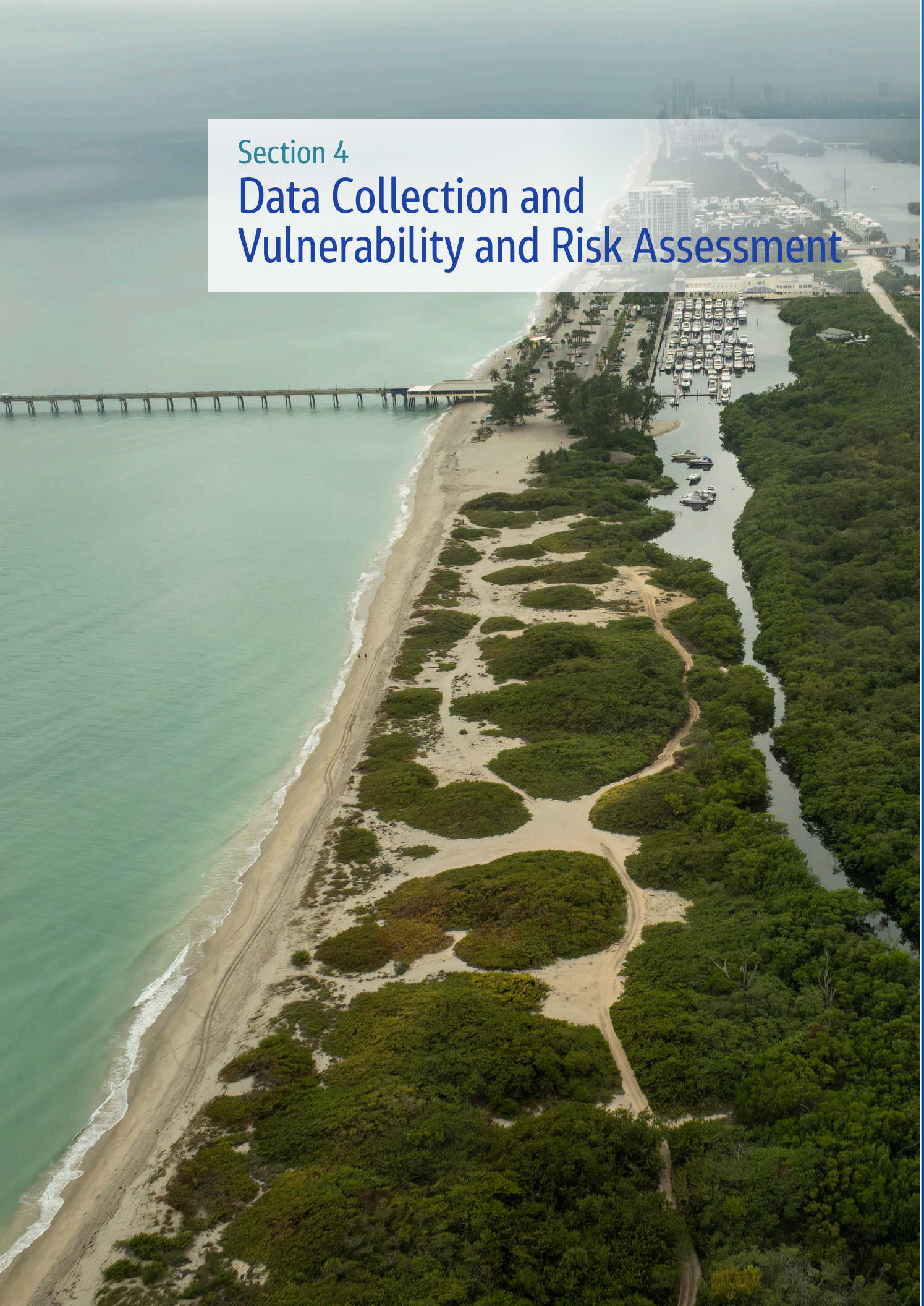

Section 4

Data Collection and Vulnerability and Risk Assessment

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Section 4

Data Collection and Vulnerability and Risk Assessment

The initial phase of the South Florida MIRR was data collection to support the subsequent project phases including the vulnerability assessment and adaptation planning (Figure 4-1). The objective of the data collection was to gather sufficient geospatial, contextual, and anecdotal information to answer these primary questions:

- How should the study area(s) be defined?
- What assets are critical to the mission(s) of each of the four military installations within the scope of this South Florida study?
- What hazards are likely to impact the critical assets in the study area and create vulnerabilities for the installations or their mission?
- How does the adaptive capacity and ongoing mitigation and resilience planning efforts reduce risk for the installations and their mission?

Defining the Study Area Boundaries

A variety of factors influenced the boundary distinctions used for the assessment of each military installation. Key infrastructure and assets such as major roads and utility infrastructure in direct proximity to the installations were the initial guiding forces for the determination of each study area boundary. The boundaries were then expanded on an individual basis to include assets located at greater distances from the installations that prove to be critical to the installation's operation, security, and safety. The locations of the nearest sector assets of interest varied for each installation, augmenting the size and scope of each boundary used. It is important to note that installation study areas were also adjusted as needed to be inclusive of the direction of propagation of relevant threats to comprehensively evaluate adaptation strategies.

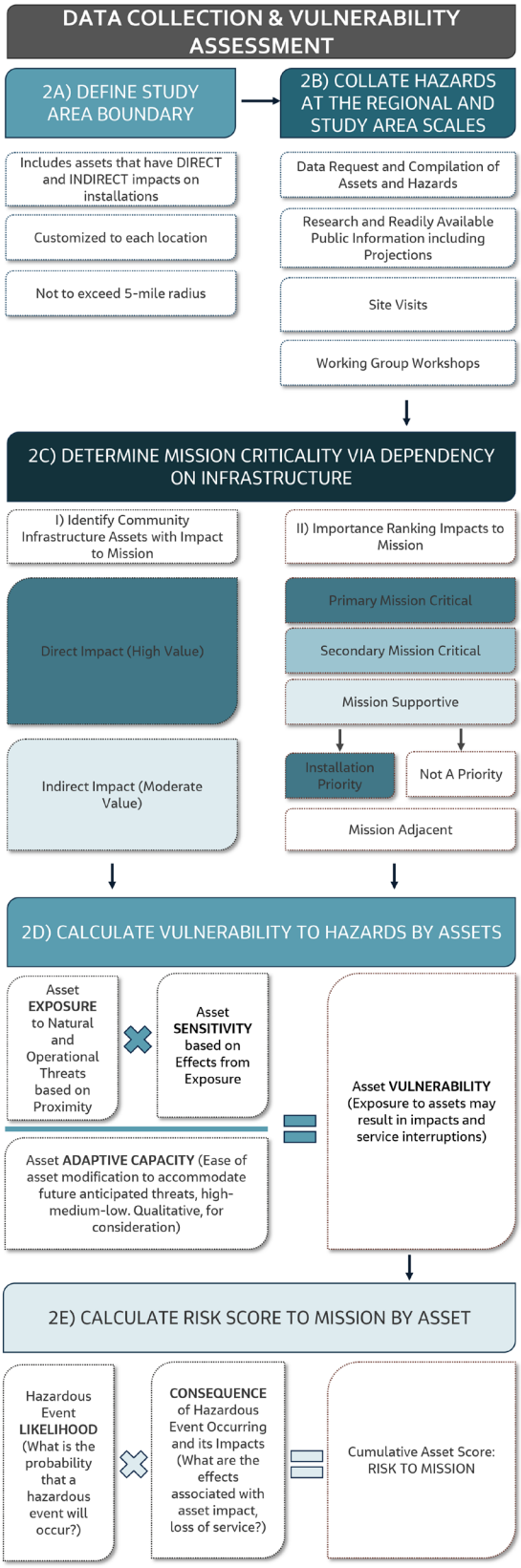


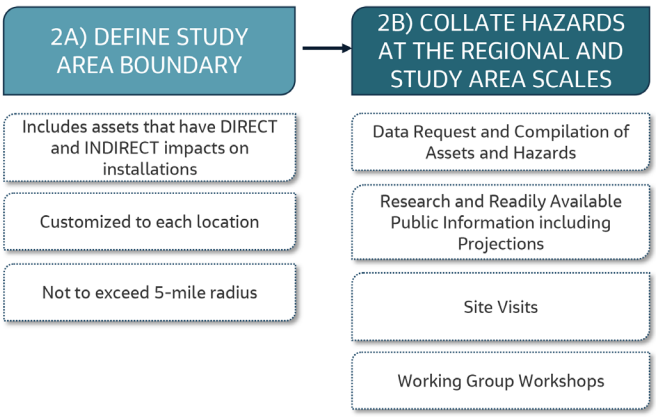
Figure 4-1. Adaptation Methodology Step 2

