Wintertime Wave Activity Along the U.S. Naval Academy Farragut Seawall

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Abstract

The U.S. Naval Academy (USNA) Farragut seawall (revetment) is subject to wave action, shear from currents, and potentially more frequent overtopping and nuisance flooding as local sea level increases. In this study, RBR pressure sensors were deployed to investigate wave activity, and current data, bathymetry, and sidescan imagery were collected along the USNA Farragut Seawall in order to provide information for future infrastructure improvements.

Study Area and Methods

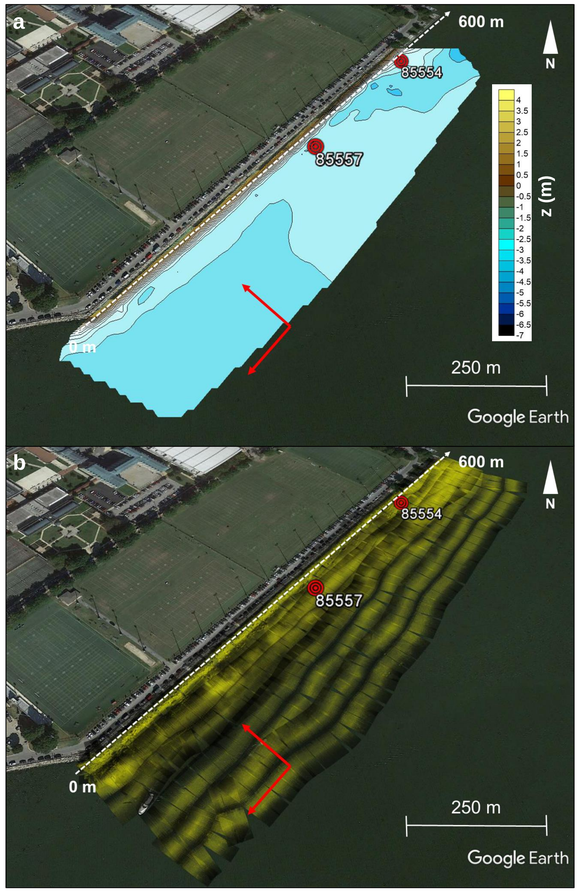


Figure 1. Study area along the USNA Farragut seawall, a revetment protecting USNA from wave activity from the Chesapeake Bay showing (**a**) bathymetry and (**b**) sidescan imagery of the bottom. Bathymetry is referenced as z (m) with increasing negative values indicating increasing depth. Contours were made using Surfer v.11 using a kriging interpolation method. Seawall heights were collected using a Trimble Geo7X GNSS system. The white dashed line indicates the positive direction along the wall and the red solid lines indicate directions for positive currents into and along the seawall, respectively. The red targets show the locations for bottom-moored RBR*solo* D|wave 16 Hz pressure sensors, serial numbers 85554 and 85557, deployed at two locations ~ 10 m off the seawall from 15-22 February 2019.

On 14 February 2019, the USNA Coastal Kayak autonomous surface vehicle ASV (*Ackleson et al., 2017*) was deployed on an autonomous 'ladder' mission to collect bathymetry and sidescan imagery over a ~ 250 m wide swath along the 600 m face of the USNA Farragut seawall (**Fig. 1** and **Fig. 2a**). At the same time, a Teledyne RiverRay Acoustic Doppler Current Profiler (ADCP) was towed along the seawall from a small boat (6 passes; **Fig. 2a**) to measure water column currents in 0.25 m binned depths. From 15-22 February 2019, RBR*solo* D|wave 16 Hz pressure sensors were deployed on bottom moorings at two locations ~ 10-m off the seawall.

