

Evaluation of Sunny Day Flooding at Hampton Beach, New Hampshire

Allison Bickford, Alexander Charest, Matthew Gigliotti, Cassidy Wilson
Dr. Drummond Biles and Dr. Diane Foster



University of New Hampshire
College of Engineering and Physical Sciences

Motivation

With sea levels rising, flooding along the coast due to naturally occurring tides and storm surges have become a more prevalent problem. Hampton, NH experiences street flooding during the largest monthly "king" tides. These increasingly frequent extreme events require residents to be alerted as to whether or not they need to evacuate. Measurements of water level along Hobson Ave, a street in Hampton that consistently floods when the tide elevation is above 10 feet, were taken with purpose-built ultrasonic sensors. These king tide events can last up to 4 days. Over time, this has led to the community advocating for new defense strategies against flooding, such as flood walls. Our goal with this research is to further investigate the time frame and maximum heights of the flooding in this community. Our long term goal is to develop affordable measurement techniques to help the community address this critical issue.



The pictures above show some of the damage these tides have caused. When the sensors were first deployed, a barrier wall was in tact but when we visited later, the wall had been knocked over and destroyed.

Location

Hobson Ave. is one of the local Hampton streets that sees regular flooding. Due to its low elevation, Hobson Ave and Hampton Beach as a whole are great places to study the flooding not only for the effects it has on the area, but for understanding this phenomenon on a global scale for larger cities.



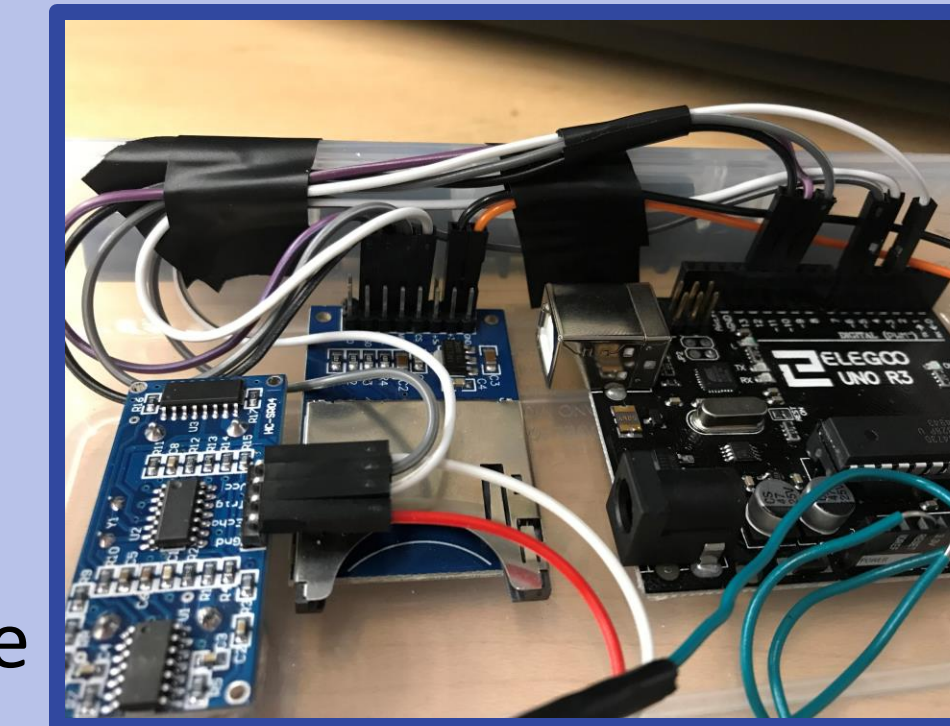
The pictures above show the location of sensors on Hampton Beach

Methods/ Deployment

An ultrasonic sensor was used to measure the distance from the sensor to the ground. As the water levels rose, the distance that the sensor read decreased, allowing us to calculate how high the water rose. Since the sensor is near the water and must endure the field conditions, a case was needed for waterproofing.

