Looking to the Future to Protect the Past: Managing the Effects of Climate Change and Sea Level Rise on Archaeological Sites at Fort Eustis, Newport News, Virginia.

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Introduction

Global climate change poses myriad threats to coastal and riverine cultural heritage, which encompasses a range of categories such as, but by no means limited to, archaeological sites, underwater shipwrecks, historic buildings, paintings, and oral traditions. Perhaps the most pressing threat to tangible cultural heritage such as archaeological sites and historic buildings is erosion resulting from sea level rise, increased tidal range, flooding from increased rainfall, and intensifying storm surges. These erosive forces are increasing the rate of shoreline retreat, undermining buildings and structures, and eroding cultural heritage, a problem that will become more acute over the next few decades. The scope of this problem is international and grows more concerning as climate change intensifies. As Erlandson (2008:168) notes, "if left unchecked, rising seas, accelerated erosion, and larger and more frequent megastorms will destroy many of the world's most important coastal…sites."

A United Nations Educational, Scientific, and Cultural Organization (UNESCO) study of coastal World Heritage Sites estimated that of the 720 cultural and mixed (i.e., cultural and natural) sites listed as of 2014, 136 sites would be directly impacted by sustained sea level rise (2.3 meters per degree of global mean temperature increase) over the next 2,000 years (Marzeion and Levermann 2014). Other studies have underscored the threats to heritage around the world, including a 2015 report by the United States National Park Service (NPS) that noted more than 3,900 NPS assets valued at over $40 billion are highly vulnerable to erosion (Peek et al. 2015). These figures do not include the likely hundreds of thousands of cultural heritage sites, known and unknown, in threatened areas of the United States, let alone globally. These studies, among many others, demonstrate a necessity for effectively planning for climate change impacts to cultural heritage.

Planners and designers of coastal and riverine facilities are increasingly factoring in the potential long-term impacts of climate change to ensure that projects are designed in such a way to protect costly investments. However, impact analyses often focus on the direct effects to cultural heritage resulting from project construction or short-term preservation measures implemented within the first few years of the analysis. If a project is engineered to withstand potential impacts from things such as sea level rise, should not the preservation and mitigation methods for cultural heritage be similarly designed?

The preservation of cultural heritage does not stop at project completion, but must be extended throughout the use-life of a project. The question then becomes, how we can factor the threats from climate change into impact assessment, project planning, and design, to better protect cultural heritage (and other important resources) over the long-term, not just during project construction?

This paper will focus on a case study from a U.S. military installation, Joint Base Langley-Eustis, in Tidewater Virginia. For the study, AECOM assessed 31 threatened archaeological sites, and then made recommendations regarding site significance and long-term planning and mitigation for each site, as appropriate.

Fort Eustis Archaeological Site Management Study

The study of short- and long-term erosion threats to archaeological sites at Fort Eustis used methods that can be applied to other coastal and riverine cultural heritage affected by direct or indirect effects of climate change.

Fort Eustis, part of Joint Base Langley-Eustis, is located on Mulberry Island, technically a peninsula bounded by the Warwick River on the east and the James River on the south and west (Figure 1). Both rivers are tidally influenced, and the James River enters the Chesapeake Bay approximately 30.5 kilometers downstream. Due to Mulberry Island's low elevation, especially the southern two-thirds where most of its known archaeological sites are located, it is extremely vulnerable to the threat of sea level rise and erosion. Currently, dozens of archaeological sites at the base are experiencing erosional damage, including sites where human remains have been found protruding from erosional scarps.

United States federal agencies are subject to Section 110 of the National Historic Preservation Act, the intent of which is to ensure agencies manage the cultural resources on their lands and integrate historic preservation into their overall program goals. This includes establishing preservation programs and ensuring that historic properties under their jurisdiction are sufficiently managed and maintained.

To meet the installation's short- and long-term planning needs and their regulatory obligations, the Fort Eustis Cultural Resources Management Program implemented a study of the effects of shoreline erosion on the 31 threatened archaeological sites. The interdisciplinary study involved archaeologists and coastal engineers from AECOM. The ultimate goals of the study were to provide an evaluation of current and long-term threats to the archaeological sites as well as provide a variety of management options that base planners could implement to protect or mitigate these threats.

The Fort Eustis Cultural Resources Manager identified threatened sites as those being vulnerable to environmental and erosional processes such as rainfall runoff, daily tidal cycles, and storm surges, both in the short- and long-term as exacerbated by global climate change and sea level rise. The study examined the historic, present, and possible future states of erosion for archaeological sites with a focus on severity, rate of destruction, and loss of information in order to develop comprehensive risk assessments and potential management strategies that take into

consideration the spectrum of site types, their prospective research value, potential and active threat statuses, and resource management objectives.