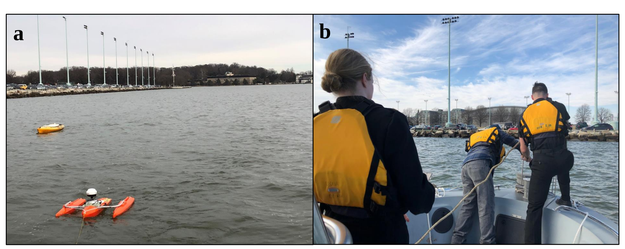
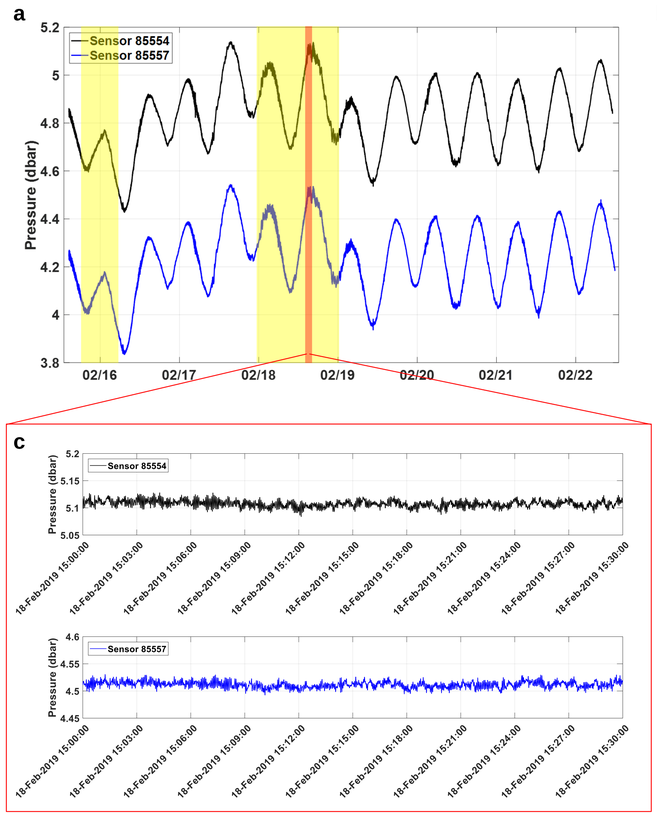
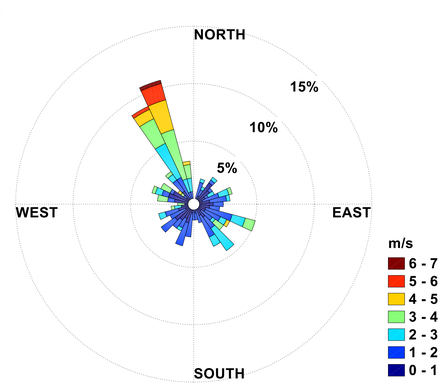


Figure 3. (**a**) The USNA Coastal Kayak ASV and RiverRay ADCP underway along the Farragut seawall and (**b**) MIDN 1/C Greg Gruseck and MIDN 1/C Darby Minton working with Mr. Luis Rodriguez to deploy pressure sensor moorings.

Results and Discussion





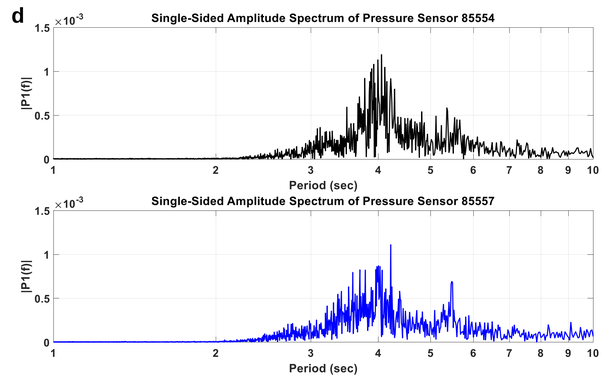
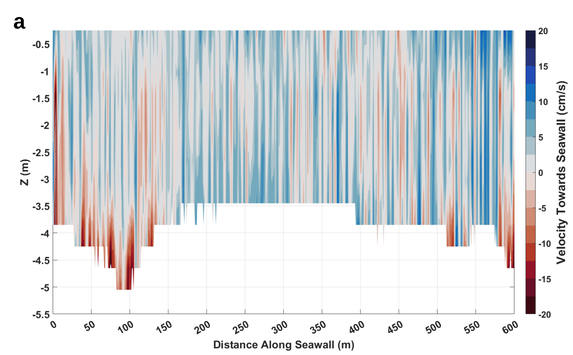


