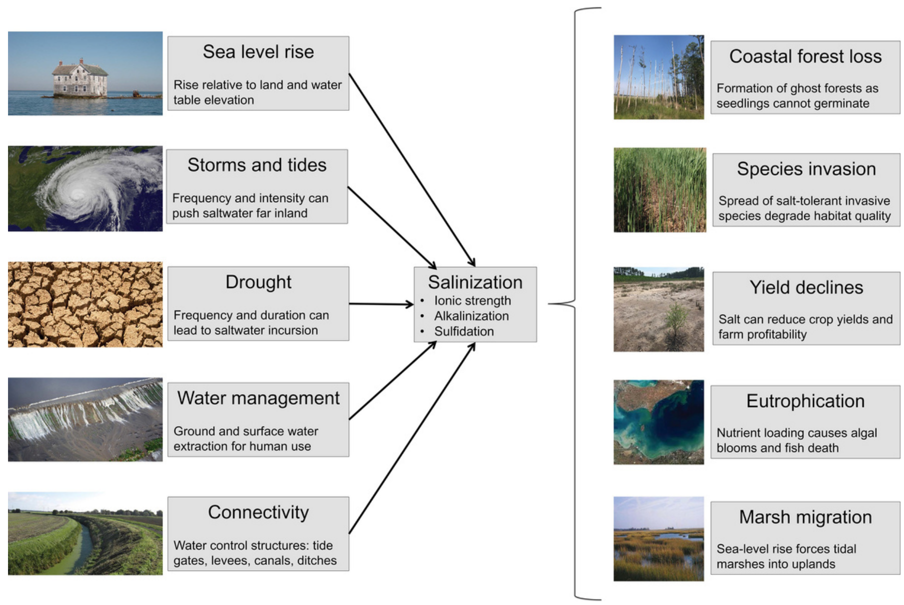
INTRODUCTION TO SALTWATER INTRUSION IN THE NORTHERN GULF OF MEXICO



Drivers of saltwater intrusion. Tulley et al. 2019.

Saltwater intrusion is of increasing concern along the northern Gulf of Mexico. While pulse events of intrusion have happened in the past due to storms, we are now facing a more continuous threat due primarily to sea-level rise.

The northern Gulf of Mexico has some of the highest rates of sea-level rise in the country and is 10% higher than the global average (Sweet et al. 2022). As the water rises, salt can reach further inland for longer periods of time.

The reach of saltwater is further extended by channels into upland habitats. These channels include natural rivers and artificial canals built for transportation. Human activity worsens saltwater intrusion through the extraction of groundwater for public use and agriculture (White and Kaplan 2016)

This report explores the impacts of saltwater intrusion on both the natural and built environment and the monitoring of it along the northern Gulf of Mexico coast.

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SALTWATER INTRUSION EFFECTS ON SALT MARSHES

KEY TAKEAWAYS

- MOST OF THE VEGETATION ALONG THE COAST ARE ALREADY SALT-TOLERANT
- WE HAVE TOOLS THAT CAN MODEL THE EFFECTS OF FLOODING ON VEGETATION

Much of the vegetation that populates our coastlines is already salt-tolerant (i.e., *Juncus roemerianus, Spartina sp., Schoenplectus sp*.). Because they can thrive in high levels of salinity, the plant health is not threatened by saltwater intrusion (USDA NRCS 2022) Instead, the flooding that goes hand-in-hand with saltwater intrusion poses the biggest challenge to saltmarsh persistence.

Increased inundation will drive salt marsh vegetation to migrate upland. When upland space is not sufficient or there are barriers to upland migration, we can expect that salt marsh ecosystems will convert to open water.

For this reason, tools that model the effects of flooding on marsh vegetation will be useful to natural resource managers (e.g., Hydro-MEM from gommarsh.org, SLAMM,).

