Prospectus for Synthesis and Assessment Product 4.1

Coastal Elevations and Sensitivity to Sea level Rise

Lead Agencies: USEPA, NOAA, USGS
Supporting Agencies: U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Federal Emergency Management Agency, DOE, NASA

1. Overview: Description of Topic, Audience, Intended Use, and Questions to be Addressed

Studies over the last two decades have identified numerous decisions that may be sensitive to sea level rise (e.g. NRC 1987; Williams et al. 1995; Section 3.1 of Titus and Narayanan 1996.) To inform those decisions, better information about the implications of sea level rise is needed at various scales. For analyzing national decisions (e.g., incorporating shoreline retreat into flood insurance or wetland protection programs), nationwide estimates are important, perhaps with a state-by-state breakdown. Shore-protection and land-use decisions, by contrast, are mostly made at the local level or on a parcel-specific basis; those decisions require maps that show site-specific implications. Researchers may require fine-scale maps for process-specific analysis and coarse-scale data for analyzing broader implications.

During the 1980s and 1990s, quantitative assessments of the implications of sea level rise generally proceeded on two independent tracks to meet the very different needs of national (Park et al. 1989; Leatherman 1989; Weggel et al. 1989; FEMA 1991; Titus et al. 1991; Gornitz and White, 1992; Yohe et al. 1996) and state or local (Kana et al. 1984; Leatherman 1985; State of Maine 1995, Kearney and Stevenson 1985) decision makers. The evolution of geographic information systems (GIS), however, now makes it more feasible to use the same information for a variety of purposes. GIS systems also make it easier to develop information that can be useful for a variety of scales (Kemelis et al. 2003).

The recent advances do not, however, imply that all of the implications of a rising sea are well understood. The effects of sea level rise include tidal inundation of low lying areas; coastal erosion of wetlands, beaches, and other types of shores; vertical accretion of wetlands; increased coastal flooding during storm surges and periods of extreme rainfall; and increased salinity of aquifers and estuaries, especially during droughts. Providing maps that predict effects other than tidal inundation is scientifically challenging at best, and in many cases, impossible. The literature may provide the basis for a qualitative prediction, but not always with the precision--or in the form--that decision makers require.

Many agencies and individuals are developing data that can provide insights regarding the implications of sea level rise. For example, the Federal Emergency Management Agency (FEMA), the Army Corps of Engineers, and several states are developing elevation data for floodplain management. The National Oceanic and Atmospheric Administration (NOAA) and USGS are developing Digital Elevation Models (DEMs) that use a common vertical reference frame for both topographic and bathymetric maps (NOAA , 2004). Local governments and major coastal conservancies are developing GIS land-use data for managing ecosystems and economic growth. U.S. Fish and Wildlife Service (USFWS) develops wetland data. NOAA's coastal change analysis program periodically provides a comprehensive assessment of vegetation changes in the coastal zone of the United States. The U.S. Geological Survey (USGS) collects high resolution LIDAR elevation data for coastal areas for use in producing assessments of shoreline erosion and other coastal processes through the National Assessment of Shoreline Change Project of the Coastal and Marine Geology Program (e.g. Morton et al. 2004 ; Thieler and Hammar-Klose 1999, 2000a, and 2000b); and FEMA has done so in the past. USGS also evaluates the ability of wetlands to keep pace with rising relative sea level (Rybczyk and Cahoon 2002).

Synthesis and Assessment Product 4.1 will synthesize information from the ongoing mapping efforts by federal and non-federal researchers related to the implications of rising sea level. It will overlay the various data layers to develop new results made possible by bringing together researchers that are otherwise working independently. Because of time, data, and resource limitations, the synthesis will focus on a contiguous portion of the U.S. coastal zone (New York to North Carolina). The report will also develop a plan for a sea level rise research program to answer the questions that are most urgent for near-term decisionmaking. This report will provide information that supports the specific goal in Chapter 9 of the *Strategic Plan for the Climate Change Science Program* (CCSP, 2003) to analyze how coastal environmental programs can be improved to adapt to sea level rise while enhancing economic growth.

This report will address the implications of sea level rise on three spatial scales:

- Data overlays and a state-of-the-art quantitative assessment concerning coastal elevations for a multi-state study area along the U.S. Atlantic Coast: New York to North Carolina. Depending on availability of data, this report also may evaluate sea level rise and vulnerability to flooding in the multi-state study area.
- Case studies that document in greater detail the impact of sea level rise on smaller areas or specific issues within the study area.
- A literature review that puts the report within the larger nationwide context.

Within the multi-state study area, the synthesis product will examine five key questions that address the four most commonly cited factors contributing to the sensitivity of coastal lands to rising sea level: low elevations, coastal erosion, wetland accretion, and human modifications of the coastal zone. The five key questions are:

1) Which lands are currently at an elevation that could lead them to be inundated by the tides without shore protection measures?

2) What are the existing 1-, 10-, 100-, and 500-year floodplains and what are the associated surge elevations? How would the floodplain boundaries change as sea level rises?
3) What are the effects of sea level rise and sedimentation on the coastal zone? Among those lands with sufficient elevation to avoid inundation, which land could potentially erode in the next century? Which lands could be affected by related coastal processes?
4) What is a plausible range for the ability of wetlands to erode or vertically accrete, and how do those ranges depend on whether shores are developed and protected, if at all? That is: will sea level rise cause the area of wetlands to increase or decrease?
5) Which lands have been set aside for conservation uses so that wetlands will have the opportunity to migrate inland; which lands have been designated for uses requiring shore protection; and which lands could realistically be available for either wetland migration or coastal development requiring shore protection?

