Resilience of Coastal Wetlands to Sea Level Rise, CONUS, 1996-2100

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Documentation Revision Date: 2021-11-30

Dataset Version: 1

Summary

This dataset provides information about the resilience of tidal wetlands to sea-level rise under three scenarios of global change. With rising seas, regularly inundated tidal wetlands may persist by vertical accretion of sediments (vertical resilience) and/or by migrating inland (lateral resilience), but local and regional conditions constrain these options. This dataset provides a vertical resilience index (VR) for coastal wetlands at 30 m resolution across the continental US predicted for 2100. The VR index was computed for current sea levels, local tidal dynamics, and coastal topography. It was also calculated for future sea levels predicted for 2100 by three IPCC Realized Concentration Pathway (RCP) scenarios: 2.5, 4.5, and 8.5. Moreover, the VR index incorporates estimated rates of sediment accretion. Relevant to lateral resiliency, the data include current and future tidal areas identified by mapping mean higher high water spring tide locations under the RCP scenarios. A shapefile outlining watershed units with tidal wetlands is included along with land cover classes for these areas for 1996 and 2011.

The study area was geographically defined by mapping all contiguous USA coastal watersheds containing tidal wetlands based on the National Wetlands Inventory (NWI) for each coastal state including Washington, Oregon, California, Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey, Pennsylvania, New York, Rhode Island, Connecticut, Massachusetts, New Hampshire, and Maine. The VR index is based on the local tidal range and relative sea-level rise. Spatial data on tidal range, mean higher high water spring tide (MHHWS) line, elevation relative to MHHWS were used to identify tidal areas subject to sea-level rise. The supporting analysis used 1,004 accretion rates from 116 different studies in emergent tidal marshes of North America.

There are 13 data files included in this dataset: 11 files in GeoTIFF (*.tif) format, one compressed shapefile (*.zip), and one file in comma-separated values (*.csv) format.

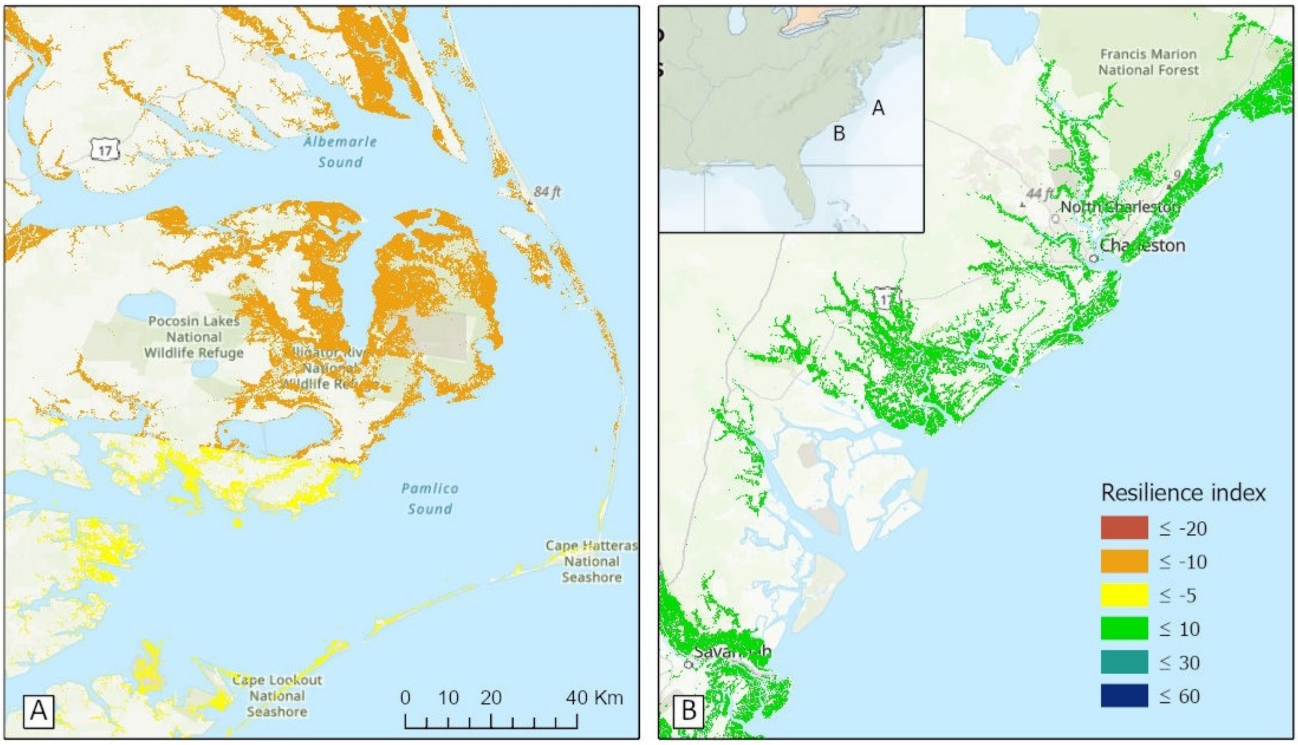

Figure 1. Contrasting levels of resilience of tidal marshes to sea-level rise in eastern North Carolina (A) and coastal South Carolina (B), U.S. Lower values of resilience indicate increased vulnerability of these wetlands to impacts of rising sea levels as modeled from RCP 4.5. Source: vertical_resilience_index_30m_2000to2100_RCP4p5.tif

