National Park Service
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Natural Resource Stewardship and Science

Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment for Castillo de San Marcos National Monument and Fort Matanzas National Monument

Summary of Results

NPS 343/186743, NPS 347/186743 November 2022

PROGRAM FOR THE STUDY OF DEVELOPED SHORELINES

Western Carolina University

ON THE COVER
Aerial view of terreplein and bastions at Castillo de San Marcos National Monument
Photo credit: NPS

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Program for the Study of Developed Shorelines
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Executive Summary

This document presents the results of the **Coastal Hazards & Sea-Level Rise (SLR) Asset Vulnerability Assessment (VA)** completed by Western Carolina University at Castillo de San Marcos National Monument and Fort Matanzas National Monument (together referred to as CASA-FOMA) in 2021. In this VA, we evaluate the vulnerability (as a combination of exposure and sensitivity) of NPS buildings and transportation assets[1] to identified coastal hazards and climate change factors, approximately to the year 2050 (for full methodology, see Peek et al. 2022).

We assessed 29 buildings/structures (including a visitor center, offices, quarters, battery, moat, and other fortification features) and 20 transportation assets (roads, parking lots, boardwalks, waterfront systems, and a seawall) at CASA-FOMA. One-third (33%) of analyzed assets have high vulnerability to the evaluated coastal hazards and SLR, just over one-third have moderate vulnerability, and one-third (33%) have low vulnerability. None of the assets evaluated have minimal vulnerability. Scoring details and results for all assets evaluated at CASA-FOMA are reported in the provided Excel sheets.

Exposure Results

Exposure is a measure of the character, magnitude, and rate of changes a target may experience (e.g., from the impacts of climate change or a natural hazard influenced by climate change; NPS 2021). In this VA, we evaluate the exposure of each asset to the following coastal hazard indicators: flooding potential, shoreline change, SLR inundation, extreme event flooding, and reported coastal hazards (Table 1).

Table 1. Exposure indicators and hazard data sources used.

Exposure Indicator (Description)	CASA-FOMA Data (Citation)
Flooding potential (1% annual-chance)	Effective FEMA VE & A zones (FEMA 2018)
Shoreline change (coastal proximity)	35-m shoreline proximity buffer (Peek et al. 2022)
SLR inundation (2050)	NPS 8.5 RCP SLR model, 0.25 m rise (Caffrey et al. 2018)
Extreme event flooding (category 3 surge)	NPS storm surge inundation model (Caffrey et al. 2018), NOAA national storm surge hazard maps, cat 2 high tide (Zachry et al. 2015), NOAA 10 ft SLR (NOAA 2020), USACE FEMA 2017 LiDAR (OCM Partners 2022)
Reported coastal hazards (historic flooding)	Questionnaire results & discussions (Peek et al. 2022)

[1] The NPS Facility Management Software System (FMSS) database defines assets as "...a physical structure or grouping of structures, land features, or other tangible property that has a specific service or function, such as a farm, cemetery, campground, marina, or sewage treatment plant. The term 'asset' shall also be applied to movable items, such as vehicles and equipment."

Assets with high exposure are within at least four exposure indicator hazard zones. Assets with moderate exposure are within two or three exposure indicator hazard zones. Assets with low exposure are within only one exposure indicator hazard zone. The asset could still be seriously impacted by this hazard. Assets with minimal exposure are not in any exposure indicator hazard zone. This does not mean that the asset has no exposure to coastal hazards, but it is not within the exposure hazard data used in this study.

The majority (80%) of assets analyzed at CASA-FOMA have either high or moderate exposure to the evaluated coastal hazards (Table 2, and Figures 1-2). Nearly one-third (31%) have high exposure and almost half (49%) have moderate exposure. Six assets (one building/structure and five transportation) at CASA-FOMA are within all evaluated exposure zones, including the FOMA Fort, CASA Seawall, FOMA Waterfront Systems (both Fort and VC side), FOMA Fishing Road, and FOMA Rattlesnake Island Parking. Only 20% of assets have low exposure, all of which are located at FOMA.

Table 2. CASA-FOMA exposure results. Sum of percentages may not equal 100 due to rounding.

	High Exposure		Moderate Exposure		Low Exposure		Minimal Exposure		Total
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
Buildings	6	21%	18	62%	5	17%	0	0%	29
Transportation	9	45%	6	30%	5	25%	0	0%	20
All Assets	15	31%	24	49%	10	20%	0	0%	49

Figure 1. CASA exposure results summary. Only high exposure assets are labeled. Background map is ESRI streaming imagery.

Figure 2. FOMA exposure results summary. Only high exposure assets are labeled. Background map is ESRI streaming imagery.

