National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment for George Washington Birthplace National Monument

Summary of Results

NPS 332/187362, January 2023

PROGRAM FOR THE STUDY OF DEVELOPED SHORELINES

Western Carolina UNIVERSITY

ON THE COVER
The Obelisk at George Washington Birthplace National Monument
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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 George Washington Birthplace National Monument (GEWA) in 2020. 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 34 buildings/structures (including a comfort station, museum, visitor center, offices, maintenance buildings, historic buildings, monument, treatment plants, and a water tower) and 21 transportation assets (roads, parking lots, trails, and a dam) at GEWA. Only 5% of assets analyzed have high vulnerability to the evaluated coastal hazards and SLR, while the majority (76%) have minimal vulnerability. Scoring details and results for all assets evaluated at GEWA 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)	GEWA Data (Citation)
Flooding potential (1% annual-chance)	Effective 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; 0.63 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

[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.

Only two of the assets analyzed at GEWA have high exposure to the evaluated coastal hazards (Nature Trails and Spit Road). Five assets have moderate exposure, and six have low exposure (Table 2, and Figure 1). The majority (76%) of the assets analyzed have minimal exposure. These results are primarily a result of the park's higher elevation areas (most of the park is 15 to 25 feet above sea level) leading to lower exposure overall to coastal flooding and SLR.

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

	High Exposure		Moderate Exposure		Low Exposure		Minimal Exposure		Total
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
Buildings	0	0%	1	3%	3	9%	30	88%	34
Transportation	2	10%	4	19%	3	14%	12	57%	21
All Assets	2	4%	5	9%	6	11%	42	76%	55

