Union of Concerned Scientists

FACT SHEET

The US Military on the Front Lines of Rising Seas

Exposure to Coastal Flooding at Portsmouth Naval Shipyard, Maine

HIGHLIGHTS

With seas rising at an accelerating rate, coastal military installations are increasingly exposed to storm surge and tidal flooding. The Union of Concerned Scientists (UCS) conducted analyses of this changing exposure for 18 installations along the East and Gulf coasts. Analysis for Portsmouth Naval Shipyard (NS) found that in the second half of this century, in the absence of preventive measures, the installation can expect frequent and extensive tidal flooding, loss of currently utilized land, and substantial increases in the extent and severity of storm-driven flooding to which it is exposed.

The US Armed Forces depend on safe and functional bases, such as the Portsmouth NS, Maine, to carry out their stated mission: to provide the military forces needed to deter war and to protect the security of the country. A roughly three-foot increase in sea level would threaten 128 coastal Department of Defense (DOD) installations in the United States and the livelihoods of the people—both military personnel and civilians—who depend on them (NAS 2011). In the area of the Portsmouth NS, seas are projected to rise between 3.5 and 5.9 feet over the course of this century.

To enable decision makers to better understand the sea level rise threat, and where and when it could become acute, UCS has performed a new analysis of 18 East and Gulf Coast military installations, including Portsmouth Naval Shipyard. These sites were selected for their strategic importance to the armed forces, for their potential exposure to the effects of sea level rise, and because they represent coastal installations nationwide in terms of size, geographic distribution, and service branch.

UCS projected exposure to coastal flooding in the years 2050, 2070, and 2100 using the National Climate Assessment's midrange, or "intermediate-high," scenario (referred to here as "intermediate") and, in light of the low tolerance for risk in some of the military's decisions, a "highest" scenario based on a more rapid rate of increase (Parris et al. 2012).[1] We modeled tidal flooding, permanent inundation, and storm surge from hurricanes.[2] The results below outline potential future flooding to which Portsmouth NS could be exposed, assuming no new measures are taken to prevent or reduce flooding.[3] This analysis finds the following key results.

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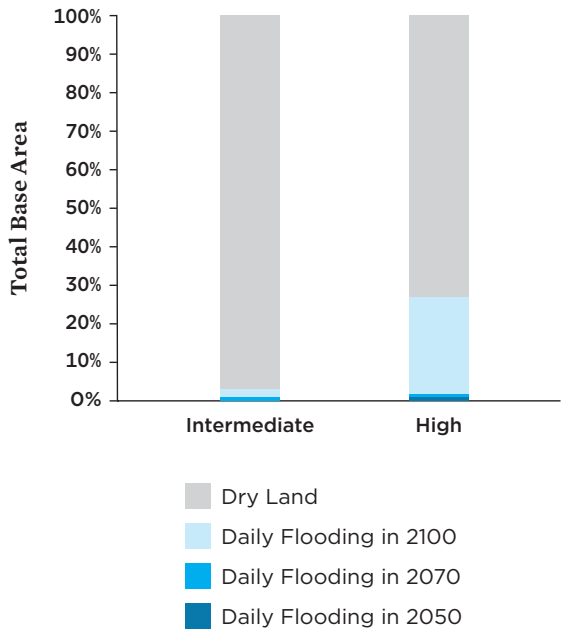
TWO IF BY SEA: TIDAL FLOODING THREATENS PORTSMOUTH NS

Portsmouth NS, which lies on the banks of the Piscataqua River, not far from the Atlantic Ocean, sees little tidal flooding today, even as low-lying areas of coastal New Hampshire and southern Maine have seen an increase in such flooding. Depending on the rate of sea level rise this century, however, extreme high tides could eventually bisect the shipyard.

TIDAL FLOODING AND LAND LOSS

- **Areas currently affected by occasional tidal flooding could flood daily.** By 2050, low-lying areas in this region could experience between 80 and 190 floods per year—compared to fewer than a dozen currently—depending on the scenario. By 2070, in the highest scenario, flood-prone areas throughout the region could on average experience flooding with each of the two daily high tides and be underwater more than 15 percent of the time.
- **Flooding during extreme high tides will become more extensive.** Today, Portsmouth NS itself sees little tidal flooding. By 2100, flooding during extreme tides could bisect the shipyard nearly a dozen times per year.
- **Sea level rise threatens to claim currently utilized areas.** How much of Portsmouth NS remains dry, usable land hinges on the trajectory of sea level rise through the end of the century and on the shipyard's adaptation measures. In the highest scenario, more than a quarter of the shipyard's land area, including places currently key to operations, would become part of the tidal zone.

