

**Task Agreement P13ACAC00891
Against
Cooperative Agreement
P09AC00212 (formerly H4503090700)
between
The United States Department of the Interior
National Park Service
and
University of Rhode Island**

Project Title: Elevation Mapping of Critical Park Areas for Planning and Post- and Future Storm Evaluation and Modeling

CFDA: 15.945, Cooperative Research and Training Programs – Resources of the National Park System (CESU)

This Task Agreement is entered into by and between the University of Rhode Island and the United States Department of the Interior, National Park Service, hereinafter called “NPS.”

ARTICLE I – BACKGROUND AND OBJECTIVES

Cooperative Agreement Number P09AC00212 (formerly H4503090700) dated June 19, 2009, was entered into by and between the Department of the Interior, National Park Service (NPS), Northeast Region and the University of Rhode Island. The purpose of this cooperative agreement is to support coastal national parks in the Northeast Region of the National Park Service, and Servicewide, by providing research, technical assistance, and education through the cooperative relationship with partners of the North Atlantic Coast Cooperative Ecosystem Studies Unit (CESU), including the University of Rhode Island. Unless otherwise specified herein, the terms and conditions as stated in the Cooperative Agreement will apply to this Task Agreement.

Following Hurricane Sandy in October 2012, it was apparent that the parks along the Northeast coast (Fire Island NS, Gateway NRA and Assateague Island NS) that sustained severe impacts from the hurricane, lack detailed site-specific elevation data and maps for planning and post storm evaluation for many areas. Data that existed, pre-storm would only be useful if post-storm elevation data could be collected and comparisons made in order to better understand storm impacts. Topography and elevation are key parameters that influence many of the physical processes active along the coast, and the measurement and representation of coastal topography in the form of digital elevation models provide important data to address critical issues such as sea-level rise and storm impacts. Depending on the interrelated physical factors, the response of a particular section of the coast, or park in this case, to sea-level rise and storm surge, may be simple inundation, or it may be a more complex response such as, erosion, shoreline retreat, wetland accretion, or dune migration. No matter what the specific response, the geomorphic setting, which is expressed in elevation and

terrain characteristics, is a primary variable that helps determine the vulnerability of coastal landscapes.

Along with sea-level rise and the increase in the number and intensity of storms, park areas will ultimately continue to sustain additional flooding, erosion, and severe storm damage and alteration. As a result, it has become increasingly important for park managers and planners to know what areas of their parks are most vulnerable to intense erosion and/or sustained periods of inundation in order to plan and manage accordingly for the future. In order to identify the most vulnerable park areas, a number of planning, data collection and mapping efforts need to occur.

This project primarily focuses on the collection of high resolution elevation data and inundation modeling in order to create the data infrastructure and technical procedures that will be used in preparing for and responding to future storm events at three National Parks – Fire Island National Seashore (FIIS), Gateway National Recreational Area (GATE), and Assateague Island National Seashore (ASIS).

ARTICLE II – AUTHORITIES

Authorities for this task agreement under Cooperative Agreement **are:**

- Pursuant to 16 U.S.C. Section 1g, the National Park Service may in fiscal year 1997 and thereafter enter into cooperative agreement that involve the transfer of National Park Service appropriated funds to State, local and tribal governments, other public entities, educational institutions, and private nonprofit organizations for the public purpose of carrying out National Park Service programs pursuant to 31 U.S.C. 6305 to carry out public purposes of National Park Service programs.
- Pursuant to 16 U.S.C. Section 1a-2(j), also known as " The Omnibus Parks and Public Lands Management Act of 1996" the National Park Service may "enter into cooperative agreements with public or private educational institutions, States, and their political subdivisions, for the purpose of developing adequate, coordinated, cooperative research and training programs concerning the resources of the National Park System, and, pursuant to any such agreements, to accept from and make available to the cooperator such technical and support staff, financial assistance for mutually agreed upon research projects, supplies and equipment, facilities, and administrative services relating to cooperative research units as the Secretary deems appropriate; except that this paragraph shall not waive any requirements for research projects that are subject to the Federal procurement regulations."
- 16 U.S.C. Section 5933, Cooperative Study Units, authorizes and directs the Secretary to enter into cooperative agreements with colleges and universities, including but not limited to land grants schools, in partnership with other federal and state agencies, to establish cooperative study units to conduct multi-disciplinary research and develop integrated information products on the resources of the national park system, or the large region of which parks are a part.

ARTICLE III – STATEMENT OF WORK

- A. The University of Rhode Island agrees to implement the attached study proposal/work plan (ATTACHMENT A).
- B. The NPS agrees to the tasks presented in ATTACHMENT B.

ARTICLE IV – TERM OF AGREEMENT

This Agreement will become effective upon signature by the NPS Agreements Officer and extend through December 30, 2016.

ARTICLE V – KEY OFFICIALS

The personnel specified below are considered to be essential to ensure maximum coordination and communication between the parties and the work being performed hereunder. Either party, on notice to the other party, may designate another person or persons to act in his/her place for point of contact positions that do not require specific designation.

The NPS Agreements Technical Representative (ATR) will be designated in writing by the Agreements Officer. Authorities and limitations of authority will be explained in the designation letter.

The Cooperator/Recipient may change its Key Officials by notifying the NPS Agreements Officer in writing. The Cooperator/Recipient will address any communication regarding this Agreement to the NPS ATR.

