**Statement of Interest**

**W912HZ-18-SOI-0018**

**Project to be initiated in 2019**

**Project Title: Development and Testing Advancements in Spectral Wave Measurements, and Nearshore Process Methods for Risk-Based Guidance.**

Responses to this Request for Statements of Interest will be used to identify potential investigators for a research and development project to be a funded by the U.S Army Corps of Engineers (USACE) Engineer and Research and Development Center’s Coastal and Hydraulics Laboratory, Vicksburg, MS (ERDC/CHL). This project is expected to last five (5) years.

Approximately $5M is expected to be available to support this project in the first year. Funding for future years (4 option periods) may also be available at an estimated amount of $5M/year for an anticipated total of $25M for this project including base and option years.

**Background:**

The study of surface gravity waves has been an on-going research initiative since the U.S. Army Corps of Engineers (USACE) entered in the field of coastal engineering. Nearly all studies promoted by research activities performed along the US coastline are affected by temporal and spatial variation in the wave climate. Waves are the primary forcing function affecting the USACE’s coastal engineering work and mission. The problem of estimating a wave field in any body of water is extremely challenging. Without a wave monitoring program[[1]](#footnote-1) there would not be any means to perform this evaluation, let alone continue developments in the field of wave modeling. This also holds true to quantify the influence of climate change to assess the risks of future damage to our coastal environment. Research activities in the area of waves are stimulated by measuring waves in diverse environments. For example, we would not know how well our numerical wave models perform or be able to improve those technologies without measurements; we would not know how the wave environment is being affected by climate change; and we would not know the accuracy level in different measurement platforms. Beach and nearshore monitoring is vital to quantify long-term, seasonal, and storm- induced dune, beach, and nearshore environment changes. These data also promote research and development of methodologies essential to the determination of erosion and accretion rates, sand budgets, inlet or entrance shoaling, beach fill requirements, and shoreline impacts of man’s activities and natural events.

Long-term statistical data on physical environmental parameters, stimulates research activities such as the wave climate, erosion and/or accretion rates along the shore, coastal currents, water levels, and the location, quantity, and quality of sand resources, are needed for numerical model revisions and upgrades and for coastal navigation, coastal flood protection, and beach erosion control project planning, design, construction, operation, and maintenance.

**Brief Description of Research:**

In the field of surface gravity wave estimation and research, there is a dire need for data in order to update and improve state-of-the-art wave modeling technologies. The collection of high-resolution directional wave measurements at strategic locations along all US coastal waters is essential to a continued collaborative development and evaluation of state-of-the-art wave modeling technologies that support public, private, and commercial users. High-resolution directional wave measurements are used to assess predictive spectral wave model performance, and are paramount to understanding the mechanisms affecting the temporal and spatial variability in the wave climate. New and innovative techniques are needed to quantify model to measurement errors. Field experiments with multiple buoy systems are needed to perform necessary analysis on wave generation source terms (atmospheric input, nonlinear wave-wave interaction, dissipation, shallow water wave-bottom effects, etc.) and will lead to better wave models and more accurate long-term wave estimates.

In the wave research community (theoretical, modeling, and application), it has been accepted practice to assume wave measurements as being ground truth, or the measurements are exactly what nature produces. Recent evidence has prompted a re-evaluation of this basic premise. A wave buoy containing a sensor actually measures the buoy motion and not the free surface. There are complex mathematical algorithms that convert the buoy response to an estimate of the waves. If the buoy hull (size, composition, shape), super- and sub-structures to the mooring varies, so will the response function. Data gathered as a part of this research will be used to modify and improve existing analytical tools such as the WavEval Tool, new innovative methodologies that need to be developed, and to provide critical guidance to the entire wave modeling community.

With an increased amount of long-term data records available, tracking monthly, annual, and multi-decadal changes in climate variability will be related to large-scale markers such as the Pacific Decadal Oscillation, the North Atlantic Oscillation, and the El Nino Southern Oscillation (PDO, NAO, and ENSO). Long-term measurements seldom are continuous, and occasionally miss storm extremes. New and innovative techniques (RH-Tests for Homogeneity, Neural Network, temporal correlation functions, and geo-statistical interpolation) to fill those gaps are needed in the USACE’s wave climate studies.