For example, the study area for the SFOMF not only encompassed the individual military structures, but the entire expanse of the connecting Dr. Von D. Mizell-Eula Johnson State Park. Additionally, the study area was widened to incorporate the nearby airport, port, Florida Power & Light (FPL) power plant, NSU Marina, and AT&T infrastructure. Local schools, communication towers, and national shelters located beyond 2 miles from the installation. SOUTHCOM's study area was expanded to include nearby communication facilities, a national shelter system facility, the local hospital, and stormwater and fuel infrastructure. These areas adjacent to the SFOMF facilities also exhibit vulnerability to a combination of hazards including SLR, king tide flooding, storm surge, and urban heat island. By expanding the study area to include the nearby critical infrastructure and interfacing hazards, the local picture and potential risk to the installation is better captured.

Minimal critical assets are near the HARB resulting in a broadening of its study area to incorporate the wide-scale canal system, the local hospital, stormwater and wastewater infrastructure, and nearby hotels and communication towers. The greater geographic study area also fully portrays the interaction between hazard forces impacting the facility and the nearby infrastructure and networks upon which the facility depends. These hazards range from SLR and storm surge risk to heat risk.

The NASKW property includes the majority of Boca Chica Key. Additional U.S. Navy assets are located on Fleming Key, Dredgers Key, and the mainland of Key West. Critical wastewater infrastructure, communication facilities, schools, electrical substations, and gas stations are located on these surrounding islands, necessitating the greater geographical scale of the NASKW study area. Unique to this study area is the predicted predominance of king tide flooding, which impacts areas all along Key West. The study area expanse displays flood exposure variations and combinations and resulting areas of shoreline erosion.

To account for the overall connectivity of the installations and of electricity, transportation, and regional facilities, it is critical to also assess



Adaptation Methodology Step 2A and 2B

these assets regionally. While each installation is in a unique locality, many utility systems, road networks, and military systems are interdependent. It is important to maintain an understanding of these interdependencies to better adapt at wider scales.

Collating Hazards at Regional and Study Area Scales

Data Collection and Compilation

The criticality and location of the assets was determined by collection of data from stakeholder surveys, site tours, workshops, interviews, public data search and an iterative process to address data gaps. Hazards and threats were identified and then ranked based on likelihood and potential magnitude of impact to obtain a list of threats and hazards of concern for use in the vulnerability assessment. A preliminary risk calculation was completed to categorize the identified hazards. The high-risk hazards included extreme rainfall, hurricanes, tornados, and extreme wind. The medium risks included wildfire, extreme heat, storm surge, SLR, failure of aging infrastructure, and housing/ staff retention. The low risks affecting the project area were identified as lightning and land use/encroachment. The data collected was consistent with project scope requirements and state guidance for vulnerability assessments and was inclusive of the best available public data.

Interviews included a request for data to address items identified during site tour workshops (Appendix B) and a discussion of potential vulnerabilities and potential cascading effects on the entities' operations and plans, any known interests in partnering with the military installations or local governments, preliminary review of specific adaptation strategies, and questions or next steps raised during the stakeholder workshops.

Interviews were held or scheduled with the following entities

- Office of the Monroe County Chief Resilience Officer
- SFWMD
- The Nature Conservancy (TNC)
- Florida Keys Aqueduct Authority
- Sea Life Rescue
- Broward Metropolitan Planning Organization (MPO)
- Florida Department of Transportation (FDOT), Districts 4 and 6
- FPL
- Homestead Electric
- USCG

Regional Asset Inventory

The regional asset inventory is a collection of the assets and systems in South Florida that may be impacted by shocks and stressors. This inventory provides the input necessary to conduct the vulnerability assessment and develop adaptation strategies. Data was collected by asset class and type (Figure 4-2), integrated into the geodatabase and spatially represented on context maps.
The primary sources for asset data were local government open spatial data portals (county, municipal, FDOT, Florida Department of Emergency Management [FDEM], FDEP, USACE, Esri, shapefiles shared by data owners [utilities]) and discussions

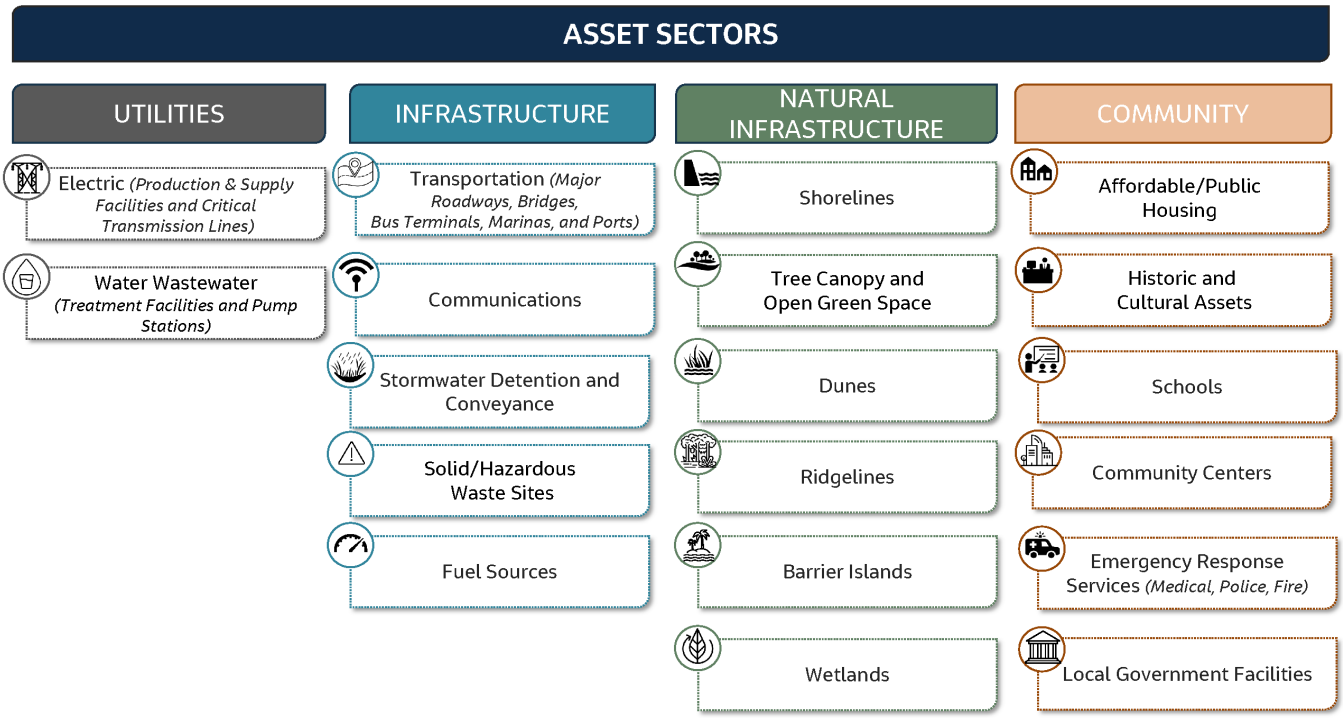


Figure 4-2. Asset Sectors

with military installation and government representatives to understand general locations of assets on the installation site and interconnections with external assets. Some identified asset data was requested via public records or special access requests and was added to the inventory prior to completion of the vulnerability assessment when received. Per state guidance, the assets evaluated for inclusion in the data inventory included the types in Figure 4-3.