1. For the National Park Service:

Signatory Agreements Officer

NER Agreements Officer
National Park Service
US Custom House
200 Chestnut Street-3rd Floor
Philadelphia, PA 19106
Telephone: 215-597-6476

Agreements Technical Representative

Mary K. Foley
National Park Service, Northeast Region
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Boston, MA 02109
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Telephone: 617-223-5024

Project Technical Contact

Sara Stevens

National Park Service
University of Rhode Island
1 Greenhouse Rd
Kingston, RI 02881
401-874-4548
Sara_stevens@nps.gov

2. For the University of Rhode Island:

Signatory
Mary Kate DeMarco
Director, Office of Sponsored Projects
University of Rhode Island
70 Lower College Rd.
Kingston, RI 02881
401-874-2775
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Principal Investigator
Peter V. August, Ph.D.
Department of Natural Resources Science
University of Rhode Island
Kingston, RI 02881
401-874-4794
pete@edc.uri.edu

ARTICLE VI – AWARD AND PAYMENT

- A. The NPS has approved this project and the following documents have been submitted by the University of Rhode Island prior to award:
1. SF-424, Request for Federal Financial Assistance
 2. SF-424A, Budget Information, Non-construction Programs
 3. SF-424B, Assurances, Non-construction Programs
- Budget Information from the SF-424A is summarized later in this Article.
- B. Financial Assistance: NPS will provide funding to the University of Rhode Island in an amount not to exceed \$820,000 in fiscal year 2013 for the work described in Article III and in accordance with the approved budget. Any award beyond the current fiscal year is subject to availability of funds.

Appropriation Data: The chargeable appropriation for this Task Agreement is
\$820,000 ----FC: PPNENEROJ0 FA: PLCLISD5S.CN0000 WBS: PX.P0195575A.00.1

- C. The University of Rhode Island shall request payment in accordance with the following:

1. **Method of Payment.** Payment will be made by advance and/or reimbursement through the Department of Treasury's ASAP system.
 2. **Requesting Advances.** Requests for advances must be made submitted via the ASAP system. Requests may be submitted as frequently as required to meet the needs of the Cooperator/Recipient to disburse funds for the Federal share of project costs. If feasible, each request should be timed so that payment is received on the same day that the funds are dispersed for direct project costs and/or the proportionate share of any allowable indirect costs. If same-day transfers are not feasible, advance payments must be as close to actual disbursements as administratively feasible.
 3. **Requesting Reimbursement.** Requests for reimbursements must be submitted via the ASAP system. Requests for reimbursement should coincide with normal billing patterns. Each request must be limited to the amount of disbursements made for the Federal share of direct project costs and the proportionate share of allowable indirect costs incurred during that billing period.
 4. **Adjusting payment requests for available cash.** Funds that are available from repayments to, and interest earned on, a revolving fund, program income, rebates, refunds, contract settlements, audit recoveries, credits, discounts, and interest earned on any of those funds must be disbursed before requesting additional cash payments.
 5. **Bank Accounts.** All payments are made through electronic funds transfer to the bank account identified in the U.S Treasury ASAP system by the Cooperator/Recipient.
 6. **Supporting Documents and Agency Approval of Payments.** Additional supporting documentation and prior Agency (NPS) approval of payments may be required when/if a Cooperator/Recipient is determined to be "high risk" or has performance issues. If prior Agency payment approval is in effect for an award, the ASAP system will notify the Cooperator/Recipient when they submit a request for payment. The Recipient must then notify the NPS Awarding Officer identified on the Assistance Agreement that a payment request has been submitted. The NPS Awarding Officer may request additional information from the recipient to support the payment request prior to approving the release of funds, as deemed necessary. The Cooperator/Recipient is required to comply with these requests. Supporting documents may include invoices, copies of contracts, vendor quotes, and other expenditure explanations that justify the reimbursement requests.
- D. Nothing contained in this Agreement will be construed as binding the NPS to expend in any one fiscal year any sum in excess of the appropriation made by Congress or administratively allocated for purposes of this Agreement in that fiscal year.

ARTICLE VII – PRIOR APPROVAL

Provisions as set forth in the Cooperative Agreement shall apply to this Task Agreement.

ARTICLE VIII – LIABILITY

Provisions as set forth in the Cooperative Agreement shall apply to this Task Agreement.

ARTICLE IX – REPORTS AND/OR DELIVERABLES:

- A. **Where to Submit** – In accordance with 43 CFR Part 12, the Cooperator/Recipient will submit reports to the NPS Agreements Officer at the address specified in Article V. The Cooperator/Recipient will also submit a copy of each report to the ATR at the address specified in Article V.
- B. **What and When to Submit** – The Cooperator/Recipient will submit to the NPS the following reports at the specified times:
1. Federal Financial Report (FFR), SF425, submitted quarterly, no more than 30 days after the end of the reporting period. The following reporting period end dates will be used for quarterly reports: 3/31, 6/30, 9/30 or 12/31. Upon completion of the project a final FFR will be submitted no more than 90 days after the final project end date.
 2. FFR reports will be submitted for this agreement for any period of time within the quarterly report period.
 3. Performance Reports - In accordance with 2 CFR 215.51 or OMB Circular A-102, **Cooperator/Recipient** will provide quarterly performance reports describing the accomplishments of the Cooperator/Recipient, the expenses and income of the Cooperator/Recipient, and each entity to which the Cooperator/Recipient made any grant during the fiscal year. Quarterly reports shall be due 30 days after the end of the reporting period. Annual reports shall be due 90 days after the grant year. The final performance report is due 90 days after the end of the award.
- C. **Recordkeeping** – The Cooperator/Recipient will keep records concerning this Agreement in accordance with the requirements of the General Provisions, CFR and applicable Office of Management and Budget Circulars.
- D. The Secretary of the Interior and the Comptroller General of the United States, or their duly authorized representatives, will have access, for the purpose of financial or programmatic review and examination, to any books, documents, papers, and records that are pertinent to the Agreement at all reasonable times during the period of retention in accordance with 2 CFR 215.53 or OMB Circular A102.
- E. **Specific Deliverables**
A list of project deliverables and due dates for this Agreement include:
Objective 1 Deliverables - Pre- and Post Hurricane Sandy Data and Information Needs Assessment
1. Synthesis report of data and information requirements- October 2013

