Union of Concerned Scientists

The US Military on the Front Lines of Rising Seas

Exposure to Coastal Flooding at Naval Submarine Base Kings Bay, Georgia

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 military installations along the East and Gulf coasts. Analysis for Naval Submarine Base (NSB) Kings Bay found that in the second half of this century, in the absence of preventive measures, this installation can expect substantial increases in the extent and severity of storm-driven flooding to which it is exposed and frequent tidal flooding.:

The US Armed Forces depend on safe and functional bases, such as NSB Kings Bay, Georgia, 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 Kings Bay, seas are projected to rise between 3.7 and 6.1 feet by the end 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 NSB Kings Bay. 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 NSB Kings Bay could be exposed, assuming no new measures are taken to prevent or reduce flooding.[3] This analysis finds the following key results:

US Navy

NO BASE IS AN ISLAND

Low-lying areas around NSB Kings Bay, eventually including roadways, are projected to experience substantial increases in the frequency and extent of tidal flooding. This flooding of neighboring areas will potentially affect the installation itself.

STORM SURGE

- **Sea level rise exposes previously unaffected areas of NSB Kings Bay to storm surge flooding**. In either the intermediate or the highest scenario, the area exposed to flooding during a Category 1 storm in 2100 is equivalent to the area exposed during a Category 2 storm today. In an end-of-century worst-case scenario involving a Category 4 storm, six feet of sea level rise could expose 20 percent more of the base to storm surge flooding than is exposed today.
- **Sea level rise increases the exposure of NSB Kings Bay to deeper, more severe flooding**. A Category 4 storm today would expose almost none of the base to 20-foot storm surge depths. With six feet of sea level rise projected in the highest scenario for late this century, a Category 4 storm would flood nearly 95 percent of the base, and more than half of that area would be under 20 feet or more of water.

TIDAL FLOODING

- **Certain areas face daily high tide flooding**. Today, tidal flooding affects low-lying, mainly wetland areas of NSB Kings Bay, just a couple of times per year on average. This flooding occurs roughly 250 times per year in 2070 in the intermediate scenario and more than 600 times per year in the highest scenario, with flooding occurring during both daily high tides on average.
- **Sea level rise threatens certain areas with permanent inundation**. With such regular flooding, areas that are currently wetlands would be at risk of shifting to open water, depending on the ecosystem's ability to keep up with rising seas. Since wetlands typically provide flood protection to inland areas, their health and integrity have bearing on the vulnerability of the installation itself.

Base Information

NSB Kings Bay is located along the Intracoastal Waterway near the town of St. Marys, Georgia. Roughly one-quarter of the base's approximately 18,000 acres consist of protected wetlands (JDA Camden County 2014). The mainland installation is somewhat protected by Cumberland Island, the state's largest barrier island (JDA Camden County 2014).

As the home for the Navy's Atlantic-based nuclear-powered submarines armed with ballistic or guided missiles, NSB Kings Bay is an important part of the country's strategic defense system (CNIC 2016; DOD 2016). Additionally, the base's Trident Training Facility trains sailors to operate submarines, and the Trident Refit Facility maintains and repairs them.[4]

NSB Kings Bay

Size (Acres):	18,058
Established:	1978
Active Duty:	5,244
Total Workforce:	8,797
Total Economic Impact:	$706 million

SOURCE: CAMDEN PARTNERSHIP 2016; JDA CAMDEN COUNTY 2014.

Camden County is home to nearly 3,400 current members of the Armed Forces and more than 7,000 veterans (US Census Bureau 2014).

Historic Exposure to Storm Surge and Flood Hazards

The Naval Research Laboratory has found that NSB Kings Bay is extremely vulnerable to the effects of a hurricane strike, and it is expected to experience sustained hurricane winds once every 28 years, on average (Handlers and Brand 2004).

Since 1851, there have been 59 hurricanes that have come within 150 nautical miles of the base, of which 26 were within 75 miles (NOAA n.d.). Since 1985, no significant storm surge has occurred in Kings Bay, which is somewhat protected from open ocean swell and waves generated in the deeper areas of the adjacent tidal sounds (Handlers and Brand 2004). Simulations of hypothetical storms using the SLOSH model, however, demonstrate that, despite the region's natural protection, storm surge could significantly affect the area.

Future (Projected) Exposure to Storm Surge and Flood Hazards

SEA LEVEL RISE

The intermediate scenario projects that NSB Kings Bay will experience 3.7 feet of sea level rise and the highest scenario projects 6.1 feet of rise by 2100. This rise will lead to increased exposure to different types of coastal flooding.

TIDAL FLOODING

As sea level rises, flooding associated with extreme tides is expected to become more extensive and frequent. NSB Kings Bay contains large swaths of low-lying marshland, much of which already floods during occasional extra-high tides.

Tidal flooding would occur roughly 250 times per year in the intermediate scenario and more than 600 times per year in the highest scenario by 2070. With the highest scenario, this flooding occurs with both daily high tides on average.