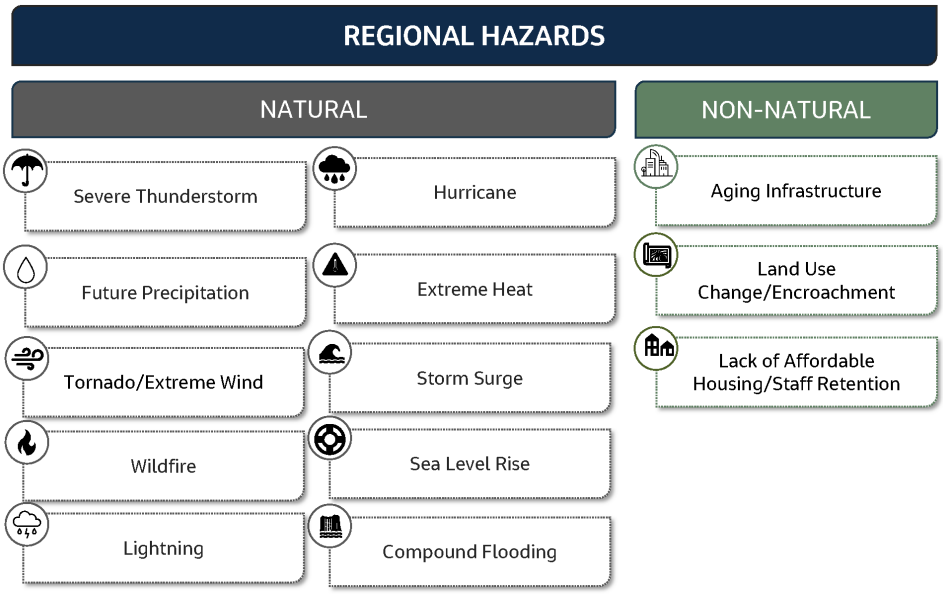


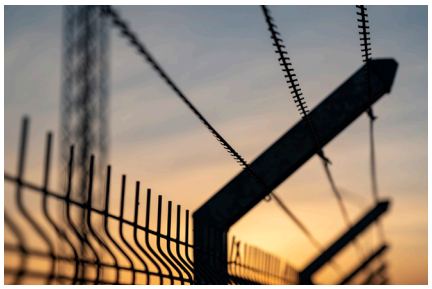
Figure 4-3. Regional Hazards Collected for Vulnerability Assessment

Regional Hazards

Vulnerability assessments and adaptation planning depend on identifying relevant threats and hazards that may impact critical assets (Figure 4-3). As a definition, threats and hazards cause events that result in negative impacts that lead to a problematic outcome. For example, rainfall and storm surge during hurricanes can cause a severe flooding event. During the flood event, structures and power infrastructure can be damaged. As an outcome, power outages will occur.

Note that different studies have different approaches to classifying hazards. As an example, coastal flooding can be identified as a hazard, grouping the many ways coastal flooding occurs such as storm surge, severe thunderstorms, SLR, compound flooding or groundwater rise or each of the flooding mechanisms (like storm surge) could be identified as individual hazards. Alternatively, individual hazards occurring simultaneously may be aggregated and classified into a single hazard to better represent the overall conditions affecting a larger spatial area. As an example, a hurricane can be a hazard that includes the individual hazards of extreme wind, tornados, extreme rainfall, riverine flooding and storm surge. In this section, known threats and hazards were reviewed, reclassified into categories that aligned with the project scope, and distilled into a list of relevant threats and hazards affecting the military installations in South Florida. A preliminary risk analysis of the list of relevant hazards was performed at the end of the section to determine hazards to be included in the vulnerability assessment.

A comprehensive list of known threats and hazards was developed by Aptim with input from stakeholders for the South Florida region inclusive of findings from government assessments and modeling, recommendations from state guidance for resilience planning, and documented hazards from stakeholder workshops and interviews. This list was reviewed and refined to include only threats and hazards relevant to the project and the military installations. Several hazards were determined to be low or no risk in South Florida by the FEMA National Risk Index or were outside of the scope of this study. Identified threats that were low risk that were not discussed in the local mitigation strategy documents by stakeholders, or that were not included in the project scope were excluded from further analysis. Note the risk ratings from the FEMA National Risk Index do not account for future conditions and may explain low risk ratings. However, the local mitigation strategies and the USACE South Atlantic Coastal Study included SLR and acknowledgement of changing future conditions (USACE 2021a.



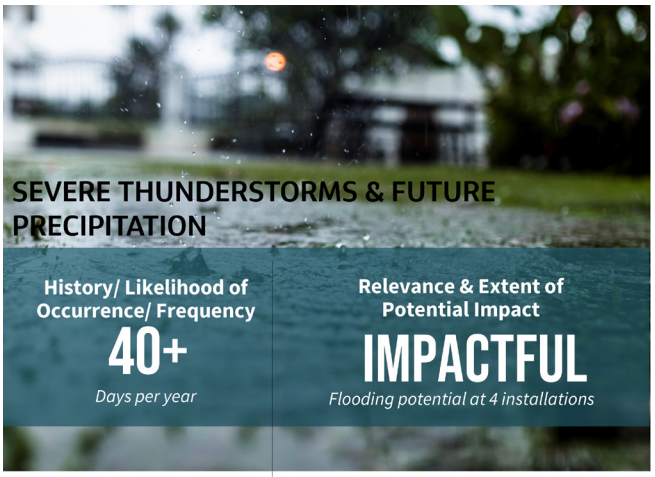
Several hazards were listed in local mitigation plans but do not directly affect the assets included in the regional inventory. These hazards are disease and winter weather as a hazard to crops and the homeless. The following hazards were listed in county and local mitigation strategies but were considered irrelevant and/or not within the scope of this project.

- Earthquakes (irrelevant)
- Riverine flooding (irrelevant because of lack of presence of this feature; canals are not rivers)
- Biological and vector related hazards (not in project scope, still a potential hazard)
- Cyber attacks (not in project scope, still a potential hazard)
- Physical security threats (not in project scope, still a potential hazard)
- Terrorism (not in project scope, still a potential hazard)
- Hazardous material incidents (not in project scope, still a potential hazard)

Natural, technological, and human-caused threats and hazards can result in loss of life, property damage, service disruption, and impacts to mission. The costliest damage in South Florida is caused by natural hazards. From 2011 through 2021, the tri-county area had six declared disasters and received more than $892 million in FEMA assistance for damages (FEMA 2021). Technological hazards, including hazardous materials release or failure of aging infrastructure, can be a consequence of natural hazard damage and can lead to cascading effects on interdependent services. For this project, human-caused threats are not the typical intentional act of violence but rather the implications of policy and market activity. Being able to compare the importance of these hazards is essential for prioritization in adaptation planning.

Severe Thunderstorms and Future Precipitation

A severe thunderstorm includes thunder, lightning and heavy rainfall. In this hazard category, severe thunderstorm refers to the heavy rainfall component that overwhelms drainage and flood control systems and causes floods (hurricanes discussed separately). Inland flooding from severe thunderstorms in South Florida may last for several days depending upon drainage capacity in the canals, stormwater systems and substrate. Annual flooding from severe thunderstorms is likely to occur within each of the study areas (NOAA 2022b). The 24-hour, 100-year (1% annual chance) rainfall event precipitates 14 to 16 inches in South Florida (NOAA 2022c). The SFOMF and NASKW are entirely within the 100-year floodplain. The areas surrounding USAG-Miami/SOUTHCOM and HARB are partially within the 100-year floodplain. Future rainfall is anticipated to increase 13% to 20% by 2070 (Broward County 2021).



With climate change, severe thunderstorms are projected to increase in rainfall intensity and volume

SFOMF and NASKW are entirely within the 100-year floodplain. The areas surrounding SOUTHCOM and HARB are partially within the 100-year floodplain. Poses risk to drainage systems and roads

For HARB, several Secondary Mission Critical stormwater treatment facilities and pump stations are at high risk for 100-year flood. Approximately 30 Secondary Mission Critical catch basins and the Preston Water Treatment Plan within USAG-Miami/SOUTHCOM study area are under medium risk to 100-year and 500-year flooding. For NASKW, several Secondary Mission Critical streets and shorelines in the study area are shown to be at risk to a 100-year flood.