New, innovative wave measurement systems such as small drifters could be deployed in areas where moored buoys are unable to perform. Water bodies containing ice (annual development and decay), and persistent currents as in the case of the Florida and Gulf Stream, are areas where drifters could be applicable. It is equally important to ascertain the energy derived from distant storm events originating in the far northwestern Pacific Ocean where moored buoys could not be deployed, and altimeters, despite their resounding success, may not be able to measure extreme significant wave heights in the events. An array of drifters could monitor areas, transmitting real-time directional wave data until its power supply fails.

Waves are the primary energy input into the coastal zone. As they reach shallow water, waves interact with near-coast bathymetry transforming until they break in the surf zone. Surf-zone wave processes drive complex circulation patterns and ultimately result in sediment transport and morphology evolution. In addition, inundation at the shoreline is directly controlled by the transformation of infragravity and sea-swell waves across the surf-zone bathymetry and beach foreshore. Wave-driven setup and run-up can be large during storms and alongshore gradients in wave setup can drive surf-zone flows. The resultant bathymetric and topographic evolution (m’s of vertical change) can be rapid (minutes to days) and vary in space and time over the course of a storm. This morphological evolution is driven by interactions between cross-shore undertow, alongshore currents, and oscillatory incident- and infragravity wave-driven flows to change sediment transport magnitude and direction. While many of the aforementioned wave and hydrodynamic processes are fairly well understood and can be well simulated with state-of-the-art coastal numerical models, the resultant sediment transport is poorly understood. Estimating morphology evolution at longer time scales involves summing over these short-timescales, while including potential changes in wave climate, water level, and sediment supply. Basic research on sediment transport at a range of spatial and temporal scales is needed to drive improvements in the USACE’s ability to properly manage both sediment and risks during coastal storms and over project-relevant (30-year) timescales.

**Public Benefit:**

As research activities are important, serving the public is equally vital to the success of the proposed work. As previously mentioned, wave data collection stimulates wave research. It also serves an equally important role, providing near real-time conditions along the U.S. coastline directly to the public. When posted to the internet, wave observations contain valuable information filling the needs of a large user group. The wave observations are essential for individuals requiring knowledge of existing conditions for planning activities in the coastal area and thus reducing the potential of loss of property and/or life. The benefits based on the dissemination of wave observations would be realized from the recreational boating community, commercial fishing/shipping industries, serving various Federal, State and Local agencies, from early warning (e.g. high surf, increased surge resulting from wave set-up, rip current formation, safely navigating into and out of coastal harbors) to Search and Rescue. Wave data collection will lead to improvements in our wave modeling technologies, provide improved estimates predicting extreme storm events and in-turn better serve the public.

Beach and nearshore monitoring will stimulate research efforts (model development, improvements, and new methodologies) and ultimately serve the public from the results of the investigations leading to impacts on commercial, private, and public usage of US waterways. This includes wave set-up and run-up increasing the storm surge along a coast that would potentially overtop existing berms serving as shore protection. Without the monitoring program and subsequent research, public, private and commercial property in coastal zones would be at increased risk of physical damage, risk to public safety from flooding and long-term erosion. Improved management of sediment and understanding of natural sediment transport processes will allow for the development of sound engineering solutions that work with natural processes as well as decrease risk and costs to coastal populations and our nation during natural disasters.

**Objectives:**

The project has four primary objectives: (1) collect, analyze and archive critical data using innovative methods; (2) evaluate new wave, morphology evolution, and sediment transport observation techniques; (3) execute field experiments using new and proven technologies; and (4) analyze experiment results utilizing (or developing) relevant state-of-the-art numerical models when appropriate. A successful proposal requires a collaborative research and development effort between the vendor and the USACE to conduct scientific research on waves and nearshore processes. In the spirit of the U.S. Coastal Research Program, the USACE encourages wave and nearshore processes research that is both grounded in strong, physics-based analysis at storm through decadal timescales but also recognizes the interdisciplinary nature of the nearshore and emphasizes a systems-based approach to the research, including incorporation of hydrological, geological, biological, ecological, chemical, and sociological processes when relevant. The project will include:

