Assessing the Risk of Sea Turtle Nest Inundation on Sandy Beaches: A Field Experiment on Galveston Island, Texas

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Introduction

- 6 of 7 sea turtle species are endangered (IUCN red list)
- Sea turtles need sandy beaches to lay their nests
- During incubation (6-8 weeks), **nests can get flooded** by high tides, wave runup, elevated groundwater, etc.
- Sex ratios are determined by incubation sand temperature
- Nature-based solutions may help preserve and expand nesting habitats, for example through turtle friendly beach nourishment (Christiaanse et al., in review)

Case study — Galveston Island, TX

- Barrier-bay system in Gulf of Mexico, connects Houston metro to the Sea
- Barrier beaches are important nesting habitat for **critically endangered Kemp's ridley turtle**
- Characterized by **continuous erosion and (tidal) inundation**
- All nests are currently excavated and moved to Padre Island
- Large-scale coastal protection interventions planned in response to hurricane flooding & damage (TAMUG, 2017)

Field experiment

Objective: monitor the different flooding mechanisms and their interactions on the nesting beaches at Galveston Island: High tide, storm surge / wind setup, wave runup, and groundwater.

Photo impressions of the field experiments

Data preview: Storm on 13 November 2023

Water levels

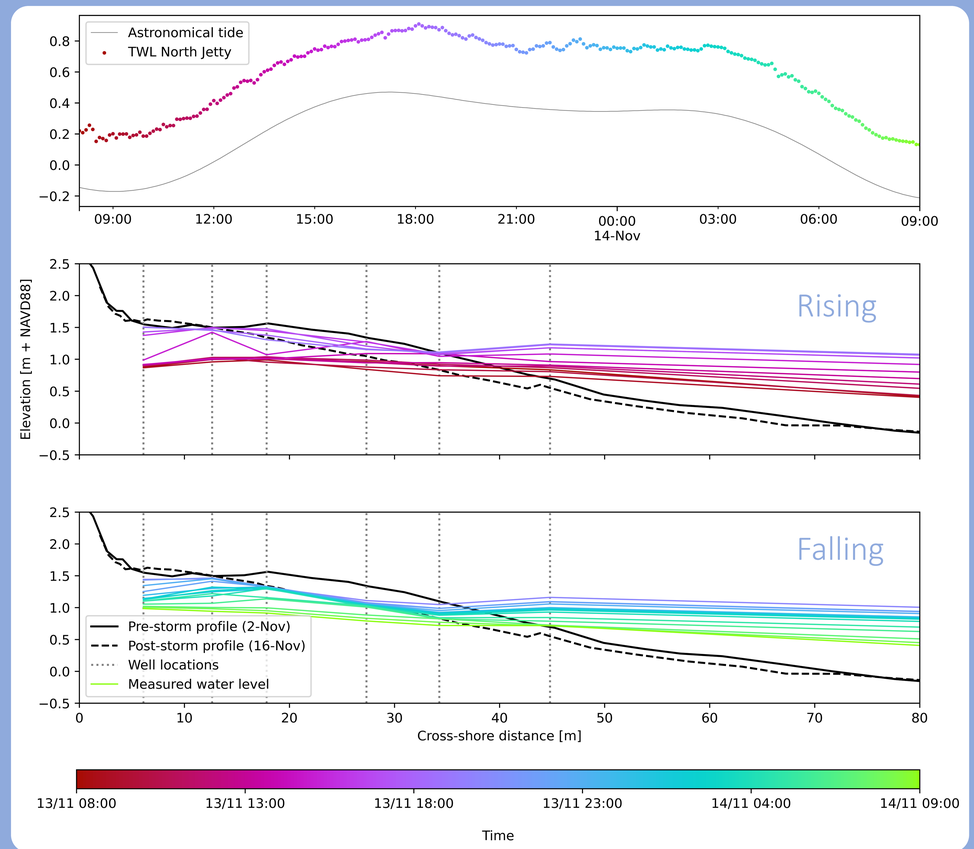


Figure 1: Water levels during a storm from 13 Nov 8am to 14 Nov 9am, 2023. Upper panel shows the astronomical tide and total observed water level from a NOAA wave gauge at the Northern Jetty of Galveston Bay entrance channel (20km from T2). The two lower panels show a time stack of measured (ground) water levels along the cross-shore transect of field site T2. The rising water level phase is shown in the middle panel and falling in the lower panel. The colors indicate the time.