The product will answer as many of those questions as possible with a state-of-the-art quantitative analysis for the range of uncertainty regarding current coastal elevations and how much sea level may rise along the mid-Atlantic Coast. Where such an analysis is not feasible, the product will rely on older quantitative assessments if possible, or provide a qualitative evaluation. To ensure comparability with other assessments, the magnitude of sea level rise considered will be expressed in round numbers such as 50 cm and 1 meter. Like previous assessments, this product will consider the implications of a two meter rise in sea level; but it will focus on the impacts of a rise between 25 cm and 1 meter. Nevertheless, in much of the United States, the lowest contour on available topographic maps is 10 feet above the National Geodetic vertical datum of 1929, that is, roughly two meters above the upper edge of tidal wetlands. Therefore, the area inundated by a two meter rise can be more accurately estimated than the area inundated by a rise of 25-100 cm. Along the mid-Atlantic coast, a two meter rise in sea level is possible over the next two centuries (*See e.g.* Section 11.5.4 of IPCC 2001). To the extent that impacts depend on the timing of sea level rise, the product will focus primarily on the implications for the 21st century, but it will also consider land potentially vulnerable during the next two centuries.

The case studies will depend upon available data and contributing authors identified by the public comment period. The synthesis product may include case studies for any of the following questions for all or part of the multi-state study area:

- What are the population, economic activity, and total property value within the area potentially inundated, eroded, or subject to increased flooding due to sea level rise, given alternative levels of shore protection?[2]
- What is the expected cost of shore protection?[3]
- What are the ecological implications of sea level rise given various levels of shore protection and other response options?[4]
- How would expected flood damages change, as a function of the level of shore protection?[5]
- How does sea level rise affect the public's access to—and use of—the shore?[6]
- Which near-term actions (if any) have outcomes sufficiently sensitive to sea level rise so as to justify different decisions, depending on how much sea level is expected rise?[7]
- What options are being considered by specific organizations that manage land for environmental purposes? What are the specific implications of each option?[8]

- Given the foregoing results, what adaptation options are being considered by specific state or local governments? What are the specific implications of each option?[9]
- What lessons can the Mid-Atlantic States learn from the unfolding consequences of relative sea level rise, wetland loss, storms, and coastal erosion in Louisiana?

[FOOTNOTE 2: Based on Question 9.2 from the *CCSP Strategic Plan*.]
[FOOTNOTE 3: Based on Question 9.2 from the *CCSP Strategic Plan*. See also Figure 9-1 and Illustrative Research Question 4, under Section 9.2.]
[FOOTNOTE 4: Based on Illustrative Research Questions for both *CCSP Strategic Plan* Chapters 8 ("What are the effects of … increased rates of sea level rise … on … functioning of coastal ecosystems?") and 9 ("What factors determine the vulnerability of natural systems to the adaptive measures that people may implement in response to global change?").]
[FOOTNOTE 5: Based on Question 9.2 from the *CCSP Strategic Plan*: "What are the … potential future impacts of [climate change] on human welfare … and how can resilience be increased and vulnerability reduced?"]
[FOOTNOTE 6: Based on Question 9.2 from the *CCSP Strategic Plan*: "What are the current and potential future impacts of [climate change] on human welfare...?"
[FOOTNOTE 7: A continuing mission of the *CCSP Strategic Plan* is "Decision Support", which is not possible without a consideration of the decisions that may actually depend on the information produced.
[FOOTNOTE 8: Based on Question 9.2 from the *CCSP Strategic Plan*: "…and how can resilience be increased and vulnerability reduced?"]
[FOOTNOTE 9: Based on Milestone #6 under *CCSP Strategic Plan* Section 9.2.]

2. Contact Information and Role of Lead Agencies

2.1 Contact information.

The following table lists the designated contact person for each agency supporting this effort.

CCSP Agency	Contact	E-mail
USEPA	James G. Titus	Titus.jim@epa.gov
NOAA	Mike Szabados	Mike.Szabados@noaa.gov
USGS	Eric Anderson	Eric.K.Anderson@noaa.gov
USFWS	Brian Czech	brian_Czech@fws.gov
Corps of Engineers	Charles Chesnutt	Charles.b.Chesnutt@usace.army.mil
FEMA	Mark Crowell	Mark.Crowell@dhs.gov
DOE	Anjuli Bamzai	anjuli.bamzai@science.doe.gov
NASA	Eric Lindstrom	Eric.J.Lindstrom@nasa.gov

2.2 Lead Agency Roles and Responsibilities

The lead agencies—U.S. Environmental Protection Agency (USEPA), NOAA and USGS-- as designated co-leads, are jointly responsible for the final CCSP deliverable and will perform the necessary work to ensure project completion. The joint responsibilities include development of the draft report, as well as the nomination and obtaining of authors and expert reviewers. The lead agencies are responsible for overall project coordination. In addition to these joint responsibilities, each lead agency has specific responsibilities:

USEPA is the Lead Agency for Information Quality Act (IQA) and Federal Advisory Committee Act (FACA):

1. USEPA is the overall project lead agency for project management and as such has responsibility for official reporting purposes for the requirements of the Information Quality Act.
2. USEPA is responsible for Federal Advisory Committee Act compliance.
3. USEPA is responsible for the managing the formal literature review portion of the project.
4. USEPA is responsible for coordinating the acquisition of the authors' time as needed for this project, except for those authors that are employed by Lead Agencies and their grantees.