A desktop analysis was first conducted that reviewed existing aerial imagery, erosion analyses, and sea level rise and storm surge inundation projections to evaluate the potential impacts of coastal erosion on the selected archaeological sites. Among the data sets included in the analysis were Virginia Institute of Marine Science coastal data layers (Berman et al. 2012), the United States Army Corps of Engineers' Sea-Level Change Curve Calculator (version 2015.46; Huber and White 2015), and the Federal Emergency Management Agency Flood Insurance Study for the City of Newport News, Virginia (FEMA 2014). A field assessment supplemented the digital data and included the documentation of bank erosion, shore accretion and sediment transport, beach conditions, evidence of human and animal impacts, and archaeological observations, such as eroding artifacts.

Using the digital and field data, a scoring system was established for the project-rated historic erosion rates, shoreline stability, current erosion threats, and future erosion and inundation threats with low and high sea level rise projections within the next 5, 10, 20, and 50 years. The present erosion threat was determined based on the amount of erosion viewed during the field reconnaissance, and the future erosion threat was determined based the high sea level rise scenario and the distance of cultural resources from the shoreline. The wave hazard threat was established based on fetch (the length of water over which wind blows) and exposure to open water. Twenty-nine of the 31 archaeological sites are experiencing on-going erosion, including observed loss of archaeological deposits, with some projected to be completely inundated within 50 years based on high sea level rise projections.

Site-specific erosion mitigation options were developed using information regarding present and future erosion, existing marsh features and other vegetative buffers, wave hazard, and knowledge of available and practical shoreline protection methods. Options provided for each site included a variety of erosion control measures such as oyster reefs, living shorelines, geotextile tubes, and hardening (e.g., rip-rap) alone or combined with archaeological mitigation; no action was recommended for locations with low threat profiles.

In addition to the individual recommendations for archaeological and/or erosion control actions, management recommendations were presented regarding the integration of the site-specific recommendations into the Fort Eustis Cultural Resources Management Program. These recommendations have to be balanced with funding limitations and the larger mission of the installation and the United States Department of Defense, but they give the installation a road map to ensure that the management and protection of its cultural heritage is accounted for as it plans for its future.

This includes refocusing Section 110 efforts to conduct site significance evaluations for sites with a higher risk of eroding due to normal conditions, storm events, and projected sea level rise in order to determine if long-term erosion control measures are necessary. These efforts will be prioritized over site evaluations within low-threat areas that may be buffered from the effects of climate change for decades. Recommendations also included determining where short-term

erosion controls could be implemented to reduce the threat profile while the sites are integrated into a longer-term targeted program to assess their significance.

Recommendations

The methods used in the study are relevant to project-specific impact assessment to ensure the protection, preservation, and/or mitigation of cultural heritage from direct and indirect human or environmental effects resulting from sea level rise or project-related impacts. With more pro-active management and planning, the effects of global climate change and project impacts on coastal and riverine cultural heritage can be reduced, or in some cases eliminated.

Using available data sets, impact assessments can examine how various sea level rise projections in a project area could negatively affect the integrity of cultural heritage that otherwise is not directly impacted by project construction. That information can then be used to provide recommendations for project design that would help ensure cultural heritage can be protected and preserved following project completion. While the accuracy and granularity of available data is globally variable, even the use of simple data such as local topographic conditions and global sea level rise projections can provide useful and actionable information.

In relation to project-related effects, the methods for assessing direct impacts are routine and straight-forward. When it comes to assessing indirect effects, however, the methods are not so clear-cut. Development projects in riverine and coastal environments often result in altered currents, reduced permeable surfaces, wetland destruction, and channelization of drainages, all of which can threaten the long-term preservation of cultural heritage. Assessing indirect cultural heritage impacts requires a more holistic approach, integrating not just proposed engineering designs but also proposed changes to natural resources, such as the removal of vegetation or the planting of vegetative buffers.

Project planners should approach the mitigation of a project's direct and indirect impacts in a systemic sense, looking at impacted resources as a whole and how design and mitigation can positively and negatively affect different resource types, including how a negative for one could be a plus for another and vice versa. The time depth for a resource to feel those effects is also important, as some effects may be compounded over time or exacerbated as sea levels rise.

Modeling water flow and fetch can be used to identify locations where erosion may be increased or diminished, based on different project designs. Hardened construction, like a groin or seawall, can result in increased sedimentation in one area and increased erosion in another. This can have the effect of aiding the preservation of one cultural heritage object but facilitating the destruction of another. Planting shoreline vegetation, such as mangroves, may not only mitigate natural resource destruction from project implementation but also serve a role in preserving cultural heritage. Monitoring programs that last throughout the life-span of a development should be implemented to assess changing impacts to cultural heritage and provide remedies should preservation methods fail.

While global climate change threatens cultural heritage across the world, we can and should take steps to manage and mitigate the effects and we need to acknowledge that impact assessment has

a role and a responsibility in this. Even in our roles as client advocates, we are resource professionals and have an ethical duty to ensure that we are helping preserve important cultural heritage for future generations.

Figures

Figure 1. Project Location.

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