

The Growing Exposure of Air Force Installations to Natural Disasters

Recent natural disasters have underscored the vulnerability of Air Force installations to natural hazards. In 2018, Tyndall Air Force Base (AFB) experienced a direct hit from Hurricane Michael, causing \$4 billion worth of damage. Flooding at Offutt AFB in 2019 damaged buildings, runways, and other assets. A wildfire near Vandenberg AFB delayed a scheduled rocket launch and endangered two space launch pads.

These incidents have prompted the Department of the Air Force (DAF) to examine how to improve AFB resilience to natural hazards. To reduce the exposure of these installations to the threat of disasters, the DAF asked RAND's Project AIR FORCE to assess base-level exposure to flooding, wildfires, and high winds and identify potential mitigation options. The analysis combined geospatial and other asset-level information with national hazard data for each base. The approach demonstrates how an enterprise-wide view of installation exposure to natural hazards can inform a variety of policy decisions.

Flooding

Flooding can result from extreme weather or human factors, such as inadequate stormwater infrastructure. Climate projections suggest that the global intensity of storms will grow, as will the geographic distribution of severe storms. Flooding poses particular risks to some Air Force installations in coastal areas, which are subject to heavy rain and surges from hurricanes and tropical storms and to sea-level rise from climate change. The Special Flood Hazard Area (SFHA), as designated by the Federal Emergency Management Agency (FEMA), is an area with a

KEY FINDINGS

- The uneven exposure of installations to natural hazards means that for the DAF to get the most out of its resilience resources, it should look critically at the entire enterprise.
- For some hazards, although only a fraction of an installation might be exposed, this exposure could have a disproportionate effect on mission performance.
- Portions of 20 DAF bases have high or very high wildfire potential. A few bases have nearby power transmission infrastructure in areas with much higher wildfire potential than the base.
- A few installations facing multiple hazards deserve special attention because of the difficulty of formulating policies that address multi-hazard exposure. The following coastal installations face multiple hazards: Eglin, Hurlburt, Keesler, Langley, MacDill, Patrick, and Tyndall.
- Although enterprise-level assessments of exposure can provide insights for the DAF, they do not replace deeper-dive, local assessments.

1-percent annual exceedance probability of flooding in any given year (usually referred to as a 100-year flood). Figure 1 shows the percentage of land in each AFB that is located in the SFHA.

As shown in Figure 1, two bases have more than 75 percent of their area in flood hazard zones: Langley (Virginia) and MacDill (Florida). More-granular analysis shows that Langley and MacDill each have multiple assets in flood hazard zones, including all runways. Wright-Patterson, Eielson, and Seymour Johnson AFBs also have assets in multiple categories in the SFHA zones.

Hurricanes

Tyndall AFB suffered extensive damage from Hurricane Michael in 2018: Approximately 750 assets were hit. Future hurricanes could inflict even greater damage on high-risk bases (shown in Figure 2). To estimate the potential costs of future hurricane damage, the researchers simulated future building-repair costs for installations that suffer similar damage. The analysis simulated cases with roughly 15 percent higher (worst