NOAA is the Lead Agency for Logistics:

1. NOAA is responsible for setting up and hosting four meetings for the authors, with the first meeting to be held in Silver Spring, MD and the other three to be held at suitable locations in the Mid-Atlantic regions to have stake-holder input to the authors. NOAA will manage the invitational travel for the authors as required.
2. NOAA is responsible for managing the compilation and production of the final report. This includes editing, report layout, and printing.

USGS is the Lead Agency for the Research Plan:

USGS is responsible for managing the development of a supporting research plan that identifies key areas of applied and basic research that supports and provides a scientific context for this deliverable.

3. Lead Authors and Expert Reviewers: Required Expertise and Biographical Information

The lead agencies have prepared a list of author nominees, based on interest in this product and record of accomplishments in the relevant fields of expertise. Biographical information for the nominees is included in Appendix A.

3.1. Authors

The team generating the product (hereinafter "synthesis team") will have between five and nine lead authors. Lead authors will be jointly responsible for the entire product, including the text itself and any analysis required to synthesize the underlying studies on which the product is based. The lead authors will decide how best to manage the team, including division of responsibility, time requirements, and whether to designate a managing author.

The team will also have one or more reviewing authors, and as many contributing authors as necessary. Reviewing authors will represent the interests of the intended audience, both in terms of the substance provided by the product and the quality of the writing. They will not be responsible for the initial draft of the product, but will be responsible for ensuring that the final product is as responsive as possible to comments from reviewers.

Contributing authors will either be responsible for preparing a case study or for a portion of the research plan that will constitute the final chapter of the product. Contributing authors will be responsible solely for their own contributions.

3.2. Required Expertise of Authors and Expert Reviewers

Lead authors should be accomplished writers and have technical backgrounds in at least one field relevant to the implications of sea level rise. Regardless of discipline, each lead author must have produced or managed the production of a GIS product that informs our understanding of the implications of sea level rise, or have extensive experience using such products while developing responses to coastal erosion, flooding, or wetland loss.

Contributing case-study *authors* should have the expertise required to complete proposed case studies that answer one or more of the case study questions. Contributing authors for the research plan must have a general familiarity with key uncertainties regarding the implications of sea level rise, familiarity with at least one Federal research agency, and an understanding of the general principles of how to set priorities for information collection. Unlike lead authors, contributing authors need not have any experience with GIS.

Reviewing authors should have a broad background that includes either the implications of sea level rise or management of the inter-tidal zone, or managing people engaged in such activities. They need not have any expertise in GIS systems. At least one of the reviewing authors must have a quantitative background, and at least one of the reviewing authors must have demonstrated excellent writing and communication skills, and a portfolio of publications oriented to a general non-scientific audience (e.g., newspapers, general interest magazines, major web sites, court opinions). A reviewing author must have a strong background in activities that involve listening to divergent views.

Expert reviewers should have well-established credentials in at least one of the topics that this product will examine. To ensure independence and avoid conflicts of interest, reviewers will not be employees or recent contractors of the lead agencies.

3.3. Current Author Nominees

Lead Author Nominees

James G. Titus, USEPA (coordinating lead author)
Stephen Gill, NOAA
S. Jeffress Williams, USGS
Donald R. Cahoon, USGS
Andrew Morang, US Army Corps of Engineers
Michael Craghan, FEMA

Contributing Author Nominees

K. Eric Anderson, USGS
Brian Czech, USFWS
Mark Crowell, FEMA
Daniel Hudgens, Industrial Economics Incorporated
Nancy Jackson, New Jersey Institute of Technology
Michael Kearney, University of Maryland
Curt Larsen, USGS
Karen Nook, US Army Corps of Engineers
Denise Reed, University of New Orleans
Ben Poulter, Duke University
Jay Tanski, New York Sea Grant Program
E. Robert Thieler, USGS
Michael Weinstein, New Jersey Marine Sciences Consortium
Jue Wang, ICF Incorporated

Reviewing Author Nominees

Reviewing authors will be coastal experts with experience reviewing/editing coastal publications for a diverse audience.

Expert Reviewer Nominees

USEPA will assemble a panel of expert reviewers representing agencies from each of the states in the multi-state study area, as well as local governments and experts on modeling coastal elevations and sensitivity to sea level rise.

The public is invited to nominate authors and experts to participate in the peer review of the draft product. Nominations should be sent to <4.1-Sea_Level@climatescience.gov> by January 28, 2006. Nominations must include CVs and publications listing. The Lead Agencies will ensure that selected authors and reviewers are technically qualified (as demonstrated by scientific

experience and published work). The Environmental Protection Agency will screen for real or perceived conflict of interest and independence from the Lead Agencies and contributing agencies. The Environmental Protection Agency will ensure that the slate of reviewers reflects a balance of scientific/technical perspectives.

4. Stakeholder Interactions

Numerous individuals—as well as federal, state, and local governments and agencies, together with non-governmental organizations (NGOs)—are involved in managing lands that may be affected by rising sea levels. Coastal decisionmakers include coastal planners, engineers, policy analysts, investors, homebuyers, public officials, and citizens who provide input to coastal decisions within the study area.

This report will be primarily written and produced by a subset of stakeholders. The Army Corps of Engineers, USFWS, FEMA, NOAA, and USEPA, make decisions that affect the coast and produce data needed by decision makers. Each of these agencies will contribute writers to this product. In addition, at least two state coastal programs may contribute writers. The Nature Conservancy may also contribute an author.

State and local governments that will not participate directly in this assessment have participated in the creation of the underlying products. NOAA's coastal zone management program will obtain reviews of the product outline, and each of the underlying products, from all of the state coastal zone management and state wetland regulatory programs within the study area. The Army Corps of Engineers may seek comments from district wetland regulatory and shore-protection offices. USFWS may seek comments from the coastal refuges and national parks. Sixty city and county planning departments have reviewed the sea level rise/shore protection maps of the USEPA planning study; USEPA will seek comments on the synthesis product from all localities highlighted by the synthesis product.

