Union of Concerned Scientists

FACT SHEET

The US Military on the Front Lines of Rising Seas

Exposure to Coastal Flooding at Hunter Army Airfield, 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 Hunter Army Airfield (HAAF) found that in the second half of this century, in the absence of preventive measures, this 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 HAAF, 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 HAAF, seas are projected to rise between four and 6.4 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 HAAF. 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 the airfield could be exposed, assuming no new measures are taken to prevent or reduce flooding.[3] This analysis finds the following key results:

US Army

HAAF AND AN UNFORESEEN RISK

Exposure of HAAF's developed areas to regular tidal flooding is projected to remain fairly low this century. However, the installation's protective wetlands are highly exposed: they risk shifting to open water, depending on the ability of the ecosystem to keep pace with rising seas.

TIDAL FLOODING, PERMANENT INUNDATION, AND LAND LOSS

- **Areas currently affected by occasional tidal flooding could flood with each high tide.** Today, low-lying, flood-prone areas around HAAF experience tidal flooding about 10 times per year. In the intermediate scenario, these areas would experience tidal flooding more than 150 times per year on average by 2050; in the highest scenario, tidal flooding would occur nearly daily by that date. In the highest scenario, flood-prone locations flood twice daily on average and are underwater roughly 30 percent of the time by 2070.
- **Flooding during extreme high tides will become more extensive.** Later this century, the nearby towns of Savannah and Georgetown could experience tidal floods far more extensive than those experienced today. Such flooding could affect transportation routes and other infrastructure important to HAAF.
- **Sea level rise threatens to permanently inundate certain areas.** With such regular flooding, the airfield's protective wetland areas would be at risk of shifting to open water, depending on the ecosystem's ability to keep up with rising seas.

STORM SURGE

- **Sea level rise exposes previously unaffected areas of HAAF to storm surge flooding.** By 2100 in the intermediate scenario, sea level rise increases the area exposed to flooding by a Category 1 storm from 25 percent to over 30 percent; it increases to almost 45 percent in the highest scenario.
- **Sea level rise exposes HAAF to deeper, more severe flooding.** In an end-of-century worst-case scenario, three-quarters of the airfield is exposed to storm surge flooding, and more than half of that flooding is 10 feet or more deep.

Base Information

HAAF is located in a low-lying area of Chatham County, Georgia, about 10 miles south of Savannah. Roughly one-third of the installation consists of wetlands (US Army 2015).

HAAF provides training, administrative, and logistical support to soldiers stationed at nearby Fort Stewart, the largest Army installation on the East Coast (DOD 2016). The airfield is home to the Army's longest East Coast runway (over 11,000 feet) as well as Coast Guard Air Station Savannah, which provides search and rescue coverage of the region (US Army 2015). An important unit stationed at HAAF is the First Battalion of the 75th Ranger Regiment.

Hunter Army Airfield (HAAF)

Branch:	Army
Established:	1929
Size (Acres):	5,496
Active Duty:	5,700
Active Duty Family Members:	5,212
Civilians:	737
Retirees:	6,004
Retirees' Family Members:	9,177

SOURCE: DOD 2016; US ARMY 2015

HAAF is an integral part of Chatham County's community and, more broadly, the economy of southeast Georgia. Together with nearby Fort Stewart, HAAF's total economic contribution in southeast Georgia is estimated at $5.2 billion annually (SGFFSH 2012).

Historic Exposure to Storm Surge and Flood Hazards

Since 1853, 91 coastal storms, including five hurricanes, have affected Chatham County (NOAA n.d.; Chatham County 2012). During that time, 53 hurricanes have passed within 150 nautical miles of the base (NOAA n.d.). The last hurricane to make landfall in Chatham County was the "Sea Islands Hurricane," which hit in 1893. The storm surge may have reached as high as 30 feet, and the hurricane caused an estimated 1,000 to 2,000 deaths (Chatham County 2015; Chatham County 2012). Another hurricane, in 1898, was the last to directly hit the state of Georgia, making landfall on Cumberland Island with peak wind speed of around 135 miles per hour. Damage was valued at over $1 million, with storm surges along most areas of the Georgia coastline leading to fatalities as well as damage to and destruction of crops and boats (Chatham County 2015).

In recent history, however, there has been no record of direct storm surge events affecting HAAF (Chatham County 2012; Bettinger, Merry, and Hepinstall-Cymerman 2010). During this lull, critical resources have been amassed at local installations, raising the risk of damages should a storm strike.

Future (Projected) Exposure to Storm Surge and Flood Hazards

The intermediate scenario projects that HAAF will experience four feet of sea level rise, and the highest scenario

projects 6.4 feet of rise, by 2100. This rise will lead to increased exposure to different types of coastal flooding.