2. Finalization of work plan-December 2013

Objective 2 Deliverables - Park Preparedness for Future Storms

Task 1 - Determination of the Adequacy of Tide Gauge Data for Accurate Measurement of Ocean Elevation

1. Maps of the spatial structure of tidal datums (MHW, MHHW, MLW, MLLW) and mean sea level elevation relative to NAVD88 for each park as well as the estimated accuracy in these elevations- December 2013
2. Report summarizing the methodology and findings, including the discussion of uncertainty in tidal datum elevation and recommended locations of additional tide gauge measurements if needed to achieve the desired datum accuracy-February 2014

Task 2 - Identification of Park-critical Locations for Elevation Measurement and Inundation Modeling

1. Database of Park-critical sites and locations with photos and descriptions- February 2014
2. Maps of prioritized sites and locations-February 2014

Task 3 - Development of Inundation Modeling Protocols and Identification of Their Data Requirements

1. Report outlining a comprehensive modeling approach for each park -September 2014

Task 4 - Reconciliation of Available LiDAR Elevation Data Relative To Mapping and Modeling Needs

1. Ongoing updates to FIIS, GATE, I&M data managers, and Northeast Region GIS Coordinator on planned Federal, State, or other sponsored LiDAR acquisition initiatives.
2. Ongoing updates on information of the accessibility of collected LiDAR data.
3. Ongoing updates on the spatial index of available LiDAR data on online map viewer.

Task 5 - Development of a Communication Plan to Support Park Preparedness and Response to Large Storms

1. Communication plan -August 2015
2. Science “backgrounders” - August 2015

Task 6 - Designing an Online Interactive Web Viewer for FIIS, ASIS, and GATE that is Accessible Publically, Showing Critical Park Areas and Associated Available Data

1. Report on existing viewer technologies - February 2014
2. Conceptual design of online web viewer for ASIS, GATE, and FIIS-August 2014

Objective 3 Deliverables -Creating a State of Storm Preparedness for ASIS, FIIS, and GATE

Task 1 - Creating an Enhanced Elevation Dataset for Parks

1. Gap assessment report- February 2014
2. ArcGIS format point file of precise coordinates and elevations of Park-critical resources-June

2015

3. Tidal monumentation installed to support future tide gauge installation-December 2014
4. Installation of new monummentation based on gap assessment-September 2015

Task 2 - Inundation Model Prototyping at Site and Landscape Scales

1. Final report presenting prototype inundation maps and models-August 2015

Task 3 - Creating an Online Interactive Web Viewer for FIIS, ASIS, and GATE that is Accessible Publically, Showing Critical Park Areas and Associated Available Data

1. Online interactive web-map viewer for each park-February 2015
2. Training manuals for each park-August 2015

ARTICLE X – PROPERTY UTILIZATION

Provisions as set forth in the Cooperative Agreement shall apply to this Task Agreement.

ARTICLE XI – MODIFICATION AND TERMINATION

Provisions as set forth in the Cooperative Agreement shall apply to this Task Agreement.

ARTICLE XII – GENERAL AND SPECIAL PROVISIONS

1. Provisions as set forth in the Cooperative Agreement shall apply to this Task Agreement.
2. **Certifications** – The following certification is required in accordance with the provisions of this Agreement: Certification in Regards to Lobbying, on individual awards made under this Agreement that are \$100,000 or over.

ARTICLE XIII – ATTACHMENTS

The following documents are attached and made part of this Task Agreement:

- A. The University of Rhode Island study proposal and budget, titled “Elevation Mapping of Critical Park Areas for Planning and Post- and Future Storm Evaluation and Modeling”
- B. Statement of work for which the National Park Service agrees to perform.

ARTICLE XIV – SIGNATURES

IN WITNESS WHEREOF, the parties hereto have executed this Cooperative Agreement on the date(s) set forth below:

FOR THE UNIVERSITY OF RHODE ISLAND:

Date

FOR THE NATIONAL PARK SERVICE

Agreements Officer
Northeast Region
Date

ATTACHMENT A: University of Rhode Island Study Proposal

PROPOSAL TITLE: Elevation Mapping of Critical Park Areas for Planning and Post- and Future Storm Evaluation and Modeling

PRINCIPAL INVESTIGATORS: Peter August, Charles LaBash, Michael Bradley, Aimee Mandeville, Sunshine Menezes, David Ullman, and Nathan Vinhateiro

PROJECT GOAL AND MEASURABLE OBJECTIVES: The goal of this project is to create the data infrastructure and technical procedures that will be used in preparing for and responding to storm events at three National Parks – Fire Island National Seashore (FIIS), Gateway National Recreational Area (GATE), and Assateague Island National Seashore (ASIS). We will focus primarily on elevation data and inundation modeling.