Public input is currently solicited on this prospectus, which has been posted in the Federal Register. Offers to contribute case studies for all or part of the case study area are welcome. The lead agencies will make the data being developed to answer the key questions (discussed in the next section) available in time for case studies that need such data. Three of the four primary meetings of lead authors will be held in communities vulnerable to a rise in sea level of 2 feet or less, and include a half-day meeting with stakeholders in those areas. NOAA will coordinate a stakeholder review of the draft report, and the lead authors will incorporate stakeholder concerns before the "first draft" for expert review is produced. Public input will also be solicited on a draft of the product following the expert review period.

5. Drafting, including Materials to be Used in the Product

The product will be twofold. First, for the coastal practitioner, this product will include provide shape files and (where appropriate) grid files that provide site specific estimates and assessments

of all the quantitative analysis undertaken to address the key questions. The data will be distributed electronically via by CDs or DVDs, with smaller files also available on lead agency web sites. Second, for the general public, CCSP will provide maps and a report that answers the questions. The report will be devoid of jargon and written for a general audience. The maps and reports will be placed on the web sites of the lead agencies.

This product will use GIS databases from a variety of sources. The best data for answering the five key questions will be developed specifically for this product. NOAA and USEPA are both producing the specific elevation and shore protection maps enunciated in the *CCSP Strategic Plan*, which announced this synthesis product. Both agencies have long planned to complete those products during 2005. Such completion will make it possible to include the results of those studies in this product. Those studies are essential for answering Key Questions 1 and 5 provided in Section 1 of this prospectus.

USGS also has ongoing efforts that could support this product—most significantly the ongoing assessment of shoreline change (Key Question 3). Similarly, FEMA is likely to have state-of-the-art flood maps for portions of the case study (Key Question 2).

The lead agencies will make all of the underlying products available for reviewers so that they can examine the data and assumptions. They will also make the data available to those researchers interested in contributing case studies to the synthesis.

As the principal agency for the national map, USGS may also take on the task of facilitating the exchange of GIS data that may be used in any case studies that might be conducted. In cooperation with other parts of the Department of Interior (DOI), USGS will also investigate the feasibility of contributing GIS layers for subsidence, wetland erosion and accretion, and beach erosion and accretion (Key Questions 3 and 4), and provide GIS layers for as much of the study area as possible. USGS may also provide user-friendly data files that explicitly define those tidal wetlands that tend to be above mean sea level, and those that may be technically inter-tidal but below mean sea level.

FEMA may provide user-friendly GIS layers depicting coastal floodplains for various flood frequencies for the entire study area, except for those areas (if any) where digital Flood Insurance Rate Maps have not been prepared. FEMA may also provide GIS information on erosion rates for representative counties in the multi-state case study area.

USEPA, NOAA, DOI, DOD, and NASA may collaborate to improve USEPA's GIS layer responsive to Key Question 5.

6. Review

This product will be reviewed in several phases. First, the lead and supporting agencies will solicit comments on a stakeholder review draft, from state and local governments, and other stakeholders who express an interest. USGS will solicit comments on the research plan from

users and producers of the information the plan proposes. The lead authors will modify the product to incorporate the stakeholder concerns and prepare a complete first draft version of the synthesis and assessment product.

EPA will then submit the product to a panel of experts for review selected from among those nominated in the process described in section 3.3 above. The panel will include no less than three reviewers with a strong background in the issue of each of the key and case study questions analyzed, but each reviewer will review the document as a whole. Reviewers will be asked to address the following questions in formulating their comments.

1. Is the charge, outlined in the prospectus, clearly described in the product? Are all aspects of the charge fully addressed? Do the authors stay within their charge and expertise? If not, are such departures reasonable?
2. Are the conclusions and recommendations adequately supported by evidence, analysis, and argument? Are uncertainties or incompleteness in the evidence explicitly recognized? If any recommendations are based on value judgments or the collective opinions of the authors, is this acknowledged and are scientifically defensible reasons given for reaching those judgments?
3. Are the data and analyses handled competently? Are statistical methods applied appropriately?
4. Are the product's exposition and organization effective? Is the title appropriate?
5. Is the report fair? Is its tone impartial and devoid of special pleading?
6. Does the executive summary concisely and accurately describe the key findings and recommendations? Is it consistent with other sections of the product?
7. Are signed papers or appendices, if any, relevant to the charge? If the product relies on signed papers to support consensus findings or recommendations, do the papers meet criterion 3 above?
8. What other significant improvements, if any, might be made to the product?

Following this review, the lead authors will revise the document and present the second draft for public comment. The public comment period will be held during October - November 2006. The lead authors will then prepare a third draft of the product, taking into consideration the comments submitted during the public comment period. The scientific judgment of the lead authors will determine responses to the comments.

Once the revisions are complete, the Environmental Protection Agency will certify compliance with the Information Quality Act and submit the synthesis and assessment product to the CCSP Interagency Committee. If the CCSP Interagency Committee determines that further revision is necessary, its comments will be sent to the lead agency for consideration and resolution by lead authors. If needed, the panel of experts will be asked to provide additional scientific analysis to place bounds on the scientific uncertainty associated with specific issues. If the CCSP Interagency Committee review determines that no further revisions are needed and that the product has been prepared in conformance with the *Guidelines for Producing CCSP Synthesis*

and Assessment Products, they will submit the product to the National Science and Technology Council (NSTC) for clearance. Clearance will require the concurrence of all members of the Committee on Environment and Natural Resources. NSTC review comments will be addressed by the CCSP Interagency Committee in consultation with the lead and supporting agencies and the lead authors.