Figure 4. (**a**) Absolute pressure (dbar) measured by RBR*solo* D|wave 16 Hz pressure sensor 85554 and 85557 deployed on bottom moorings at two locations ~ 10 m off the Farragut seawall from 15-22 February 2019. The semidiurnal tidal signal can be seen clearly in both pressure series. (**b**) A wind rose of hourly averaged wind speed and direction from 15-22 February 2019 at the Severn River Watershed Observatory (SRWO) Node 1 at the USNA Hendrix Oceanography Lab. The highest wind forcing experienced over the time of pressure sensor deployment were on 15-16 February 2019 and 18-19 February 2019 (highlighted in yellow) with sustained winds from the northwest (NW) at > 4 m/s. **(c)** A time period of slack water from 1500-1530 on 18 February 2019 (highlighted in red) with hourly average wind speeds > 5 m/s from NW was chosen for a more detailed look at the high-frequency wave field. Wave heights were << 0.1 m. (**d**) A Fast Fourier analysis of the wave field over this time revealed wave periods of 3-6 seconds.

Bathymetry and sidescan sonar images along the USNA seawall revealed a relatively smooth seafloor with depths ranging from ~ 3.5 – 5 m (**Fig. 1**). During the week long period of pressure sensor deployment, wind-driven wave activity was minimal (**Fig. 4**). Water levels measured along the seawall were clearly influenced by the semidiurnal tides although there are other possible interesting harmonics, wave interactions, and non-linear signals present that may be worth examining further (**Fig. 4a**). The prevailing wind speed and direction (from NW) during the time of sensor deployment was not conducive to the generation of wind-driven waves at the USNA Farragut seawall. However, higher winds from the NW > 5 m/s on 18 February 2019 still generated some limited wave activity (< 0.1 m wave height) with a periodicity of 3-6 seconds (**Fig. 4c & d**). Measured current velocities towards (**Fig. 5a**) and along (**Fig. 5b**) the seawall were low (< 10 cm/s) and were likely related to tidal currents. This study represents a preliminary evaluation of the current and wave field along the USNA Farragut seawall and similar studies should continue, especially under more energetic, episodic conditions.



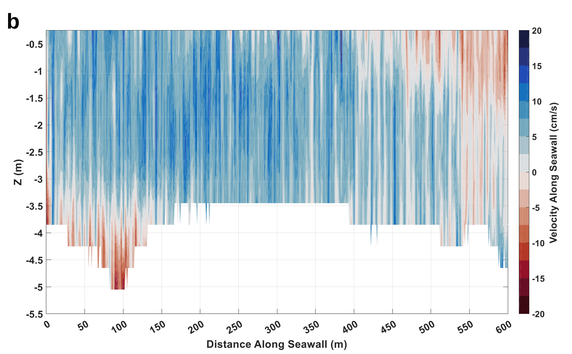


Figure 5. Smoothed (1 m) contour plots of bin-averaged (0.25 m depth) horizontal current velocities (cm/s) measured on 14 February 2019 referenced (**a**) towards the USNA Farragut seawall and (**b**) along the USNA Farragut Seawall. Current data is the smoothed mean of 6 RDI Teledyne RiverRay ADCP tows over the 600 m long 250 m wide swath along the USNA Farragut Seawall from the seawall end near Annapolis City dock towards USNA Triton Light. Positive current velocities are referenced as shown on **Figure 1**. RiverRay ADCP data was processed using the U.S. Geological Survey Velocity mapping Tool v. 4.08 (*https://hydroacoustics.usgs.gov/movingboat/VMT/VMT.shtml*) and MATLAB R2017a.

Conclusions

- ***This assessment of wintertime wave activity along the USNA Farragut seawall from 15-22 February 2019 revealed a low-energy, wave and current environment.***
- ***In order to provide information for future infrastructure improvements and planning, future efforts should attempt to collect data on the current and wave field along the USNA Farragut seawall during specific episodic forcing events (such as storms) that are conducive to the generation of wind-driven waves.***

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