Wave Measurements:

* Central Infrastructure, collection of real-time directional wave observation for sites along all US coasts (including the Great Lakes and US Territorial waters)
  + Monitor all operating buoys 24/7 for consistency, operating in watch circle, battery consumption, bio-fouling, etc. and subject to scheduled/unscheduled visits to the site.
  + Quality Control / Quality Assurance (QA/QC) of acquired data.
  + Posting of the data on local website and transmitted to the National Oceanographic and Atmospheric Administration’s (NOAA) National Data Buoy Center’s (NDBC) data portal. And when applicable, transmitted to other agency websites for further use.
  + Maintain complete local archive of all acquired data, and metadata, and transmit archives to NOAA’s National Centers for Environmental Information (NCEI).
* Field / Local Operations
  + Plan for scheduled maintenance visits to each buoy. Unscheduled visits based on monitoring performed under Acquisition.
  + Trained local field team, planned vessel for deployment/maintenance/recovery.
  + Calibration and refurbishment procedures and facilities.
* Analysis
  + Assessment of temporal/spatial variability of point-source wave measurements.
  + Analysis of long term (decadal) variation in the wave climate.
  + Development of methods and analysis procedures for intra-measurement and directional wave system evaluations.
  + Assessment of wave measurements from drifters: to the Wave Information Study (WIS) and altimeter wave estimates.
  + Development of methods to incorporate wave measurements into wave hindcast estimates.
* Evaluation testing of sensors, systems and observational techniques for the measurement of wind-generated surface gravity waves
  + Expendable wave measurement drifters in active currents (e.g. Florida and Gulf Stream), and ice fields (e.g. Great Lakes, Arctic).
* Execution of field experiments
  + Design, planning and execution of wind-generated surface gravity wave directional wave measurements to evaluate and improve USACE’s discrete spectral wave modeling technologies.

Nearshore Processes Research:

Data Collection

* Collection of long-term large-scale beach and surf-zone morphological data along the southern California coastline.
  + Data should include diverse coastlines where possible (developed, undeveloped, cliffs, inlets, sandy beaches, cobble beaches, etc).
  + Data should include both sub-aerial beach topography and sub-aqueous bathymetry.
  + Data should span long stretches of coastline (10s to 100s of km).
  + Data should be collected frequently enough to quantify relevant changes to the system on storm through decadal timescales.
* Execution of a short-term (1- 3 year) focused field experiment designed to answer specific research questions relevant to improving the state of sediment transport science and prediction of coastal storm risks.
  + The short-term field experiment(s) could be located within an existing large-scale coastal monitoring site, or be located at site(s) with unique characteristics.
  + Short-term field experiment data should also be designed with the testing and evaluating of numerical models in mind.
* Development of new observation techniques to monitor coastal morphodynamics at high spatial and temporal resolution over long periods of time, with a focus on improving observations of morphological evolution and/or sediment transport to match temporal resolution of hydrodynamic observations in natural environments.

Data Analysis

* Analysis of long-term data sets with a focus on improving regional sediment management techniques and predictions of annual to decadal-scale coastal morphology evolution. Operate and maintain an archive for all data collected. Data analysis and scientific findings should be documented in peer-reviewed journal articles and include evaluation of state-of-the art numerical models. Specific topics of interest to USACE include:
  + Needed frequency and magnitude of beach nourishment efforts
  + Geological (or other external) control on sediment supply
  + Exchange between terrestrial and coastal systems (importance of ephemeral inlets, cliffs, riverine inputs, etc)
  + Alongshore variations in long-term erosion/accretion rates
* Analysis of the short-term data set(s) with a focus on improving our basic physics understanding of sediment transport and morphology evolution as well as coastal vulnerability and resilience. Data analysis and scientific findings should be documented in peer-reviewed journal articles and include evaluation of state-of-the art numerical models. Specific topics of interest to USACE include:
  + Dune erosion and growth processes
  + Onshore sediment transport
  + Two-dimensional swash processes & hydrodynamics
  + Surf & swash-zone sediment transport and morphology evolution
  + Berm scarping and foreshore slope evolution
  + Heterogeneous sediment environments
  + Infra-gravity motions
  + Groundwater and coastal flooding

Other Innovative Research:

* Development of other innovative nearshore processes research ideas and methodologies. While the USACE has specific needs relating to beach and surf-zone sediment transport, in the spirit of basic research, the USACE also recognizes that there may be other topics of relevance and interest to navigation, regional sediment management, and coastal storm risk assessment that are not explicitly described above, and encourages submission of option year tasks addressing these needs.