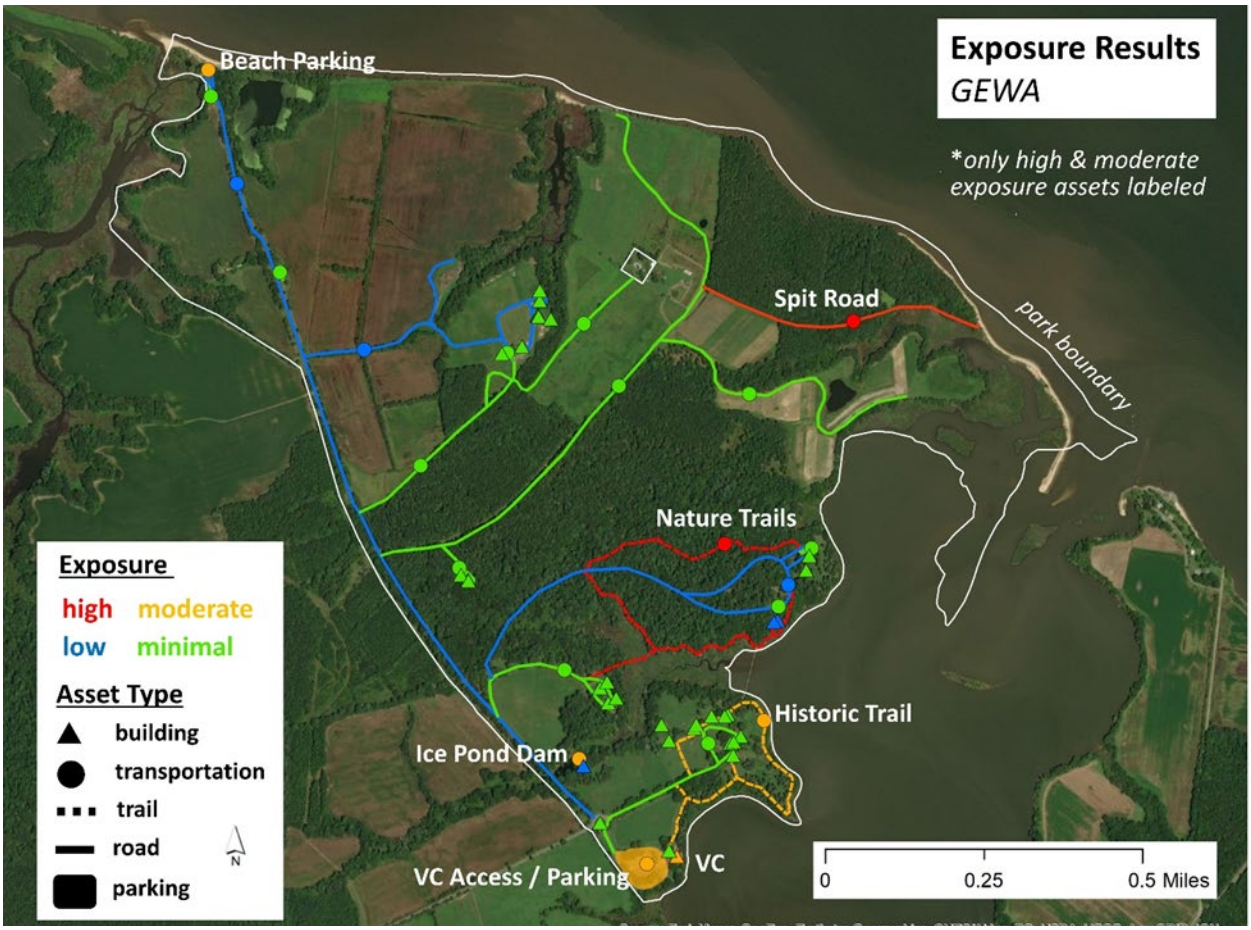

Figure 1. GEWA exposure results summary. Only high and moderate exposure assets are labeled. Background is ESRI streaming imagery.

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 42 assets at GEWA).

Four transportation assets analyzed at GEWA have high sensitivity to coastal hazards and SLR, including the Ice Pond Dam, Beach Road - RT 12 (Bridges Creek Road), Nature Trails, and Spit Road (Table 3). The assets with high sensitivity are not elevated or storm resistant, lack protective engineering, and have been damaged by coastal flooding in the past. Two of these assets (Ice Pond Dam and Spit Road) received an unfavorable rating for all sensitivity indicators. The majority (69%) of assets analyzed have moderate sensitivity, and none have low sensitivity.

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

	High Sensitivity		Moderate Sensitivity		Low Sensitivity		Total Analyzed	Excluded*
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**#**
Buildings	0	0%	4	100%	0	0%	4	30
Transportation	4	44%	5	56%	0	0%	9	12
All Assets	4	31%	9	69%	0	0%	13	42

*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).

The majority (76%) of assets analyzed at GEWA have minimal vulnerability to coastal hazards and SLR (Table 4, and Figure 2). Only three assets have high vulnerability: the Spit Road, Nature Trails, and Ice Pond Dam. Only two assets (Ice Pond Dam and Beach Road) have high or moderate vulnerability and a high asset priority index (API ≥ 70, as reported in FMSS). These results are primarily due to the lower overall exposure to coastal hazards and SLR.

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

	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		Total
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
Buildings	0	0%	1	3%	3	9%	30	88%	34
Transportation	3	14%	4	19%	2	10%	12	57%	21
All Assets	3	5%	5	9%	5	9%	42	76%	55

