Tidal Wetlands Soil Organic Carbon and Estuarine Characteristics, USA, 1972-2015

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Documentation Revision Date: 2019-10-30

Dataset Version: 1

Summary

This dataset provides a synthesis of soil organic carbon (SOC) estimates and a variety of other environmental information from tidal wetlands within estuaries in the conterminous United States for the period 1972-2015. The data were compiled from several existing data resources and include the following: soil organic carbon stock estimates, the proportion of the catchment area containing the wetlands that is barren, tidal wetland area, nontidal wetland land, open water, saltwater zone, mixed zone, agricultural, urban, forest, and wetland areas, land elevation, ocean salinity, sea surface temperature, ocean dissolved inorganic phosphorus, estuary latitude, longitude, depth, perimeter, salinity, and estuary volume, river flow, carbon, nitrogen, and phosphorus river flux, sediment organic carbon content, windspeed, mean temperature, daily and mean precipitation, frost days, and the population within each catchment. Estuaries were also classified to one of six typological categories. Coastal locations were determined by natural environmental and political divisions within the US. The data were used to investigate how tidal wetland soil organic carbon density is distributed across the continental US among various coastal locations, estuarine typologies, vegetation types, water regimes, and management regimes, and to identify whether SOC density is correlated with different environmental variables. The analytical results are not included with this dataset.

There is one comma-separated (.csv) data file with this dataset.

Figure 1. Estuaries were assigned to one of six estuarine typological classes in the study: former river valley primary estuary, former glacier valley primary estuary, river delta primary estuary, tectonic structural primary estuary, coastal lagoon secondary estuary, and unclassified estuary (Hinson et al., 2019).

Citation

Hinson, A.L., R.A. Feagin, and M. Eriksson. 2019. Tidal Wetlands Soil Organic Carbon and Estuarine Characteristics, USA, 1972-2015. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1742

Table of Contents

1. Dataset Overview

This dataset provides a synthesis of soil organic carbon estimates and a variety of other environmental information from tidal wetlands within estuaries in the conterminous United States for the period 1972-2015. The data were compiled from several existing data resources and include the following: soil organic carbon stock estimates, the proportion of the catchment area containing the wetlands that is barren, tidal wetland area, nontidal wetland land, open water, saltwater zone, mixed zone, agricultural, urban, forest, and wetland areas, land elevation, ocean salinity, sea surface temperature (sst), ocean dissolved inorganic phosphorus, estuary latitude, longitude, depth, perimeter, salinity, and estuary volume, river flow, carbon, nitrogen, and phosphorus river flux, sediment organic carbon content, windspeed, mean temperature, daily and mean precipitation, frost days, and the population within each catchment. Estuaries were also classified to one of six typological categories. Coastal locations were determined by natural environmental and political divisions within the US. The data were used to investigate how tidal wetland soil organic carbon (SOC) density is distributed across the continental US among various coastal locations, estuarine typologies, vegetation types, water regimes, and management regimes, and to identify whether SOC density is correlated with different environmental variables. The analytical results are not included with this dataset.

Project: North American Carbon Program (NACP)

The North American Carbon Program (NACP) is a multidisciplinary research program to obtain scientific understanding of North America's carbon sources and sinks and of changes in carbon stocks needed to meet societal concerns and to provide tools for decision makers. The NACP is supported by a number of different federal agencies. The central objective is to measure and understand the sources and sinks of Carbon Dioxide (CO2), Methane (CH4), and Carbon Monoxide (CO) in North America and in adjacent ocean regions.

Related Publication:

Hinson, A.L., Feagin, R.A., and Eriksson, M. (2019). Environmental Controls on the Distribution of Tidal Wetland Soil Organic Carbon in the Continental United States. Global Biogeochemical Cycles. DOI: 10.1029/2019GB006179

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2. Data Characteristics

Spatial Coverage: Estuaries and coastal areas in the Continental US

Spatial Resolution: Multiple points

Temporal Coverage: 1972-01-01 to 2015-12-31

Temporal Resolution: Annual estimates

Study Areas (All latitude and longitude given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Estuaries and coastal areas in the Continental US	-124.385	-67.0547	47.82224	25.18731

Data File Information

There is one data file in comma-separated (.csv) format with this dataset: *tidal_wetland_estuaries.csv*

This file provides estuarine data for the continental United States tidal wetlands for the period 1972 -2015. The data were compiled from several existing data sources (see Table 2) or were calculated.

