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624

Development of Geodetic Modeling through Unmanned Aircraft Systems to Improve Estimation of Sea-Level at U.S. Navy Installations

Comparison of aerial imagery collected at Port Hueneme, CA. Overhead view of building from satellite imagery (~20 in. resolution, TOP) compared to imagery collected by UAS (~0.63 in. resolution, BOTTOM). Increased resolution will provide more detailed estimates for effective modeling of SLR.

(Photo credit: NAVFAC EXWC UAS Program: Jean Pan, Shea Broussard)

OBJECTIVE

This project will utilize unmanned aircraft systems (UAS) to collect high-resolution data to develop more accurate models of sea level rise (SLR) at Department of Defense (DoN) Environmental Restoration sites.

PROBLEM STATEMENT

SLR poses significant risks to coastal Navy installations, necessitating high-resolution geospatial data for accurate inundation analyses. Due to the complexity of these environments, traditional models using less detailed data may suffice for regional assessments but fall short for specific military sites. High-resolution, geo-rectified imagery collected via UAS can enhance SLR estimates and inform effective mitigation and remediation strategies.

DESCRIPTION

The project team will create a method for estimating mean sea level, mean high water (MHW), and mean higher high water (MHHW) at DoN sites using UAS-collected imagery and traditional tide gauge data.

UAS equipped with a red-green-blue camera and multispectral sensors will be used to collect imagery data at the four sites. Data will be collected at multiple high and low tide events to capture the extent, temporal variation, and interaction of current tidal events within the existing environment. Flight paths will be designed to collect data that allow for 2-D and 3-D modeling and analyses of the environments. Ground control points will be collected during the aerial surveys to assess accuracy of imagery data. Imagery from surveys will be used to produce separate digital elevation models (DEMs) for each imaging system, with multispectral imagery enhancing these models.

Generated DEMs will be correlated with observed tide gauge data at a local scale to determine mean sea level, MHW, and MHHW. By comparing UAS imagery taken at different water levels, both land surface topography and tidal stages can be extrapolated. To improve MHHW estimates, the project team will explore the use of multispectral imagery to identify the

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maximum extent of the high tide water line based on sand moisture and spectral albedo.

After estimating sea levels, DoD Regional Sea Level (DRSL) SLR scenarios will be applied to the topographic model at each site using the estimated mean sea level and MHHW. The data processing steps will be compiled into an ArcGIS toolbox, enabling generation of site-specific sea-level estimates in areas lacking tide gauge data, allowing UAS data to be used for tide stage estimation.

The results of the project will allow for local estimations of mean sea-level and MHW/MHHW and higher resolution imagery that in turn will allow for more accurate estimation of sea level rise at Navy sites.

RETURN ON INVESTMENT

This project's main cost savings will come from reducing the financial impact of sea level rise at U.S. Navy installations. The methodology will provide more accurate seawater inundation estimates, enabling site managers to prioritize remediation at the most vulnerable locations and implement protective measures like seawalls and levees to prevent contaminant spread and infrastructure damage.

The project will help select remedial options adaptable to changing site conditions. While focused on environmental readiness, the models will also benefit infrastructure and public works, broadening the project's impact.

NAVY BENEFITS

Coastal inundation at environmental remediation (ER) sites can damage existing remedies and increase contaminant transport. High-resolution UAS imagery helps the Navy identify areas vulnerable to seawater inundation and assess overlaps with ER sites. This enables more effective strategies, such as constructing barriers or engineering controls, preventing future contamination and remedy damage costs.

The Navy can also factor in expected hydrological and biogeochemical changes in remedy designs, leading to additional cost savings. This project will improve environmental readiness and can be applied to all coastal Navy installations, which make up about 90% of Navy sites, including remote and overseas locations.

TRANSITION DESCRIPTION

Several Navy sites have begun climate adaptation investigations, generating strong interest in this project. The final guidance document, peer-reviewed article, and online training webinar will be shared with Navy end users through relevant working groups.

The project results will be presented to NAVFAC HQ and BRAC leadership. Findings will also be shared at conferences, such as the NAVFAC ER Training, to introduce the ArcGIS toolbox and UAS techniques to end users, including Regional Program Managers.

CONTACT

For more specific information about this project, contact the Principal Investigator, at nicolette.e.andrzejczyk.civ@us.navy.mil

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by Office of the Chief of Naval Operations (OPNAV) Compliance and Mission Readiness Division (N4I1) and managed by the Naval Facilities Engineering Systems Command (NAVFAC) from the Engineering and Expeditionary Warfare Center (EXWC) in Port Hueneme, CA.

The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes and materials; and by filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring fleet readiness.

For more information, visit the program's web site at www.navfac.navy.mil/nesdi
or contact the NESDI Program Managers at NESDI.fct@navy.mil