



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
AIR AND RADIATION

December 16, 2009

MEMORANDUM

SUBJECT: Methodology, Considerations, and Limitations of Using the Enclosed Elevation and Sea Level Rise Planning Studies and Data

FROM: Rona Birnbaum, Chief, Climate Science and Impacts Branch
Climate Change Division

A handwritten signature in blue ink that reads "R. Birnbaum".

TO: Parties interested in using the studies and data

Overview

We appreciate your interest in obtaining and utilizing the studies and data in the enclosed DVDs and/or CDs. Portions of what is being requested has been formally released by EPA and some has not. As with any EPA funded dataset that is not considered deliberative or sensitive and would be subject to release under the Freedom of Information guidelines, EPA is pleased to make all such datasets available to the public.

Although the information in the enclosed DVDs and/or CDs has been funded wholly by the U.S. Environmental Protection Agency, it does not necessarily reflect the views of the Agency and no official endorsement should be inferred. Additionally, many of these materials were never fully completed and thus are provided here only in a draft stage. Special precaution should be taken when analyzing and using this data.

The data and maps are based on two separate efforts:

- 1) A study of coastal elevations along the Atlantic coast from Massachusetts to Florida;
- 2) A sea level rise planning study from Massachusetts to Florida, plus Texas.

The data and maps for each of those two studies must be further subdivided into two geographical regions: the mid-Atlantic states (New York to North Carolina) and the rest of the study area (i.e. MA, RI, CT, SC, GA, FL, and TX).

This memo explains in detail for each area a) the methodology used to obtain the data and create, if applicable the maps and/or studies, b) considerations regarding use and interpretation of these data and materials, and c) use limitations.

Part 1: Elevation data and maps of coastal zones for certain states in the Eastern U.S.

The elevation data provided by the U.S. Environmental Protection Agency consists of elevation

maps of the coastal zones for each state. These data are intended to be used for the purposes of analyzing vulnerability to rising sea level. The data for the mid-Atlantic should not be used to create maps at scales greater than 1:100,000; the data for the other Atlantic states may be less reliable and should generally not be used to characterize local impacts. The domain of the data sets extend up to the 40 foot (NGVD29) contour line, but the primary focus of the analysis has focused on land below the 20 foot contour line.

A) Sources of Data

Sources of elevation data include the United States Geological Survey (USGS) 1:24,000 Digital Line Graphs (DLG), Corps of Engineers and state spot elevation data, county DLG's, and LIDAR. Since the development of these data sets, elevation data of higher quality are available for many areas. Nonetheless, the elevation data generated for each state were derived from the highest quality data sets that were publicly available at the time of production. The study also used wetlands data and NOAA data on tide elevations both to improve vertical accuracy and to express elevations relative to sea level.

B) Considerations regarding use and interpretation

Since the elevation data are based on topographic maps and computer models as opposed to survey data, there is significant uncertainty associated with the "true" elevation at any particular location. Additionally, the accuracy of the elevation values vary spatially depending on the quality of the source data used to generate the elevation models.

For the mid-Atlantic states, the metadata provided with each data set includes maps of the source and quality of the data used and estimates of the overall vertical accuracy. Two types of error analysis were conducted and reported in Titus and Wang (2008) and Titus and Cacela (2008) (both of which are included as supplemental metadata in the zip files in which the data is distributed). Data users therefore are encouraged to review the metadata that accompany each data set to evaluate the appropriateness of the intended uses of the information.

For the rest of the study area, no error analysis was conducted. (Because these elevation data were created as part of the sea level rise planning study, additional facts about the elevation data for states outside the Mid-Atlantic are discussed below in the section about the sea level rise planning study.)

Users are also cautioned that the elevation values used in these data are relative to spring high water (SHW) elevations. SHW values were used because they represent the highest elevation regularly inundated on a bi-monthly basis. SHW is higher than the mean tide level or mean sea level. Spring tide ranges were derived by estimating spring tide range and the elevation of mean tide level relative to a geodetic reference plane (e.g. NGVD29). The spring tide ranges were derived from tide gage data and represent the bi-monthly high tides averaged over the tidal epoch (e.g., 1983-2001) or the period of record for the tide gages along the coast. Mean tide level was derived based on NGS benchmark elevation data. Therefore, this data cannot be merged directly with other data sets such as the National Elevation Dataset (NED) which were developed relative to national vertical datums such as the North American Vertical Datum of 1988 (NAVD88) or National Geodetic Vertical Datum of 1929 (NGVD29).