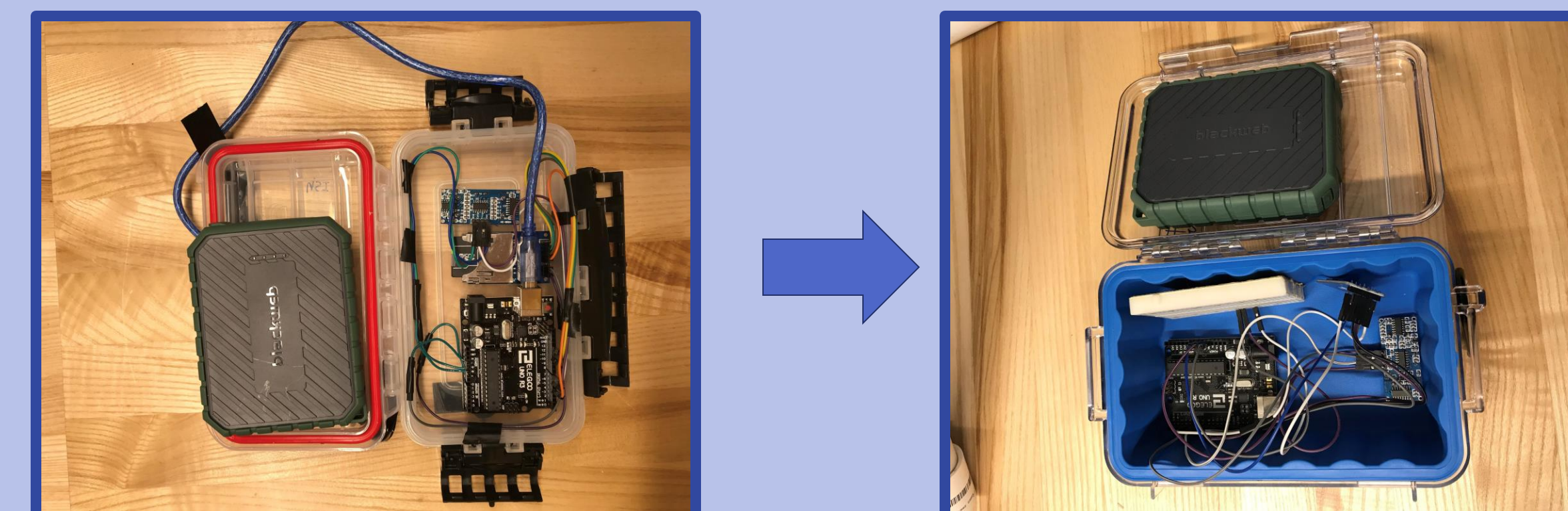
The instrument package contains:

- Arduino
- Ultrasonic sensor
- SD card reader & SD card
- Breadboard and breadboard leads
- 9V battery (Replaced by portable phone charger)
- 80-20 aluminum brackets for mounting