FIGURE 1: Portsmouth NS Could Experience Land Loss



The pace of sea level rise matters greatly to Portsmouth NS. High tide would inundate 1 percent of its area by 2050, but 27 percent by the end of the century, given the faster rate of sea level rise assumed in the highest scenario. Inundated areas include some that are heavily utilized today. By contrast, given the moderate rate of rise assumed in the intermediate scenario, just 3 percent would shift to the tidal zone by late in this century.

STORM SURGE

- **Sea level rise exposes previously unaffected areas of Portsmouth NS to storm surge flooding.** By 2100 in the highest scenario, sea level rise will increase the area exposed to flooding by Category 1 and 2 storms by roughly 20 percent. By this time, the area exposed to flooding from a Category 1 storm is greater than the area exposed to flooding by a Category 2 storm today.
- **Sea level rise increases the exposure of Portsmouth NS to deeper, more severe flooding.** By 2100 in the intermediate scenario, roughly 25 percent of the base would be exposed to flood depths of five feet or more by a Category 1 storm, compared to just 8 percent today.

Base Information

Portsmouth NS is located on Seavey Island in York County, Maine, near the town of Kittery. The shipyard lies on the banks of the Piscataqua River, across from Portsmouth, New Hampshire. It is one of only four naval shipyards in the country and the oldest continuously operated one. Portsmouth NS is responsible for repairing, overhauling, and modernizing the Navy's nuclear powered submarines (NAVSEA n.d.).

Portsmouth NS

Branch:	Navy
Established:	1800
Size (Acres):	281
Service Members:	200*
Civilians:	4500*
Docks:	3

*Approximately

SOURCE: DOD 2016.

New England has a long history of shipbuilding, and Portsmouth NS, which was established in 1800, has long been part of the region's maritime culture. Portsmouth NS is a high-density industrial area housing 376 buildings of which 116 are located in the Portsmouth NS Historic District and 50 listed on the National Register of Historic Places (NREL 2014).

Historic Exposure to Storm Surge and Flood Hazards

In the region surrounding Portsmouth NS, severe summer and winter storms are considered significant hazards (Kirshen et al. 2014; KEMA and YCEMA 2011). Indeed, the area is

US Navy

One of the country's four naval shipyards, Portsmouth NS specializes in maintaining the Navy's submarine fleet. Here, workers wrap up maintenance on the Los Angeles-class submarine USS San Juan (SSN 751) in August, 2011. This area of the shipyard is at risk of daily tidal inundation later this century.

no stranger to storm damages: A total of 48 tropical storms—including 18 hurricanes—have passed within 150 nautical miles of the shipyard since 1858 (NOAA n.d.). In August 1991, Hurricane Bob passed 13 nautical miles to the east of the coast. Residents within a quarter mile of the shore were ordered to evacuate, and, although the winds were less than hurricane force, an estimated 2.1 million businesses and homes lost power at some point during the storm (Handlers and Brand 2004). Ultimately, several million dollars worth of damage occurred in York and Cumberland counties (Cotterly 1996; Hidlay 1991).

In addition to acute damage from storms, tidal flooding is a growing problem in the region.

The highest water levels recorded locally occurred during the Blizzard of '78, when the combined height of the tide and storm surge, predicted to be 10.2 feet, reached 13.4 feet. This nor'easter and another that same winter inflicted major damage in York County (Colgan 1979). In 2007, the Patriots' Day storm caused an estimated $45 million of damage to public infrastructure, including $31.5 million to roads alone (Colgan and Merrill 2008).

In addition to acute damage from storms, tidal flooding is a growing problem in the region. Regular flooding of low-lying areas can damage homes and businesses and disrupt travel and has led local municipalities to take adaptive and educational action, including offering walking tours of flood-prone areas (Spanger-Siegfried, Fitzpatrick, and Dahl 2014; CPPD 2013).

Future (Projected) Exposure to Storm Surge and Flood Hazards

The intermediate scenario projects that Portsmouth NS will experience 3.5 feet of sea level rise locally and the highest scenario projects 5.9 feet of rise by 2100. This rise will lead to increased exposure to different types of coastal flooding.