The elevation data for states outside the Mid-Atlantic are provided in raster-based format. For mid-Atlantic states (New York through North Carolina), additional files are included that contain information on the process employed in creating the data and the underlying data quality. In

addition, ArcGIS map projects (mxd) and exported images (jpg) are included for these states. In the remainder of the states (MA, CT, RI, SC, GA, and FL), the primary elevation data sets were created, but not the associated files. As such, only the raster data are available for these areas.

C) Use limitations

1. Republishing.

Researchers are free to use this data. However, when reproducing the data provided here, the republisher should include all of the metadata (including the metadata files automatically opened by GIS software, “readme files”, and other supplemental material included in the .zip files in which this data is distributed), except in those cases where there is no metadata. In addition, the following statements should be included:

For the mid-Atlantic States.

Source: Titus J.G., and J. Wang. 2008. Maps of Lands Close to Sea Level along the Middle Atlantic Coast of the United States: An Elevation Data Set to Use While Waiting for LIDAR. Section 1.1 in: Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1, J.G. Titus and E.M. Strange (eds.). EPA 430R07004. U.S. EPA, Washington, DC.

For other Atlantic Coastal states (MA, RI, CT, SC, GA, and FL).

These data were created by Industrial Economics Incorporated (IEc) under contract to the US Environmental Protection Agency following the methodological approach of Titus J.G., and J. Wang. 2008. Maps of Lands Close to Sea Level along the Middle Atlantic Coast of the United States: An Elevation Data Set to Use While Waiting for LIDAR. Section 1.1 in: Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1, J.G. Titus and E.M. Strange (eds.). EPA 430R07004. U.S. EPA, Washington, DC. Unlike the Titus and Wang data, however, these data rely almost exclusively on the National Elevation Dataset (NED) of the United States Geological Survey. Neither IEc nor EPA have conducted any sort of additional quality assurance or quality control to supplement that of the NED. Nor has this product been peer reviewed. Additionally, although this information was funded wholly by the U.S. Environmental Protection Agency, it does not necessarily reflect the views of the Agency and no official endorsement should be inferred.

Map Captions.

Map captions should list the researchers who conducted the study, rather than EPA, as the source. An acceptable source citation for mid-Atlantic maps would be Titus J.G., and J. Wang. 2008. Maps of Lands Close to Sea Level along the Middle Atlantic Coast of the United States: An Elevation Data Set to Use While Waiting for LIDAR. Section 1.1 in: *Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1*, J.G. Titus and E.M. Strange (eds.). EPA 430R07004. U.S. EPA, Washington, DC. An acceptable source citation for elevation maps from other states would be: Industrial Economics 2009 (following the methods of Titus and Wang 2008).

Disclaimers warning the reader of the data limitations are advisable. A suitable disclaimer would be (e.g. for the Delmarva Peninsula):

This map is a general graphical representation of elevations in the area depicted, not designed to estimate the precise elevation at particular locations. Due to the use of a variety of data sources, actual elevations at specific locations may be 30 cm above or below the elevation shown in Maryland but 75 cm above or below the elevation shown in Delaware and Virginia.

Example captions throughout the mid-Atlantic are available on the CD. Figure 1.1.5 in the Titus and Wang (2008) paper displays the vertical error at specific locations in the mid-Atlantic. Similar graphics accompany the state-specific directories for states outside the mid-Atlantic.

Part 2: Sea-level rise planning study data and maps for certain states in the Eastern U.S.

The DVDs and/or CDs contain products culminating from EPA's multi-year sea level rise planning study, which divides lowlying dry land into four land-use categories representing different levels of existing and/or planned development as a proxy for the likelihood that people will attempt to keep the land dry and thereby prevent the inland migration of wetlands and beaches. The study area for this work extends along the Atlantic Coast from Massachusetts through the Florida Keys, and up the Gulf Coast as far as Tampa Bay, plus the state of Texas. Here we provide additional information on the data provided, methods used to create these products, and important considerations for any individual using the information.