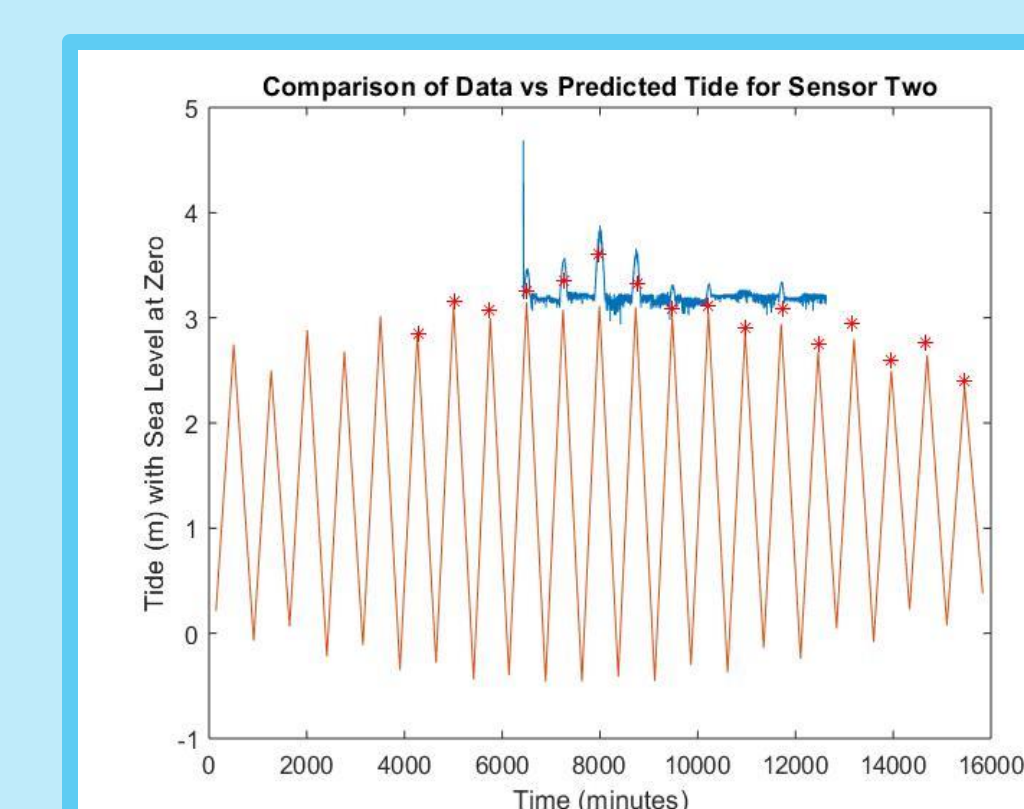
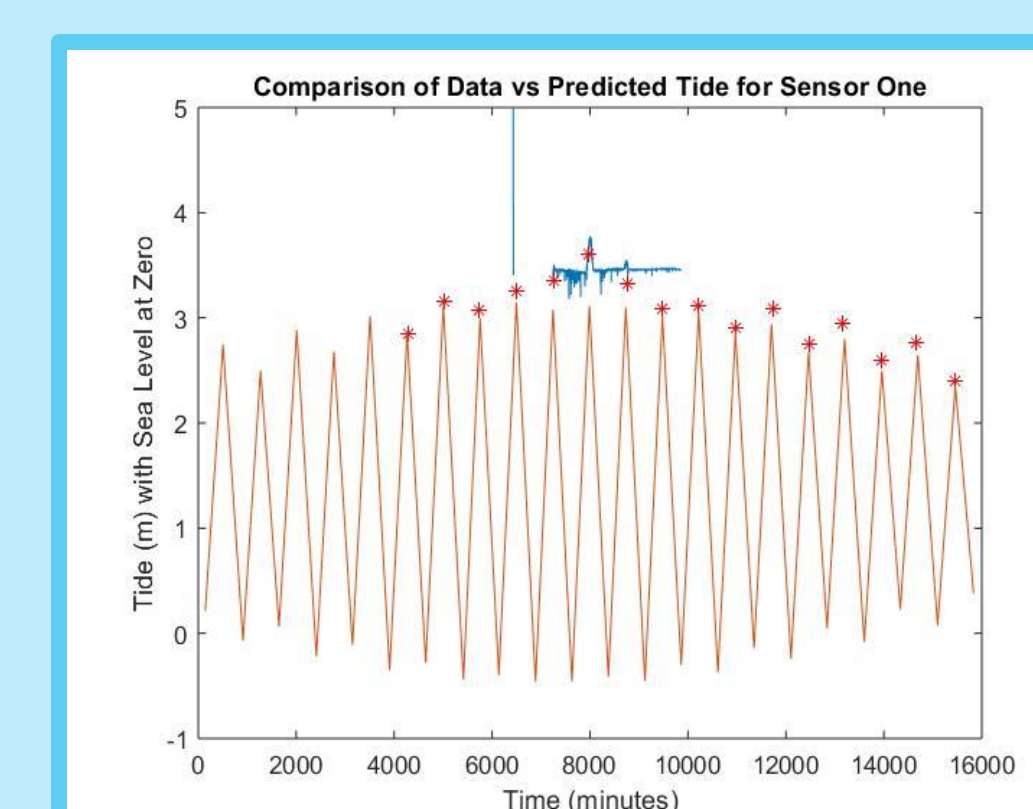
The original 9V batteries only collect data for a few hours, but after switching to portable 10,000 mAh phone chargers as a power source, the battery lasted for over 4 days.

The sampling frequency of the ultrasonic sensor was set to once per minute to resolve the tide over the four day window.