To meet this goal, we will accomplish the following objectives:

1. Pre- and Post-Storm Data and Information Needs by the Parks. We will evaluate the availability and resolution of elevation data assets for each of the three Parks prior to Hurricane Sandy (October 2012). Working with Park personnel we will identify what geospatial data processing tasks were done in preparation for and response to Hurricane Sandy. We will identify data or information gaps that hindered the response to Hurricane Sandy and data/information resources that were especially important in responding to the storm. We will pay special attention to elevational data and data required to support inundation modeling and mapping.
2. A Vision for Park Preparedness for Future Storms. Working with Park personnel, we will develop a vision for data and information availability that would be essential in preparing for and responding to future storm events. Our focus will be on elevation data and inundation modeling and we anticipate that the vision will include: (a) a comprehensive inventory of Park locations (key cultural and natural resource areas, historic buildings and other key park infrastructure, and areas of public concern) for which precise elevations are required, (b) Inundation models that describe impact at multiple scales and multiple spatial resolutions for various storm scenarios, and (c) design of a distributed data processing system that is resilient to the loss of IT capacity at one or more Park locations following a storm.
3. Creating an Expanded Level of Storm Preparedness for ASIS, FIIS, and GATE. Based on objectives 1 and 2 above, we will begin developing the data and information infrastructure required of each of the three Parks for planning and responding to significant coastal storms. The Preparedness Plan will include the following elements: (a) assessment of the availability and accuracy of tidal data to support inundation modeling and mapping, (b) precise elevation measurements for specific high-value, high vulnerability park locations, (c) consolidation and accuracy review of existing digital elevation models, especially those based on LiDAR data for the parks, (d) identification of inundation modeling methods and requisite

data that meet Park needs with respect to scale and resolution, and (e) development of a communication plan to support pre-storm planning and post-storm response activities by the Parks.

PROJECT ACTIVITIES:

Objective 1 - Pre- and Post Hurricane Sandy Data and Information Assessment

Task 1 - Needs Assessment

In August 2013, we will work with each of the three Parks in this study (FIIS, GATE, ASIS) to determine data and information that served the Park well in Hurricane Sandy and data and information that were not available but would have been useful in preparing for and responding to the storm. We will accomplish this by having critical park personnel (GIS analysts, resource managers) complete a very short web-survey followed by a visit by URI personnel to the Park to discuss data needs. A synthesis of data and information requirements will be developed and sent to the Parks for review and evaluation. This analysis of needs and data gaps will lay the foundation for the specific elevation data collection, inundation modeling, information system design, and communication planning that will be done for the project.

We will be most interested in learning the following from each of the Parks.

1. Pre-storm Preparedness
 - a. What elevational geospatial data processing and mapping activities were prominent in the pre-storm period?
 - b. What elevational data, information products, and maps were most valuable
 - c. What elevational data, information products, and maps were unavailable but would have been useful
 - d. What were the limitations in pre-storm planning with respect to elevational geospatial data, information, and Maps (personnel, time, specific data, etc.)
 - e. What elevational geospatial resources do Park personnel require to be more effective in planning and preparing for future storms.
2. During the Storm
 - a. What activities dominated park personnel during the storm
 - b. What elevational data, information, and maps were used during the storm
 - c. What elevational data, information, and maps were unavailable but would have been useful.
 - d. What elevational geospatial resources do Park personnel require to be more effective during storm events.
3. Post-Storm Recovery and Damage Assessment

- a. What activities dominated park personnel following the storm
- b. What elevational data, information, and maps were critical following the storm
- c. What elevational data, information, and maps were unavailable but would have been useful following the storm.
- d. What elevational geospatial resources do Park personnel require to be more effective in recovering from large storm events.

Deliverables & Timeline

3. Synthesis report to be provided to the NPS, October 2013
4. Finalization of workplan, December 2013

Responsible Personnel

Peter August
Michael Bradley
Charles LaBash

Objective 2 - A Vision for Park Preparedness for Future Storms

Task 1 - Determination of the Adequacy of Tide Gauge Data for Accurate Measurement of Ocean Elevation

A basic element necessary for maximizing park preparedness is an accurate measure of present sea level with respect to the fixed vertical orthometric datum (e.g., NAVD88) that is used as the reference for vertical elevation data on land. Due to spatial variability in the oceanic tidal response and in non-tidal currents, the vertical height of a particular tidal datum (e.g., Mean Sea Level (MSL) or Mean High Water (MHW)) relative to an orthometric datum is generally not spatially uniform. A major effort by NOAA has provided the VDatum transformation tool that can be used to convert between various vertical datums, as is necessary for example, in merging bathymetric data (relative to Mean Lower Low Water (MLLW)) and elevation data (relative to NAVD88 or an ellipsoidal datum) to produce a digital elevation model. VDatum coverage is available each of the three parks, but an open question at present is whether the accuracy of vertical datum elevation provided by VDatum is sufficient for various management activities in the parks.

Estimates of the maximum uncertainty in a transformation from an ellipsoidal datum to a tidal datum have been made on a regional basis by NOAA, and for the regions along the northeast coast these are in the range of 8-14 cm (NOAA, 2012). However, since these uncertainty estimates pertain to an entire VDatum region and tidal datum elevations vary spatially, it is not *a priori* clear

how well they represent uncertainties within the coastal parks, which are geographically small areas within the VDatum regions. As part of this project, the accuracy of VDatum elevation estimates will be evaluated by comparing with datum elevations derived from observations at all available tide gauge locations within and near the two coastal parks (GATE, FIIS). In consultation with NPS staff, we will assess the (spatially variable) datum accuracy with respect to the accuracy needed for enhanced preparedness. If deficiencies in accuracy are found, we will provide recommendations on where to locate new tide gauge stations in order to provide the necessary improvements to datum control.