# Tasks by Year: Base Year

* Wave Measurements:
  + **TASK 1:** Central Infrastructure: collection of directional wave data at selected sites along the US coasts including the Great Lakes. This includes monitoring all sites 24/7, QA/QC of real-time records, transmission of data to web site(s) and to NOAA’s NDBC data portal, generation of products, maintaining operational archive (data and metadata), and transmission to NOAA’s NCEI. Refurbishment, pre and post-calibration of buoys and maintenance of records for each buoy.
  + **TASK 2:** Field Operations: scheduled and unscheduled buoy maintenance, on-hand batteries, and moorings available for quick response. Either use existing personnel, or train field teams for distant deployment/examination/recovery of buoys, including vessel acquisition (owned and operated or contracted).
  + **TASK 3:** Analysis:
* **Task 3.1** Assessment of temporal/spatial variability of point-source wave measurements
* **Task 3.2** Analysis of long-term (decadal) variation in the wave climate at multiple measurement sites along the US coastal waters.
* **Task 3.3** Development of methods and analysis procedures for intra-measurement and directional wave system evaluations.
* **Task 3.4** Assessment of wave measurements from drifters and comparison to the WIS hindcast and altimeter wave estimates.
* **Task 3.5** Development of methods to assimilate wave measurements into wave hindcast results.
* Nearshore Processes:
  + **TASK 4**: Long-term Data Collection: collection of long-term, large-scale coastal topography and bathymetry in diverse coastal environments.
  + **TASK 5**: Field Data Collection Methods Development: development, testing, and validation of new field data collection methods to improve our understanding of sediment transport.
  + **TASK 6**: Analysis: analysis of long-term data sets with a focus on regional sediment management and morphology evolution at storm through decadal timescales.
  + **TASK 7**: Short-duration Field Experiments: planning or pilot tests for short-term (1- 3 year) focused field experiment(s) designed to answer specific research questions relevant to improving the state of sediment transport science and prediction of coastal storm risks.
  + **TASK 8**: Other Innovative Research: Development of other innovative nearshore processes research ideas and methodologies.

# Option Year 1

* Wave Measurements:
  + Central Infrastructure to continue Base Year Tasks.
  + Field Operations to continue from Base Year Tasks.
  + Analysis to continue from Base Year Task 3.1-3.5
* **Task 3.6** Initial testing of drifters in ice region (Great Lakes). Deploy (TBD: ~2-4 buoys in Lake Erie)
* Nearshore Processes
  + Long-Term Data Collection to continue Base Year Tasks
  + Field Methods Development to continue Base Year Tasks
  + Analysis to continue from Base Year Tasks
  + Short-Duration Field Experiment: execute follow-on experiment or continue ongoing experiment from Base Year Tasks; initiate analysis
  + Other Innovative Research to initiate or continue from Base Year Tasks

# Option Year 2

* Wave Measurements:
  + Central Infrastructure to continue Base Year Tasks.
  + Field Operations to continue from Base Year Tasks.
  + Analysis to continue from Base and Option Year Tasks 3.1-3.5
* **Task 3.6** Analysis of drifting buoy data recovered from initial deployment, document, and plan for future deployments.
* **Task 3.6** Deploy ~4 drifter buoys off Florida coast (Florida or Gulf Stream Current, or TBD), collect data, and analyze.
* Nearshore Processes
  + Long-Term Data Collection to continue Base Year Tasks.
  + Field Methods Development to continue Base Year Tasks.
  + Analysis to continue from Base Year Tasks.
  + Short-Duration Field Experiment/Analysis: execute follow-on experiment or continue ongoing experiment from prior years; continue analysis.
  + Other Innovative Research to initiate or continue from prior years