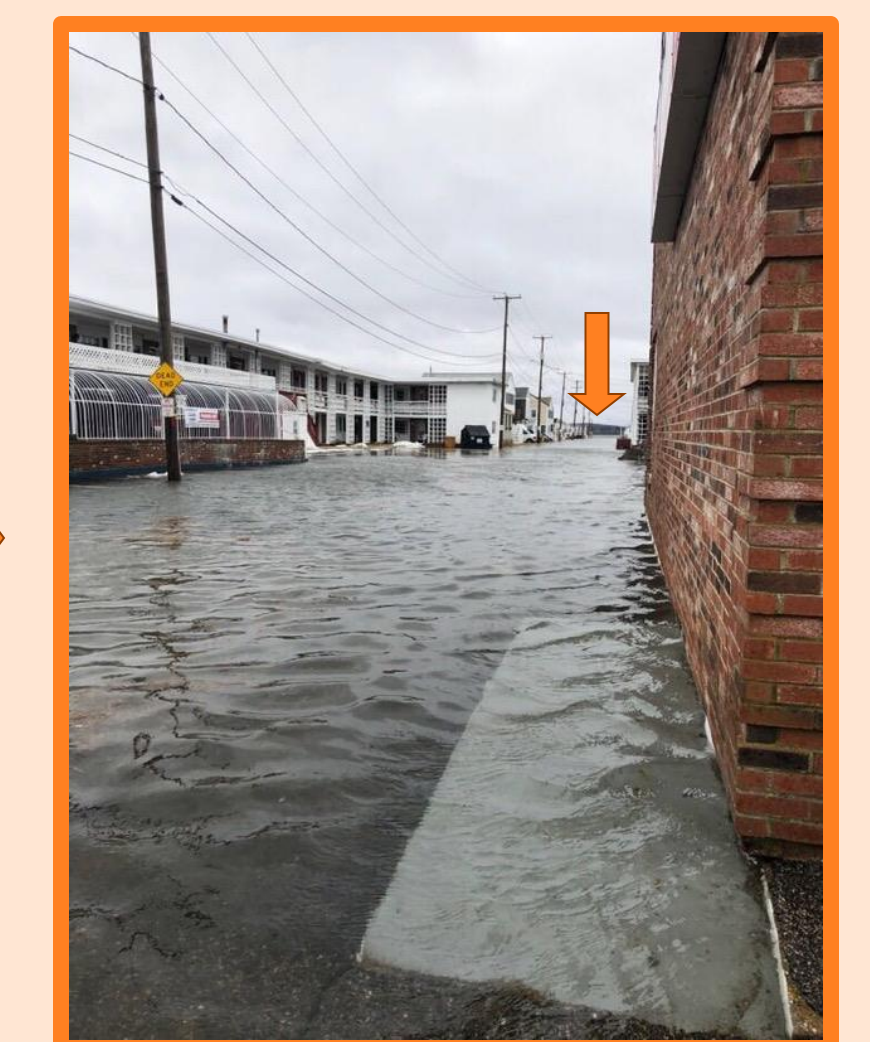
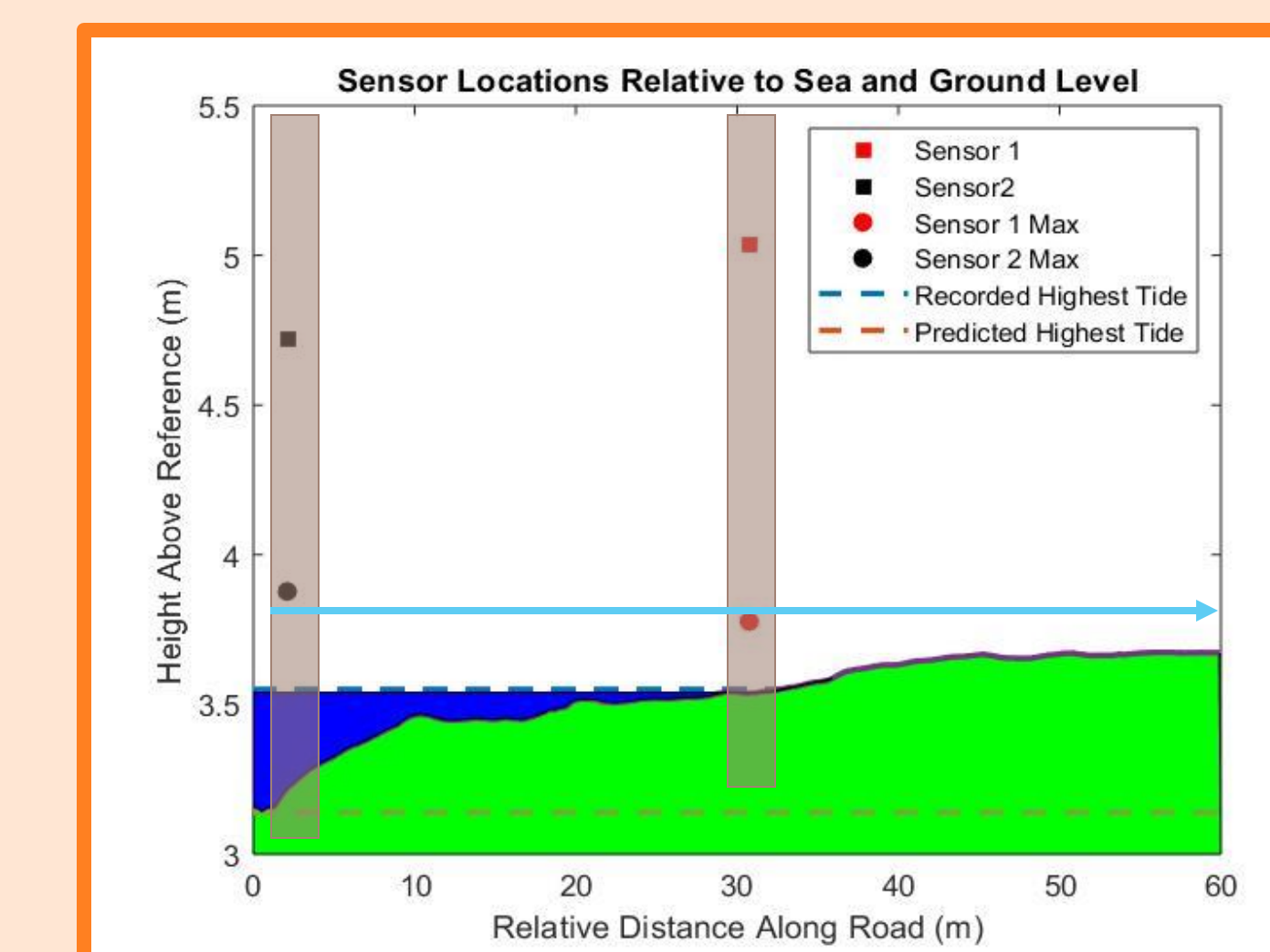
Data