TIDAL FLOODING

Today, tidal flooding affects low-lying areas in this region about 10 times per year, on average. At HAAF, mainly wetland areas are affected, but in neighboring Savannah, this flooding can be disruptive to daily lives and the regional economy (City of Savannah n.d.). Savannah, moreover, is a major port, relied upon for the shipment of materials and equipment that support local bases, including the Third Infantry Division at Fort Stewart (US Army 2015).

By 2070, tidal flooding would occur, on average, roughly 440 times per year in the intermediate scenario and roughly 670 times per year in the highest scenario, meaning flooding would occur with more than daily frequency (see Table 2). By the end of the century, flood-prone areas are underwater roughly 40 to 60 percent of the time, depending on scenario. This means that adjacent areas at higher elevation will also be underwater, although for shorter durations.

In both scenarios, tidal flooding is expected to disrupt neighboring communities on which HAAF depends by mid-century and to reach into HAAF by late century, inundating

TABLE 1. HAAF: Projected Sea Level Rise (Feet) in Two Scenarios

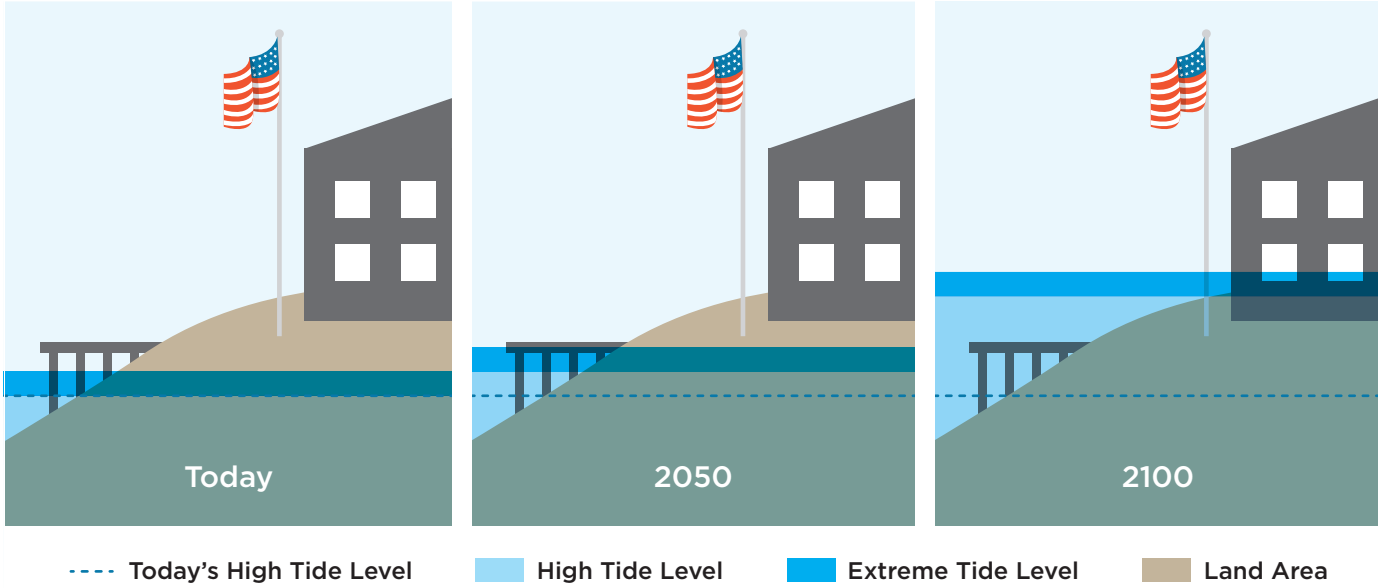
Year	Intermediate	Highest
2050	1.2	1.8
2070	2.1	3.3
2100	4.0	6.4

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 A GROWING PROBLEM AROUND HAAF

Extreme tides in October 2015 drove flooding of Highway 80, about 15 miles from HAAF. Tidal flooding in the region is projected to increase this century and to affect not just current flooding hot spots like this route, but also significant areas of neighboring cities such as Savannah and Georgetown. This may in turn affect HAAF and other bases in the region, given their interdependencies with the cities.

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.

roadways. Beyond nuisance flooding, Savannah and Georgetown could experience widespread disruptive flooding an average of 10 times per year in the latter half of the century.

Without substantial adaptive measures, affected land, including low-lying roadways and neighborhoods, could become unusable in these timeframes; the consequences of flooding on the surrounding region—for example, damage to housing and travel delays affecting the HAAF community of workers and personnel housed off base—could affect HAAF.

Within HAAF itself, wetlands are projected to be inundated later this century, depending on the ecosystem's ability to keep up with rising seas. Because wetlands typically provide flood protection to inland areas, their fate can have a bearing on the rest of the airfield.

