Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment for the Manhattan Sites

Summary of Results

NPS 665/189833, July 2023

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Program for the Study of Developed Shorelines
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Cullowhee, North Carolina 28723

This document has been developed by the NPS Climate Change Response Program and Park Facilities Management Division in partnership with Western Carolina University through a Task Agreement with the Southern Appalachian Cooperative Ecosystems Studies Unit.

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 African Burial Ground National Monument (AFBG), Castle Clinton National Monument (CACL), Federal Hall National Memorial (FEHA), General Grant National Memorial (GEGR), Governors Island National Monument (GOIS), Hamilton Grange National Memorial (HAGR), Saint Paul's Church National Historic Site (SAPA), and Theodore Roosevelt Birthplace National Historic Site (THRB), together referred to as the Manhattan Sites (MASI), in 2023. 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 44 buildings (including visitor centers, fortifications, fortification related structures, historic structures, memorials, statues, and a church), and 10 transportation assets (roads, parking, a dock, and a moat bridge) at MASI. Over one-third (35%) of assets evaluated have high or moderate vulnerability to the assessed coastal hazards and SLR. Over one-half (59%) have minimal vulnerability. Scoring details and results for all assets 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, extreme event flooding, and reported coastal hazards (Table 1).

Table 1. Exposure indicators and hazard data sources used.

Exposure Indicator (Description)	MASI Data (Citation)
Flooding potential (1% annual-chance)	Preliminary Post-Sandy FEMA VE & A zones (FEMA 2015)
Shoreline change (coastal proximity)	30-m shoreline proximity buffer (Peek et al. 2022)
SLR inundation (2050 proxy) *	NPS 2100 4.5 RCP SLR model; 0.58 m rise (Caffrey et al. 2018)
Extreme event flooding (category 3 surge)	NPS storm surge inundation model (Caffrey et al. 2018)
Reported coastal hazards (historic flooding)	Questionnaire results & discussions (Peek et al. 2022)

*See Unique Considerations

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[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.

Seven assets analyzed at MASI (all at GOIS) have high exposure to the evaluated coastal hazards (Table 2, and Figures 1-2), including Castle Williams and the Visitor Contact Station. Ten assets have moderate exposure, and five have low exposure. The Governors Island Pier Area Docks is the only asset within all exposure zones (Figure 2). Most assets (59%) have minimal exposure, including all assets at AFBG, FEHA, GEGR, HAGR, and THRB.

Table 2. MASI exposure results. Sum of percentages may not equal 100 due to rounding.

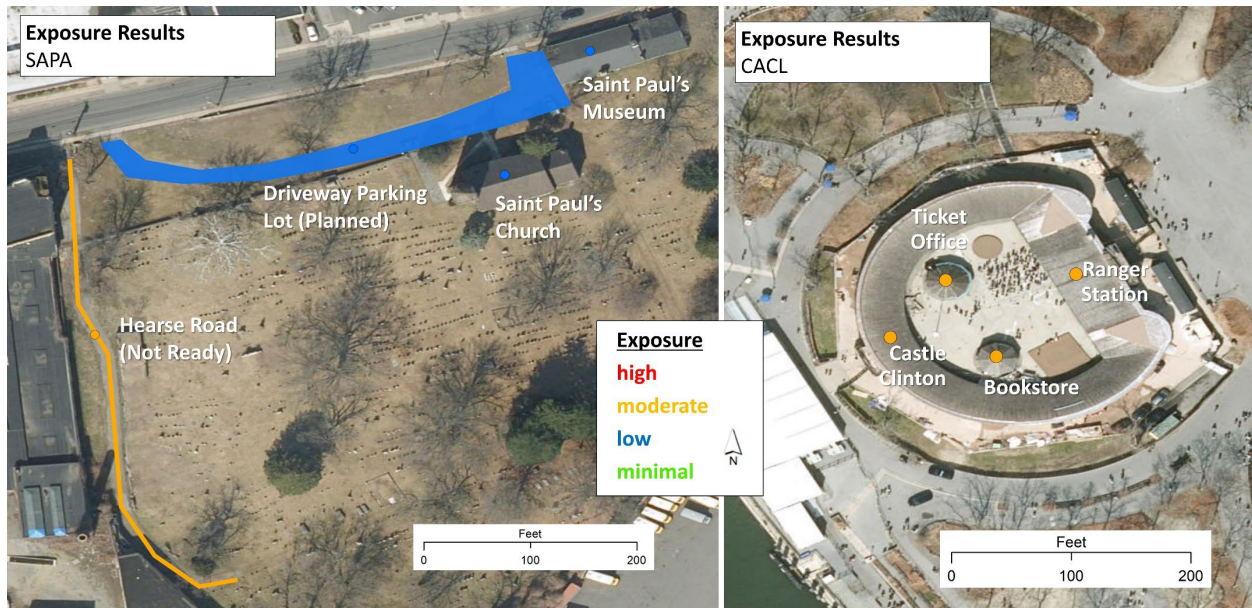| Assets	High exposure		Moderate Exposure		Low Exposure		Minimal Exposure		Total
	#	%	#	%	#	%	#	%	#
Buildings	4	9%	6	14%	4	9%	30	68%	44
Transportation	3	30%	4	40%	1	10%	2	20%	10
All Assets	7	13%	10	19%	5	9%	32	59%	54