TABLE 1: Portsmouth NS: Projected Sea Level Rise (Feet) in Two Scenarios

Year	Intermediate	Highest
2050	1.0	1.6
2070	1.8	3.0
2100	3.5	5.9

In the intermediate scenario, ice sheet loss increases gradually in the coming decades; in the highest scenario, more rapid loss of ice sheets occurs. The latter scenario is included in this analysis to help inform decisions involving an especially low tolerance for risk. Moreover, recent studies suggest that ice sheet loss is accelerating and that future dynamics and instability could contribute significantly to sea level rise this century (DeConto and Pollard 2016; Trusel et al. 2015; Chen et al. 2013; Rignot et al. 2011). Values shown are local projections that include unique regional dynamics such as land subsidence (see www.ucsusa.org/MilitarySeasRising).

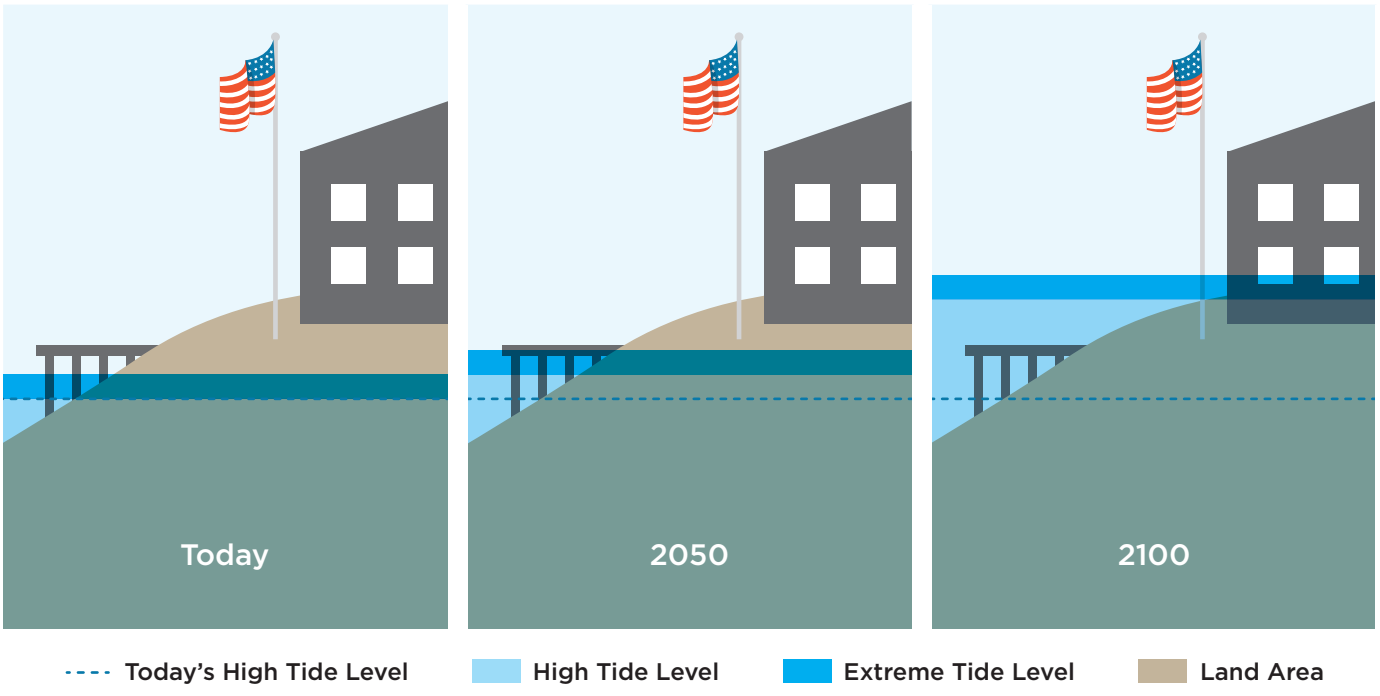
TIDAL FLOODING AND LAND LOSS

By 2050, nuisance tidal flooding could occur in low-lying locations on the surrounding seacoast on two of three days on average in the highest scenario. Without substantial adaptive measures, affected areas such as low-lying roadways and neighborhoods could become unusable land within the next 35 years. Though the affected area on Seavey Island itself could be limited to the immediate shoreline, the consequences of frequent flooding in the surrounding region—for example, damage to housing and travel delays affecting the shipyard's community of workers and its personnel housed off base—could affect the shipyard nonetheless.

As sea level rises further, periodic extreme tides would drive more extensive flooding, including at Portsmouth NS. In both the intermediate and highest scenarios, flooding during extra-high tides could bisect Seavey Island.