Table 1. Variables in *tidal_wetland_estuaries.csv*

Variable name	Units	Description
edacda	Letter followed by 3 numbers	Estuary and coastal drainage areas code consisting of a letter followed by 3 numbers; example, G120, from CAF
name		Estuary name from CAF
coast		Coast location from CoBluCarb
wet_area	km2	Total tidal wetland area from CoBluCarb
stock_0-15_low	Tg	SOC stock low estimate from CoBluCarb
stock_0-15_high	Tg	SOC stock high estimate (0-15cm depth) from CoBluCarb
awd_0-15	g/cm3	Area weighted SOC density (0-15cm depth) from CoBluCarb
estu_area	m2	Estuary area (open water area) calculated from AREA_MI2 attribute from CAF database
estu_latitude	decimal degrees	Center point latitude for estuary (centroid Y)
estu_longitude	decimal degrees	Center point longitude for estuary (centroid X)

estu_depth	m	Estuary depth from digital bathymetric chart if available; otherwise NOAA planimetry (est_z = V/water_area)
estu_perimeter	m	Estuary perimeter
land_area	m2	Land area (drainage area) calculated from AREA_MI2 attribute from CAF database
land_latitude	decimal degrees	Center point latitude for catchment (centroid Y)
land_longitude	decimal degrees	Center point longitude for catchment (centroid X)
land_mean_elev	m	Mean catchment elevation calculated from catchment shapefiles + Hydro1K (a global 1-km grid of elevation)
land_max_elev	m	Maximum catchment elevation calculated from catchment shapefiles + Hydro1K (a global 1-km grid of elevation)
urban_area	m2	USGS Land Use and Land Cover (LUDA) for entire watershed 1972 with CENSUS 1990 information, base year early 1990s
agri_area	m2	Agricultural area: USGS Land Use and Land Cover (LUDA) for entire watershed 1972 with CENSUS 1990 information, base year early 1990s
forest_area	m2	Forested area: USGS Land Use and Land Cover (LUDA) for entire watershed 1972 with CENSUS 1990 information, base year early 1990s
nontidal_wetl_area	m2	Nontidal wetland area: USGS Land Use and Land Cover (LUDA) for entire watershed 1972 with CENSUS 1990 information, base year early 1990s
range_area	m2	Range area: USGS Land Use and Land Cover (LUDA) for entire watershed 1972 with CENSUS 1990 information, base year early 1990s
barren_area	m2	Barren, non-vegetated area: USGS Land Use and Land Cover (LUDA) for entire watershed 1972 with CENSUS 1990 information, base year early 1990s
population		Population within each catchment; based on gridded (1-km) US 1990 census data, corrected for catchments extending outside US (with LANDSCAN)
tide_ht	m	NOAA estimate of tide height, back-calculated from tide volume; in some cases guessed from nearby systems
daily_precip	m3/d	Direct precipitation on system, derived from PRISM shapefile
daily_evap	m3/d	Direct evaporation from system, derived from LOICZ 0.5 degree database
freshwater_area	m2	Tidal Fresh area, calculated from NOAA shapefiles
mix_area	m2	Mixing Zone area, calculated from NOAA shapefiles
saltwater_area	m2	Saltwater area, calculated from NOAA shapefiles
estu_salinity	psu	Based on NOAA estimate of freshwater volume
ocean_salinity_mean	psu	From LOICZ 0.5 degree database, originally from World Ocean Atlas, ANNUAL ESTIMATE FOR OPEN SHELF
ocean_salinity_max	psu	From LOICZ 0.5 degree database, originally from World Ocean Atlas, ANNUAL ESTIMATE FOR OPEN SHELF
ocean_salinity_min	psu	From LOICZ 0.5 degree database, originally from World Ocean Atlas, ANNUAL ESTIMATE FOR OPEN SHELF
air_temp_mean	degrees C	Mean air temperature for estuary, derived from LOICZ 0.5 degree database
frost_days_per_yr		Number of frost days per year for estuary, derived from LOICZ 0.5 degree database
windspeed	m/s	Estuary windspeed derived from LOICZ 0.5 degree database
ocean_sst_mean	degrees C	Mean ocean sea surface temperature from LOICZ 0.5 degree database, originally from World Ocean Atlas, ANNUAL ESTIMATE FOR OPEN SHELF
ocean_diss_inorg_p	uM	Ocean dissolved inorganic phosphorous from LOICZ 0.5 degree database, originally from World Ocean Atlas, ANNUAL ESTIMATE FOR OPEN SHELF
ocean_no3	uM	Ocean nitrate from LOICZ 0.5 degree database, originally from World Ocean Atlas, ANNUAL ESTIMATE FOR OPEN SHELF
typl_1		Estuarine Typology: R: former river valley primary estuary, G: former glacier valley primary estuary, D: river delta primary estuary, T: tectonic structural primary estuary, S: coastal lagoon secondary estuary, and U: unclassified estuary
wetland_area	m2	Tidal Wetland Area
river_flow	m3/d	Freshwater Inflow (from SPARROW)
river_total_n_flux	mol/d	Mean daily river total nitrogen flux (from SPARROW)
river_total_c_flux_total_wetl	mol/d	Daily river influx of total organic carbon including approximate load from tidal wetlands (from SPARROW)
sparrow_total_wet_area	m2	Tidal wetland area (from SPARROW)
river_tot_p_flux	mol/d	Mean total influx of daily phosphorous (from SPARROW)