We provide the planning response data in four formats. These include:

- The original output of the study in ArcGIS Shapefile format (polygons). We also include a layer file to assist users in quickly displaying the anticipated shore protection likelihood data along with information on wetlands and a mask to cover lands outside of the study area. In addition, the study area mask shades lands within the area between 10 and 20-feet in elevation since this area is considered of lesser concern compared to the land under 10 feet in elevation.
- A raster-based version of the anticipated shore protection likelihood data.
- A set of ArcGIS Shapefile lines that identify the shore planning category for the land immediately adjacent to tidal water (wetlands and open water).
- Images, in jpg format, of the final shore protection planning maps created using the GIS datasets.

A) Methodology

The study consists of 14 state-specific studies (MA to GA and TX) plus six separate studies that each focus on a different planning region along the Coast of Florida. The following description applies to all of these studies.

The planning studies' primary objective was to create draft maps that integrate information that provides an indication of the likelihood of future shore protection, including land use, zoning, and anticipated development areas (as identified by local planners). To create the maps the authors first researched state and county laws, plans for development, and other policies that affect coastal management decisions. Next, the authors met with state regulators and county planners to further investigate existing and anticipated coastal policies and land uses. The primary question for this study involves many of the same issues that planners routinely consider most important: which areas will become densely developed, which areas will be placed off-limits to

development, and which areas are conservation lands.

During the initial meetings, state and local staff explained which policies would have an effect on the eventual response to sea level rise. The authors then asked state and local planners to consider the anticipated planning responses if sea levels rise 1 to 3 feet in the next 100 years and as much as 10 feet over the next few hundred years. They also discussed public access to the water, economic conditions, areas of cultural or historical importance, and flood-prone areas.

Wherever possible, planners suggested general categories of land, which often would correspond to a designation in a GIS dataset, enabling them to create a generalized sea level rise planning map by applying a GIS “decision rule” to the data. Those general categories consider existing policies that influence future development as well as shoreline armoring and nourishment efforts. For example, a decision rule might be that lands likely to be developed in the near future (e.g., areas zoned for development) are likely to be protected (red). The actual approach in a given county depended on land values, shore protection costs, existing land use policies, and the availability of data needed to apply specific GIS decision rules.

To ensure that the maps correctly conveyed the expectations of county officials, the draft maps were sent to each of the counties. Follow-up “stakeholder review” meetings were conducted at which suggested changes were obtained. Those changes were then incorporated into the accompanying maps. In many cases, additional follow-up conversations were held to clarify issues raised during the stakeholder review meetings.

The mid-Atlantic studies (including an overview synthesis and three technical appendices) were subjected to a first-order peer review; however, they were not formally published by EPA under the guidelines for “highly influential” documents. The other documents (coastal elevations, wetland accretion, and vulnerable habitat) were published in EPA (2008). The authors revised the reports to fully address the peer reviews. The planning studies outside the mid-Atlantic, by contrast, have not been subjected to a peer review and have not been published.

B) Considerations regarding use and interpretation

Before using the planning data included here, it is important to understand several key limitations and caveats of the study. These include:

- The planning maps identify the anticipated likelihood that specific areas will be armored or nourished in response to sea level rise. These delineations are based on land use planning and local-level regulations that control development and shoreline protections. The delineations are not a judgment as to whether or not development and/or protection should occur in a given area.
- The land use, zoning, and other data used in developing these products may no longer be reflective of local conditions. Much of the raw data used in this study was obtained between 2000 and 2004 (and in some cases the vintage of the data source was older). These maps serve as a “snapshot” regarding where shore protection seemed likely at the time of the study.
- While potentially suitable as an off-the-shelf product for analyzing states or multi-state regions, these data may not be appropriate for use in a local-level analysis unless the user is familiar with the locality depicted or intends to use the data as a starting point for additional analysis. Given the frequency of local changes in development pressures, political considerations, and/or economic conditions, the likelihood of development and shore protections may vary. For example, it is possible that areas once considered

unlikely to be developed (e.g., agricultural zoning) have become developed. It will often be the case that large areas once considered likely to become developed have been subsequently subdivided into lands that have been developed and parklands where development is precluded.