# Option Year 3

* Wave Measurements:
  + Central Infrastructure to continue Base Year Tasks.
  + Field Operations to continue from Base Year Tasks.
  + Analysis to continue from Base and Option Year Tasks 3.1-3.5.
* **Task 3.6** Document results from drifter buoys deployed in Florida, Gulf Stream (or TBD) and evaluate to WIS and altimeter wave estimates.
* **Task 3.7** Conduct small-scale field experiment on wind-generated surface gravity wave directional waves used to improve deficiencies found in USACE’s wave modeling technologies.
* Nearshore Processes
  + Long-Term Data Collection to continue Base Year Tasks.
  + Field Methods Development to continue Base Year Tasks.
  + Analysis to continue from Base Year Tasks.
  + Short-Duration Field Experiment/Analysis: execute follow-on experiment or continue ongoing experiment from prior years; continue analysis.
  + Other Innovative Research to initiate or continue from prior years.

# Option Year 4

* Wave Measurements:
  + Central Infrastructure to continue Base Year Tasks.
  + Field Operations to continue from Base Year Tasks.
  + Analysis to continue from Base and Option Year Tasks 3.1-3.5
* **Task 3.7** data analysis, documentation of small-scale field experiment and assessment/modifications to USACE’s discrete spectral wave modeling technologies.
* Nearshore Processes:
  + Long-Term Data Collection to continue Base Year Tasks.
  + Field Methods Development to continue Base Year Tasks.
  + Analysis to continue from Base Year Tasks.
  + Short-Duration Field Experiment/Analysis: finish any ongoing experiments from prior years; complete analysis.
  + Other Innovative Research to complete from prior years tasks if applicable.

# Requirements:

Successful applicants should have expert knowledge and experience handling wave measurement systems (deployment, and recovery). They should also have technical expertise in the field of wave data evaluation, QA/QC, statistical analysis, higher order analysis skills (e.g. Neural Network, EOF, and Canonical Correlation), climate trend analysis, data archiving systems, and dissemination of the data to the public in usable form. Applicants should also have knowledge, experience, and expertise in field data collection, analysis, and numerical modeling of surf-zone morphodynamic processes and strong signal processing skills. Applicants must have an excellent publication record on these topics and have proven experience collecting in-situ and remotely sensed data successfully in the nearshore region.

# Government Furnished Property and Services:

The Government will collaborate with the investigator to identify new wave monitoring sites and protocols, new modeling technologies and data quality measures for wave measurements, and will provide access to the Wave Information Study hindcast archive, WaveEval Tools, and other data/software necessary to perform the stated tasks. The Government will also collaborate with the investigator to develop new field methodologies (e.g. lidar, UAS, in-situ altimetry, etc) to identify appropriate numerical models to evaluate, to share knowledge on data servers, and on data analysis and publication, where appropriate.

# Materials Requested for Statement of Interest/Qualifications:

Please provide the following via e-mail to:

[Robyn.D.Wells@usace.army.mil](mailto:Robyn.D.Wells@usace.army.mil)

(maximum length 2 pages, single spaced 12 pt. font)

1. Name, Organization and Contact Information
2. Brief Statement of Qualifications including:
   1. Biographical Sketch
   2. Relevant past projects and clients with brief description of project
   3. Staff, faculty and students available including area of expertise
   4. Brief description of capabilities to successfully complete this project

Note: a proposed budget is NOT requested at this time.

**Review of Statements Received:** Based on a review of the Statements of Interest received, an investigator or investigators will be invited to prepare a full study proposal. Statements of Interest will be evaluated based on investigators specific experience and capabilities in areas related to the study requirements. Additionally, the evaluation method and selection criteria for research and development awards must be: 1) The technical merits of the proposed research and development; and 2) Potential relationship of the proposed research and development to the USACE missions.

# Please send responses or direct questions to:

Robyn D. Wells

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**Timeline for Review of Statements of Interest:** Review of Statements of Interest will begin after the SOI has been posted on the CESU website for 10 working days.

1. Regulation No. 1110-2-1406 [↑](#footnote-ref-1)