Union of Concerned Scientists

FACT SHEET

The US Military on the Front Lines of Rising Seas

Exposure to Coastal Flooding at Naval Station Mayport, Florida

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 Naval Station (NS) Mayport found that in the second half of this century, in the absence of preventive measures, this installation can expect more 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 NS Mayport, Florida, 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).

Low-lying Florida faces rising sea levels along its 1,200-mile coastline: water is encroaching from both the Atlantic and Gulf coasts and up through the Everglades (Climate Central n.d.; Oskin 2013). Seas are projected to rise between 3.7 and 6.1 feet over the course of this century in the area of NS Mayport, which includes the coastal city of Jacksonville. This rise will greatly increase the area's exposure to flooding.

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 NS Mayport. 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.

US Navy

THE INLAND MARCH OF HIGH TIDE

NS Mayport, located at the mouth of the St. Johns River in northern Florida, is home to the US Navy's third-largest fleet. Tidal flooding occurs in this area roughly seven times per year today, but by 2050 could occur 150 to nearly 370 times per year.

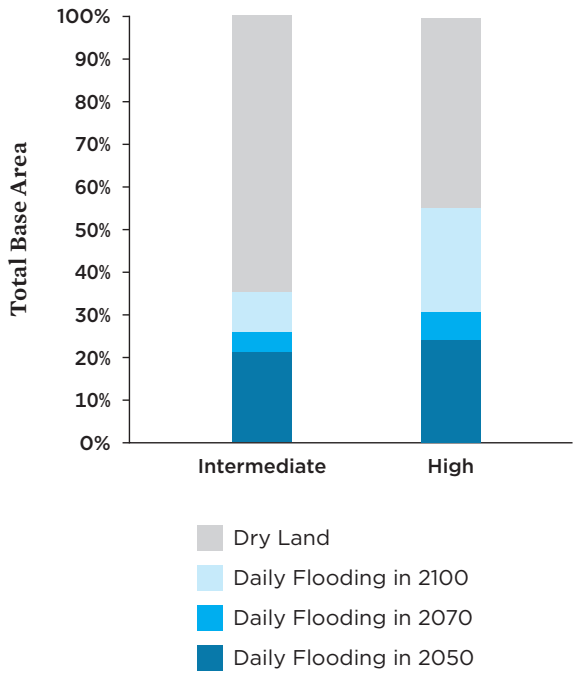
UCS projected exposure to coastal flooding in the years 2050, 2070, and 2100 using the National Climate Assessment's midrange or "intermediate-high" scenario (referred to here as "intermediate") and, in light of the low tolerance for risk of some in the military's decisions, a "highest" scenario based 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 NS Mayport could be exposed, assuming no new measures are taken to prevent or reduce flooding.[3] This analysis finds the following key results:

TIDAL FLOODING AND LAND LOSS

- **Areas currently unaffected by tidal flooding could flood with each high tide.** Today, tidal flooding around NS Mayport affects wetlands and other low-lying areas about seven times per year, on average. But in the intermediate scenario, flood-prone areas could be inundated at least once daily, on average, during high tides by 2070.

FIGURE 1. NS Mayport Could Experience Major Land Loss



As high tide reaches farther inland, extensive land loss is possible at NS Mayport. Affected land may include developed and undeveloped areas and even wetlands that reside above the current high tide mark. In this analysis, installations that are projected to see major land loss, including NS Mayport, see substantial loss of currently developed and utilized areas.

- **Flooding during extreme high tides will become more extensive.** Today, the areas affected by tidal flooding at NS Mayport are primarily wetlands. But in the intermediate scenario, this flooding, though occasional, could encompass a third of the station's current land area by 2070.
- **Substantial land loss at NS Mayport is possible.** Some parts of NS Mayport are projected to flood with such frequency by 2100 that they would effectively be part of the tidal zone, as opposed to dry, usable land. Indeed, given 6.1 feet of sea level rise by the end of the century, as projected in the highest scenario, NS Mayport could lose 55 percent of its current land area to the tidal zone.