Figure 1. Exposure results for SAPA (left) and CACL (right). Parking lots are represented by polygons and roads by lines. Only high exposure assets are labeled. Background map is ESRI streaming imagery.
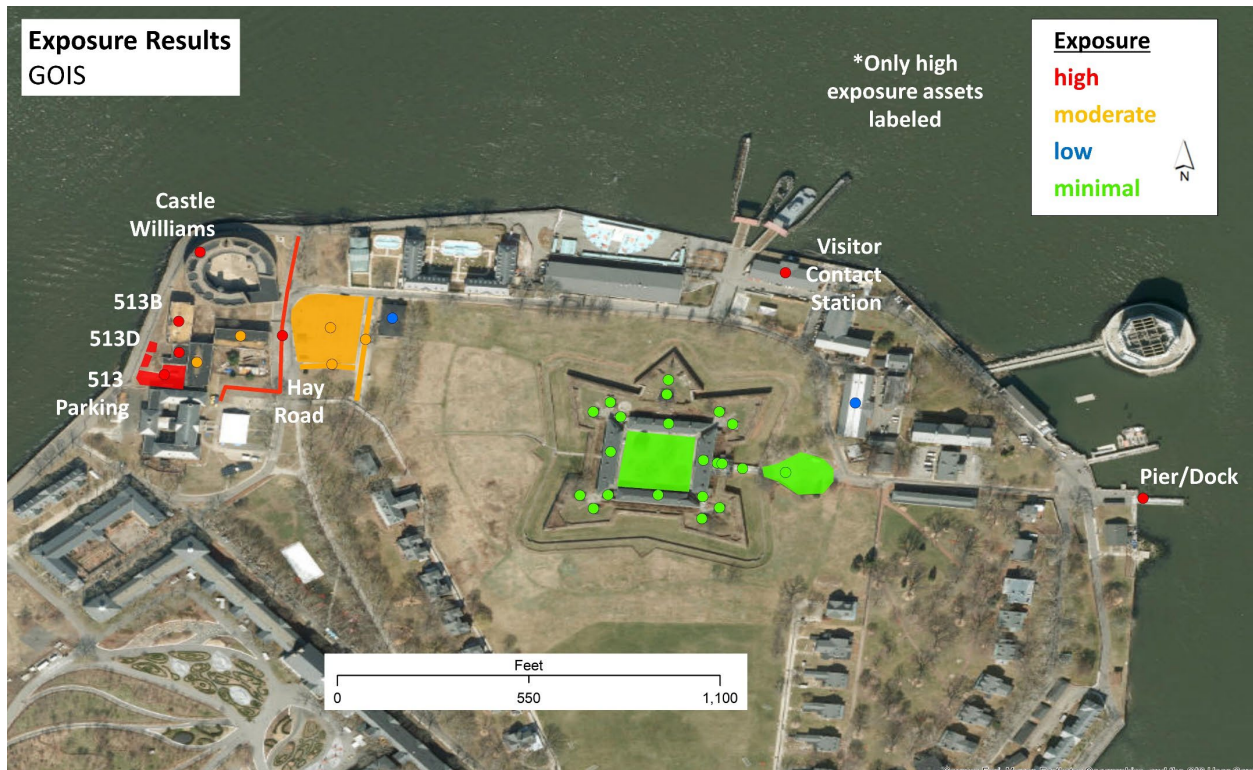
Figure 2. Exposure results for GOIS. Only high exposure assets are labeled. Parking lots are represented by polygons and roads by lines. Background map is ESRI streaming imagery.