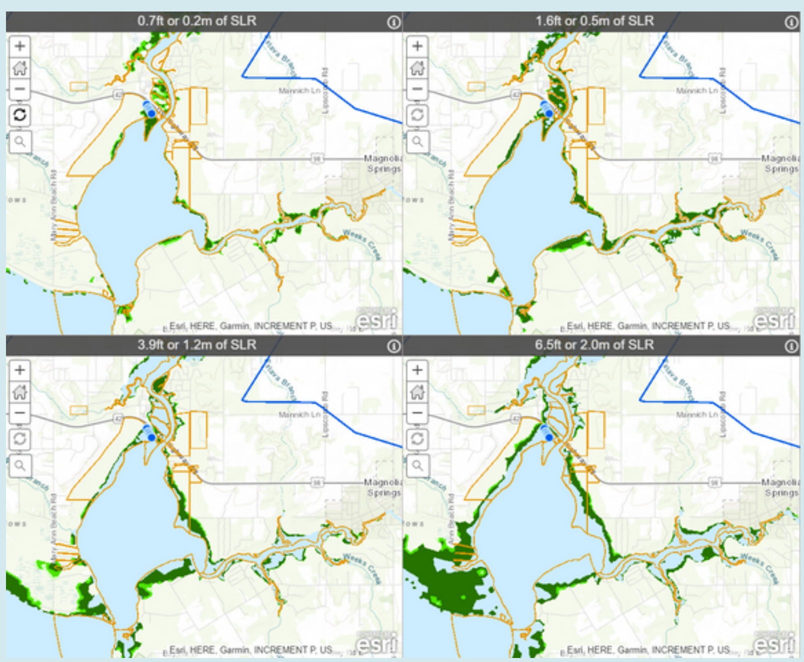


Image from GOMmarsh.org

This tool shows outputs from Hydro-MEM, a marsh model that estimates the change in productivity of marsh habitats under various SLR scenarios.

04

SALTWATER INTRUSION EFFECTS ON TIDAL FRESHWATER WETLANDS

Tidal freshwater wetland plant species are not tolerant of salinity. Prolonged exposure to saltwater reduces the primary productivity of vegetation (Neubauer 2013) and decreases photosynthesis (Sutter et al. 2013). Sutter et al. (2013) also found that plant biomass declines at 2ppt and plant death at 6ppt. With gradual changes in salinity, tidal freshwater species will likely migrate upland into fresher habitats while brackish or salt marsh species move in, reducing plant diversity (Neubauer et al. 2013).

Saltwater intrusion also contributes to elevation loss in tidal freshwater wetlands. The decrease in belowground biomass with saltwater intrusion led to almost 3cm of elevation loss across two recent studies (Charles et al. 2019; Solohin et al. 2020). Saltwater intrusion has also been found to increase the rate of microbial decomposition (Weston et al. 2011), contributing further to elevation loss. This, in turn, will make tidal freshwater wetlands more susceptible to sea-level rise and saltwater intrusion.

Tidal freshwater wetlands under chronic saltwater stress, also have reduced ability to absorb nitrogen species (Widney et al. 2019); however, this was not observed in pulse events.

With future sea-level rise, we can expect that these habitats will have more frequent exposure to saltwater and therefore conversion of these habitats to brackish marsh, salt marsh, mudflats, or open water is likely.

KEY TAKEAWAYS

- PLANT BIOMASS DECLINES AT 2PPT AND PLANT DEPTH AT 6PPT
- SALTWATER INTRUSION CONTRIBUTES TO ELEVATION LOSS IN TIDAL FRESHWATER WETLANDS

Image from Eric Sparks

Receding marsh in Grand Bay, AL

SALTWATER INTRUSION EFFECTS ON TIDAL FRESHWATER FORESTED WETLANDS

These habitats are sensitive to prolonged exposure to saltwater. At 1ppt salinity, tidal freshwater forested wetlands (TFFW) will begin their conversion to tidal marsh (Hackney and Avery 2010). At 2 ppt salinity, the conversion occurs rapidly (Hackney et al. 2007).

KEY TAKEAWAYS

- FOREST LOCATION IS DRIVEN BY HYDROLOGY
- PLANT SPECIES COMPOSITION THROUGHOUT A FOREST IS DRIVEN BY SALINITY
- WITH INCREASING SEA LEVEL RISE, FORESTS WILL CONVERT TO MARSH

In riverine tidal freshwater forested wetlands, the conversion to salt marsh is likely slower due to the input of freshwater from rivers. A recent study along the East River and St. Marks River in Florida found that the downriver extent of the TFFW was driven by hydrology, as the salinity was not high enough to limit the extent. However, the species composition dispersed throughout the wetland was increasingly driven by salinity (Celik et al., 2014). Similar results were found in Liu et al. 2017 where wetland habitat loss was not seen as the salinity remained well below the critical threshold of 2ppt.

Historically, this process has occurred over the course of centuries, or longer, as saltwater slowly moved inland. However, with the increasing rate of sea-level rise, the conversion of these habitats is accelerating. As the TFFW convert to marsh, they lose elevation and become more susceptible to sea-level rise.