In addition to the long-term water level observations at National Water Level Observation Network (NWLON) tide gauges, the VDatum project has made use of measurements at a number of secondary tide gauges in constraining model-derived tidal datums in the various VDatum sub-regions. Highly accurate VDatum elevation estimates (to within the accuracy to which datum elevations are known) are thus expected at these locations. The assessment of VDatum accuracy away from these locations can best be accomplished using tide gauge data that has not been used as a model constraint. The first step in the project will be the identification of all available water level observations within the targeted coastal parks. These will include, in some cases, NOAA tide gauge data that were used to constrain the VDatum tidal datums, but in many parks other data are available. Critical information will include the length of the data record and the presence or absence of surveyed benchmarks at the tide gauge locations.

For each park, datum elevations (relative to NAVD88) will be computed using VDatum on a grid of locations covering the individual park and its immediate environs. These values will be used to produce maps showing the spatial structure of the vertical elevation of the datums as well as the mean tidal range (MHW-MLW). The accuracy of VDatum-derived elevations of tidal datums (MHW, MHHW, MLW, MLLW) and mean sea level will be evaluated by comparing with values derived from observations at all available tide gauge locations within and in the vicinity of each coastal park. In some cases (e.g. non-NOAA tide gauges), datum elevations may need to be computed from the data. This will be performed using the standard methodology used by NOAA for NWLON data, which includes estimates of datum accuracy when computed from short time series (NOAA, 2003).

Deliverables & Timeline

1. Maps of the spatial structure of tidal datums (MHW, MHHW, MLW, MLLW) and mean sea level elevation relative to NAVD88 for each park as well as the estimated accuracy in these elevations. December 2013
2. Report to NPS summarizing the methodology and findings, including the discussion of uncertainty in tidal datum elevation and recommended locations of additional tide gauge measurements if needed to achieve the desired datum accuracy. February 2014

Responsible Personnel

David Ullman

Task 2 - Identification of Park-critical Locations for Elevation Measurement and Inundation Modeling

One of the first steps towards a management plan for hurricane preparedness and resilience is identification of at risk critical resources. Hurricane Sandy provided a new baseline for what might be considered “at risk” or “critical.” Although sentinel sites have been initially identified, we look to expand, review, refine and prioritize these sites as a result of Hurricane Sandy. During the needs assessment phase, we would review and critically examine the list of existing sentinel sites. Afterwards, we would provide a database that would contain baseline information, description, priority rank, condition, location, as well as other information based on input from the needs assessment.

Deliverables & Timeline

1. Database of Park-critical sites and locations with photos and descriptions. February 2014
2. Prioritization of sites and locations for surveying. February 2014
3. Maps of prioritized sites and locations. February 2014
4. Consultation with NGS staff to develop plan for accurate elevation calculations. Ongoing

Responsible Personnel

Michael Bradley
Graduate Student Intern

Task 3 - Development of Inundation Modeling Protocols and Identification of Their Data Requirements

Results of the project scoping meetings in August 2013 will be used to define the specific modeling needs pertaining to storm preparedness and recovery at each park. URI and ASA will then work to reconcile those needs against existing geospatial data, future LiDAR acquisitions, and the enhanced elevation and water level infrastructure proposed herein. The addition of ASA to the project team brings world-renowned expertise in numerical modeling of physical processes, including storm surge, inundation, and sediment transport as well as domain experience in meteorology, oceanography, hydrography, coastal geology, GIS, and software development. The URI-ASA team will leverage this expertise to ensure that data collection tasks support the future modeling needs of the NPS and will guarantee that derivative elevation and tidal data products are easily ingestible by computer models.

In developing the modeling approach, we will meet with NPS and other agencies (USGS, USACE, NOAA) to inventory and obtain digital copies of existing internal data relevant to inundation modeling at the three parks including LiDAR, tidal elevations, nearshore bathymetry, land cover, observed and hindcast wave data, historic storm characteristics, and coastal infrastructure. We will

also work closely with park staff to identify external resource managers, researchers, and local experts who can provide additional knowledge pertaining to data and suggest other sources of relevant existing material. In consultation with NPS, all datasets will be reviewed in a systematic manner. Minimum data quality standards for modeling will be established and each dataset will be evaluated and compared against these standards. Data gaps identified during the data compilation process will be noted for possible future data collection efforts.

The organization, format, resolution, and spatial/temporal coverage of these data will be fundamental to understanding their suitability for pre-storm planning and modeling purposes. We will recommend modeling protocols that accommodate the stated needs of each park, and take into account the available data, the scale and type of inundation, and the range geomorphic environments under investigation. Based on the specific concerns of NPS staff, these will range from "bathtub" flood visualizations to high-resolution ocean circulation models coupled with nearshore, wind-generated wave solutions. Furthermore, we will work closely with USGS Woods Hole geologists (Drs. R. Thieler and E. Lentz) on most suitable modeling methods. USGS has just initiated a review of modeling approaches to support structured decision-making for coastal National Parks and USFWS refuges under the auspices of the Landscape Conservation Cooperative (LCC) program.