By 2100, more than 25 percent of the shipyard's currently dry land would fall below the high tide line in the highest scenario. The level of inundation is much lower in the intermediate scenario: by 2100, just 3 percent of the dry land area would be inundated.

FIGURE 2. How Sea Level Rise Causes Tidal Flooding and Land Loss



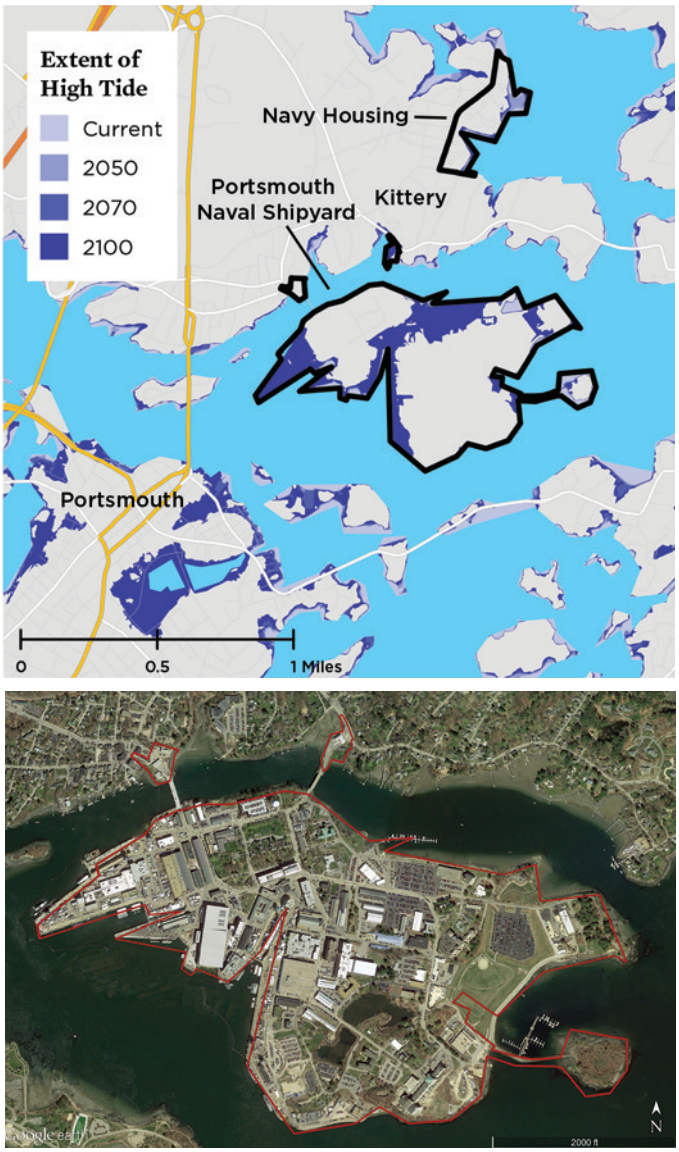
As sea level rises, extreme tides cause local flood conditions to occur more often, to a greater extent, and for longer time periods. And the daily high tide line can eventually begin to encompass new areas, shifting the tidal zone onto presently utilized land. In this analysis, land inundated by at least one high tide each day is considered a loss. This is a highly conservative metric: far less frequent flooding would likely lead to land being considered unusable.

THE CHANGING THREAT OF HURRICANES

Category 1 storms are the most likely type of hurricane to affect this area.[4] A Category 1 storm today exposes roughly 40 percent of Portsmouth NS to flooding related to storm surge. By 2070, the area exposed to flooding increases to 50 percent in the intermediate scenario and to 55 percent in the highest scenario. In the highest scenario, the area inundated by a Category 1 storm in 2100 is greater than the area inundated by a Category 2 storm today.

Sea level rise also changes the depth of flooding Portsmouth NS can expect with major storms. Whereas less than 10 percent of the inundation caused by a Category 1 storm today is more than five feet in depth, about 25 percent of the inundation would be five feet deep or more by 2100 in the intermediate scenario. In the highest scenario, nearly 40 percent of the shipyard is exposed to this degree of flooding.

FIGURE 3. Daily High Tides Will Reach Currently Utilized Land at Portsmouth NS



The reach of future daily high tides, shown on the top, is projected to encompass currently utilized land at the Portsmouth NS, shown on the bottom. The highest scenario is mapped here. By contrast, the intermediate scenario projects inundation of just 3 percent of this area.

SOURCE: GOOGLE EARTH.