The Environmental Protection Agency will establish a committee under the Federal Advisory Committee Act (FACA) to oversee the preparation of the report. After the public review, the FAC will review the report and the responses to peer review and public comments, and suggest revisions as necessary. After the Lead Authors have made the necessary revisions, the Lead Agencies will forward the product to the CCSP interagency committee and the National Science and Technology Council for final approval and dissemination.

7. Related Activities

The product will complement and reinforce assessment efforts of the National Academy of Sciences (NAS) and Congressionally mandated studies. NAS has recently started an independent assessment of ways to mitigate the environmental consequences of responses to shoreline erosion. Portions of Synthesis and Assessment Product 4.1 that cover potential habitat loss and planned responses to sea level rise will help define the background conditions for the NAS assessment. The Clean Water Act requires the Federal wetland program to avoid any cumulative environmental impacts when issuing general wetland permits, and the National Environmental Policy Act requires Federal agencies to assess environmental impacts of major Federal actions. Synthesis and Assessment Product 4.1 will help to define the research necessary for legally required assessments to correctly estimate environmental impacts of Federal actions if sea level continues to rise.

The U.S. Army Corps of Engineers is conducting a multi-year National Shoreline Study, which will examine inundation, erosion, flooding, shore protection, and other coastal processes throughout the United States. Synthesis and Assessment Product 4.1 will examine a subset of the National Shoreline Study's issues, for a portion of the nation, and be completed sooner. Therefore, this synthesis product may serve as an initial pilot effort for the longer-term National Shoreline Study.

8. Communications

USEPA and NOAA will release the completed product using a standard format for all CCSP synthesis and assessment products. The final product and the comments received during the Expert Review will be posted without attribution on NOAA and USEPA web sites, and mirrored on the CCSP web site. A response to the expert review comments will also be posted. The comments received during the Public Comment period will be posted with attribution. Final report production and layout will be managed by professional technical editors and writers.

Within six months of the final publication of Product 4.1, the Lead Agencies will convene a meeting of lead and contributing authors and interested stakeholders to explore options for creating a coastal vulnerability assessment tool to provide the results of the product in a form useful to coastal decision makers along the Atlantic Coast.

9. Timeline

The following schedule is proposed for the completion of this product. Because this product will require development of new data, the final deadline is contingent on approval of the prospectus on the schedule shown as well as completion of review deadlines following completion of the draft products.

Prospectus posted on CCSP web site for public comment	December05
Final prospectus posted on the CCSP web site	February 06
First Federal Advisory Committee Meeting	March 06
Rough draft for Key Questions 1-5	May 06
Rough draft for Case Studies	July 06
Stakeholder Review Draft complete	September06
Stakeholder Review complete	November 06
Expert Review (first) draft complete	December 06
Public Comment (second) draft complete	February 07
Public Comment Period	May 07
Third draft submitted to CCSP Interagency Committee	September07
Final product posted on CCSP web site	October 07
Initial Meeting on sea level vulnerability tool	March 08

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Appendix A. Biographical Information for Authors

K. Eric Anderson
B.S. Purdue University (Economics)
M.S., Ph.D. Northwestern University (Geography)
Eric Anderson is a senior research geographer with the US Geological Survey (USGS). His research focuses on the development of tools and techniques involving integrated multidisciplinary data sets and their application across a range of scales from global to local. Current projects have particular emphasis upon techniques for mapping and communicating coastal hazards including seismic risk, coastal flooding, and storm surge. At the USGS, he has worked in digital cartography, geographic research, and the development and applications of geographical information systems. He served as Chief of the Eastern Region of the National Mapping Division until 2000. He is a Past President of the American Congress on Surveying and Mapping and was one of the founding editors of the International Journal of Geographical Information Systems. He served as the Director of Auto-Carto 9 and co-Director of Auto-Carto 2005.

Donald R. Cahoon
B. A., Botany, with Honors, Drew University, 1972
M.S., Plant Ecology, University of Maryland, 1975
Ph.D., Plant Ecology, University of Maryland, 1982
Don Cahoon, a senior research ecologist with the U. S. Geological Survey, has more than 25 years experience investigating wetland plant ecology, wetland accretionary processes, and wetland restoration and management; and has published his findings in more than 100 research papers and reports. With his colleagues, he has developed a research approach for measuring wetland elevation dynamics (surface elevation tables (SET) used in conjunction with artificial soil marker horizons), which is being used in 18 countries by 65 coastal scientists. He and his colleagues have developed: 1) a global network of elevation monitoring sites using standard measurement protocols (SET and marker horizons) on coastal wetlands to give an advance warning of change, 2) new predictive models to determine the long-term potential for submergence of coastal wetlands, and 3) new elevation monitoring technology to improve our understanding of subsurface process influences on elevation. These developments are being used to determine: 1) the vulnerability of coastal wetlands to global change (e.g., sea-level rise and storms), 2) the critical driving forces and subsurface processes controlling elevation for a wide range of wetland types, and 3) the impact of current wetland management and restoration practices on elevation dynamics and wetland stability. The SET-marker horizon methodology is described in the website www.pwrc.usgs.gov/set.