Deliverables & Timeline

1. Report outlining a comprehensive modeling approach for each park that identifies the park needs, existing data resources, recommended data requirements, and protocols to model inundation at multiple scales and multiple spatial resolutions. September 2014

Responsible Personnel

Nathan Vinhateiro

Task 4 - Reconciliation of Available LiDAR Elevation Data Relative To Mapping and Modeling Needs

Numerous agencies at the Federal and State levels arrange for routine LiDAR acquisition to meet a variety of agency-driven programmatic objectives. Often, LiDAR data are collected over GATE and FIIS and information about timing, specifications, and data accessibility does not reach park managers in a timely fashion so that adjustments to area of coverage or data specification can be negotiated through buy-up or cost sharing. This is especially critical during a post-storm response period when emergency managers are making rapid decisions about deploying resources and acquiring new remotely-sensed data.

After consultation with resource managers at GATE and FIIS, we will develop a spatial index of available LiDAR data and host this using the online web mapping technology we will develop for this project. We will accomplish this by consulting with the NPS Northeast Region GIS Coordinator,

NPS I&M Data Managers, establishing channels of communication with key Federal and State agencies (e.g., NPS, NOAA, USGS, USACE, FEMA, USFWS, USFS, State GIS-DNR-DOT), multi-agency programs (e.g., NDEP, 3DEP, NEEP, USGS Liaison Network), consortiums (e.g., Northeast LiDAR, State), and NGO's (e.g., TNC, local land trusts and conservancies). We will monitor their activities and remain abreast of new data acquisition initiatives by subscribing to the email distributions; participating in webinars, telecons, and regional/national professional conferences that feature special interest meetings of these groups.

Upon discovery of data gathering missions, we will inform FIIS, GATE, and I&M data managers of impending LiDAR overflights and discuss whether any buy-up or cost-sharing is in order to extend coverage over critical park areas or buy-up of data specification is necessary. Upon acquisition we will track the LiDAR data and ensure they are accessible to FIIS, GATE, I&M data managers, and the FTSC.

Project PI LaBash served in this role for the multi-institutional Northeast LiDAR project, a complex partnership of State, Federal, and NGO organizations.

Deliverables & Timeline

1. Updates to FIIS, GATE, I&M data managers, and Northeast Region GIS Coordinator on planned Federal, State, or other sponsored LiDAR acquisition initiatives. Ongoing
2. Information on accessibility of collected LiDAR data. Ongoing
3. Spatial index of available LiDAR data on online map viewer. Ongoing

Responsible Personnel

Chuck LaBash

Task 5 - Development of a Communication Plan to Support Park Preparedness and Response to Large Storms

In addition to understanding how national parks will be affected by major coastal storms, it is imperative that the parks have the tools to communicate this information to a wide variety of audiences, including park visitors, educators, and decision makers.

Using the information gathered through the initial needs assessment, results of the other project teams, and additional interviews with Park staff, we will develop a comprehensive communication plan for the FIIS, GATE, and ASIS Parks with regard to storm preparedness and response. Led by staff from the University of Rhode Island's (URI) Metcalf Institute for Marine & Environmental Reporting at the URI Graduate School of Oceanography and with additional input from faculty at the URI Harrington School for Communication and Media, this team will work with communication and outreach staff from each park to integrate past approaches that have been especially successful and to improve or exclude any that have been previously shown to be ineffective. Given

the need to reach broad audiences quickly and inexpensively in the times surrounding major storms, special attention will be given to the most effective use of social networking tools and the use of web-based videos to share targeted messages with broad audiences.

As a national leader in improving science communication, Metcalf Institute is a powerful partner in this project. The Institute strives to improve news coverage of science and environmental issues through science immersion programs for journalists and science communication programs for scientists, and regularly integrates topics relevant to this project within its workshops, seminars, and resources for professional journalists. This experience allows us to add an additional element to the communication efforts for this proposal, namely the development of two science backgrounders: 1) describing the use of elevation mapping to plan for and respond to coastal storms and 2) summarizing the project's scientific findings. In addition to making these available through NPS outlets, Metcalf Institute will post the backgrounders on the Resources section of its website and share them with its large network of professional journalists who cover science and environmental stories.

Deliverables & Timeline

1. Communication plan provided to NPS, including (August 2015):

- Pre-, during, and post-storm communication objectives
- Key messages
- Tactics (recommended communication vehicles)
- Projected timeline
- Estimated costs
- Success measures, where applicable

2. Science backgrounders describing the use of elevation mapping to plan for and respond to coastal storms. August 2015

Responsible Personnel

Sunshine Menezes
Graduate Student Intern

Task 6 - Designing an Online Interactive Web Viewer for FIIS, ASIS, and GATE that is Accessible Publically, Showing Critical Park Areas and Associated Available Data

The EDC has considerable experience in designing, implementing, and hosting online web viewers. We have developed viewers using ArcGIS's Java and Flex APIs as well as the ArcGIS.com and Google platforms. Project PI Mandeville teaches an ArcGIS web-mapping class a few times each year and has developed a variety of training aids to teach new users how to operate web-mapping systems.

Web viewers demonstrated themselves to be an important means of consolidating geospatial data during Hurricane Sandy. For example, NOAA made effective use of a web viewer for

disseminating post-hurricane imagery (<http://storms.ngs.noaa.gov/storms/sandy/>). The NOAA SeaSketch viewer was effectively used to disseminate information on post-storm data acquisition (<http://www.seasketch.org/#projecthomepage/510a7b17b64014e92e298ce2>). ESRI has developed a large suite of live-feed data that can be incorporated into web viewers (<http://www.esri.com/services/disaster-response/hurricanes/resources>).