estu_vol	m3	Estuarine depth by the estuarine area (estu_depth * estu_area)
tide_vol	m3	Tide volume: (tide_ht * estu_area)
tide_flow	m3/d	The tidal flow: (tide_vol * tides_per_day)
tau_salt	d	Residence time: (estu_vol/(river_flow + daily_precip - daily_evap) * (1-estu_salinity/ ocean_salinity_mean)
tau_flush	d	The estuarine flushing time estimated by: Flushing Time = estu vol/(tidal flow + river flow)
mean_precip	inch	Precipitation (30-yr avg) spatially calculated from PRISM based on CoBluCarb boundaries
mean_temp	degrees C	Temperature (30-yr avg) spatially calculated from PRISM based on CoBluCarb boundaries

3. Application and Derivation

Tidal wetlands contain relatively high quantities of soil organic carbon. Estuarine-level analysis could provide a better understanding for the conditions that lead to enhanced or degraded carbon sequestration rates in times of rapid global change and could lead to future conservation efforts within specific estuarine boundaries.

In Hinson et al. (2019), tidal wetland SOC density was investigated in conjunction with associated environmental characteristics. The data used are provided in this dataset.

4. Quality Assessment

Normality and heteroscedasticity is discussed in detail in the paper associated with the data. For any direct uncertainty data, the original source of the data should be referenced.

5. Data Acquisition, Materials, and Methods

Following is a brief synopsis of the data compilation and derivation activities. Please see Hinson et al. (2019) for details and additional data source information.

Data compilation

Identifiers and geographic variables

The variables originated from, or were calculated from, the National Estuarine Eutrophication Assessment (NEEA), the National Oceanic and Atmospheric Administration's Coastal Assessment Framework (CAF), and the United States Geographical Survey's SPAtially Referenced Regressions On Watershed attributes (SPARROW) (Table 2). The values for each variable were sourced from the CAF dataset, unless otherwise explicitly stated. The set of environmental variables that varied by coordinates and geographic boundaries (considered geographic variable set) included the total catchment size (total watershed basin), estuary latitude and longitude (for the estuarine waters portion of the catchment only), the estuarine area (the open water area only), the land area (drainage area only), the tidal wetland area (from CoBluCarb database), the tidal wetland area (from SPARROW), the average tidal height, the tidal volume, and the tidal flow (the tidal volume divided by the tides per day).

Soil organic carbon

SOC densities were aggregated separately for each scale from United States SOC database, CoBluCarb (Hinson et al.,2017; see also https://bluecarbon.tamu.edu). This database was created using spatially explicit data from United States Department of Agriculture's Soil Survey Database (SSURGO) and National Wetland Inventory (NWI) database. In Hinson et al. (2017), all methods and assumptions for CoBluCarb are discussed.

Coastal location

The coastal location factor was determined by natural environmental and political divisions within the US. The individual wetlands on the East and West Coast are primarily arrayed across latitude, whereas those on the Gulf Coast are primarily arrayed across longitude. The division between the East and Gulf Coasts in southern Florida was based on county lines closest to the tip of the Florida Peninsula.