The following graphs show the measured water level (blue), from our sensors, predicted tides (orange), taken from tidesandcurrents.NOAA.gov for Hampton Bay, and recorded highest tides (red stars), from Hampton Tide Gauge 2, over a four day window. The highest predicted tide was 3.14 meters above sea level, while the ground below our sensors were 3.54 and 3.22 meters above sea level based on our survey data. The ground height above sea level was considered for the recorded data in the plots, which shows that the flooding for the March king tide was approximately 0.7 meters higher than predicted (based on our recorded data). Sensor one was further up the road, which is visible in that sensor two caught more high tide moments, as the water did not always reach sensor one. While the tide did reach about 0.7 meters higher than predicted, it is important to know that during this particular king tide there was also a storm surge.



Results

The graph below shows the maximum water level along Hobson Avenue. The reference elevation is 0 at sea level. The green represents the topography of the land on which the data was taken, and the blue is the maximum recorded water level from Hampton Tide Gauge 2. The maximum water level observed at each location, corresponding to our measured data are shown as black and red circles, and the blue arrow denotes the average.



The graph above shows that the predicted tide level is lower than the observed water level. The picture on the above right shows that at high tide, Hobson Ave. was completely flooded. The arrow on the picture shows the sensor locations. The water level predicted by the tidal model would have only reached sensor 1, but our observations and the photographic evidence show that the total level was significantly higher, resulting in the flooding of the entire street.



Dr. Biles doing a handstand around the predicted flooding height (right)



Ongoing Work

Research of sunny day flooding in Hampton, New Hampshire is an ongoing project.

- Hobson Ave. ⇒ Other sites in the community
- Ultrasonic sensors ⇒ Laser sensors
- 2 sensors ⇒ 4 sensors



Further data collection will allow a better overall picture of what the flooding looks like and how it affects Hampton as a whole.

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