Vertical soil temperature & moisture content at dunetoe

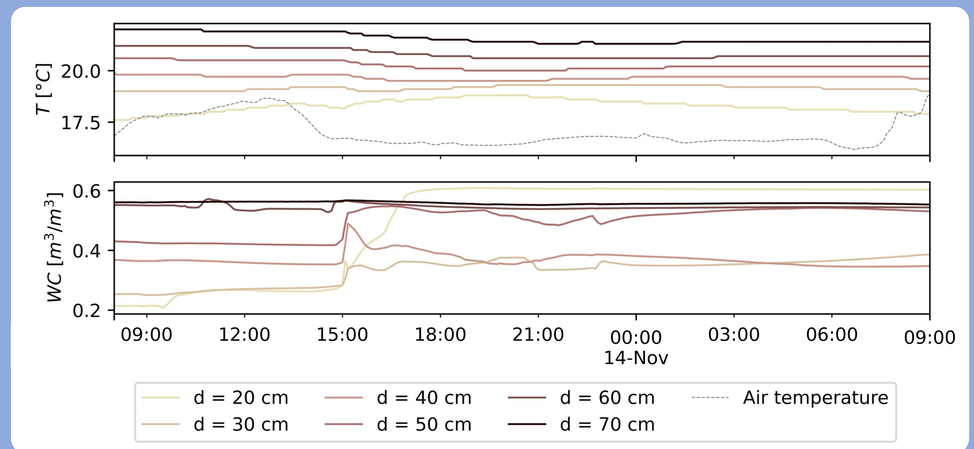
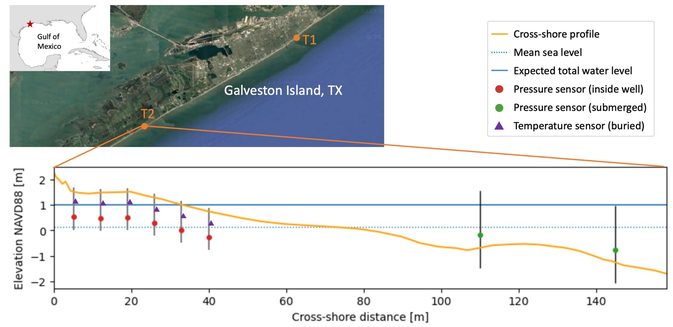


Figure 2: Soil temperature (upper panel) and moisture content (lower panel) at six different depths in the sand at the dune toe (main nesting area).

Nesting Kemp's ridley turtle

Experimental setup

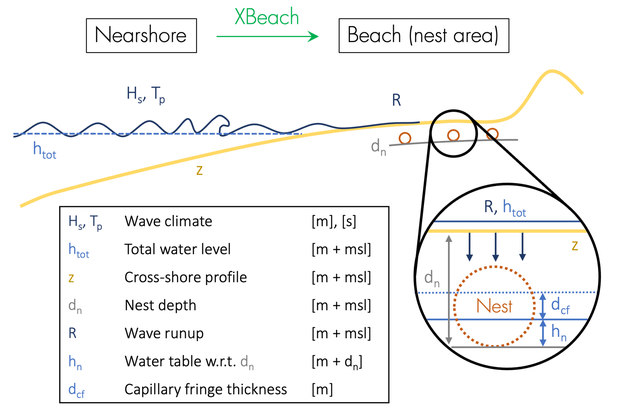
- 2 Field sites on Galveston Island:
  - Seawall (T1), nourished,
  - Tipsy Turtle (T2), 'natural'
- Cross-shore array of six slotted wells with pressure loggers and a buried temperature logger at nest depth (40cm)
- Two pressure loggers in nearshore
- Wave buoy 1.5 km offshore
- GoPro footage of wave runup
- Vertical array of moisture/temperature sensors at dune toe



Outlook & next steps

Use field data to calibrate a **predictive modelling tool** (XBeach) to:

1. Help coastal managers to make decisions on relocation nests
2. Help coastal engineers in the long-term design and implementation of **turtle friendly beach nourishment**



H_s, T_p	Wave climate	[m], [s]
h_{tot}	Total water level	[m + msl]
z	Cross-shore profile	[m + msl]
d_n	Nest depth	[m + msl]
R	Wave runup	[m + msl]
h_n	Water table w.r.t. d_n	[m + d_n]
d_{cf}	Capillary fringe thickness	[m]

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References

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