Mark Crowell
B.S. University of Maryland (Geology)
M.S. Virginia Tech. (Geology, Invertebrate Paleontology)
Mark Crowell is a geologist who has worked for FEMA the past 15 years. He has worked on several erosion and coastal flood related projects, including Project Officer of the *Evaluation of Erosion Hazards* study by the Heinz Center. Before coming to FEMA, he worked for several

years at the Lab for Coastal Research at the University of Maryland where he oversaw the production of historical shoreline mapping projects for Massachusetts and New Jersey. Over the past 15 years he has had more than 20 papers and numerous abstracts published on the subject of long-term erosion rate analysis and historical shoreline mapping. This includes 13 papers in the *Journal of Coastal Research*, and *Shore and Beach*. He is the co-editor (with Stephen Leatherman) of a Special Issue of Journal of Coastal Research entitled, "Coastal Erosion Mapping and Management," published in 1999, and co-editor (with Mark Byrnes) of a second JCR Special Issue (published in 2003) entitled "Shoreline Mapping and Change Analysis: Technical Considerations and Management Implications." Mark Crowell recently contributed an entry entitled "Erosion: Historical Analysis and Forecasting," that will appear in the "Encyclopedia of Coastal Science" (ed. Maurice Schwartz), scheduled for publication in 2005.

Michael Craghan
B.S. Rutgers University (Civil Engineering) 1989
M.S. Geography, Rutgers University (1995).
Ph.D. Rutgers University, New Brunswick, N.J. (Geography). 1999
Michael Craghan has expertise in floodplain modeling, estuarine sedimentation processes, coastal zone land use planning, and civil engineering. He is currently an engineer and GIS floodplain modeler for the Federal Emergency Management Agency's regional office in Philadelphia. His Ph.D. Dissertation was entitled "An Investigation of Sediment Delivery and Accumulation on a Developed Estuarine Shore." He has also prepared a report analyzing land use planning for sea level rise in New Jersey, and serves on the Environmental Conservation Board of the Town of Manasquan, New Jersey.

Brian Czech
B.S. University of Wisconsin (Wildlife Ecology) 1982
M. S. University of Washington (Wildlife Science) 1988
Ph.D., University of Arizona (Renewable Natural Resources) 1997
Brian Czech is a conservation biologist in the national office of the U.S. Fish and Wildlife Service, National Wildlife Refuge System, Arlington, VA. His major duties include planning and policy development for maintaining the biological integrity, diversity, and environmental health of the Refuge System. He has served as a Refuge System lead for interagency sustainability initiatives pertaining to forests, rangelands, and climate change. Dr. Czech is also an adjunct professor at Virginia Polytechnic Institute and State University, National Capitol Region, Alexandria, where he has taught ecological economics, sustainability science, and endangered species policy and management. Between 1988-1993, he was a conservation biologist and Director of Recreation and Wildlife for the Apache Tribe in San Carlos, Arizona.

Stephen Gill
B.S. New York University School of Engineering and Science. 1970 (Meteorology and Oceanography)
M.S. New York University School of Engineering and Science. 1975. (Physical Oceanography)
Stephen Gill is Senior Oceanographer for the NOAA/NOS Center for Operational Oceanographic Products and Services (CO-OPS). Mr. Gill has been with NOAA's tides and water levels program in various capacities since 1975 and has operational experience in water level measurement, data processing, analyses and tidal datums, and product development for

tides and sea level applications. Most recently, he has been working to develop various training programs in the application of tides and sea level measurement to surveying and mapping as well as to coastal zone management and habitat restoration, and is working to develop the Federal backbone for the Integrated Ocean Observing System (IOOS). Prior to coming to NOAA, Mr. Gill was an oceanographer for three years at the New York Ocean Science Laboratory in Montauk, NY. His educational background also includes one-year of applied research in tides and tidal theory at Scripps Institution of Oceanography under the tutorship of Bernard Zetler.

Daniel E. Hudgens
B.S. Cornell University (Natural Resources) 1996
M.S. University of Massachusetts (Environmental, Coastal, and Ocean Sciences) 1999
Dan Hudgens is an environmental consultant with Industrial Economics Incorporated. His masters research article "Adapting the National Flood Insurance Program to Relative Sea Level Rise," was published in *Coastal Management.* Since joining Industrial Economics in 1999, Mr. Hudgens has continued to work on projects associated with sea level rise, such as EPA's project to create GIS maps depicting local planner expectations on how communities will respond to sea level rise. He also undertook a GIS-based study for the Electric Power Research Institute estimating the cost of sea level rise along the California coast. Other projects include contracts with National Marine Fisheries Service (Draft Atlantic Large Whale Take Reduction Plan Environmental Impact Statement, as well as a GIS model to assess the change in fishing line usage), EPA's Office of Emergency and Remedial Response (evaluating impacts of extreme weather events on subaqueous contaminated sediment sites) and EPA's Office of Policy (draft benefits report for the revised Concentrated Animal Feeding Operations rule).

Nancy Jackson
B.A. Clark University (Geography) 1978.
M.S. Antioch/New England Graduate School (Natural Resource Management and Administration) 1986.
Ph.D. Rutgers University. (Geography) 1992.
Nancy Jackson is a physical geographer and coastal geomorphologist. She is an Associate Professor in the Department of Chemistry and Environmental Science at New Jersey Institute of Technology and Director of the Graduate Program in Environmental Policy. Her research focuses on coastal processes on beaches and dunes with particular emphasis on foreshore processes and sediment transport in estuarine and low wave energy environments. Specific research projects have examined wave activation and sediment mixing, longshore sediment transport, swash - beach water table interactions, and geomorphic-biotic interactions on sandy foreshores in estuaries. Applied research she has undertaken focuses on humans as an agent of coastal landform change and specifically how physical – biological –social processes increase or decrease resilience of coastal environments. Dr. Jackson has published over 40 journal articles on coastal processes and management. She is an Associate Editor of *Estuaries: An International Journal of Coastal Science* and serves on the Editorial Board of *Journal of Coastal Research*. She was awarded the 2004-2005 *Fulbright Distinguished Chair in Environmental Policy and Legislation* at the Politecnico di Torino, Italia.