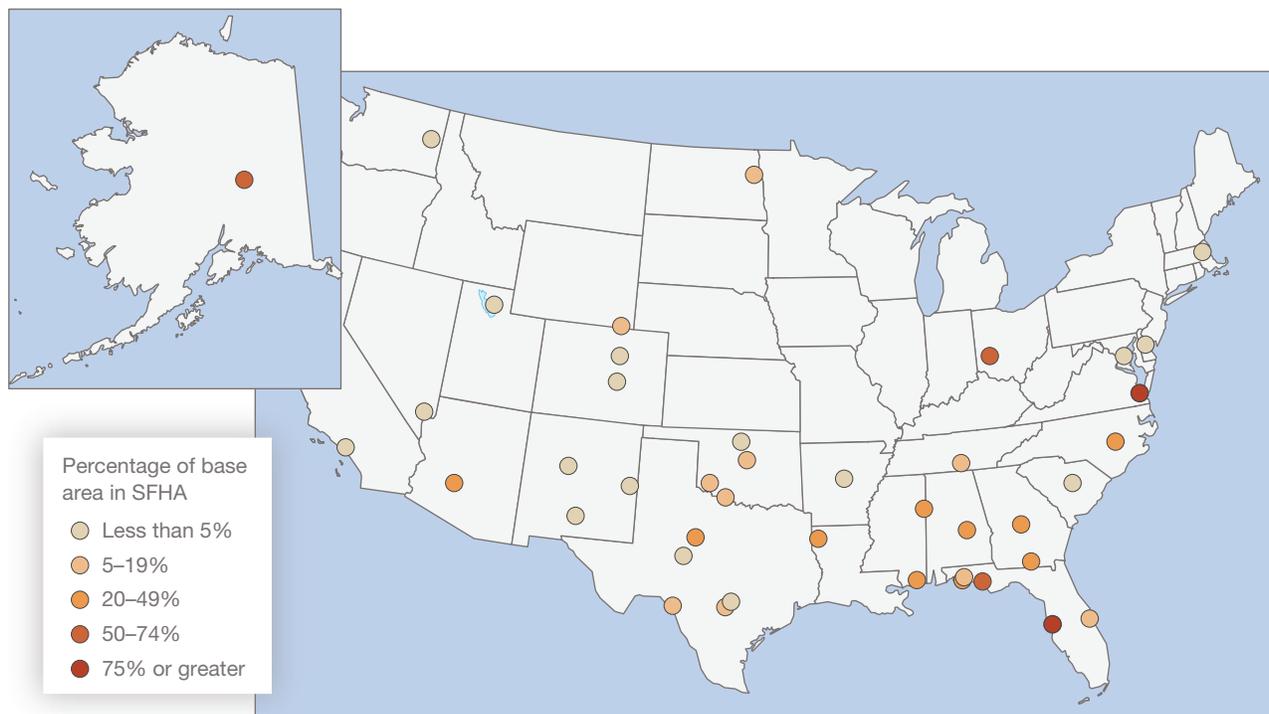
case) and 15 percent lower (best case) damage than the Tyndall case.

The simulation showed that five locations would have costs spanning a range similar to Tyndall’s costs. Four locations, however (Lackland, Eglin, Robins, and Patrick), would have notably higher estimated costs. These costs stem from a combination of the number and types of buildings at these locations. The results suggest that the variation in assets exposed to a Michael-like hurricane could translate to substantially different repair costs for different installations.

Wildfires

The average base-wide exposure to wildfire is low or very low for 80 percent of installations; however, 20 installations have areas with high or very high Wildfire Hazard Potential (WHP—see Figure 3). Vandenberg, Eglin, Beale, Mountain Home, and Moody AFBs have the highest relative average exposure. These five bases also have the highest percentage of base area with high or very high WHP. Fifteen other bases face elevated risks from wildfire exposure. Because fires threaten

FIGURE 1
Two Bases Have More Than 75 Percent of Their Area in Flood Hazard Zones



SOURCES: RAND analysis of FEMA National Flood Hazard Layer data and Homeland Infrastructure Foundation-level data.

FIGURE 2

A Simulation Showed That Hurricane Michael–Level Damage Could Exceed That Inflicted on Tyndall in 2018