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. Assets with minimal exposure are not analyzed for sensitivity (this is the case for 32 assets at MASI). The following sensitivity scores are based on data from a combination of sources, including historic flooding information, aerial imagery, Google Street View imagery, and the Federal Highway Administration (FHWA) Road Inventory Program (RIP) reports (see Unique Considerations).

Six assets analyzed at MASI have high sensitivity to coastal hazards and SLR (Table 3). The majority (64%) of assets have moderate sensitivity, and two have low sensitivity. No assets are significantly elevated above local ground level, and most are not protected by effective engineering (e.g., seawalls, bulkheads). Only one asset has been damaged in the past by coastal floods. The Governors Island Pier Area Docks received an unfavorable rating for all sensitivity indicators.

Table 3. MASI sensitivity results. Sum of percentages may not equal 100 due to rounding.

Assets	High Sensitivity		Moderate Sensitivity		Low Sensitivity		Total Analyzed	Excluded*
	#	%	#	%	#	%	#	#
Buildings	1	7%	11	79%	2	14%	14	30
Transportation	5	63%	3	38%	0	0%	8	2
All Assets	6	27%	14	64%	2	9%	22	32

*Minimal exposure assets were excluded from the sensitivity analysis; total number analyzed is different for sensitivity.

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).

Fifteen percent of assets analyzed at MASI have high vulnerability to the evaluated coastal hazards, 20% have moderate vulnerability, and only 6% have low vulnerability (Table 4). These assets are all located at CACL, GOIS, and SAPA (Figure 3-4). The majority (59%) of assets have minimal vulnerability. Three assets have both high vulnerability and a high asset priority index (API > 70, as reported in FMSS): Governors Island Pier Area Docks and Hay Road at GOIS (Figure 4), and Hearse Road at SAPA (Figure 3). Two moderate vulnerability assets have the highest possible API (100): Castle Clinton and Castle Williams.

Table 4. MASI vulnerability results. Sum of percentages may not equal 100 due to rounding.

Assets	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		Total
	#	%	#	%	#	%	#	%	#
Buildings	2	5%	9	20%	3	7%	30	68%	44
Transportation	6	60%	2	20%	0	0%	2	20%	10
All Assets	8	15%	11	20%	3	6%	32	59%	54

Figure 3. Vulnerability results for SAPA (left) and CACL (right). Parking lots are represented by polygons and roads by lines. Only high exposure assets are labeled. Background map is ESRI streaming imagery.

Figure 4. Vulnerability results for GOIS. Only high exposure assets are labeled. Parking lots are represented by polygons and roads by lines. Background map is ESRI streaming imagery.

MASI Unique Considerations

Shoreline change: United States Geological Survey or other shoreline erosion rate data are not available for the coastlines within MASI. As a result, we used a simple coastal proximity buffer of 30 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 30-year (2050) timeframe of this analysis (Peek et al. 2022).

SLR data: We used the 2100 4.5 Representative Concentration Pathway SLR projections and inundation model from Caffrey et al. (2018) developed specifically for NPS units to score exposure for this indictor (0.58 m rise for MASI). These data are used as a proxy for 2050 SLR to accommodate higher SLR projections recently released by the National Oceanic and Atmospheric Administration (see Peek et al. 2022).

Linear assets: Roads at MASI were not segmented, as most are relatively short features or have a small geographic footprint (e.g., less than 0.5 miles). Therefore, each road has only one score for exposure, sensitivity, and vulnerability. Any statistics or estimates of value represent the entire asset, even if only a small portion has high exposure or vulnerability.

Sensitivity Analysis: Due to staffing capacity issues at the time of this VA, no one at MASI was able to complete the sensitivity questionnaire. We scored sensitivity instead based on a combination of data sources, including historic flooding information, aerial imagery, Google Street View imagery, and the FHWA RIP reports. It would be beneficial to confirm the sensitivity results if appropriate park staff with local knowledge or other data become available.

References

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