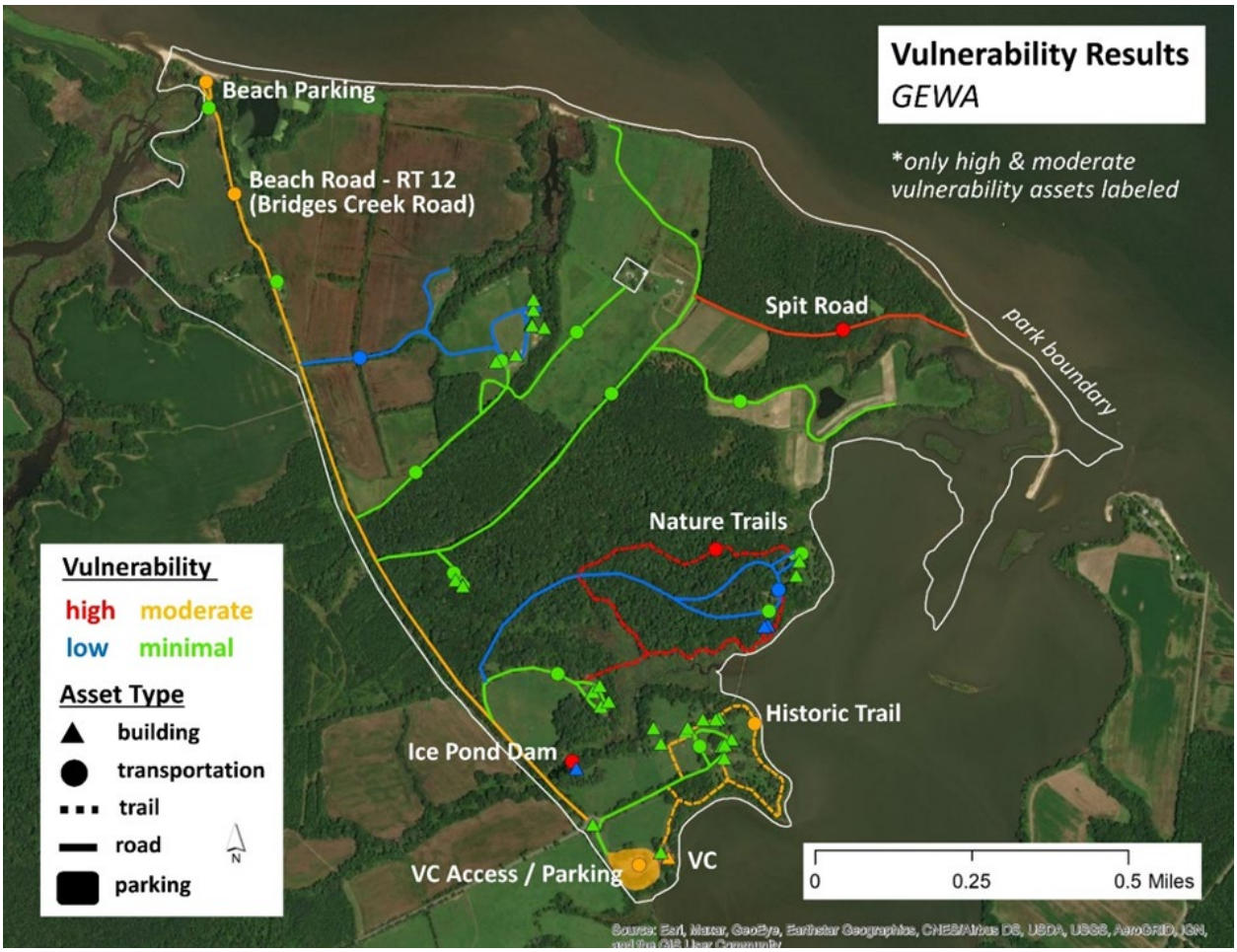

Figure 2. GEWA vulnerability results summary. Only high and moderate vulnerability assets are labeled. Background is ESRI streaming imagery.

GEWA Unique Considerations

Shoreline change: United States Geological Survey (USGS) or other shoreline change rate data are not available for GEWA, which has non-oceanfront coastlines. 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 (approximately 2050) timeframe of this analysis (see 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 indicator (0.63 m rise for GEWA). These data are used as a proxy for 2050 SLR to accommodate higher SLR projections recently released by the National Oceanic Atmospheric Administration (NOAA; see Peek et al. 2022).

Linear assets: Roads and trails at GEWA were not segmented, as most are already relatively short features. 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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