

# METHODS AND APPLICATIONS FOR WATER LEVEL EXTRACTION FROM IMAGERY

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## INTRODUCTION

Accurate water level measurements are important for environmental monitoring, project management, and modeling applications. Within the United States, federal agencies such as the National Oceanic and Atmospheric Administration (NOAA), the United States Geological Survey (USGS), and the US Army Corps of Engineers (USACE) are tasked with installing and maintaining various buoys and water gages for water level measurements. While accurate, high installation and maintenance costs limit the spatial coverage of these instruments. Currently there is 241 water level stations that have an uneven distribution across the United States' 95,000 km of shoreline.

The popularity of coastal imaging products has continued to grow in recent years due to decreasing costs and increasing image resolution and spatial coverage. Within USACE, the CorpsCam initiative was developed to help monitor coastal areas of interest and consists of three tiers: the research grade Argus system, a commercial off the shelf trail camera, and the crowd-sourced citizen science CoastSnap (Harley and Kinsela, 2022). Images captured at all tiers are transmitted over wireless cellular network to an internal server for processing and analysis. CorpsCam projects have focused on coastal monitoring and exploring new ways to quantify extracted features such as shoreline change, surface current measurements, and estimated bathymetry in the nearshore. This paper will investigate the accuracies of using low-cost cameras at various study sites to extract and quantify water level from imagery.

## STUDY SITES

Three study sites were chosen with varying hydrodynamic conditions to develop a dataset for water level extraction. The USACE Field Research Facility (FRF) in Duck, North Carolina was chosen to compare accuracy and resolution of the trail cameras for water level extraction, using the NOAA station at the end of the pier as a validation point. The camera was programmed to capture one image every second for 90 seconds at the top of every hour. The second site is Craney Island, a confined dredged material disposal site located next to the Port of Norfolk in Virginia. A planned channel deepening in the Port of Norfolk will increase the amount of placed material in the area, requiring accurate water level measurements and regularly updated imagery to ensure the containment levees are not compromised. Three cameras and two water level sensors were installed at this site, with images taken every 15 minutes. The final site is the Elizabeth River in Norfolk, Virginia, and was chosen for monitoring flooding and high-water events. A water level sensor was installed on a piling in the frame of view, and the camera was programmed similar to the FRF site.

## METHODS

Images were georectified using terrestrial lidar and the Coastal Imaging Research Network (CIRN) toolbox (Bruder and Brodie, 2020). A reference object with known geographical coordinates was identified and the real-world elevation at each pixel along that object was found using the rectification results. A water level extraction algorithm that was developed to measure a tsunami using surfcams was used for this study (McGill et al., 2024). This algorithm converts RGB images into the CIELAB color space due to its light intensity component closely related to perceived brightness. The user defines the brightness threshold relative to the reference object or water, and the water level is identified as the pixel location that the threshold is broken.

Using the new datasets available from the three study sites, the algorithm will be refined to increase accuracy in varying visibility and weather conditions. Extracted water level will be compared with observed water levels at in-situ instruments for accuracy and error analysis. Applications at each of the three study sites will be presented and discussed.

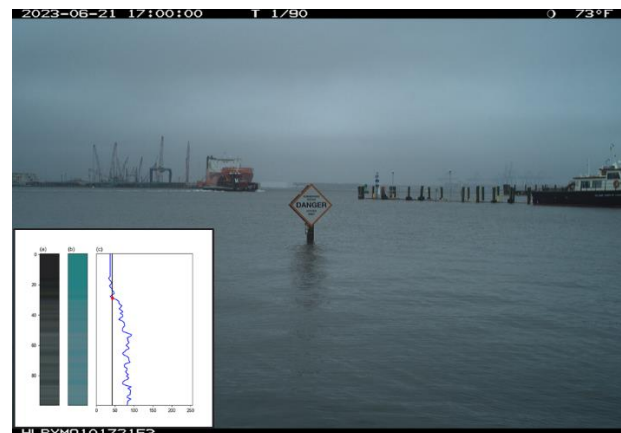


Figure 1 - Image captured at the Elizabeth River study site, with an example of the water level detection algorithm shown at the bottom left.

## REFERENCES

- Bruder and Brodie (2020): CIRN quantitative coastal imaging toolbox, SoftwareX, ELSEVIER, vol. 12, 100582
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