Citation

Holmquist, J.R., L.N. Brown, and G.M. Macdonald. 2021. Resilience of Coastal Wetlands to Sea Level Rise, CONUS, 1996-2100. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1839

Table of Contents

1. Dataset Overview

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Project: Carbon Monitoring System

The NASA Carbon Monitoring System (CMS) is designed to make significant contributions in characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes. The System will use the full range of NASA satellite observations and modeling/analysis capabilities to establish the accuracy, quantitative uncertainties, and utility of products for supporting national and international policy, regulatory, and management activities. CMS will maintain a global emphasis while providing finer scale regional information, utilizing space-based and surface-based data, and will rapidly initiate generation and distribution of products both for user evaluation and to inform near-term policy development and planning.

Related Publications

Holmquist, J.R., L.N. Brown, and G.M. MacDonald. 2021. Localized scenarios and latitudinal patterns of vertical and lateral resilience of tidal marshes to sea-level rise in the contiguous United States. Earth's Future 9:e2020EF001804. https://doi.org/10.1029/2020EF001804

Related Dataset

Holmquist, J.R., L. Windham-Myers, B. Bernal, K.B. Byrd, S. Crooks, M.E. Gonneea, N. Herold, S.H. Knox, K. Kroeger, J. Mccombs, P.J. Megonigal, L. Meng, J.T. Morris, A.E. Sutton-grier, T. Troxler, and D. Weller. 2019. Coastal Wetland Elevation and Carbon Flux Inventory with Uncertainty, USA, 2006-2011. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1650

- Sea level datums from this dataset were used to create sea level rise simulations for the current dataset.

Acknowledgments

This study was funded by the NASA Carbon Monitoring System (grant NNH14AY67I).

2. Data Characteristics

Spatial Coverage: Coastal watersheds of the contiguous United States (CONUS)

Spatial Resolution: 30 m

Temporal Coverage: 1996-01-01 to 2100-12-31

Temporal Resolution: Once

Study Area: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Longitude	Southernmost Latitude
CONUS	-127.9840278	-64.96774722	49.2068823	22.72757778

Data File Information

There are 13 data files included in this dataset: 11 files in GeoTIFF (*.tif) format, one compressed shapefile (*.zip), and onef ile in comma-separated values (*.csv) format.

Table 1. File names and descriptions.

File Name	Description
slr_zone_30m_2100_RCPxxx.tif	Three files, one for each RCP (xxx = 2p6, 4p5, or 8p5), with the projected SLR zone by 2100 according to modern mean higher high water spring (MHHWS) tide maps from Holmquist et al., (2018) and localized SLR scenarios by Kopp et al. (2014). 1 = below modern MHHWS 2 = below projected future MHHWS
slr_zone_landcover_30m_2100_RCPxxx.tif	Three files, one for each RCP (xxx = 2p6, 4p5, or 8p5), with landcover of the modern potential tidal areas by 2100. Values are defined in the file CCAP_1996to2011_classes.csv (Table 3).
	Three files, one for each RCP (xxx = 2p6, 4p5, or 8p5), for vertical resilience

vertical_resilience_index_30m_2000to2100_RCPxxx.tif	index, spatially extrapolated and downscaled to a 30 m resolution map of potential tidal wetlands. Data have units of mm x 10 per year.
vertical_resilience_index_30m_1996to2011.tif	Vertical resilience index, spatially extrapolated and downscaled to a 30 m resolution map of potentially tidal wetlands representing the recent past. Data have units of mm x 10 per year.
coastal_wetland_landcover_30m_2011.tif	Landcover of modern potentially tidal area. Values are defined in the file CCAP_1996to2011_classes.csv (Table 3).
coastal_intermediate_watershed_units.zip	A compressed shapefile (*.shp) providing the hydrological Unit Code 8 (HUC8) intermediate scale watershed units, identified as containing tidal wetlands according to the national wetlands inventory (NWI).
CCAP_1996to2011_classes.csv	Definitions of C-CAP landcover classes which provide the metadata for cell values in the landcover data file.