DoD and USACE Emergency Operations and Management Teams are the first to respond to any impacts of natural disasters within military installations. Apart from the internal military disaster response teams, the following entities respond to flooding caused by severe thunderstorms:

- **FEMA and Local Emergency Management Agencies (County or State):** Coordinates emergency response efforts and communication during severe weather events.
- **Floodplain Management Department:** Implements and enforces regulations for construction in flood-prone areas.
- **City/County Public Works:** Manages drainage systems, maintenance of culverts, and flood control infrastructure.
- **National Weather Service:** Provides early warning and forecasts for severe thunderstorms and flooding.

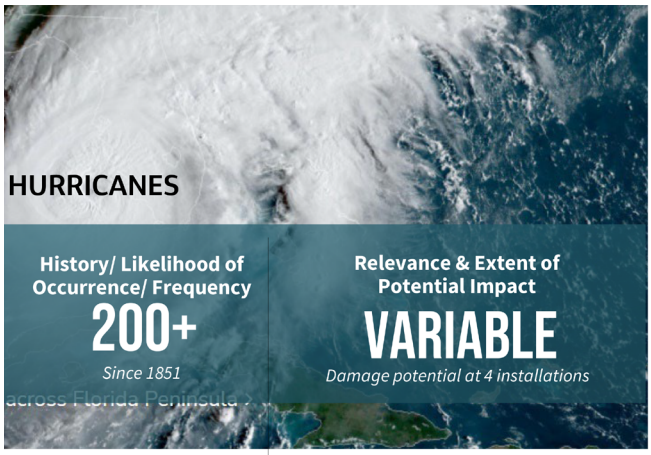
Plans to address this hazard include floodplain management plans, evacuation plans, emergency response plans, and flood hazard mitigation plans.

Hurricanes/Extreme Wind/Tornados

A hurricane is a powerful and destructive tropical cyclone with sustained wind exceeding 74 miles per hour (mph) that forms over warm ocean waters. In South Florida, hurricane season extends from June 1 to November 30 annually. South Florida has experienced more than 200 hurricanes since 1851 (NOAA 2022d). The average number of hurricanes that for per year is six. The annual probability of a hurricane affecting the South Florida area is approximately 54%. The annual probability of a Category 3 storm affecting Broward County is more than 10%. The annual probability of a hurricane landfalling in Monroe County is 3%; however, the annual probability of a hurricane affecting Monroe County is 90% (NOAA 2022d). While the impacts of Category 1 and Category 2 hurricanes are likely to be mild, Category 3 through 5 hurricanes may cause significant damage to critical infrastructures including wall and roof failures, major shoreline erosions, inland flooding, and power losses due to the damage to electric substations.

Hurricanes and thunderstorms can generate tornados. Tornados have wind speeds of 40 to 300 mph, measured using the Enhanced Fujita scale from EF0 to EF5. Extreme winds are included in this category of hazard. Broward County records approximately two tornado touchdowns per year, mostly of moderate or significant intensity. Miami-Dade County averages two tornados per year. Miami-Dade County has a 17% annual probability of extreme winds. Monroe County has a 100% annual probability of high winds that cause property damage. The Key West area has an annual probability of tornados of 26% based on historic records not accounting for climate change (NOAA 2022b).

The extreme wind speeds and transport of debris turned projectiles within tornados causes property damage and loss of life. Strong winds can cause damage to trees, vehicles, and roofs. Most damage from thunderstorms results from straight-line winds that can gust at 100 mph and damage as much infrastructure as a tornado.



A hurricane is a tropical cyclone with sustained winds exceeding 74 mph. Hurricane season extends from June 1 to November 30 annually.

Cat 1: Generally results in coastal flooding and tree damage.
Cat 2: Winds may result in roof damage.
Cat 3: Winds may cause damage to small buildings and may cause inland flooding.
Cat 4: Can result in wall and roof failures in housing, major beach erosions and inland flooding.
Cat 5: Can result in complete roof and small building failures, flooding of structures along the coast.

Future wind speeds are anticipated to increase by 2-11%.

The high wind speeds and transport of debris turned projectiles within tornados causes property damage and loss of life. Strong winds can cause damage to trees, vehicles, and roofs. Most damage from thunderstorms results from straight-line winds which can gust at 100 miles per hour and damage as much infrastructure as a tornado.

Extreme wind is a moderate contributor to high risk for all installations included in the MIRR study and proves to be a significant threat across South Florida. Results indicate that extreme wind is significantly impactful at NASKW on high-risk Primary Mission Critical power transmission lines along US1, southeast of Key West Golf Club, and from Key West Airport to Trumbo Point. At HARB, extreme wind is the greatest contributor to the low-high risk classification of the installation's Secondary Mission Critical power transmission lines. In addition to mission critical power transmission lines, Primary and Secondary Mission Critical electric production and supply facilities experience the greatest risk from extreme wind across infrastructure sectors for all installations.

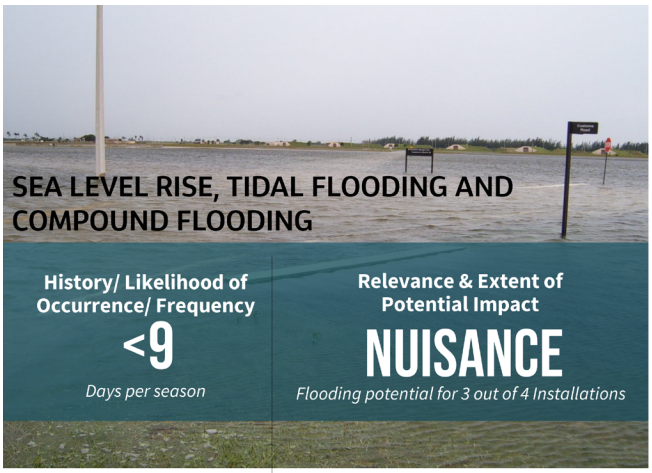
Apart from the internal military disaster response teams, the following entities respond to hurricane, extreme wind, and tornado-related disasters:

- **State Emergency Management Agency:** Coordinates resources and support across regions for hurricane response and recovery.
- **FEMA:** Provides Federal assistance and resources during and after hurricanes.
- **Local Law Enforcement:** Manages evacuation efforts, enforces curfews, and ensures public safety.
- **Non-Governmental Organizations:** Provide disaster relief services, shelter, and aid to affected communities.

Plans to address this hazard include hurricane preparedness plans, evacuation plans, shelter management plans, and debris management plans.

Sea Level Rise

Sea level has been measured as rising in South Florida for more than 100 years. The Southeast Florida Regional Climate Change Compact projects that sea level will rise 3.3 feet by 2070 above 2000 mean sea level, aligning with the NOAA Intermediate High projection from Key West (Figure 4-4) (Compact 2020). SLR leads to compound flooding when rainfall, tidal flooding and surge flooding occur simultaneously. SLR also contributes to groundwater rise, seepage through the ground surface, degradation of transportation assets, saltwater intrusion of inland freshwater/ potable water supplies and capacity reduction of stormwater systems. SLR will eventually overtop and inundate coastal infrastructure if adaptation does not occur.



Sea level rise leads to compound flooding when rainfall, tidal flooding and surge flooding occur simultaneously.

Tidal flooding occurs today in coastal areas with elevations lower than 1.6 feet NAVD. Sea level rise also contributes to groundwater rise, seepage through the ground surface, degrading transportation assets and reducing capacity of stormwater systems. Sea level rise will eventually overtop and inundate coastal infrastructure if adaptation does not occur. Sea level rise also causes saltwater intrusion of inland freshwater/ potable water supplies.