STORM SURGE

- **Sea level rise exposes previously unaffected areas of NS Mayport to storm surge flooding.** Sea level rise has a significant effect on the extent of inundation, particularly during Category 1 storms. In 2100 in the intermediate scenario, the area at NS Mayport exposed to flooding from a Category 1 storm would increase by 17 percent; it would increase by nearly 30 percent in the highest scenario.
- **Sea level rise exposes NS Mayport to deeper, more severe flooding.** As sea level rises, the depth of inundation related to storm surge increases. At NS Mayport, this is true across all the storm categories, depth intervals, and sea level rise scenarios in the UCS analysis. By 2100 in the highest scenario, surge inundation from a Category 2 storm is deeper and more severe than from a Category 3 storm today.

Base Information

NS Mayport is located 15 miles east of Jacksonville at the mouth of the St. Johns River. One of two major naval installations in the area, NS Mayport has a well-protected harbor that serves as a busy port.

NS Mayport is home to the US Navy's third-largest fleet (DOD 2016). Its harbor can accommodate 34 ships, including aircraft carriers, and has an 8,000-foot runway that can handle almost all military aircraft (DOD 2016). The station's infrastructure has been valued at $1.3 billion (Barnick et al. 2013).

NS Mayport is an integral part of Duval County's community and economy. Over 15,000 active duty personnel and 32,000 family members live at NS Mayport, and the county itself is home to more than 85,000 veterans (DOD 2016; US Census Bureau 2014). Spending by the DOD drives more than $11 billion of gross regional product and provides 100,000 jobs (Barnick et al. 2013).

NS Mayport

Branch:	Navy
Established:	1917
Size (Acres):	3,409
Active Duty:	15,150
Ships:	19
Tenant Commands:	70

SOURCE: CNIC N.D.; DOD 2016.

Historic Exposure to Storm Surge and Flood Hazards

NS Mayport is currently highly exposed to storm surge flooding. A Category 1 storm hitting today exposes more than 60 percent of the station's area to flooding. Storm surge from Category 3, 4, and 5 storms exposes more than 90 percent of the station's area.

Since 1852, there have been 60 recorded hurricanes that have come within 150 nautical miles of NS Mayport (NOAA n.d.). The area's topography is low lying and therefore does not provide an extensive windbreak. The Mayport Basin at the St. Johns River channel entrance has little protection from storm surge (Clune, Englebretson, and Brand 1999). While storms approaching over land from the southwest are not of high concern, hurricanes approaching from the open ocean, from the southeast, are (Clune, Englebretson, and Brand 1999).

Hurricane Dora, striking in 1964, is the only hurricane to have made landfall in Jacksonville since the 1800s (Dumm et al. 2009). Making landfall near St. Augustine, Dora caused a storm surge of five to eight feet along the coasts of Florida and Georgia (NOAA 1964).

With the 6.1 feet of sea level rise projected for the end of the century in the highest scenario, more than half of the station, including developed areas, will flood daily.

TABLE 1. NS Mayport Could See Six Feet of Sea Level Rise by 2100

Year	Intermediate	Highest
2050	1.1	1.7
2070	1.9	3.1
2100	3.7	6.1

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).

