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# 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 (Christiaan 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

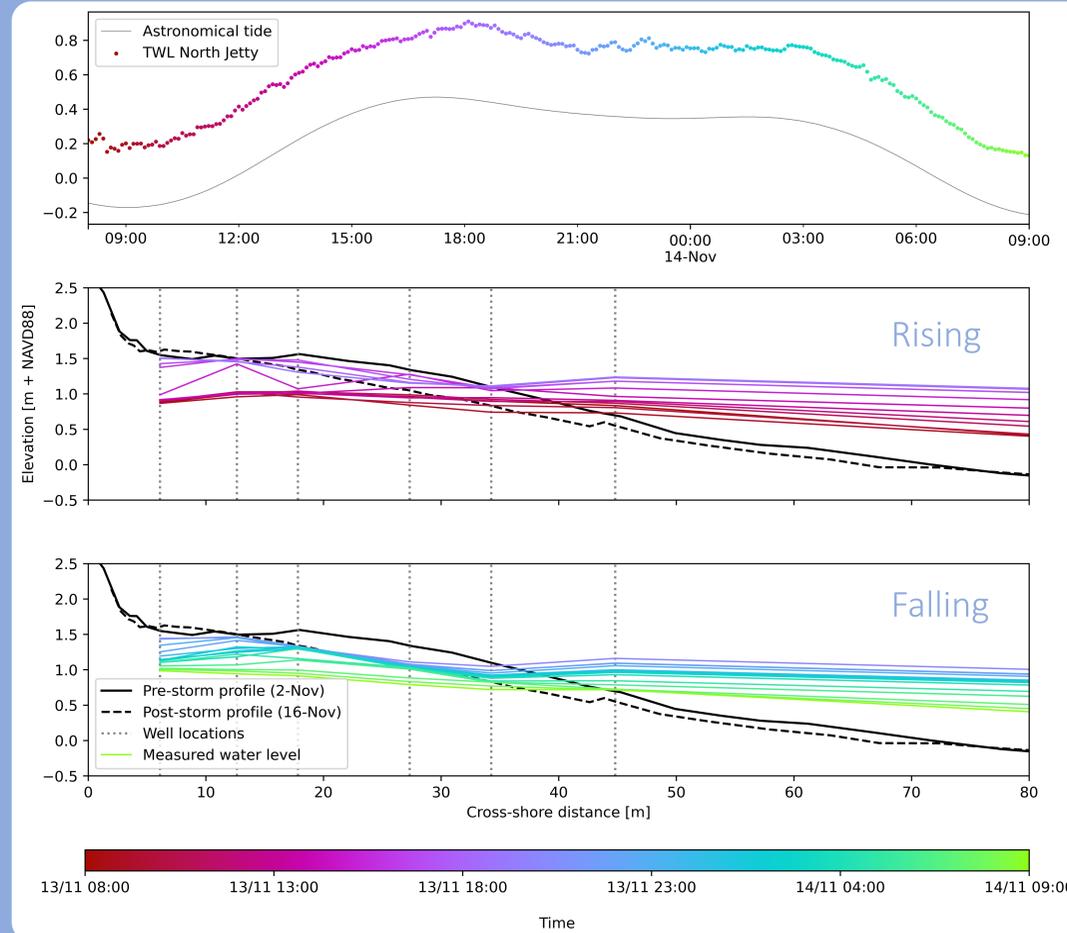


Figure 1: Water levels during a storm from 13 Nov 8am to 14 Nov 9am, 2023. Upper panel shows the astronomical tide and total observed water level from a NOAA wave gauge at the Northern Jetty of Galveston Bay entrance channel (20km from T2). The two lower panels show a time stack of measured (ground) 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 dune toe