Estuarine typology

Based on the estuarine typology descriptions described in Bianchi (2007), there were six estuarine typological levels considered:

(1) former river valley primary estuary (n=170,194),

(2) former glacier valley primary estuary (n=12,049),

(3) river delta primary estuary (n=19,916),

(4) tectonic structural primary estuary (n=5,132),

(5) coastal lagoon secondary estuary (n=144,666), and

(6) unclassified estuary (n=27,932).

These six levels were also grouped into primary (n=207,291) and secondary estuary systems (n=144,666). Coastal drainage areas (CDA) (n=56,677) were added for additional analysis (Figure1). The Coastal Assessment Framework (or 'CAF' dataset, National Ocean Service) defines both estuarine (EDAs) and coastal drainage areas (CDAs). The majority of tidal wetlands fall within the EDAs and the Bianchi (2007) typology is one possible method to group them (Hinson et al., 2019).

Oceanic variables

The oceanic variables included the ocean salinity (minimum, mean, and maximum), sea surface temperature (mean), ocean nitrate, ocean dissolved inorganic phosphorus, estuarine salinity (mean), estuarine depth, estuarine perimeter, saltwater zone area, mixed zone area, freshwater tidal area, estuarine volume (estuarine depth by the estuarine area), estuarine residence time, and estuarine flushing time. The equation used to determine estuarine residence time was:

Residence time = EST. vol / (riv.flow + daily precip-daily evap) *(1-est sal/mean ocean sal)

For this equation, the daily precipitation was derived from the NEEA.

The estuarine flushing time was estimated by:

Flushing Time = EST vol/(tidal flow + river flow)

Catchment and riverine variables

The terrestrial variables included the proportion of the catchment area containing the wetlands that is barren (non-vegetated) land, rangeland, non-tidal wetland, forested area, agricultural area, and urban area, the population within each catchment, the maximum and mean catchment elevations, daily freshwater inflow quantity (mean), daily riverine flux of total nitrogen (mean), daily riverine flux of total organic carbon (mean), daily riverine influx of total organic carbon including approximate load from tidal wetlands, and the daily riverine influx of total phosphorous (mean). All river-related variables were derived from the SPARROW dataset.

Meteorological variables

The atmospheric set of variables included the 30-year averages for precipitation and temperature (both modeled from Oregon State PRISM, 2017), daily evaporation, wind speed, air temperature (mean), daily precipitation, and frost days per year (latter five were determined from the NEEA database) (Hinson et al., 2019).

Table 2. Data sources

CAF: National Oceanic and Atmospheric Administration (NOAA). 2012. Coastal Assessment Framework. http://coastalgeospatial.noaa.gov/ or http://coastalsocioeconomics.noaa.gov.
CoBluCarb: Hinson, A. L., Feagin, R. A., Eriksson, M., Najjar, R. G., Herrmann, M., Bianchi, T. S.,et al. (2017). The spatial distribution of soil organic carbon in tidal wetland soils of the continental United States. Global Change Biology, 23(12), 5468-5480. https://doi.org/10.1111/gcb.13811
Land Ocean Interactions in the Coastal Zone (LOICZ): https://ian.umces.edu/loicz/ or http://www.ihdp.unu.edu/organizations/?id=87
LANDSCAN: https://landscan.ornl.gov/
NEEA: National Estuarine Eutrophication Assessment (NEEA). Available at https://ian.umces.edu/neea/
SPARROW: Schwarz, G.E., Hoos, A.B., Alexander, R.B., and Smith, R.A., 2006, The SPARROW Surface Water-Quality Model—Theory, Applications and User Documentation: U.S. Geological Survey, Techniques and Methods 6–B3, 248 p. Available at: https://pubs.usgs.gov/tm/2006/tm6b3/
PRISM: PRISM Climate Group. (2017). PRISM Climate Data. 1991-2017, 2017
USGS Land Cover: https://archive.usgs.gov/archive/sites/landcover.usgs.gov/usgslandcover.html

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

Bianchi, T.S. (2007). Biogeochemistry of estuaries. New York, NY: Oxford University Press.

Hinson, A.L., Feagin, R.A., and Eriksson, M. (2019). Environmental Controls on the Distribution of Tidal Wetland Soil Organic Carbon in the Continental United States. Global Biogeochemical Cycles. DOI: 10.1029/2019GB006179

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