Sensitivity Results

Sensitivity reflects the degree to which a resource is affected by exposure (NPS 2021). In this VA, we assess the following sensitivity indicators: flood damage potential/elevated, storm resistance and condition, historic damage, and protective engineering. In general, assets with high sensitivity have unfavorable determinations for 3 or 4 of these indicators, moderate-sensitivity assets have unfavorable determinations for 2 indicators, and low-sensitivity assets have unfavorable determinations for 0 or 1 indicator.

Ten assets (20%) analyzed at CASA-FOMA have high sensitivity to coastal hazards and SLR, including the Admin Building and Facility Manager Office at CASA, and the Law Enforcement Office, VC Side Waterfront System, Rattlesnake Island Parking, and both boardwalks at FOMA (Table 3). The majority (59%) of assets have moderate sensitivity, and 20% have low sensitivity.

Almost all assets that are high sensitivity (compared to moderate) have been damaged in the past by coastal flooding. None of the assets at CASA-FOMA are significantly elevated above local ground level and only a small percentage are storm resistant or protected by engineering (e.g., seawalls, bulkheads). Only the FOMA Rattlesnake Island Parking received an unfavorable rating for all sensitivity indicators.

Table 3. CASA-FOMA sensitivity results. Sum of percentages may not equal 100 due to rounding.

	High Sensitivity		Moderate Sensitivity		Low Sensitivity		Total Analyzed	Excluded
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**#**
Buildings	6	21%	13	45%	10	34%	29	0
Transportation	4	20%	16	80%	0	0%	20	0
All Assets	10	20%	29	59%	10	20%	49	0

Vulnerability Results

Vulnerability is a measure of the degree to which park resources and assets are "susceptible to harm from direct and indirect effects of climate change, including variability and extremes" (NPS 2021). In this VA, we evaluate the vulnerability of infrastructure assets as a simple combination of exposure and sensitivity ratings. It should be noted that the vulnerability of any asset can change with time (e.g., due to adaptation actions or the result of geomorphic change).

The vulnerability results for CASA-FOMA are distributed relatively evenly between high, moderate, and low rankings, with approximately one-third of evaluated assets in each category (Table 4, and Figures 3-4). Five assets at FOMA (Law Enforcement Office, Rattlesnake Island Parking, Oceanside and Bayside boardwalks, and VC Side Waterfront Systems) have both high exposure and high sensitivity. The CASA Administration Building, CASA Water Battery, CASA Seawall, FOMA Law Enforcement Office, and FOMA VC Side Waterfront System are the only evaluated assets with high vulnerability and a high asset priority index (API ≥ 70 as reported in FMSS).

Table 4. CASA-FOMA vulnerability results. Sum of percentages may not equal 100 due to rounding.

	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		Total
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
Buildings	7	24%	11	38%	11	38%	0	0%	29
Transportation	9	45%	6	30%	5	25%	0	0%	20
All Assets	16	33%	17	35%	16	33%	0	0%	49

Reducing the vulnerability of assets at CASA will likely need to focus on sensitivity changes. Relocation is unlikely in this area, as non-fortification related assets are already located as far inland as possible within park lands (Figure 3). Many of these buildings could become moderate vulnerability with adaptation or actions such as raising the elevation (the building or ground level), improving the condition/storm resistance, or adding more effective protective engineering. Relocation could be a potential adapation strategy for a number of buildings at FOMA. Several buildings located near the riverfront could be moved further inland to reduce exposure (Figure 4). Elevating assets in the current location (or in a new location) could also reduce sensitivity.