Future (Projected) Exposure to Storm Surge and Flood Hazards

SEA LEVEL RISE

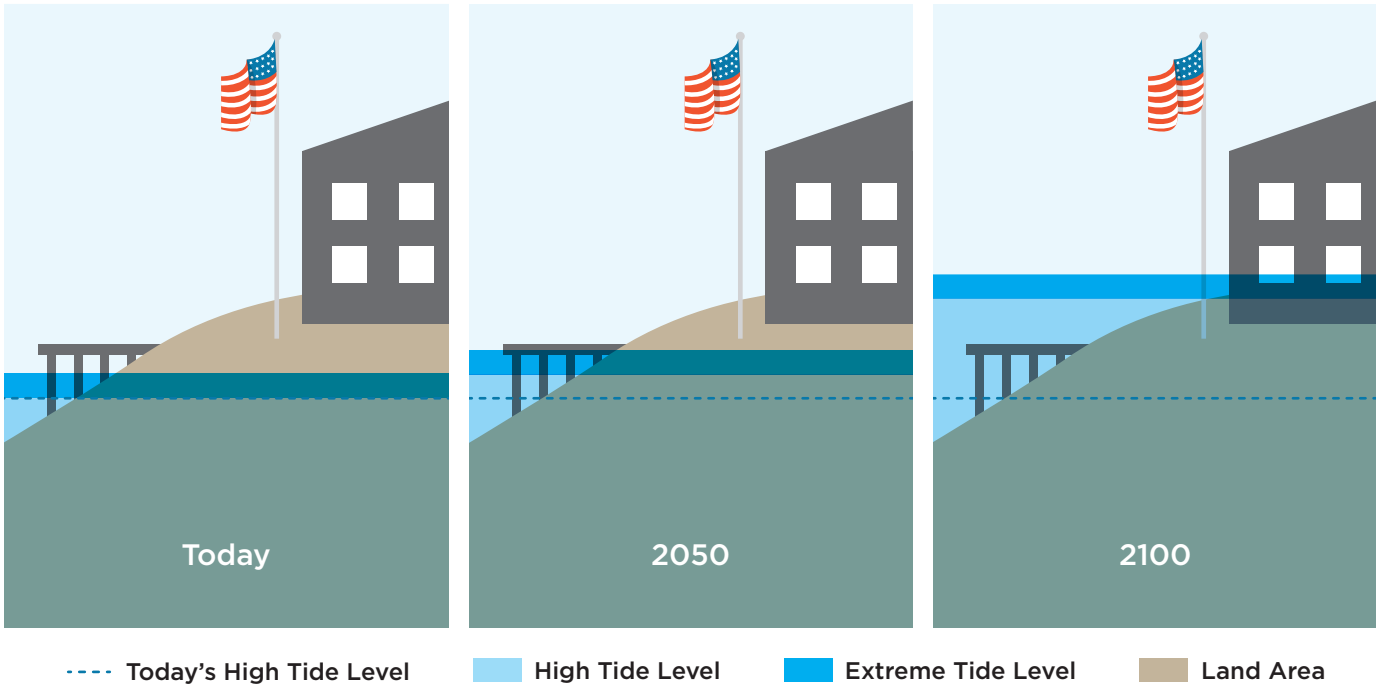
The intermediate scenario projects that NS Mayport will experience 3.7 feet of sea level rise and the highest scenario projects 6.1 feet of rise by 2100. This rise will drive the high tide line inland and lead to increased exposure to different types of coastal flooding.

TIDAL FLOODING AND LAND LOSS

As sea level rises, routine tidal flooding is expected to become both more frequent in low-lying areas and more extensive. Today, tidal flooding around NS Mayport occurs roughly seven times per year. The intermediate scenario projects that, by 2050, tidal flooding could occur roughly 150 times per year, while in the highest scenario it occurs nearly 370 times per year—that is, the base may experience flooding once daily with high tide, on average. With such regular flooding, affected areas could become unusable land within the next 35 years.

Indeed, with the 6.1 feet of sea level rise projected for the end of the century in this scenario, flood-prone areas of NS Mayport will be underwater nearly 90 percent of the year (see Table 2, p. 4), while more than half of the station, including developed areas, will flood daily, becoming part of the tidal zone (see Figure 2, p. 4).