> ***By 2100, more than 25 percent of the shipyard's currently dry land would fall below the high tide line in the highest scenario.***

The worst case for storm surge inundation of New England considered in this analysis is a Category 4 storm occurring in the highest scenario in 2100. Today, a Category 4 storm would expose 85 percent of Portsmouth NS to flooding. In the worst-case scenario, roughly 90 percent would be exposed to storm surge flooding, most of it over five feet deep. More than 25 percent of Portsmouth NS could experience flood depth of 20 feet or more.[5]

Mobilizing on the Front Lines of Sea Level Rise

A vital trait of our nation's military is its ability to adapt in response to external threats. Climate change and sea level rise have emerged as key threats of the 21st century, and our military is beginning to respond (Hall et al. 2016; USACE 2015; DOD 2014). Recognizing the threat of increased flooding, and that the most robust responses will be regional ones, the Portsmouth NS has, for example, sought opportunities to collaborate with regional stakeholders such as the Coastal Risk and Hazards Commission, the University of New Hampshire, the Shipyard Association, and state and local emergency managers (Crosby 2016).

But here and across US coastal installations there is far to go: the gap between the military's current sea level rise preparedness and the threats outlined by this analysis is large and

TABLE 2. Current and Future Tidal Flooding Frequency around Portsmouth NS

	Intermediate		Highest	
Year	Events per Year	% of Year	Events per Year	% of Year
2012	11 ± 6	0	11 ± 6	0
2050	82 ± 19	1	187 ± 26	4
2070	234 ± 31	5	558 ± 26	16
2100	647 ± 22	22	703 ± 1	43

Sea level rise is projected to cause coastal flood conditions in New Hampshire and southern Maine over significant portions of the year. Shown here are flood events in low-lying, flood-prone areas projected by the intermediate and highest scenarios. Events per year are reported as the average over a five-year period with one standard deviation. Percent of year is reported simply as the average over a five-year period. Installations will be affected by this flooding depending on the presence of low-lying land on-site.

growing. Low-lying federal land inundated by rising seas, daily high-tide flooding of more elevated land and infrastructure, and destructive storm surges—most of the installations analyzed, including the shipyard, face all of these risks.

This analysis provides snapshots of potential future exposure to flooding at Portsmouth NS. For the shipyard to take action on the front line of sea level rise, however, it will need more detailed analysis and resources to implement solutions.

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In one of the most visible signs of changes to come, extreme tides increasingly creep onto roads and into neighborhoods in the Seacoast region around Portsmouth NS, as in Hampton, NH, pictured here. With this trend, the Shipyard's lower-lying neighbors will be impacted by sea level rise decades before the installation itself, but with its large civilian workforce, this in turn can have implications for the Shipyard.

Congress and the DOD should, for example, support the development and distribution of high-resolution hurricane and coastal flooding models; adequately fund data monitoring systems such as our nation's tide gauge network; allocate human, financial, and data resources to planning efforts and to detailed mapping that includes future conditions; support planning partnerships with surrounding communities; and allocate resources for preparedness projects, on- and off-site, many of which will stretch over decades.

Military bases and personnel protect the country from external threats. With rising seas, they find themselves on an unanticipated front line. Our defense leadership has a special responsibility to protect the sites that hundreds of thousands of Americans depend on for their livelihoods and millions depend on for national security.

ENDNOTES

1 *The intermediate sea level rise scenario assumes ice sheet loss that increases over time, while the highest scenario assumes rapid loss of ice sheets. The latter scenario is particularly useful for decisions involving an especially low tolerance for risk. These results are a small subset of the full analysis. For more information, the technical appendix, and downloadable maps, see www.ucsusa.org/MilitarySeasRising.*

2 *UCS analyzed storm surge depth and exposure extent for each base using the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model, developed by the National Oceanic and Atmospheric Administration (NOAA), for storm events ranging in severity from Category 1 to Category 4, in addition to tidal floods. Both storm surge and flooding during extra-high tides can be significantly exacerbated by rainfall and wave action, neither of which was included in this study.*

3 *This analysis involved consultation with Portsmouth NS. However, in some instances, preventive measures may be planned or in place that are not reflected in the analysis; these could affect the degree of current and future flooding.*

4 *Nor'easters are more common in the region and known to generate damaging storm surge. However, they could not be included in this analysis because of SLOSH model limitations. Increases in surge extent and depth should be expected with these storms as well.*

5 *By absorbing storm surge upstream, the Piscataqua River and Great Bay may exert a dampening effect on water levels not fully captured by this modeling. Conversely, heavy rainfall that often accompanies storms can exert an exacerbating effect on water levels, also not captured here.*

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