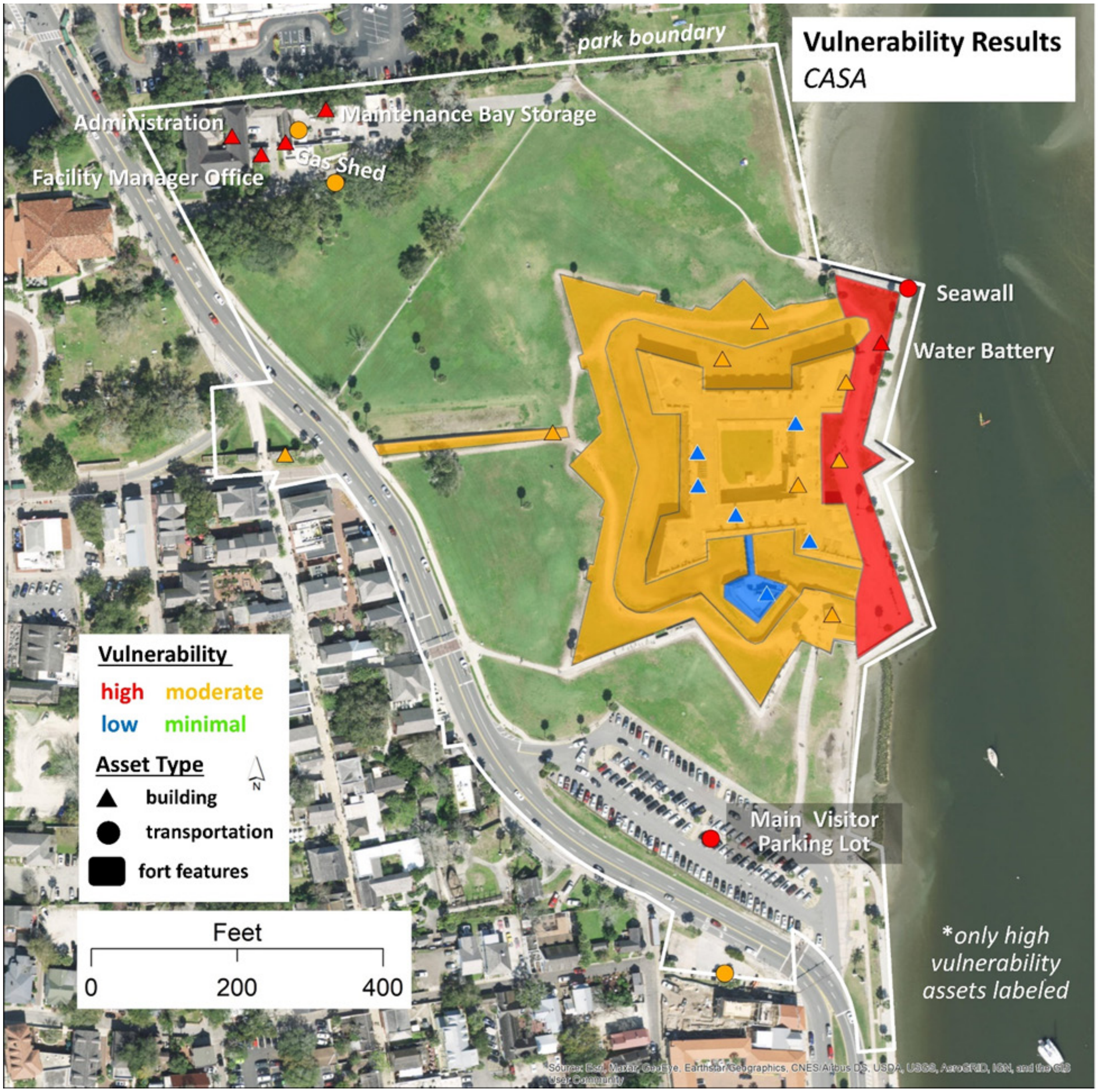

Figure 3. CASA vulnerability results summary. Only high vulnerability assets are labeled. Background is ESRI streaming imagery.

Figure 4. FOMA vulnerability results summary. Only high vulnerability assets are labeled. Background is ESRI streaming imagery.

CASA-FOMA Unique Considerations

Shoreline change: USGS (or other) shoreline erosion rate data are not available for CASA-FOMA, which has non-oceanfront coastlines. As a result, we used a simple coastal proximity buffer of 35 meters, which accommodates an erosion rate up to 1m/year and assumes that infrastructure near the coast is likely to experience multiple coastal hazards within the 35-year (approximately 2050) timeframe of this analysis (see Peek et al. 2022).

SLR data: We used the 2050 8.5 RCP SLR projection (0.25 m rise) and inundation model (Caffrey et al. 2018) developed specifically for NPS units to score exposure for this indicator. However, we also provided alternate scores using the 2100 4.5 SLR projection (0.56 m rise) for comparison (see Peek et al. 2022).

Extreme event flooding data: In most cases, we use storm surge models produced by NPS CCRP (Caffrey et al. 2018) within this protocol; however, these data are poorly mapped in the FOMA area. To evaluate exposure to extreme event flooding for FOMA, we consulted the following datasets: NOAA SLOSH Category 2 high tide inundation model (National Storm Surge Hazard Maps - Version 2; Zachry et al. 2015), NOAA SLR 10 ft inundation zone (NOAA 2020), and USACE FEMA 2017 Post IRMA DEM LiDAR (OCM Partners 2022).

Linear assets: NPS-owned roads and trails at CASA-FOMA were not segmented, as they are relatively short features (< 0.5 miles in length). Therefore, each road or trail has only one score for exposure, sensitivity, and vulnerability. Any statistics or estimates of value represent the entire road, even if only a small portion has high exposure or vulnerability.

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