Michael S. Kearney
B.A. University of Illinois, 1973, History/Geology
MA, Western Illinois University, 1976, Geography
PhD, University of Western Ontario, 1981 (Geography, specializing in geomorphology and paleoenvironmental reconstruction).
Michael S. Kearney is a Professor in the Department of Geography, University of Maryland, College Park. Since joining the faculty at College Park, Dr. Kearney has focused on coastal processes and environments, particularly problems of marsh loss and sea level rise, reconstructing of recent sea level trends, changes in historical shoreline erosion, and Bay sedimentary processes. He has also worked extensively on barrier islands, focusing barrier island evolution, the impact of storms on beach processes, and aeolian transport. In recent years, he focused on using remote sensing to assess the response of coastal marshes to sea level rise and changes in nutrient concentration in US middle Atlantic estuaries. Dr. Kearney has published over 60 refereed journal articles, book chapters, and proceeding papers and reports, and is co-author of the recent books, *Sea Level Rise: History and Consequences*, published by Academic Press, and *North American Coasts*, published by Kendall Hunt.

Curt Larsen
B.S., Geology, University of Illinois Urbana-Champaign, 1964
M.A., Sociology, Western Washington University, Bellingham,WA, 1971
Phd., Anthropology, The University of Chicago, 1980

Curtis Larsen is a senior research geologist with the U.S. Geological Survey in Reston, VA. He is a coastal geologist and geomorphologist with more than 35 years of experience investigating sea level change along the U.S. east and west coasts as well as the Persian Gulf region. He has also studied lake level change and postglacial isostatic crustal adjustments in the Great Lakes region. His current focus is on discerning the sea level history of the Mid Atlantic coast with respect to geologic and historic time scales. Most recently he has been deeply involved with modeling the impacts of prospective relative sea level rise on coastal wetlands and wetland habitats in conjunction with the U.S. Fish and Wildlife Service at the Blackwater National Wildlife Refuge. Apart from his active interest in reconstructing relative sea level history he is interested in assessing the role of wetlands as contributors of sediment to adjacent water bodies like the Chesapeake Bay. Similarly, he is interested in comparing the responses of marine coastal wetlands to current rates of relative sea level rise to those of fresh water wetlands in the Upper Great Lakes in similar water level rise situations.

Karen Nook, US Army Corps of Engineers [biography currently unavailable]

Ben Poulter
B.S. University of Idaho (Natural Resource Ecology and Conservation) 1997
Ph.D. Duke University (Environmental Science) 2005
Ben Poulter will be a research scientist at Duke University for the next 12 months, developing a GIS conservation plan for northeastern coastal North Carolina among other research projects.

His PhD. thesis focused on the effects of disturbance (fire) and sea level rise on rates and patterns of forest retreat in coastal North Carolina. He used extensive GIS and landscape modeling approaches to model historic landscape changes and project future areas likely to be inundated using lidar elevation data. His work using lidar elevation data has resulted in a manuscript that is in preparation, and an interactive GIS model where a user can specify a GCM, fossil fuel scenario, and specify a year between current and 2100 to view land areas likely to be inundated under those conditions.

Denise Reed

B.S. Cambridge University (1980).
Ph.D. Cambridge University (Geography) 1986.

Denise Reed is a Professor at the University of New Orleans. Dr. Reed's research focuses on various aspects of sediment dynamics in coastal wetlands, with emphasis on sediment mobilization and marsh hydrology, both natural and altered, as factors controlling sediment deposition. She has participated in numerous research projects concerning marsh and estuarine sediment dynamics on the Gulf and Pacific coasts of the US as well as in Europe and South America. Dr. Reed has also worked closely with the development of restoration plans in for coastal Louisiana for the last 15 years being involved in incorporating science into efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) and more recently the Louisiana Coastal Area study. Dr. Reed has recently completed publications on altered hydrology effects on Louisiana salt marsh function and restoration of tidal wetlands in the Sacramento-San Joaquin delta. She currently serves on scientific advisory boards for ecosystem restoration in San Francisco Bay and Jamaica Bay NY, as well as the CALFED program and the US Army Corps of Engineers.

Jay Tanski

B.S. Pennsylvania State University (Geology) 1978.
M.S. State University of New York (SUNY) at Stony Brook. (Coastal Geology) 1981.

Jay Tanski has been the Coastal Processes Specialist with New York Sea Grant since 1983. The program is a marine research, education and technical assistance program run jointly by SUNY and Cornell University. In his position he provides technical information and advisory services to a variety of coastal audiences including federal, state and local officials and agencies, communities, businesses and the public. He was technical advisor to the State and the Long Island Regional Planning in the development of the Long Island South Shore Hazard Management Program. He has served on the Governor's Coastal Erosion Task Force, New York State's Barrier Island Scientific Advisory Committee, and the Atlantic Coast of New York Erosion Monitoring Study Team, a collaborative effort of the U.S. Army Corps of Engineers, New York State Coastal Management Program and New York Sea Grant. Following graduate school, he worked as a project supervisor with a South Carolina consulting firm before returning to Long Island as a research associate at SUNY Stony Brook.