In developing a vision for an online web viewer system for park data, we will review the available suite of viewer architectures (software, hosting system, etc.), identify data that might be made available using web viewer technology as map and feature services, and recommend a design for a Park-specific viewer system for FIIS, ASIS, and GATE. We will present these recommendations to Park personnel and based on their feedback, finalize a design for implementation in Objective 3.

Deliverables & Timeline

1. Report on existing viewer technologies and the data they typically host. February 2014
2. Conceptual design of an online web viewer for ASIS, GATE, and FIIS. August 2014

Responsible Personnel

Aimee Mandeville

Objective 3 - Creating a State of Storm Preparedness for ASIS, FIIS, and GATE

Task 1 - Creating an Enhanced Elevation Dataset for Parks

High accuracy, on-the-ground elevation data, are a critical information resource for National Parks as they plan for the effects associated with sea level rise and climate change. LiDAR data, while comprehensive, have error in the decimeter-scale and a 'best practice' is to verify the LiDAR elevations with on-the-ground measurements. Survey-grade GPS devices regularly achieve cm-level accuracies in real time or through post-processing software. Hurricane Sandy demonstrated that the NPS has critical cultural and natural resources, as well as infrastructure, at low elevations that are at risk for damage or loss from storms.

We will enhance the geospatial framework and infrastructure of the parks impacted by Hurricane Sandy by identifying critical areas at risk (Objective 2, Task 2) and collecting precise elevations for the sites.

Deliverables & Timeline

1. Gap assessment of existing monumentation based on needs assessment. February 2014
2. ArcGIS format point file of precise coordinates and elevations of Park-critical resources. June 2015

3. Based on the assessment of the spatial resolution of the VDatum tool, new tidal monumentation will be installed to support future tide gauge installation. December 2014
4. If necessary, install new monumenation based on gap assessment. September 2015

Responsible Personnel

Mike Bradley

Task 2 - Inundation Model Prototyping at Site and Landscape Scales

The URI-ASA team will use the latest storm surge modeling technology from the research and academic communities to simulate inundation at each NPS property using updated elevation and tidal data. For hurricane-induced flooding, the process will involve selecting and parameterizing source events (i.e., historic or synthetic storms) and performing model simulations of storm surge and resulting inundation at both landscape (park-wide) and site-specific scales. Specific inundation scenarios and locations for study will be determined based on early meetings with park staff and the suitability of input data for the areas of interest. Depending on the spatial scale and requisite data at each park, inundation model prototyping will include:

- a. **Single value surface modeling ("bathtub" modeling).** For each park, we will conduct a series of bathtub inundation scenarios to visualize the impact of: (i) static flood elevations, and (ii) time and/or spatially varying water levels (e.g. storm surge model output). To accommodate each, ASA has developed a series of ArcGIS based scripts that will be used to process gridded elevation data, calculate flooded areas, remove areas of disconnected flooding, handle spatially and time-varying flood predictions, and export results to a variety of formats. The bathtub approach can provide very reasonable approximations of inundation for certain park locales (hardened shorelines, low energy back-barrier environments that may be susceptible to in-place drowning). At other sites, bathtub models will primarily be used as a screening tool to identify areas where hydrodynamic modeling may be advantageous.
- b. **Regional-scale storm surge forecast modeling (SLOSH).** NOAA's SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model will be used to estimate surge elevations and winds resulting from historical, hypothetical, or predicted hurricanes. SLOSH includes a surface wind model, and can simulate overtopping of barrier systems, levees, and roads, flow through barrier gaps, and inland inundation. Although SLOSH lacks some of the physics of more robust circulation models, a major advantage is that it requires very little computational time, meaning that for a given park or area of concern, an ensemble of SLOSH simulations (i.e., thousands of runs) can be performed to examine the effect of slight changes in wind speed, forward speed, radius of winds, track, and landfall on the extent of inundation. Using this approach, we propose to use the SLOSH model to forecast worst-case inundation scenarios and compare those to storm surge inundation from historic events. These simulations will be used for additional screening to help identify park areas where more refined modeling would be of value.
- c. **High-resolution ocean circulation modeling (ADCIRC, ROMS, FVCOM, BFHYDRO, Delft3D).** This class of models provides high-resolution grids, which can be used to more accurately define the coastline and underlying topography, utilize wetting/drying algorithms to account for dynamic changes due to inundation of cells within the computational domain, and

predict inundation levels that include the interaction of storm surge with astronomical tides. In addition, these models can be coupled with spectral wave models (e.g. SWAN, STWAVE) to predict wave-induced water level changes on top of the storm surge. This is a critical consideration for pre-storm planning as waves are responsible for the majority of erosion and inundation on open coast settings, such as the barrier beaches fronting FIIS and ASIS. Because park-wide implementation of numerical modeling at this resolution would be neither cost-effective nor necessary for pre-storm planning we will conduct prototype inundation simulations using one or more of the above models at specific park locations. Results of these simulations will be used to determine the most appropriate methods for future modeling efforts and requisite data that meet park needs with respect to scale and resolution.

Result of the modeling tasks described above will be used to identify and evaluate vulnerable locations within each park. For sites of interest, inundation layers will be combined with the 3D Sketch-Up models of critical facilities derived from LiDAR or survey-grade elevations to create visualizations of predicted flooding at each of the facilities. Outputs can be imported to either Google Earth or ArcGIS, allowing the park staff and visitors to interact with the results and view them from a variety of angles.