The number of assets exposed to SLR flooding around all four installations increased from 391 under existing conditions, to 442 by 2040 and 507 by 2070. The greatest flood depths occurred during the 2070 NOAA Intermediate High Sea Level Rise scenario and approached 5 feet for the SFOMF, 1 foot for USAG-Miami/SOUTHCOM, 3 feet for HARB, and 3 feet for NASKW. The asset types most exposed to SLR flooding in 2040 and 2070 was marinas (SFOMF), schools (USAG-Miami/SOUTHCOM), stormwater treatment facilities and pump stations and local government facilities (HARB), and communication facilities (NASKW). The SFOMF, HARB and NASKW were affected by this increase in risk over time.

SLR is a major contributor to high risk for the SFOMF and nearly half of its Primary and Secondary Mission Critical assets are vulnerable to SLR by 2040 and 2070. This includes high-risk Primary Mission Critical installation adjacent beachfront and seawalls, which was identified by stakeholders as an experienced concern. SLR proved to be a moderate contributor to high risk for HARB and NASKW, where it results in high-risk shorelines south of the runway. This area of shorelines was identified by stakeholders as a primary concern, based on local experience with recent SLR. The operations of the G-95 Canal near HARB is vulnerable to SLR, which was supported by its classification of high risk and high priority. In general, the sectors of mission critical infrastructure that are at the highest risk to impacts from SLR flooding across all installations include shorelines, wetlands, stormwater treatment facilities and pump stations, and streets.

Because SLR is a gradually occurring phenomenon, it does not result in an acute disaster by itself. When SLR is combined with tidal flooding and precipitation, compounding impacts result in compound flooding. Installations and assets experiencing impacts from two or more flood-related hazards are subject to compound flooding.

Apart from the internal military disaster response teams, the following entities respond to SLR (when compounded with tidal flooding and heavy precipitation) related acute disasters and long-term impacts:

- **Coastal Management Authority:** Develops long-term strategies for managing coastal erosion and SLR impacts.
- **City/County Planning Departments:** Develops land use policies and building codes to address SLR in development.
- **Environmental Agencies:** Monitors and protects coastal ecosystems and habitats affected by SLR.
- **Infrastructure Agencies:** Evaluates and implements measures to protect critical infrastructure from rising sea levels.

Plans to address this hazard include, coastal adaptation plans, local mitigation plans, land use regulations, and shoreline protection plans.

Tidal Flooding

Tidal flooding occurs annually during the fall season for 2 to 9 days per year. Additional tidal flooding events are beginning to occur in spring. Tidal flooding occurs today in coastal areas with elevations lower than 1.6 feet NAVD (NOAA 2022e). The results of the South Florida MIRR indicate that tidal flooding is a major contributor to high risk for three of the four military installations (HARB, NASKW, and SFOMF), with the greatest impacts occurring to water supply lines.

Apart from the internal military disaster response teams, the following entities respond to tidal-flooding-related disasters:

- **Local Emergency Management Agencies (County or State):** Coordinates response efforts and evacuation procedures during tidal flooding.
- **Stormwater Management Departments:** Manages drainage systems and infrastructure to reduce tidal flooding impacts.
- **Community Associations:** Engages with local communities to develop grassroots initiatives for tidal flooding resilience.

Plans to address this hazard include, local mitigation plans, tidal flooding response plans, and water management district's water management plans.

Lightning

Lightning occurs during thunderstorms and hurricanes. In 2019, Florida had 228 lightning events per square mile (Vaisala 2020). Monroe County experiences 12 to 28 lightning strikes per square mile per year and has a 26% annual probability of lightning strikes that cause damage (Monroe County 2021). Lightning can result in injuries to personnel, fires, and damage to power infrastructure, equipment, and vessels.

According to the results of the risk assessment, lightning is a major contributor to high risk for USAG-Miami/SOUTHCOM and significantly contributes to the medium risk determination for the power transmission line between SR 821 and Palmetto Expressway (a Primary Mission Critical Asset). Based on their experience, local stakeholders indicated that this power line and additional lines throughout the area have been impacted and their performance has been interrupted due to lightning. In addition to mission critical power transmission lines, results of the analysis show that Primary and Secondary Mission Critical streets, electric production and supply facilities, solid and hazardous waste facilities, and wastewater treatment facilities and lift stations are infrastructure sectors also at high risk to lightning impacts. Lightning is a moderate contributor to risk for NASKW and the SFOMF.

Apart from the internal military disaster response teams, the following entities respond to lightning-related disasters:

- **National Weather Service:** Provides lightning forecasts and warnings to public safety agencies and the public.
- **Fire Departments:** Responds to fires caused by lightning strikes and conducts prevention and education efforts.
- **Utility Companies:** Monitors power infrastructure for lightning-related outages and damage.

Plans to address this hazard include lightning emergency action plans, emergency communication plans, and the National Weather Service's Model Lightning Emergency Action Plan.

Lightning can result in injuries to personnel, fires, and damage to power infrastructure, equipment and vessels.

In 2019, Florida had 228 lightning events per square mile. Monroe County experiences 12 to 28 lightning strikes per square mile per year and has a 26% annual probability of lightning strikes that cause damage.

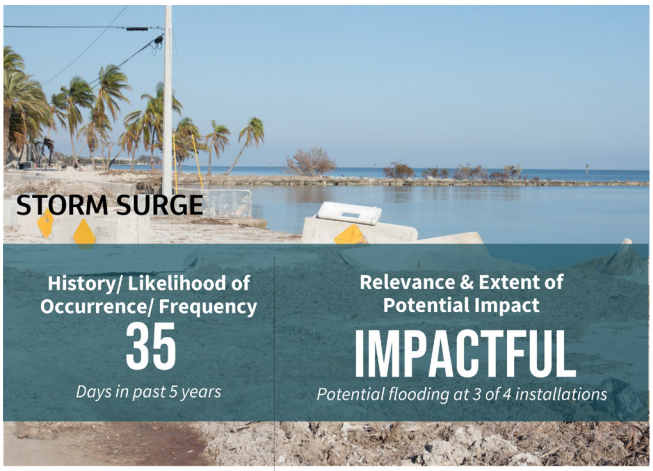
Storm Surge

Storm surge accompanies hurricanes, storms and high wind events resulting in flooding along the coastal area. Storm surge can propagate inland through canals and cause inland flooding. As defined by the National Hurricane Center, storm surge is produced by water being pushed toward the shore by the force of winds moving cyclonically around the storm.

The South Atlantic Coastal Study indicates that surge from a 10-year storm can impact the SFOMF and NASKW, and surge from a 100-year storm can impact HARB (USACE 2021b). Storm surge can cause inland flooding of buildings and roads, structural damage, unmooring of vessels, displaced residents and evacuations. The National Hurricane Center storm surge models predict no surge for the SFOMF and SOUTHCOM and surge depths of less than 3 feet for most of the HARB and NASKW areas during a Category 1 hurricane. As hurricane magnitude increases, surge depths can reach over 9 feet in the project area.

Storm surge associated with various storm categories is a major contributor to high risk for HARB, a minimal contributor to high risk for SFOMF, and not a contributor to high risk for USAG-SOUTHCOM and NASKW. Category 2 through 5 storm surge contributes heavily to HARB's Primary Mission Critical Assets at high risk, which

include the G-95 Canal, SW 288th Street, and SW 312th Street that serves as the major connector road to the local hospital. SFOMF, HARB, and NASKW stakeholders indirectly listed a related impact concern and/or anecdote regarding storm surge. The mission critical infrastructure sectors most at risk to impacts by storm surge across installations include shorelines, streets, wetlands, electric production and supply facilities, and solid and hazardous waste facilities.



As hurricane magnitude increases, surge depths can reach over 9 feet in the project area.

Storm surge can propagate inland through canals and cause inland flooding. According to the National Hurricane Center storm surge is produced by water being pushed toward the shore by the force of winds moving cyclonically around the storm. It is often the greatest threat to life and property from a hurricane event.

Apart from the internal military disaster response teams, the following entities respond to storm-surge-related disasters:

- **FEMA:** Develops hurricane evacuation and response plans.
- **Coastal Management Authority:** Develops and enforces regulations for coastal development and infrastructure.
- **Emergency Medical Services:** Coordinates medical response and care during storm surge events.
- **Marine and Port Authorities:** Manages vessel traffic, port closures, and safety measures for maritime assets.