- In light of the vintage of the data and the evolving development patterns, users that wish to examine up-to-date shore protection likelihoods at a local scale are encouraged to obtain the most recently created land use and zoning data for the area of interest and then create similar mapping products. As part of such an effort, local planners may also be able to provide more updated information on development and shore protection regulations and plans.
- Although a property along the coast might be developed and protected, there may still be land left open for wetland migration if the structure is set back from the water. As a result, even in locations where shore protection is deemed to be almost certain, there may be some land available for wetland migration. Users are encouraged to consult state and local regulations and other information to determine whether the common practice is to protect backyards from erosion or only structures that are in imminent danger.
- Due to the broad geographic extent and variation in available data, caution should be used when comparing different regions. In some states, updated land use data were available. In other states, the study personnel assembled information on existing development from older data sets along with more extensive information from local planners regarding the location of more recent developments.

C) Use limitations

1. Republishing.

Researchers are free to use this data. However, when reproducing the data provided here, the following statements should be included:

The data on shore protection likelihoods were developed by and under the direction of EPA based upon land use and zoning data as well as the input on development and shore protection considerations from planners. These data should not be used at a scale larger than the scale recommended by the technical report for a given state. Moreover, because of the dynamic nature of local-level development patterns, policies, and zoning, the largest appropriate scale depends on the intended use. Those who intend to use this product as an off-the-shelf data without additional quality control should either limit use to regions the size of a state or larger, or include clear caveats stating that the maps are mostly based on land use between 1995 and 2005. Those who intend to use these data as a starting point for additional analysis or to initiate dialogues on preferred response strategies may find the data appropriate for larger scales, but never larger than the scale recommended by the technical report.

In addition, depending on the states being reproduced, the following disclaimer should also be included.

For the Mid-Atlantic States:

Additionally, although this information was funded by the U.S. Environmental Protection Agency and has been subjected to a stakeholder review and a first-order peer review, it does not necessarily reflect the views of the Agency and no official endorsement should be inferred.

For Florida:

This information was produced under a grant from EPA to the Southwest Florida Regional Planning Council, which subcontracted the analysis to the appropriate Florida regional planning council. The product has been approved for distribution by either the Northeast Florida Regional Planning Council, the East Central Florida Regional Planning Council, the Treasure Coast Regional Planning Council, or the South Florida Regional Planning Council. Nevertheless, it has not been subjected to an EPA-managed peer review, it does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

For CT, RI, SC, and GA:

Additionally, although this information was funded by the U.S. Environmental Protection Agency it does not necessarily reflect the views of the Agency and no official endorsement should be inferred. Although the product was reviewed by local government stakeholders, it has not been subjected to an EPA-managed peer review.

For MA:

Additionally, although this information was funded by the U.S. Environmental Protection Agency it does not necessarily reflect the views of the Agency and no official endorsement should be inferred. Moreover, the product has not been reviewed by local government stakeholders, nor did it receive a final review by the EPA project manager, nor has it been subjected to an EPA-managed peer review.

2. Reproducing or Publishing the Maps.

Map captions should list the researchers who conducted the study, rather than EPA, as the source. An acceptable source citation would be (for example). Tanski, J. New York. 2009. In Titus, J.G. and D. Hudgens. *The Likelihood of Shore Protection* Volume 1. Washington D.C. Draft report to the Environmental Protection Agency.

Disclaimers warning the reader of the data limitations are advisable. A suitable disclaimer in the caption would be (e.g. for a map showing the Delmarva Peninsula):

Note: The study authors warn that this map is based largely on data published between 1997 and 2004, and site-specific changes suggested by planners in 2003 and 2005. From this information, readers can identify the general trends in protection for the study area. Planning decisions at specific locations, however, are subject to change. Consequently, to determine the likelihood of protection for specific locations, readers should contact their local planning department or the state coastal zone management program.

Examples of caveats with maps throughout the mid-Atlantic are found on the CDs.

Conclusion

The U.S. EPA is pleased to provide the enclosed elevation and sea level rise planning studies and

data to you based upon your request.

However, we want to emphasize that **although the information in the enclosed DVDs and/or CDs has been funded wholly by the U.S. Environmental Protection Agency it does not necessarily reflect the views of the Agency and no official endorsement should be inferred. Additionally, many of these materials were never fully completed and thus are provided here only in a draft stage. Special precaution should be taken when analyzing and using this data.**

If you have technical questions regarding the information contained in this memorandum, please contact Jim Titus at 202.343.9307. If you have other questions, please contact me at 202.343.9076.