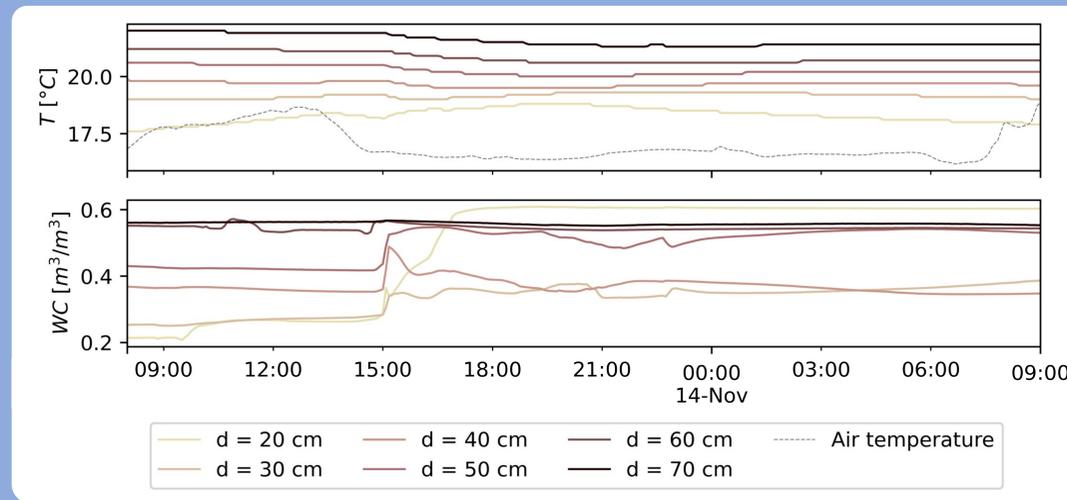


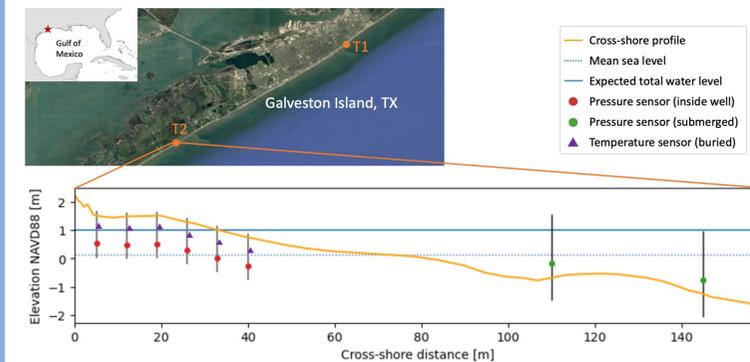
Figure 2: Soil temperature (upper panel) and moisture content (lower panel) at six different depths in the sand at the dune toe (main nesting area).



Nesting Kemp's ridley turtle

## Experimental setup

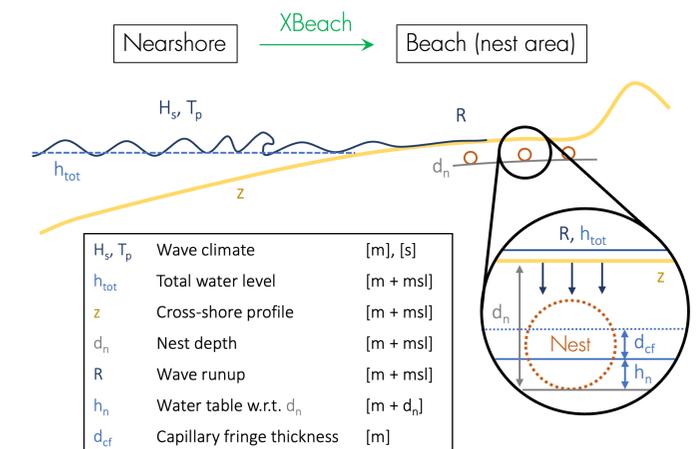
- 2 Field sites on Galveston Island:
  - Seawall (T1), nourished,
  - Topsy Turtle (T2), 'natural'
- Cross-shore array of six slotted wells with pressure loggers and a buried temperature logger at nest depth (40cm)
- Two pressure loggers in nearshore
- Wave buoy 1.5 km offshore
- GoPro footage of wave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



## References

Christiaan, J. C., Antolínez, J. A. A., Luijendijk, A. P., Athanasiou, P., Duarte, C. M., & Aarninkhof, S. (in review). Global distribution of sea turtle nesting explained from regional coastal characteristics. *Scientific reports*.

USACE and GLO (2021): Coastal Texas protection and restoration feasibility study. Final report. U.S. Army Corps of Engineers Galveston District and Texas General Land Office.

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