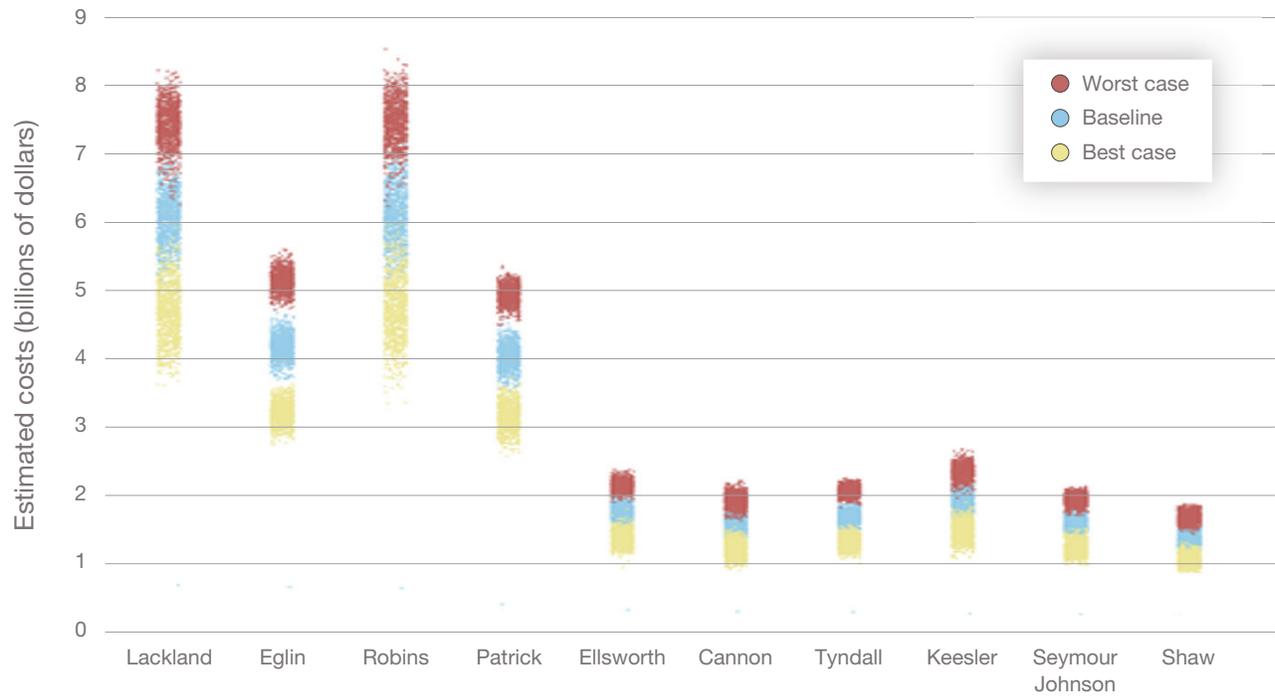
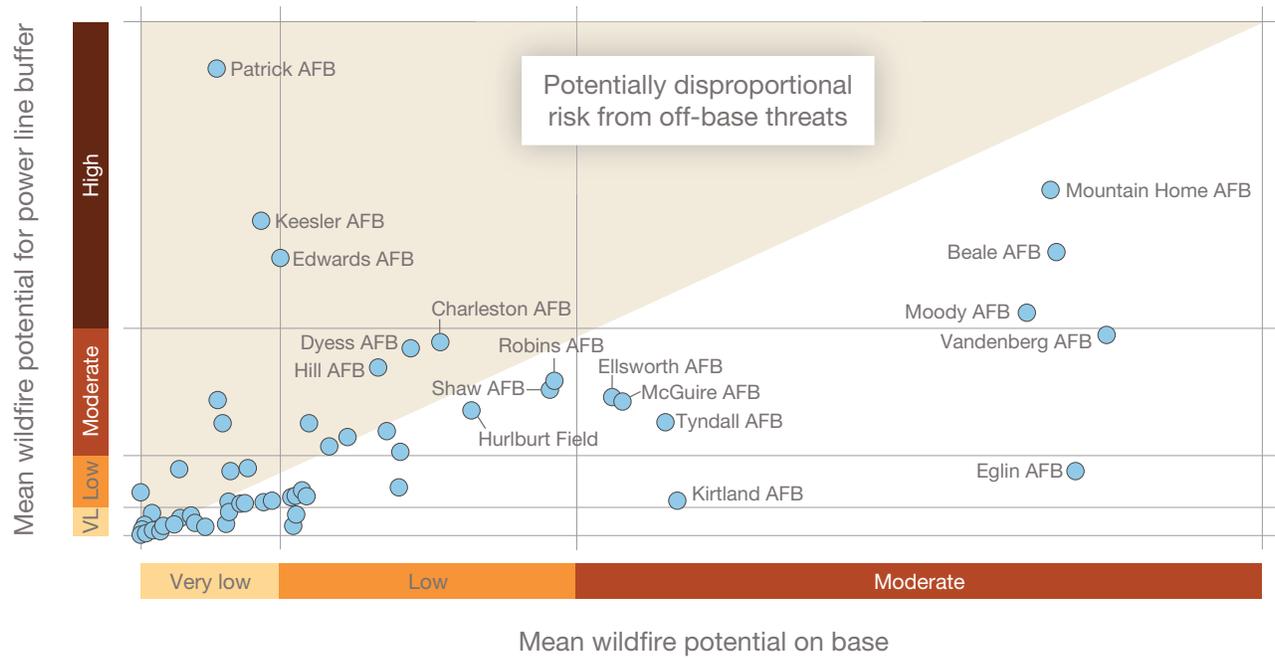


