PROJECT ID:
627

Autonomous Multi-Sensor Coastal Site Monitoring System

UAVs can access coastal sites more efficiently and generate higher quality data for near-shore and coastal site monitoring. (Photo credit: Joshua Garcia; 241024-F-QF982-1008)

OBJECTIVE

This project will demonstrate an autonomous multi-sensor coastal site monitoring system using unmanned autonomous vehicles (UAVs) to remotely sense site conditions and collect reports from unattended, underwater sensors deployed at the site to provide a more complete and accurate report of site conditions that improves natural resources management at reduced cost and risk compared to boots-on-the-ground monitoring approaches.

PROBLEM STATEMENT

More frequent and severe weather events, such as storms, flooding, droughts, and rising sea levels, pose significant risks to both human and natural systems worldwide. In response, the Department of Defense (DoD) has strengthened efforts to address changing environmental conditions through adaptation and mitigation programs, as directed by President Biden's Executive Order 14008. The Navy's "Climate Action 2030" strategy aims to reduce 5 million metric tons of carbon dioxide equivalents (CO_2e) annually through nature-based solutions by 2027. Achieving this target requires effective tools to track and quantify carbon-absorbing habitats like salt marshes and eelgrass.

Monitoring high-value nearshore and submerged lands is complex, and current methods cannot provide the detailed spatial data needed for rapid assessment, management intervention, and carbon accounting.

DESCRIPTION

Autonomous vehicles (AVs) and unattended sensors enable environmental monitoring in remote, hazardous areas, providing rapid data for resource management. UAVs are ideal for nearshore surveys, as they overcome challenges faced by underwater or surface vehicles in shallow waters and intertidal zones. Equipped with aerial sensors, UAVs offer detailed geospatial views of nearshore systems, with data that can be analyzed using remote sensing and spatial analysis tools for quantitative environmental monitoring, supporting landscape change assessments and carbon accounting tools.

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UAV remote sensing will be demonstrated at select Navy sites and will capture key components of high value ecosystems that can be analyzed for aboveground biomass and carbon sequestration potential, fine-scale wetlands mapping, restoration site condition, and ecosystem health. This approach addresses data gaps in current monitoring methods by using targeted collection and analysis of multi-sensor data from airborne electro-optical (EO) sensors and multi-spectral sensors (MSS) combined with in situ sensor data powered conventionally and by microbial fuel cell (BEACONS).

Electro-optical (EO) sensors will create aerial mosaics and 3D terrain models to support vegetation mapping, carbon accounting, and ecosystem health assessments. Multi-spectral sensors (MSS) will analyze vegetation health and submerged aquatic vegetation in salt marsh and/or sea grass habitats. In situ BEACONS and conventional sensors will monitor estuary and nearshore water properties such as temperature, salinity, and pH to track ecosystem processes and landscape change. UAVs will autonomously collect all data, showcasing an integrated monitoring system.

RETURN ON INVESTMENT

The costs of manned coastal surveys and associated analysis/interpretation versus multi-sensor coastal site monitoring system using UAVs cannot yet be conclusively calculated. However, estimates indicate that labor hours associated with manned surveys, data processing and interpretation will be reduced approximately 80% due to the speed of data acquisition and the higher quality data generated from the UAVs.

NAVY BENEFITS

Navy stakeholders will benefit from improved coastal resource management and avoid costs such as habitat restoration where unnecessary. Through this holistic management process, ecosystem health will be enhanced through improved environmental monitoring (real-time sensor data) and costs and processing time will be reduced by optimizing sensor use and data management strategies.

TRANSITION DESCRIPTION

Navy environmental program managers will be engaged throughout the project to fully understand site, monitoring and management needs. At the conclusion of this effort, a guidance document will be shared with Navy end-users through workshops to ensure familiarity with the technologies, workflows, tools and data products to support a smooth final transition.

CONTACT

For more specific information about this project, contact the Principal Investigator, at leslie.a.bolick.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