E. Robert Thieler

B.A. Dickinson College (Political Science, Environmental Studies) 1987
M.S. Duke University (Environmental Science) 1993

Ph.D. Duke University (Geology) 1997
Rob Thieler conducts marine geologic research on the geologic framework and morphodynamics of the coastal zone. This includes understanding relationships between regional geology, sediment transport, and coastal erosion, as well as assessing potential sand and gravel resources. He has worked with several state agencies (MA, MD) to develop long-term shoreline change data for coastal management. Dr. Thieler also develops GIS software for measuring historical shoreline change using a variety of statistical techniques. He has completed preliminary assessments of coastal vulnerability to sea-level rise using simple criteria at both the national scale, and more recently for 25 National Park Service units worldwide. He is the author or co-author of over 70 technical publications. Dr. Thieler serves on the editorial boards of the *Journal of Coastal Research* and *Marine Geology*.

James G. Titus
B.A. University of Maryland (Economics and Applied Math) 1978
J.D. Georgetown University Law Center 1996
Jim Titus has managed EPA's Sea Level Rise Project since 1982, the first government project designed to identify opportunities to adapt to the consequences of global warming from greenhouse gases. His publications include the first probabilistic assessment of future sea level rise, the first assessment to estimate the nationwide impacts of sea level rise and cost of shore protection, and first set of state-specific maps depicting the lands vulnerable to projected sea level rise (posted at www.epa.gov/globalwarming/sealevelrise). He also undertook the first analysis of "rolling easements" and other legal and planning mechanisms that might allow public property rights to survive rising sea level. He has visited the shores of 90 percent of the counties within the case study area, and recently elevated the family cottage on Long Beach Island, N.J in response to sea level rise. Before coming to EPA, he developed macroeconomic models and wrote FORTRAN programs for University of Maryland and Congressional Budget Office.

Jue Wang
B.S. Henan University (Geography) 1982
M.S. Fujian Teacher's University (Geography: Climate Change, Sea level Change) 1986
Ph.D. University of Kansas (Geography: GIS, Remote Sensing, Biological Geography) 2000
Jue Wang has studied physical geography for more than 20 years and remote sensing and Geographical Information Systems (GIS) for the past eight years. Before coming to the United States, he was an assistant professor in China, where he taught and conducted research in geography. From 1993 to 2000, he was a graduate research assistant in the GIS and Environmental Modeling Laboratory (GEMLab) of the Kansas Applied Remote Sensing Program (KARS) at the University of Kansas. He served as the GIS and remote sensing specialist for the Brunca conservation biology project sponsored by the Organization for Tropical Studies, the Flint Hills-Osage Plains ecoregion GIS project funded by the Nature Conservancy, and the Kansas Ecological Reserves GIS project funded by National Science Foundation. His dissertation research focused on relationship between climate, the normalized difference vegetation index, and net primary productivity. Since September 2000, he has been working as a senior GIS analyst at ICF Consulting, Inc.

S. Jeffress Williams
B.S., Geology, Allegheny College, 1967
M.S., Geology/Oceanography, Lehigh University, 1969
S. Jeffress Williams, a senior research marine geologist with the U.S. Geological Survey at the Woods Hole Science Center, has more than 30 years of experience investigating topics such as the geologic origins and evolution of coastal and estuarine and Great Lakes systems, late Quaternary sea-level history, and the geologic character of modern marine sand bodies. He has published more than 200 research papers, reports, abstracts, and chapters and been a member on more than a dozen high-level national and state science advisory committees. Prior to his current research position in Woods Hole, Williams managed the Coastal and Marine Geology Program from1996 to 2000 at the USGS headquarters, Reston, VA. Prior to joining the USGS in 1983, he was a research marine geologist with the Corps of Engineers, Coastal Engineering Research Center and an invited visiting scientist (1980) at the Institute of Oceanographic Sciences, Taunton, UK, after receiving degrees in geology/oceanography from Allegheny College and Lehigh University. Williams' current research focus is on three main topics: carrying out a national synthesis and assessment of the state-of-knowledge about offshore marine sand and gravel aggregates, assessing the risk and vulnerability of U.S. coastal regions to coastal subsidence and future rise in relative sea level, and serving as a scientific advisor to system-scale coastal and wetland ecosystem restoration activities underway and in Louisiana.

Michael P. Weinstein
B.A., Biology, Hofstra University, 1966
M.S., Zoology, Rutgers University, 1969
Ph.D., Marine and Environmental Science, Florida State University, 1975
Michael P. Weinstein is President and CEO, New Jersey Marine Sciences Consortium (NJMSC) and Director, *New Jersey Sea Grant College Program*. With more than twenty-eight years experience in research and teaching, Dr. Weinstein's primary academic interests include the role of estuarine habitat in the production of marine recreational and commercial fishes and shellfish. He has conducted extensive research in the areas of coastal ecology, fisheries science, wetland ecology, and restoration ecology, primarily in salt marshes, sea grass meadows, and mangrove habitats. Dr. Weinstein is deeply committed to technology transfer and outreach based on his research, especially in melding the science and practice of habitat restoration, sustainable development, integrated coastal zone management, and the "bottom up" management of fisheries resources. He has served on several National Research Council Committees, an NCEAS Working Group, the US-Japan CEST Panel, the Governor's Dredged Material Task Force, and currently serves on the Governor's Tourism Advisory Council as New Jersey's Ecotourism Representative. He is a member of the National Working Group for preparing the Nationwide Strategy for Coastal Habitat Restoration. He also serves on many other advisory councils and scientific advisory panels. He has been an invited speaker on numerous occasions and has authored more than 175 journal articles, abstracts, books, chapters and monographs. His most recent text, *Concepts and Controversies in Tidal Marsh Ecology* is expected to have international impact on the direction of tidal marsh research and restoration science.