FIGURE 3

Wildfire Risk Does Not Stop at the Base Perimeter



entire bases, an enterprise-wide look at wildfire risk needs to flag bases having even small areas with high exposure.

Even if wildfires do not directly affect areas on a base, they can affect critical infrastructure—such as electric power—on which DAF missions rely. The analysis also examined the exposure of key electric power assets outside the base in the surrounding region (Figure 3). Edwards AFB, for example, faces risks posed by wildfire exposure in areas outside the perimeter. Although the on-base exposure is relatively low, there are power lines nearby in the Los Angeles area mountains with high levels of exposure to wildfire.

Multiple Exposures

Many bases are exposed to more than one hazard. For example, Langley and MacDill AFBs have a large percentage of area exposed to current and future flooding from sea-level rise. Wright-Patterson has a high percentage of base area exposed to flooding and is also located in a high-wind zone. Moody AFB has about one-third of its base area in the flood hazard area, has a high base-level average wildfire hazard (relative to other bases), and is also exposed to relatively high winds.

Conclusions and Recommendations

The uneven exposure of installations to natural hazards and the presence of multiple hazards suggest that the DAF should look critically across the entire enterprise to improve installation resilience. However, although enterprise-level assessments of exposure can provide insights for the DAF, they do not replace deeper-dive, local assessments.

We recommend that the DAF take the following actions:

- Work with communities to address regional **flooding and wildfire** concerns.
- Assess whether building standards are suited to historic levels of **hurricane or other high-wind exposure** and to possible future exposures for each installation.
- Pay special attention to installations that are exposed to **multiple hazards**.
- Develop a capability to **assess installation exposure to natural hazards** and establish requisite funding mechanisms and resources at the enterprise level to address problems. A prerequisite is to develop a system to track the frequency, severity, and costs of hazards.
- Consider ways to **incorporate natural hazard-related risks into key DAF decisions**, such as those related to new construction, major renovations, installation design, and mission assignment.
- Ensure the **availability of data** needed to implement prevention and resilience policies.

This brief describes work done in RAND Project AIR FORCE and documented in *Grounded: An Enterprise-Wide Look at Department of the Air Force Installation Exposure to Natural Hazards: Implications for Infrastructure Investment Decisionmaking and Continuity of Operations Planning*, by Anu Narayanan, Michael J. Lostumbo, Kristin Van Abel, Michael T. Wilson, Anna Jean Wirth, and Rahim Ali, RR-A523-1, 2021 (available at www.rand.org/t/RR-A523-1). To view this brief online, visit www.rand.org/t/RBA523-1. The RAND Corporation is a research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors. **RAND**® is a registered trademark.

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