Deliverables & Timeline

1. Final report presenting prototype inundation maps and model output for each park and recommendations of data and model requirements that accommodate future studies. August 2015

Responsible Personnel

Nathan Vinhateiro

Task 3 - Creating an Online Interactive Web Viewer for FIIS, ASIS, and GATE that is Accessible Publically, Showing Critical Park Areas and Associated Available Data

In Objective 2 we will develop a conceptual design for an online web viewer for the three Parks. In this phase of the project we will develop the viewer system.

Deliverables & Timeline

1. A fully functional, publically accessible, online interactive web-map viewer for each park showing critical areas along with associated data available. The viewer will contain the tools and functionality agreed upon during the design phase. February 2015
2. A training webinar or onsite training will be held. May 2015
3. Training manuals will be created for each park. August 2015

Responsible Personnel
Aimee Mandeville

BUDGET AND BUDGET EXPLANATION

Start Date: 8/1/13	Man Months	Total Request
A. Personnel		
Michael Bradley, Research Associate Lvl IV	18.5	98,520
Aimee Mandeville, Research Associate Lvl III	4.9	17,819
Charles LaBash, Research Associate Lvl IV	5.2	38,000
Peter August, Professor	3.2	35,383
David Ullman, Research Scientist	5.1	15,000
Hourly Payroll for GIS Technical Support	18.5	73,008
Grad Students MESM, Academic Yr.	12.4	40,000
Grad Student, Scientific Comm., Academic Yr.	6.8	22,000
TOTAL PERSONNEL COSTS		339,730
B. Fringe		
Fringe for Bradley Res Assoc IV@ 48%		47,289
Fringe for Mandeville Res Assoc III@ 35%		6,236
Fringe for LaBash Res Assoc IV@ 48%		18,240
Fringe for Hourly Payroll GIS Technical Support		5,586
TOTAL FRINGE BENEFITS		77,351
C. Equipment		
Trimble R8/R10 GPS receiver		26,366
Trimble R8/R10 GPS tripod, laser leveler, and logging system		6,009
TOTAL EQUIPMENT		32,375
D. Travel		
Vehicle mileage RI-GATE/FIIS/ASIS (6 trips/park)		4,417
Travel per diem for Park visits (6 trips, 2 people, 2 days/trip)		19,272
Administrative travel NPS Offices in Boston, Philadelphia (2 trips, 2 people, 2 days)		2,072
GIS Conference (NEARC New England, esri UC California)		6,688
TOTAL TRAVEL		32,449
E. SUPPLIES		
GPS software, Trimble Business Office upgrade		2,070

Geodetic monumentation supplies (steel rods, brass discs, PVC tubing, cement, filtered sand, lubricant)		11,930
TOTAL SUPPLIES		14,000
F. OTHER COSTS		
EDC Computing Costs (includes GIS software, computing workstations, data backup services, security infrastructure, GPS equipment)		75,456
Sub-award (Vinhateiro)		149,942
TOTAL OTHER COSTS		225,398
TOTAL DIRECT COSTS		721,303
TOTAL MODIFIED DIRECT COSTS		563,986
FACILITIES AND ADMINISTRATIVE COSTS 0% MTDC		98,697
TOTAL REQUESTED FROM AGENCY		<u>\$ 820,000</u>

Budget Notes

Personnel consist of salaries and benefits for Michael Bradley, Charles LaBash, Aimee Mandeville, Peter August, Sunshine Menezes, David Ullman, and graduate student assistants. We will use M.S.-level students (academic year) from the GIS and remote sensing track from the CELS MESM program to assist in this project.

Equipment consists of a Trimble R8/R10 GPS receiver, supporting tripods, data collectors, and laser level accessory that will be used to collect cm-accurate elevation data.

Travel consists of URI travel to the three parks and includes mileage, per diem, and hotel costs. We anticipate three trips to each park over the course of the project with each trip spanning 3 days. Per diem rates from federal guidelines and auto mileage computed at \$0.55/mile. Also included is travel to the ArcGIS users conferences for the northeast US (NEARC) and national/international (San Diego, CA) communities to present the results of our work and to gain advanced training in elevation mapping and modeling.

EDC computing costs are based on 2 FTE seats. EDC costs include GIS software, access to desktop computers, disk storage space, data backups, network security, and use of EDC printers and plotters.

Sub-award is for Applied Science Associates to cover the cost of their modeling team and Dr. Nathan Vinhateiro (adjunct faculty CELS NRS) serving as liaison.

Indirect Costs are computed at the CESU rate of 17.5%

ATTACHMENT B

The National Park Service agrees to:

- The NPS assigns a Northeast Coastal and Barrier Network (NCBN) Program Manager as the Science Technical Advisor on this project. The Program Manager and the NCBN Data Manager will actively collaborate with the University of Rhode Island investigator, research associates, graduate students and under graduate interns on the project design, data collection, and data interpretation, and production of final deliverables including data formats.
- NPS NCBN and associated parks will provide the cooperator with all relevant GIS data sets and elevation monitoring data that may be important to the study.
- During visits to the parks for data collection, logistical support will be provided, including access and potential assistance with field surveys by both Park and NCBN staff.
- Temporary park housing will be provided on Fire Island National Seashore, Gateway NRA and Assateague Island NS, as available, for the University of Rhode Island researchers as needed.
- The NCBN Sediment Elevation Monitoring Program Lead, Jim Lynch, will provide guidance and expertise on RTK and leveling equipment and will provide expertise and assistance on field visit to the parks.