THE CHANGING THREAT OF HURRICANES

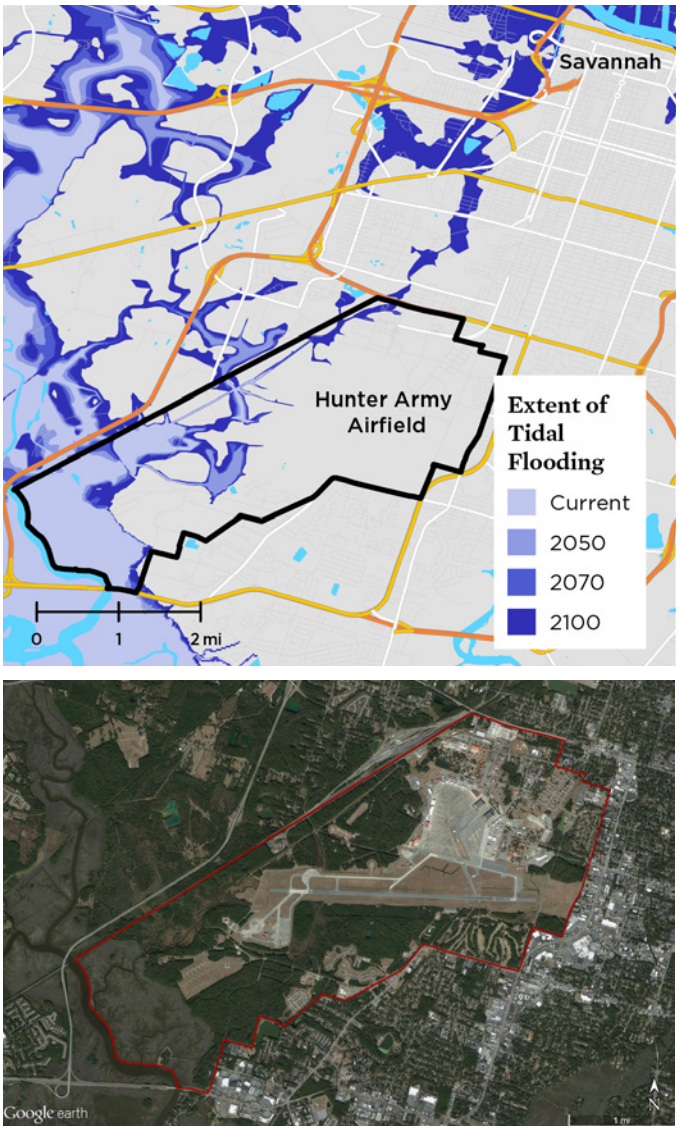
Today, a Category 1 storm exposes 25 percent of HAAF to flooding related to storm surge. In the intermediate scenario,

TABLE 2. Current and Future Tidal Flooding Frequency around HAAF

	Intermediate		Highest	
Year	Events per Year	% of Year	Events per Year	% of Year
2012	10 ± 7	0	10 ± 7	0
2050	152 ± 26	3	327 ± 38	8
2070	438 ± 38	13	671 ± 7	29
2100	698 ± 2	38	702 ± 4	62

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.

FIGURE 2. Extreme Tides to Affect Undeveloped HAAF but Developed Savannah



With the higher rate of sea level rise, tidal flooding is projected to inundate parts of Savannah and other developed areas surrounding HAAF about 10 times per year late this century.

SOURCE: GOOGLE EARTH

the area exposed to flooding increases to over 30 percent by 2100; in the highest scenario, it increases to almost 45 percent. In the highest scenario, the extent of inundation resulting from a Category 1 storm in 2100 is equivalent to the extent resulting from a Category 2 storm today.

Sea level rise also changes the depth of flooding that HAAF can expect with major storms. Today, two-thirds of the inundation resulting from a Category 1 storm at HAAF is five feet deep or less. But by 2100 in the intermediate scenario, roughly two-thirds of the flooding at HAAF would be more than five feet deep.

In our analysis, a Category 4 storm in the highest scenario is the worst case for future storm surge inundation in this region. Today, a Category 4 storm would expose just over 65 percent of HAAF to flooding from storm surge. By 2100, almost 75 percent of HAAF would be exposed to storm surge flooding; more than half of that flooding would be more than 10 feet deep.

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). Army leadership in this region of Georgia is keenly aware that it has been a long time since the last direct hurricane strike, and it is also keenly aware of future flood risks. Chatham County has flood hazard mitigation measures in place, and planning is under way for a flood and hazard mitigation plan that would cover multiple municipal jurisdictions (Chatham County 2015; Chatham County 2012).

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 HAAF, face all of these risks.