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With such regular flooding, affected locations in the region could become unusable land within the next 35 years, and wetland areas would be at risk of shifting to open water, depending on the ecosystem's ability to keep up with rising seas. By 2100 in the highest scenario, NSB Kings Bay's flood-prone areas would be underwater not just at high tide, but more than 60 percent of the year. In both scenarios, tidal flooding is projected to inundate roadways within the southern portion of the base by 2100.

TABLE 1. NSB Kings Bay Projected Sea Level Rise (Feet) in Two Scenarios

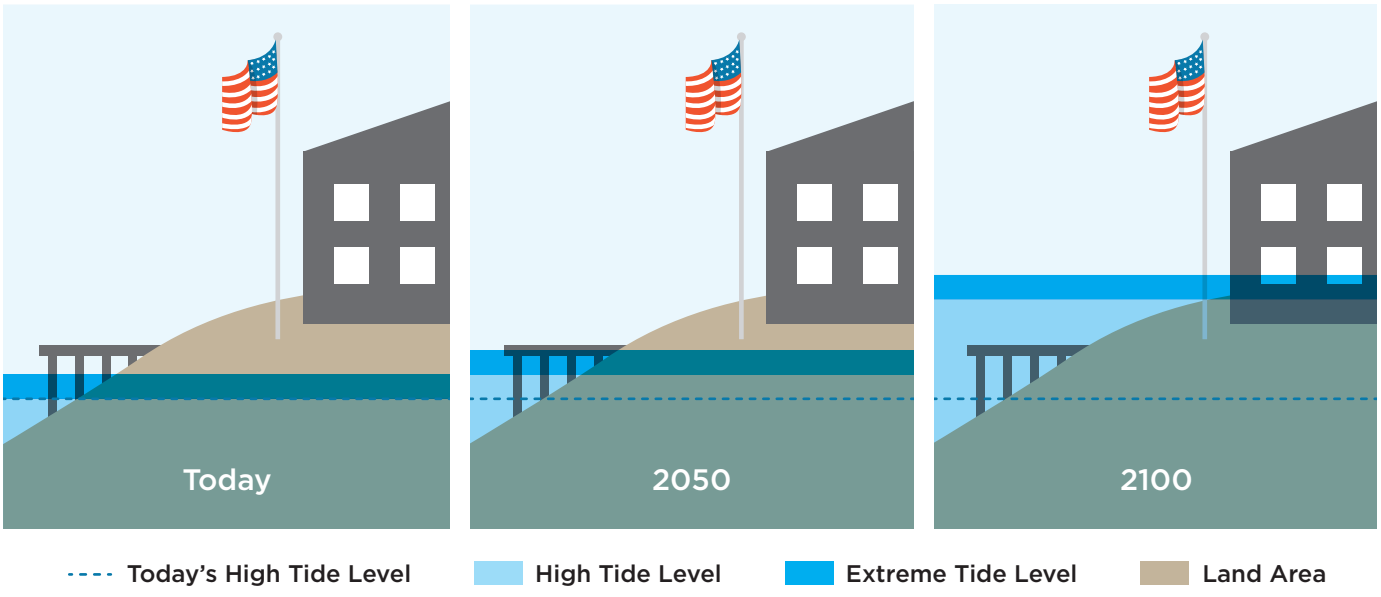
Year	Intermediate	Highest
2050	1.1	1.7
2070	1.9	3.1
2100	3.7	6.1

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).

THE CHANGING THREAT OF HURRICANES

Sea level rise contributes to greater storm surge and exposes a greater proportion of the base's area to surge from any storm category. Today, a Category 1 storm (the most likely to affect this area) exposes roughly 50 percent of NSB Kings Bay to flooding from storm surge. In the intermediate scenario, an

FIGURE 1. How Sea Level Rise Causes Tidal Flooding and Land Loss



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

TABLE 2. Current and Future Tidal Flooding Frequency around NSB Kings Bay

	Intermediate		Highest	
Year	Events per Year	% of Year	Events per Year	% of Year
2012	2 ± 3	0	2 ± 3	0
2050	56 ± 15	1	172 ± 31	4
2070	254 ± 34	6	614 ± 15	23
2100	681 ± 10	31	694 ± 9	61

Shown here are flood events in low-lying, flood-prone areas projected by the intermediate and highest scenarios. Installations will be affected by this flooding depending on the presence of low-lying land on-site. 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.

additional 1,000 acres—an area larger than Central Park—will be exposed to flooding from such a storm by 2100. In the highest scenario, the area exposed to flooding during a Category 1 storm in 2100 is equivalent to the area exposed during a Category 2 storm today.

Sea level rise also changes the depth of flooding NSB Kings Bay can expect with major storms. Whereas only about 20 percent of the base is exposed to five feet or more of flooding during a Category 1 storm today, nearly 50 percent of the base will be exposed to such flooding in 2100.