Conversion of tidal freshwater forested wetland to oligohaline marsh. *Stagg et al. 2017.*

06

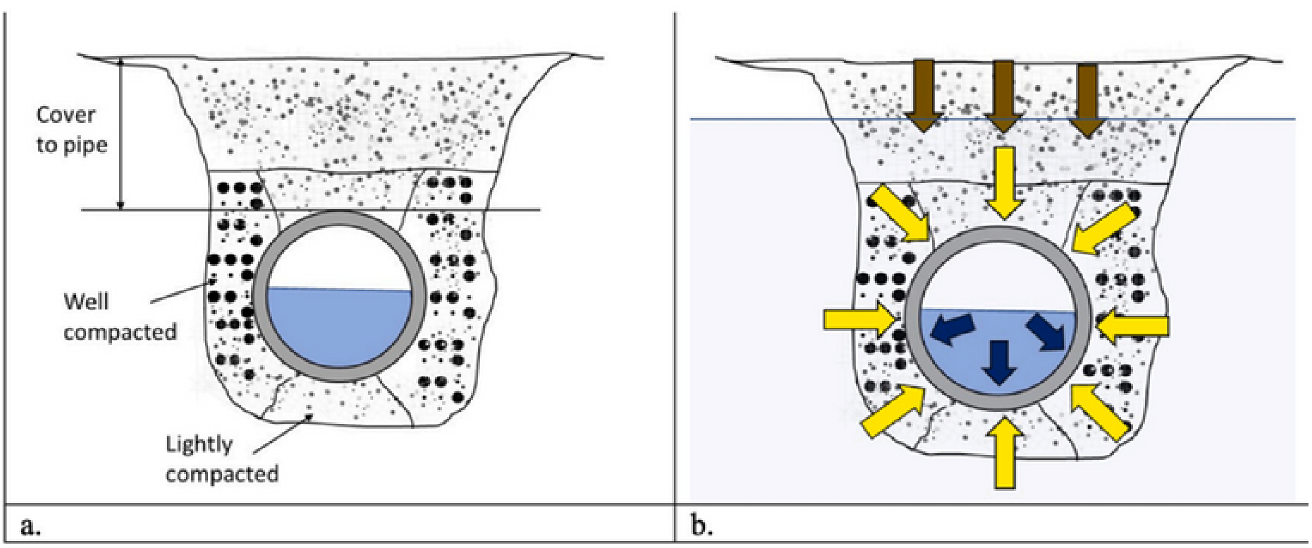
SALTWATER INTRUSION EFFECTS ON WATER DISTRIBUTION PIPELINES

KEY TAKEAWAYS

- PIPELINE SERVICE LIFETIME IS OFTEN MUCH SHORTER THAN ESTIMATED
- SALTWATER INTRUSION DECREASES THE INTEGRITY OF WATER DISTRIBUTION PIPELINES

Water pipelines are designed to transport treated drinking water to consumers. Sea-level rise and subsequent saltwater intrusion can significantly impact water and wastewater distribution pipe integrity. Normally, estimated service lifetimes of water pipelines are over 75 years (Folkman 2018). However, the actual service lifetime is much shorter, especially in warmer coastal areas.

Increased conductivity of groundwater as a result of saltwater intrusion can exacerbate the corrosion rates of pipelines due to increased salinity and pressure. As these corrosion rates increase, we will see the service lifetime of these water pipelines grow shorter in the upcoming years (Tansel and Zhang 2022). Additionally, this corrosion can cause saltwater to infiltrate the pipelines, contaminating our drinking water.



A) Pipeline before sea-level rise. Light corrosion and compaction. B) Pipeline after sea-level rise and saltwater intrusion. Severe compaction and corrosion to the pipe, decreasing integrity (Tansel and Zhang 2022).