Plans to address this hazard include local mitigation plans, coastal development plans, storm surge modeling and mapping, and evacuation plans.

Wildfire

Wildfires are generally human caused and can spread to adjacent developed areas. Fire intensity is dependent upon available fuel hazards. Miami-Dade County has a 20% annual probability of wildfires. The annual probability of wildfire in Monroe County is 10% to 100%. Wildfires can consume large areas causing damage to structures and emitting smoke that causes health impacts. Wildfire was not a major contributor to high risk for any of the installations and proved to be a very minimal contributor to high risk for NASKW, the SFOMF, and USAG-Miami/SOUTHCOM. In the risk analysis, U.S. Department of Agriculture (USDA) Forest Service 1992-2015 data was used (USDA 2018). At HARB, wildfire is a moderate contributor to high risk, most significantly impacting a couple of communication facilities.

Apart from the internal military disaster response teams, the following entities respond to wildfire-related disasters:

- **Department of the Interior:** Manages wildfire response for more than 400 million acres of national parks, wildlife refuges and preserves, other public lands, and Indian reservations.
- **USDA's Forest Service:** Responds to all wildfires detected on National Forests and Grasslands.
- **U.S. Fish and Wildlife Service:** The Service's fire management program has three main areas of focus including fuels management, wildfire management, and wildfire prevention.

Future wildfires are expected to increase as more land is developed

Wildfires can consume large areas causing damage to structures and emitting smoke that causes health impacts.

- **Bureau of Land Management:** Public safety is the top priority of the Bureau's Fire Program. Services provided include fire suppression, vegetative fuels management, and community assistance and protection.
- **FEMA:** Provides fire management assistance to state, local, tribal, and territorial governments that helps with mitigation, management, and control of fires.

Plans to address this hazard include wildfire action plans, fire management plans, and community wildlife protection plans.

Extreme Heat

Extreme heat occurs when temperatures are more than 10 degrees above the average high temperature. Average annual high temperatures are between 82°F and 84°F for South Florida (FSU 2022). Excessive heat advisories are issued in South Florida when heat index values exceed 113°F for at least 2 hours. The heat index represents the apparent temperature felt by the human body as temperatures and relative humidity increase.

The last extreme heat event occurred in 2023 (National Weather Service n.d.). The heat index exceeded 105°F more than 22 times in Monroe County over the past two decades. Annually, the heat index in Monroe County exceeds 100°F from 2 to 12 days per year. Climate change is projected to increase the number of days above 95°F by 20 to 30 days over the next 50 years (National Academies of Sciences, Engineering, and Medicine 2018). Based on this historical and projected information, the likelihood of this hazard occurring is highly likely.

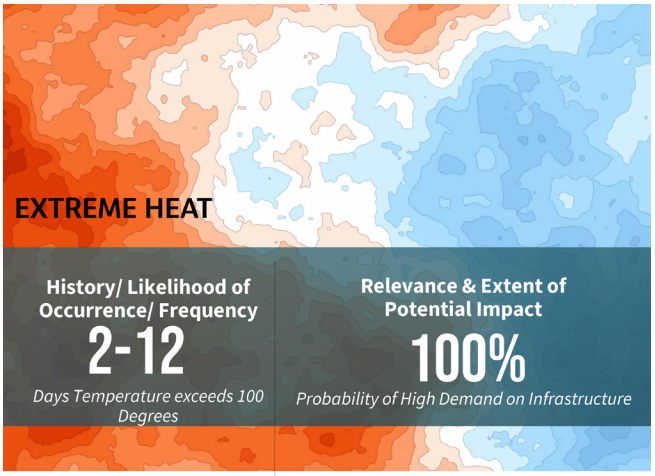
Extreme heat can cause health risks and fatalities for personnel exercising and working outdoors. Extreme heat above 120 °F may damage roads or power cables and degrade military equipment, operations, and training. Extreme heat can lead to higher energy demands that increase potential for power brownouts or disruption.

This hazard is a major contributor to high risk for USAG installation. Some mission supportive streets, stormwater assets, and electric substations among the Secondary Mission Critical Assets are at medium risk to extreme heat.

Apart from the internal military disaster response teams, the following entities respond to extreme-heat-related disasters:

- **Department of Public Health:** Provides public health guidance and information to prevent heat-related illnesses.
- **Local Community Centers:** Serve as cooling centers and aid vulnerable populations during heatwaves.
- **Utility Companies:** Monitor and manage energy demand to prevent heat-induced power outages.
- **Urban Planning Departments:** Implement heat-resilient urban design and green infrastructure projects.

Plans to address this hazard include heat action plans, cooling center management plans, and public health advisories.



Climate change is projected to increase the number of days above 95°F by 20 to 30 days over the next 50 years.

Extreme heat can cause health risks and fatalities for personnel exercising and working outdoors. Extreme heat above 120 °F may cause damage to roads or power cables and degrade military equipment, operations and training. Extreme heat can lead to higher energy demands which increases potential for power brownouts or disruption.

Non-Natural Hazards

Aging infrastructure was assessed as a non-natural hazard. Because some hazards could not be as easily assessed for likelihood of occurrence, stakeholder workshops and interviews provided anecdotal information on the remaining hazards including failure of aging infrastructure, land use change or urban encroachment, and lack of attainable housing or insurance and the

consequential difficulty in retaining or recruiting staff. Each of these hazards was determined likely to occur with significant impact to military installations based on stakeholder input. Table 4-1 displays parcel information for each installation. The parcels with build dates older than 1972 are considered likely aged given the typical building life cycle extends 50 years. As shown in Table 4-1, approximately half or 50% of parcels with build dates in the SFOMF and NASKW study areas are older than 1972. USAG-Miami/SOUTHCOM and HARB study areas are less likely to have aging infrastructure with 28% and 12% of parcels older than 1972, respectively.

Development applications, even within natural areas providing valuable flood management, are expected to continue to South Florida.

Land management is the balance of maintaining and conserving natural infrastructure and compatible use development. Near installations, buffer zones should be established to prevent encroachment and security concerns at the perimeter. Once natural areas are developed, flood management and habitat is lost.

The housing crisis in America is worsening exponentially in South Florida

Lack of affordable housing was listed as a top priority for installations, counties, and cities in South Florida. Exacerbated by rising cost of living, staff are being priced out of the area, creating unmanageable commutes or moving away completely.

Installations and communities are reliant on infrastructure systems that are supplied and maintained by county, city, and private third-party providers

Infrastructure systems continue to expand as the capacity increases, creating both the need for continued maintenance of existing and new assets, and the replacement of components prior to the end of their life cycle.

Table 4-1. Percentage of Likely Aging Infrastructure (County Property Appraiser Data)

Installation	Total Number of Parcels	Parcels with Build Date	Parcels Built In or After 1972	Parcels Built Before 1972	% of Parcels Built Before 1972
SFOMF	79,568	68,688	32,305	36,383	53%
USAG-Miami/SOUTHCOM	124,827	118,580	85,207	33,373	28%
HARB	48,155	42,235	37,244	4,991	12%
NASKW	16,832	13,584	6,945	5,539	49%

Preliminary Risk Matrix

As part of the data collection phase, the preliminary list of 11 threats and hazards that are of concern for the four military installations were evaluated in a simple manner for level of risk (Tables 4-2 and 4-3). Additional hazards exist for some, but not all, of the South Florida military installations. However, these hazards were not evaluated for risk at this point in the project. In the vulnerability assessment, the likelihood of exposure of the assets in each of the military installation's study areas and the potential resulting impacts was assessed in more detail. This task helps to confirm the ranking of the hazard list. The methodology for the initial evaluation of risk was as follows:

- Likelihood of occurrence of risk was assigned a rank of 1 - Unlikely, 2 - Possible, 3 - Likely, or 4 - Highly Likely based on *annual probability of occurrence*. Annual probability of occurrence ranges were less than 1% for unlikely, between 1% and 10% for possible, between 10% and 90% for likely and between 90% and 100% for highly likely.
- **Impact** of hazard was assigned a rank of 1 - Minor through 4 - Catastrophic based on potential damage to asset, extent of impact, or disruption. Minor impacts would include a temporary shutdown and minor damage. Limited impacts would include shutdown for over a day and damage of more than 10% of a site. Critical impacts would include shutdown for more than a week and more than 25% damage of a site. Catastrophic impacts would include shut down for more than 30 days and more than 50% damage of a site.
- **Risk** was calculated by multiplying likelihood rank by impact rank, and then assigned a risk score based on the value: high (16–10), medium (5–9) or low (1–4).