This analysis provides snapshots of potential future exposure to flooding at and around HAAF. For the Army 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 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.*

REFERENCES

Bettinger, P., K.L. Merry, and J. Hepinstall-Cymerman. 2010. *Fort Stewart timber salvage and recovery study, and modeling of potential windthrow and storm surges associated with hurricanes*. Athens, GA: The Directorate of Public Works Environmental and Natural Resources Division Forestry Branch Fort Stewart/Hunter Army Airfield. Online at *www.denix.osd.mil/nr/upload/uga_hurricane_project_phase_2-3_final_report.pdf,* accessed May 12, 2016.

Chatham County. 2012. *Flood mitigation plan: Unincorporated Chatham County*. Savannah, GA. Online at *http://engineering.chathamcounty.org/Portals/Engineering/forms/floodzones/flood%20mitigation%20plan.pdf,* accessed April 7, 2016.

Chatham County, Chatham Emergency Management Agency. 2015. *Chatham County multi-jurisdiction pre-disaster hazard mitigation plan*. Savannah, GA. Online at *www.weblink.cityoftybee.org/WebLink/0/edoc/19371/100 011 CFA%20FINAL%20DRAFT.pdf,* accessed April 7, 2016.

Chen, J.L., C.R. Wilson, and B.D. Tapley. 2013. Contribution of ice sheet and mountain glacier melt to recent sea level rise. *Nature Geoscience* 6(7):549-552.

City of Savannah. No date. *City of Savannah flood hazard mitigation plan*. Savannah, GA. Online at *http://ga-savannah.civicplus.com/DocumentCenter/View/6678*, accessed May 31, 2016.

DeConto, R.M., and D. Pollard. 2016. Contribution of Antarctica to past and future sea-level rise. *Nature* 531:591-597.

Department of Defense (DOD). 2016. Hunter Army Airfield, Georgia: Overview. Washington, DC. Online at *www.militaryinstallations.dod.mil/MOS/f?p=132:CONTENT:0::NO::P4_INST_ID,P4_INST_TYPE:1210,INSTALLATION*, accessed March 7, 2016.

Department of Defense (DOD). 2014. *Climate change adaptation roadmap*. Washington, DC. Online at *http://ppec.asme.org/wp-content/uploads/2014/10/CCARprint.pdf*, accessed May 31, 2016.

Hall, J.A., S. Gill, J. Obeysekera, W. Sweet, K. Knuuti, and J. Marburger. 2016. *Regional sea level scenarios for coastal risk management: Managing the uncertainty of future sea level change and extreme water levels for Department of Defense coastal sites worldwide*. Washington, DC: US Department of Defense, Strategic Environmental Research and Development Program. Online at *https://www.serdp-estcp.org/News-and-Events/News-Announcements/Program-News/DoD-Report-on-Regional-Sea-Level-Scenarios*, accessed May 25, 2016.

National Academy of Sciences (NAS). 2011. *National security implications of climate change for US naval forces: A report by the Committee on National Security Implications of Climate Change for US Naval Forces*. Washington, DC. Online at *www.nap.edu/download.php?record_id=12914*, accessed May 24, 2016.

National Oceanic and Atmospheric Administration (NOAA). No date. Historical hurricane tracks. Washington, DC. Online at *https://coast.noaa.gov/hurricanes/*, accessed March 14, 2016.

Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss. 2012. *Global sea level rise scenarios for the National Climate Assessment*. NOAA tech memo OAR CPO-1. Washington, DC: National Oceanic and Atmospheric Administration. Online at *http://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf*, accessed April 25, 2016.

Rignot. E., I. Velicongna, M.R. van den Broeke, A. Monaghan, and J.T.M. Lenaerts. 2011. Acceleration of the contribution of the Greenland and Antarctic ice sheets to sea level rise. *Geophysical Research Letters*, doi: 10.1029/2011GL046583.

Southeast Georgia Friends of Fort Stewart and Hunter (SGFFSH). 2012. Fort Stewart/Hunter Army Airfield/Kelley Hill, Home of the 3rd Infantry Division. Hinesville, GA. Online at *http://friendsofftstewartandhunter.com/uploads/Econ_Impact_Trifold_Jul_2012.pdf*, accessed May 12, 2016.

Trusel, L.D., K.E. Frey, S.B. Dias, K.B. Karnauskas, P. Kuipers Munneke, E. van Meijgaard, and M.R. van den Broeke. 2015. Divergent trajectories of Antarctic surface melt under two twenty-first-century climate scenarios. *Nature Geoscience* 8:927–932. doi:10.1038/NGEO2563.

US Army. 2015. Fort Stewart/Hunter AAF/Kelley Hill. Washington, DC. Online at *www.stewart.army.mil/info/?id=446*, accessed May 12, 2016.

US Army Corps of Engineers (USACE). 2015. *North Atlantic Coast comprehensive study: Resilient adaptation to increasing risk*. Brooklyn, NY. Online at *www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf*, accessed May 25, 2016.

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