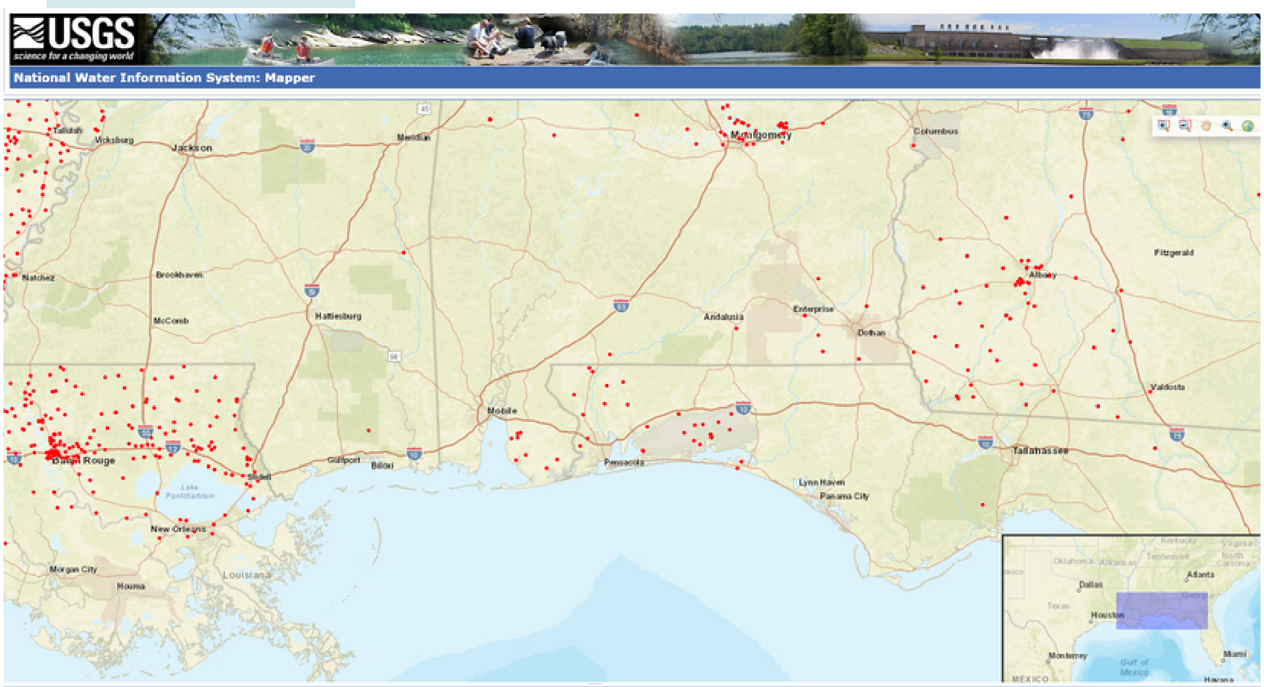
07

MONITORING SALTWATER INTRUSION IN THE NORTHERN GULF OF MEXICO

Monitoring saltwater intrusion is crucial for predicting decreases in freshwater and assessing management options. Saltwater intrusion is often monitored by measuring salinity profiles in groundwater and surface water via specific conductance. Seawater has a specific conductance of 50 mS/cm (~33ppt). For perspective, freshwater habitats are susceptible to rapid conversion around 2 ppt and freshwater for drinking can not exceed 0.5 ppt.

The United States Geological Survey has an extensive database of groundwater wells and surface water sampling sites around the country (maps.waterdata.usgs.gov/). However, the data can be overwhelming and cumbersome to access. Each point in the web mapper represents a sampling site, but access to the data requires redirecting to another webpage.

Furthermore, there are only 26 active groundwater wells across the PLACE: SLR geography (coastal counties from the Pearl River to the Suwannee River); 17 in Florida, 1 in Mississippi, and 8 in Alabama. This scarcity of groundwater wells and subsequent data is somewhat filled by individual researchers, organizations, utility authorities, and others. However, this information can be difficult to access as it is spread across sources.



Example of NWIS mapper for the PLACE: SLR region. Red dots indicate groundwater sites.

GAPS AND POTENTIAL NEXT STEPS

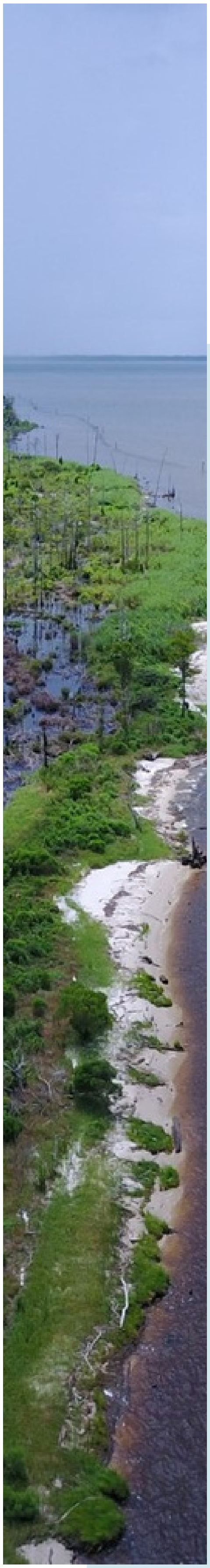
The items listed below are suggestions for the working group. PLACE: SLR welcomes any input on these or other gaps and next steps.

GAPS FOR THE NORTHERN GULF REGION

1. Identify areas that are particularly vulnerable to saltwater intrusion in our region.
2. Determine priority areas for management based on vulnerability to saltwater intrusion and ability for mitigation.
3. Enhance regional groundwater well monitoring for coastal Mississippi and Alabama

SUGGESTED NEXT STEPS

1. Create an easy to use database of up-to-date saltwater intrusion monitoring data that incorporates more groundwater wells in Mississippi and Alabama.
2. Identify management activities that can mitigate the effects of saltwater intrusion on various coastal habitats.
3. Encourage applied research into saltwater intrusion effects, and salinity in particular, on built infrastructure in the northern Gulf region.



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