Table 4-2. Risk Matrix

Hazard	Likelihood	Impact	Risk
Severe Thunderstorms and Future Precipitation	4 - Highly Likely	3 - Critical	12 - High
Hurricane	3 - Likely	4 - Catastrophic	12 - High
Tornado and Extreme Wind	3 - Likely	4 - Catastrophic	12 - High
Wildfire	3 - Likely	2 - Limited	6 - Medium
Lightning	3 - Likely	1 - Minor	3 - Low
Extreme Heat	4 - Highly Likely	2 - Limited	8 - Medium
Storm Surge	3 - Likely	3 - Critical	9 - Medium
Sea Level Rise, Tidal Flooding, and Compounding Flooding	3 - Likely	3 - Critical	9 - Medium
Aging Infrastructure	3 - Likely	3 - Critical	9 - Medium
Land Use Change/Encroachment	2 - Possible	2 - Limited	4 - Low
Housing/Staff Retention	3- Likely	3 - Critical	9 - Medium

Table 4-3. Hazards of Concern by Risk Level

Risk Level	Hazard
High	• Extreme Rainfall • Hurricane • Tornado and Extreme Wind
Medium	• Wildfire • Extreme Heat • Storm Surge • Sea Level Rise • Failure of Aging Infrastructure • Housing/Staff Retention
Low	• Lightning • Land Use/Encroachment

Study Area Hazards

South Florida Ocean Measurement Facility

The SFOMF Study Area Asset Map in Appendix C depicts the Dr. Von D. Mizell-Eula Johnson State Park, Port Everglades, the FPL Power Plant, the Fort Lauderdale-Hollywood Airport, Ocean Park, and West Lake Park as landmarks and critical assets to be included in the assessment. Also included are canals, roads (state, county, and local), the USACE Channel, the U.S. Navy Restricted Area, and land use distinctions. Infrastructure in the northern region includes federally owned groins used to maintain updrift beaches, cables, AT&T infrastructure, and the NSU marina. Natural hazards threatening this area include extreme heat and flooding caused by storm surge, king tides, and SLR. More specifically, the context maps depict most of the study area subject to flooding by the 1% annual chance flood and a significant portion of the area (both coastal and inland) subject to SLR flooding under the 2070 NOAA Intermediate High Scenario. Category 1 storm surge flood risk exists along the coastline and Category 3 storm surge risk exists along the intercoastal properties. Last, at a few inland water bodies, king tide flooding also poses as a risk.

U.S. Army Garrison-Miami/SOUTHCOM

Similar to SFOMF hazard context map, the USAG-Miami/SOUTHCOM map depicts most of the study area at risk of flooding by the 1% annual chance flood (Appendix C). According to the map, a significant portion of the facility and the surrounding area fall within urban heat islands and a portion of the facility has a very low wildfire hazard potential. Assets depicted in the context map include a national shelter system facility, sanitary sewer pump stations, gas stations, stormwater infrastructure, and state, county, and local roads. The area is also categorized by education, government/public administration, industrial, and residential land uses.

Homestead Air Reserve Base

The HARB Hazard context map depicts the military base within an area subject to flooding by the 1% annual chance flood, subject to SLR flooding under the 2070 NOAA Intermediate High Scenario, Category 1 hurricane storm surge flooding, and extreme heat (Appendix C). These hazards, in addition to wildfire hazard risk and Category 3 hurricane storm surge flooding, are also seen outside of the base. Most of the study area is currently zoned for residential or conservation purposes, and the extent of the map includes the local hospital, gas stations, hotels, roads, and stormwater infrastructure. Development pressure in South Miami-Dade County is steadily increasing, as it is seen as one of the 'final frontiers' with undeveloped land.

Naval Air Station Key West

The major natural threats facing the NASKW property are SLR flooding (under the 2070 NOAA Intermediate High Scenario), king tide flooding, and Category 3 hurricane storm surge flooding. Along the island, some areas are subject to severe heat. There is a very low risk of wildfires. Areas of shoreline erosion and aging infrastructure are highlighted along the island to indicate current impacts. The NASKW Infrastructure context map displays a variety of critical infrastructure within the island including roads, U.S. Navy wastewater infrastructure, plant sites, fuel tanks, communication centers, schools, shelters, and hospitals and emergency medical services stations (Appendix C).

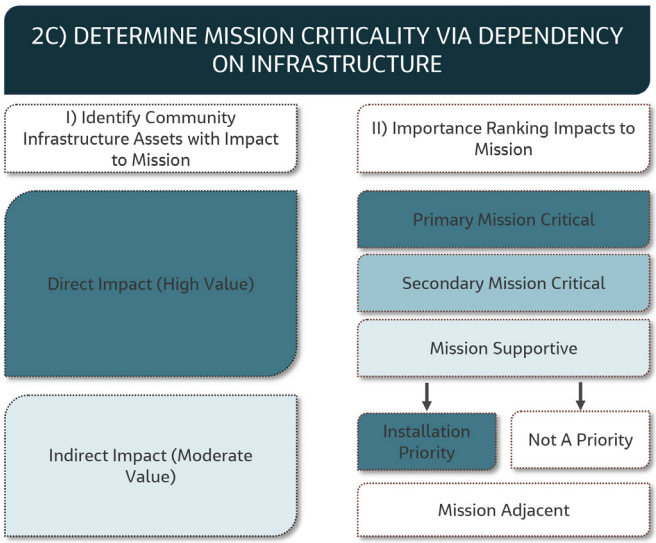
Mission Criticality via Dependency on Infrastructure

Asset Criticality

Asset criticality is a key element of a vulnerability assessment and risk analysis. The determination for criticality is based on those assets, facilities, and systems required to support military installation operations and mission assurance. While many assets and systems may not be considered critical, if critical assets are dependent on them, they too may be considered critical. The DoD uses an agency-wide definition of critical assets delineated in the Defense Critical Infrastructure Program. As part of the broader defense strategy, military installations maintain lists of assets critical for their specific mission(s). These identified critical assets, systems, and services were given priority in the evaluation and prioritization process.

Critical Assets for South Florida Military Installations

Critical assets include assets, systems, networks, and service providers that are vital to the mission of the installations (Table 4-4). The failure, destruction, or disruption of the function of the critical assets would have a debilitating impact on the mission, security, or health and safety of the installation. Data collected and stakeholder interviews were used to determine which assets were critical to each installation. **Several critical asset types were determined to be non-critical for the four military installations of the project.** For example, rail, emergency protection, and cultural and historical assets are not currently in use by the four installations and, therefore, are non-critical.



Adaptation Methodology Step 2C

Data and information regarding the assets' location, ownership, function, existing condition, and dependence on adjacent infrastructure supported further classification of the asset inventory. Reviewing the regional asset inventory spatially supported the identification of assets upon which the operations and mission of the installations were dependent. Information was also collected during stakeholder workshops and interviews on the critical nature of the assets with respect to when the asset needed to be operational, during normal periods (blue sky) and during emergency periods.

The critical assets were then categorized based on their importance to the mission and installation. The categories assigned include Primary Mission Critical, Secondary Mission Critical, Mission Supportive, Additional, and Adjacent (Figure 4-4).

The level of risk that an asset faces was also provided by the vulnerability assessment as either Low, Medium, or High.