Data File Details

For all GeoTIFF files,

- EPSG: 42303
- Projection: Albers Conical Equal Area
- Datum: North American Datum 1983
- Spheroid: GRS 1980, 6378137,298.2572221010042
- Map units: meters
- Bands: 1
- Scaling: 1

Table 2. Attributes in the file coastal_intermediate_watershed_units.shp.

FID	Feature Identification
Shape	Defines that each shape is a polygon
States	Character string indicating which U.S. state or states the watershed unit terraces.
HUC8	Unique code for each watershed unit
Name	Name of each watershed unit
Abbrev	Abbreviated name for each watershed unit
INSIDE_X	Longitude of centroid of the polygon in decimal degrees.
INSIDE_Y	Latitude of centroid of the polygon in decimal degrees.

Table 3. Definitions of C-CAP landcover classes in the file CCAP_1996to2011_classes.csv.

Column	Description
Value	Integer corresponding to a C-CAP-based landcover map
Class_1996	Landcover class in 1996
Class_2011	Landcover class in 2011
Class_Name	Full name of the landcover class

3. Application and Derivation

Coastal wetlands stores are key carbon sinks and methane drivers important to national greenhouse gas inventorying and closing carbon budgets at the terrestrial aquatic interface. However, coastal wetlands of the contiguous U.S. are geographically diverse in terms of their local relative sea-level rise forcing, their tidal ranges, and the adjacent land cover class and slope. The loss of wetland to sea-level rise may result in catastrophic loss of carbon stocks; inland migration represents a potential (though uncertain) replacement for lost carbon. The attached files are part of a study mapping geographic patterns of vertical and lateral resilience/vulnerability of tidal wetlands to localized sea-level rise, given modern accretion and sea-level rise data (Holmquist et al., 2020), tidal datum (Holmquist et al., 2018), and landcover data (NOAA, 2013), and localized sea-level rise scenarios by Kopp et al. (2014).

4. Quality Assessment

The net-accretion model was calibrated using modern data and extrapolated out into the future using projected SLR. Future conditions may be out of the boundaries of the calibration dataset (Holmquist et al., 2021).

5. Data Acquisition, Materials, and Methods

Study Area

The contiguous U.S. coastal watersheds containing tidal wetlands were mapped based on the National Wetlands Inventory (NWI) (USFWS, 2014). NWI data were downloaded for each oceanic coastal state including Washington, Oregon, California, Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey, Pennsylvania, New York, Rhode Island, Connecticut, Massachusetts, New Hampshire, and Maine. NWI polygons were included with a tidal modifier of "E" or "M," indicating estuarine or marine systems, or with both a "P," indicating palustrine system, and "R," "S," "T," or "V," which indicate palustrine tidal systems. For watershed units, Hydrologic Unit Code Level 8 (HUC8) was used for boundaries (USDA-NRCS, 2015).

Vertical Resilience Index

Relative sea-level rise (RSLR) measures sea-level changes while considering local changes in substrate elevation due to geological forces including sediment accretion. For this study, RSLR was calculated from contemporary local tidal elevation adjusted by rates of sediment accretion over time. Vertical sediment accretion was predicted as a function of relative sea-level rise (RSLR), greater diurnal tidal range (GT), and relative elevation class using a linear model (Holmquist et al., 2021). Net-accretion rates varied across major geographic gradients.

Vertical resilience (VR) was estimated by the equation

$$VR = (0.61\ RSLR + 1.4\ GT + 0.39) – RSLR$$

where RLSR is in mm yr-1 and GT is in m. VR was estimated at sites of 75 NOAA tidal gauges using their local RSLR and GT values. Then, VR was extrapolated spatially across the study area using Empirical Bayesian Kriging in ArcGIS Pro (Esri Inc., 2017). Settings included an output cell size of 300 m, no data transformation, a power semivariogram model, 100 maximum local points in each model, a local model area overall factor of 1, and 100 simulated semivariograms. Kriging algorithm used a standard circular search neighborhood with 15 maximum neighbors and a radius of 15 cells. VR was mapped for current conditions (1996–2011) and for future sea levels predicted by the RCP scenarios (Kopp et al., 2014).

Lateral Resilience

The ability for tidal wetlands to move inland under rising sea levels confers lateral resilience. Areas potentially available for inland marsh migration were identified by mapping the mean higher high water spring (MHHWS) tide locations (Holmquist et al., 2018; Holmquist and Windham-Myers, 2021). Tidal zones, defined as being below MHHWS, were mapped under current conditions and for future sea levels predicted by the RCP scenarios (Kopp et al., 2014). These SLR zone maps can be overlain on coastal wetland landcover to view the landcover types likely to be affected by sea-level rise and inland migration of tidal wetlands. See Holmquist et al. (2021) for details of this analysis.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

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Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

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