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



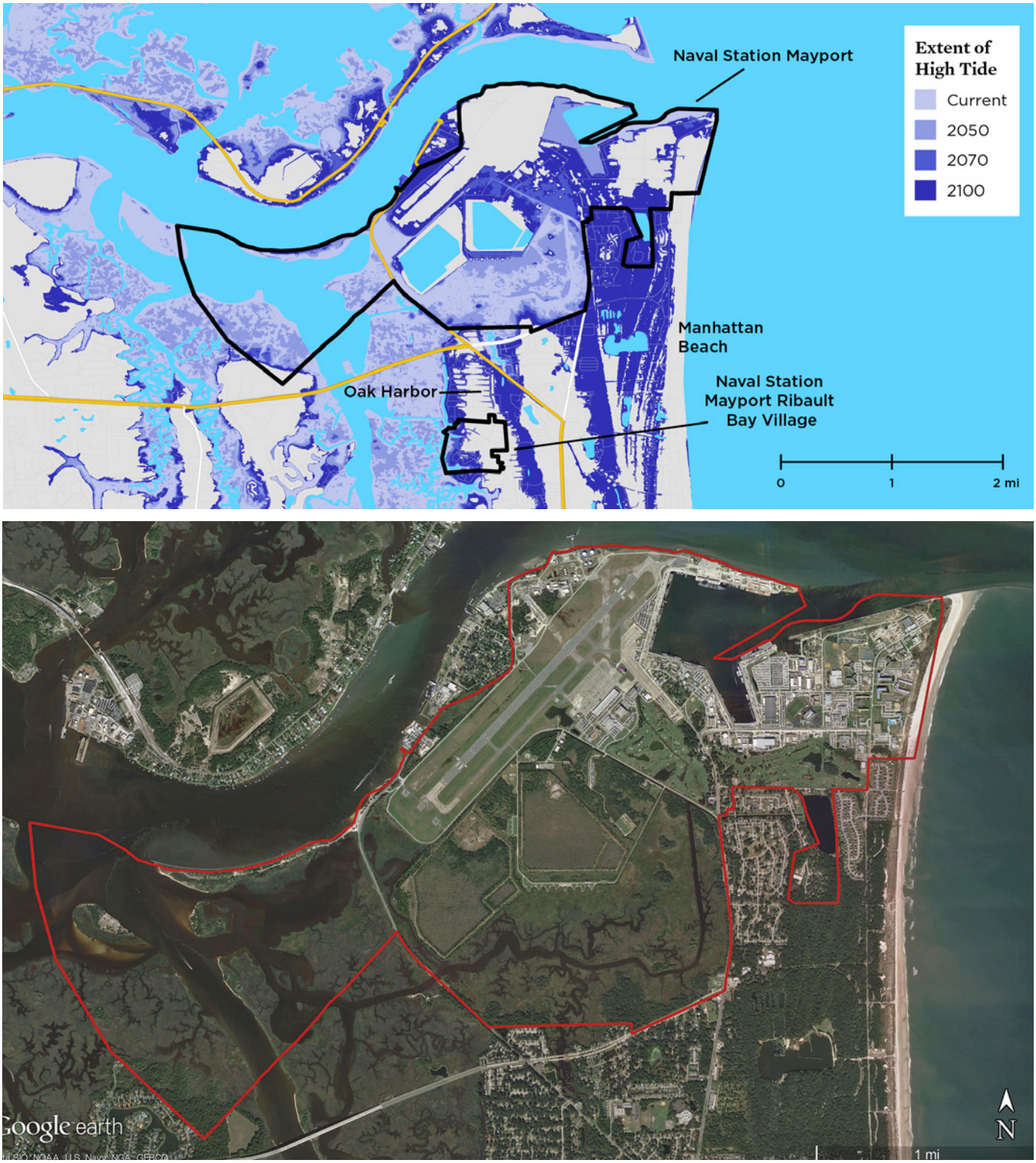
As sea level rises, extreme tides cause local flood conditions to occur more often, to a greater extent, and for longer time periods. And the daily high tide line can eventually begin to encompass new areas, shifting the tidal zone onto presently utilized land. In this analysis, land inundated by at 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.