For this region, a Category 4 storm occurring after more than six feet of sea level rise represents the worst-case scenario in our analysis for future storm surge inundation. Today, a Category 4 storm would expose about 75 percent of NSB Kings Bay—including most of its utilized land—to flooding. In 2100 in the highest scenario, roughly 95 percent of NSB Kings Bay would be exposed to storm surge flooding. Of particular note is the fact that more than half of the flooded areas would be under more than 20 feet of water, whereas today almost none of the base would see such depths.

Mobilizing on the Sea Level Rise Front Lines

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).

Because of its low elevation and hurricane risk, the military recognizes the need for flood risk planning and mitigation at NSB Kings Bay. The ability to generate power on-site and the presence of backup systems allow NSB Kings Bay to function independently of local utility systems (JDA Camden County 2014). NSB Kings Bay and Camden County have worked together to complete a joint land use study and engaged in hazard mitigation planning to help prepare for natural disasters such as hurricanes (JDA Camden County 2014).

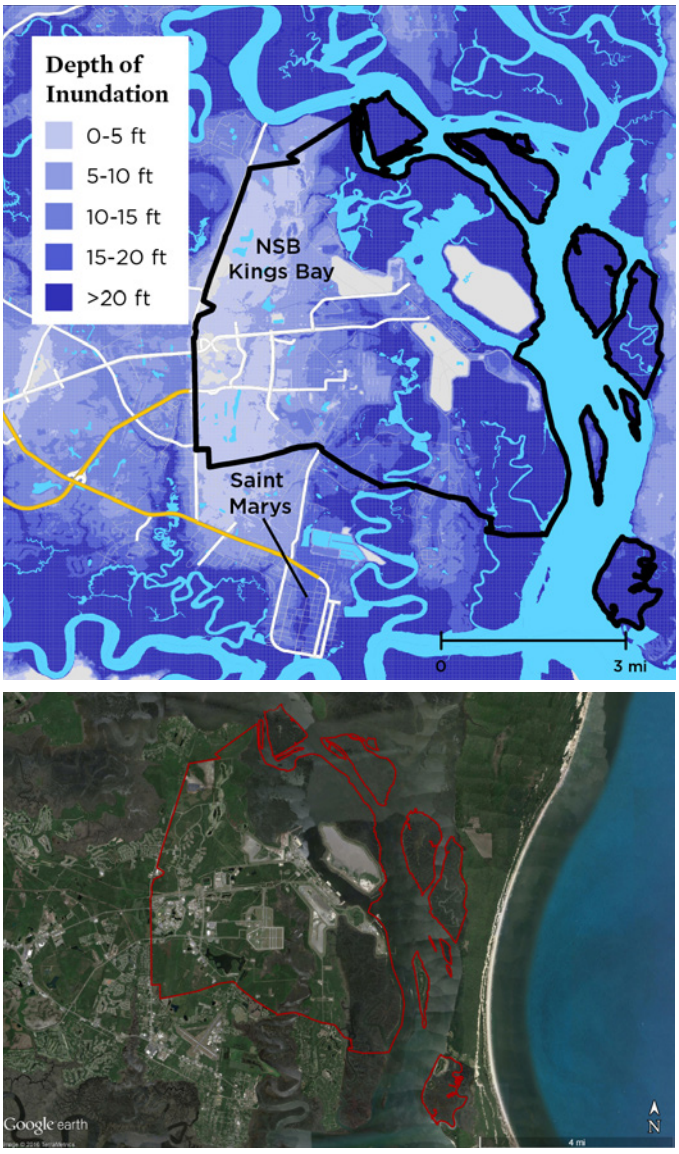
> ***The gap between the military's current sea level rise preparedness and the threats outlined by this analysis is large and growing.***

But here and across 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 NSB Kings Bay, face all of these risks.

This analysis provides snapshots of potential future exposure to flooding at NSB Kings Bay. For the military 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 sys-

tems 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.

FIGURE 2. NSB Kings Bay Faces Exposure to Increased Flood Depths



Shown here is the depth of inundation at NSB Kings Bay from a Category 4 storm in 2100 in the highest scenario. Today, almost none of the base would see flood depths over 20 feet. But in 2100, more than half of the flooded areas would be under more than 20 feet of water, affecting developed areas, shown at bottom.

SOURCE: GOOGLE EARTH.

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 was 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.*

4 *NSB Kings Bay has a total of six major commands: Strategic Weapons Facility, Atlantic; Commander Submarine Group Ten; Trident Refit Facility; Trident Training Facility; US Marine Corps Security Force Battalion; and the US Coast Guard Maritime Force Protection Unit. It also has 60 supporting commands and tenants (JDA Camden County 2014).*

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FIND THE FULL ANALYSIS AND METHODOLOGY ONLINE: www.ucsusa.org/MilitarySeasRising

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