Table 4-4. Critical Asset Types for South Florida Military Installations

Asset Type	SFOMF	USAG-Miami/SOUTHCOM	HARB	NASKW
Roads/ Bridges	X	X	X	X
Stormwater	X	X	X	X
Wastewater/ Potable	X	X	X	X
Communication	X	X	X	X
Power	X	X	X	X
Hospitals	X	X	X	X
Police/Fire/ Government	X	X	X	X
Military Installations	X	X	X	X
Waste and Debris Management Sites	X	X	X	X
Affordable/Public Housing	P	X	X	X
Natural Gas/Fuel		X	X	X
Conservation Areas	X	X	P	X
Schools/Education	X	P	P	X
Supply Chain/Vendors	X		P	X
Airport/Port/Marinas	X	X		P
Lodging	X		X	
Shorelines, Channels	X		P	X
Parks	X	X		
Shelters and Centers (Community)				X

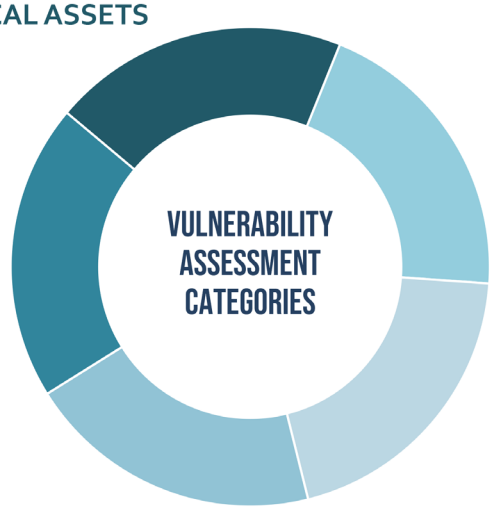
X = *indicates relevance*
P = *indicates probable relevance not verified*

PRIMARY MISSION CRITICAL ASSETS

Assets specifically identified as mission critical by stakeholders and experts

SECONDARY MISSION CRITICAL ASSETS

Utility related
- Electrical infrastructure
- Wastewater facilities
- Drinking water facilities
- Solid and hazardous waste facilities
- Shorelines *(Primary for SFOMF)*
- Streets
- Communication Infrastructure (*primary mission critical for USAG-Miami/SOUTHCOM)*



MISSION SUPPORTIVE ASSETS

Medium and High-risk secondary assets
- Gas stations
- Health care facilities, hospitals, emergency operation centers, emergency medical facilities
- Law enforcement, local government facilities, and state government facilities
- Airports, wetlands, shorelines (adjacent to non-mission critical assets), and non-adjacent streets

ADDITIONAL VULNERABILITIES

Any additional vulnerabilities noted by stakeholders to natural, social, and economic infrastructure, or inside the fenceline

ADJACENT INFRASTRUCTURE

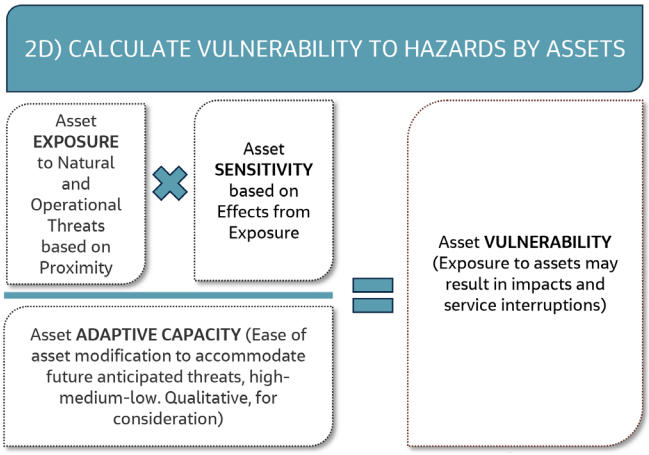
Not relevant to installation but within study area

Figure 4-4. Vulnerability Assessment Categories

Calculate Vulnerability by Assets to Hazards

The vulnerability assessment consisted of three parts, which collectively contributed to the calculation of a value representing the relative vulnerability of an asset in the study area:

- Exposure analysis (mapping proximity of asset to identified hazard, determining value that represents frequency the hazard occurs [for example, frequency of 100-year rainfall event represented by value of 1/100=0.01]).
- Sensitivity analysis (estimating likely impacts or service disruption to asset associated with exposure and assigning value to represent impact [for example, flood depths of 1 inch of flooding were assigned an impact value of 20, whereas 4 feet of flooding was assigned an impact value of 100]).
- Adaptive capacity assessment (flexibility to adapt and/or ability to withstand or ease of hardening or modification to withstand impact based on the existence of local policy or mitigation projects). Adaptive capacity across the region was assumed to be 1 for the study area based on mission relevance.

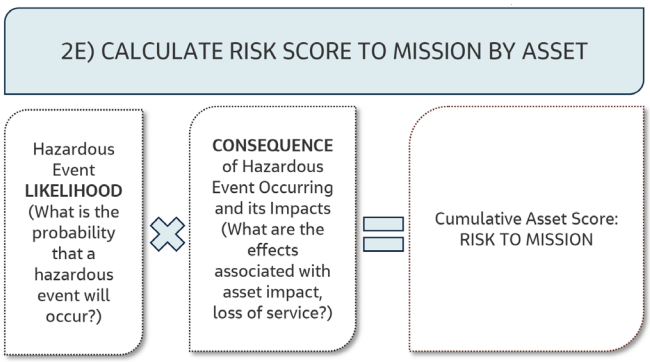


Adaptation Methodology Step 2D

A comprehensive matrix with values was assigned to each asset representing their vulnerability based on the calculation of likelihood of hazard occurrence multiplied by the severity of impact and divided by the adaptive capacity. Maps showing the sensitivity of assets within the focus areas, areas where sensitivities are concentrated, and the locations of the community assets with the highest vulnerability values (top 10% of values) were generated. Not all community assets mapped in the focus areas were relevant to the installations or their individual missions. Further analysis was completed to determine relevance of asset risk to missions.

Analysis of Risk to Mission

Each installation has a specific mission(s) with essential infrastructure onsite to ensure the mission. Through analysis, the critical infrastructure owned and maintained by local governments, state governments, or utilities upon which the onsite military installation infrastructure or operations were connected to, dependent on, or affected by were identified. To categorize the critical infrastructure ("outside the fence") based on relevance to the mission, "Primary Mission Critical Assets" were defined as mission critical by stakeholders and experts, "Secondary Mission Critical Assets" were defined as utility, transportation, and natural infrastructure critical to the mission and installation operations, and "Mission Supportive Assets" were defined as the sites, facilities, and service providers in the community on which the installation relies or uses. To filter results, only the mission supportive assets with vulnerabilities calculated with high and medium values were listed. Through stakeholder engagement and analysis, the primary mission and relevant assets of each installation were identified as noted in Table 4-5.



Adaptation Methodology Step 2E

Table 4-5. Missions and Critical Infrastructure by Installation

Installation	Mission	Onsite Military Installation Mission Critical Asset	Primary Mission Critical Asset Outside Fence	Secondary Mission Critical Asset Sector(s) Outside Fence	Mission Supportive Asset Sector(s)
SFOMF	Communications	Cables to Offshore	Beach Shoreline	Seawall Shoreline, Roads, Utilities	Utilities Not Connected to On-site Mission Critical Asset
USAG-Miami/ SOUTHCOM	Communications	Command Control Communications	Electrical Utilities	Utilities	Roads, Flood Control
HARB	Airfield	Runway	Primary Canal, Main Access Roads	Utilities, Flood Control	Service Road, Communication Utilities, Natural Areas
NASKW	Airfield	Runway	Shoreline Adjacent to Runway	Main Access Road, Other Shorelines, Utilities	Communication Utilities, Fire Station

The vulnerability calculations for each asset in the three categories related to the mission were evaluated to determine the predominant hazard of concern for each asset and the sensitivity of the asset to that hazard to support adaptation strategy development. A vulnerability value or risk score was assigned to each asset and used to analyze the potential risk to the mission. Scenario evaluation and review of anecdotal information was also applied to further qualify the potential risk that failure of the mission critical assets would have on the mission of each installation.