TABLE 2. Areas Prone to Flooding Could Be Underwater Most of the Time by 2100

	Intermediate		Highest	
Year	Events per Year	% of Year	Events per Year	% of Year
2012	7 ± 6	0	7 ± 6	0
2050	145 ± 40	4	366 ± 48	11
2070	483 ± 40	16	696 ± 5	39
2100	703 ± 2	48	391 ± 45	88

Sea level rise will lead to constant or near-constant flooding in low-lying areas around NS Mayport. Shown here are flood events 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. As flood conditions begin to span multiple high tide cycles, the number of distinct flood events gradually drops, while the duration of flooding increases. Installations will be affected by this flooding depending on the presence of low-lying land on-site.

FIGURE 3. NS Mayport Is Expected to Lose Currently Utilized Land to the Sea



The projected reach of future daily high tides, shown in the top panel encompasses currently utilized land at NS Mayport, shown on the bottom. The highest scenario is mapped here. In this scenario, the area shown in purple floods with daily high tides.

SOURCE: GOOGLE EARTH. DATA FROM SIO, NOAA, US NAVY, NGA, AND GEBCO.

US Navy

Sailors and marines aboard the USS Iwo Jima, August 2014. NS Mayport is home to both the nation's 3rd largest naval fleet and thousands of active duty service people and their family members (more than 15,000 and 32,000, respectively). Nearby residential areas are among those affected by increased flooding.

THE CHANGING THREAT OF HURRICANES

Given the history of hurricanes affecting the Atlantic coast of Florida, Category 1 and 2 hurricanes are the type most likely to hit NS Mayport. Over time, sea level rise exposes a greater proportion of the station's area to inundation. This is particularly true for Category 1 storms. Today, Category 1 and 2 storms expose about 60 percent and 80 percent of NS Mayport to storm surge flooding, respectively. The area exposed to storm surge from a Category 1 storm rises to 67 percent by 2050 and to 71 percent by 2070 in the intermediate scenario. By 2100, when the intermediate scenario projects local sea level to be 3.7 feet higher than it is now, the area of the station exposed to storm surge flooding is just short of 80 percent for Category 1 storms and more than 90 percent for Category 2 storms. A Category 1 storm in 2100 would cause about the same extent of inundation as today's Category 2 storms. Likewise, a Category 2 storm would cause about the same extent of inundation as today's Category 3 storms.

Sea level rise also makes the depth of inundation more severe for all storm categories and sea level rise scenarios at NS Mayport. Whereas the majority of flooding from a Category 2 storm today would be less than 10 feet deep, more than 25 percent of the station is exposed to flooding 10 to 15 feet deep in 2070 in the intermediate scenario. By 2100, the majority of the flooding from a Category 2 storm would be 10 to 15 feet deep.

Category 3, 4, and 5 hurricanes affecting NS Mayport today all expose more than 90 percent of the station to storm surge flooding. The depth of inundation increases with each storm category. Because flood exposure is already so high, the extent of inundation from these strong hurricanes does not increase substantially as sea level rises. The depth of flooding, however, does. For this region, a Category 4 storm in the highest scenario represents a worst-case scenario. A Category 4 storm today exposes about 50 percent of the station to floods more than 15 feet deep. In the highest scenario, the area exposed to 15 feet or deeper flooding rises to roughly 60 percent in 2050, 65 percent in 2070, and 80 percent in 2100.

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). A recent DOD study, for example, informs NS Mayport's climate preparedness activities and can help guide the installation toward cost-effective investments (Donoghue et al. 2013).

But here and across US coastal installations there is still far to go: the gap between the military's current sea level rise preparedness and the threats outlined by this analysis is large and 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 NS Mayport, face all of these risks.

This analysis provides snapshots of potential future exposure to flooding at NS Mayport. For the base to take action on the front line of sea level rise, however, it will need more detailed analysis and resources to implement solutions. 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 5, 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 we included in this study.*

3 *This analysis involved consultation with contacts at multiple installations. 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.*

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