

Biogeochemical properties of sediment cores from Barataria Basin, Louisiana, 2018 and 2019

Website: <https://www.bco-dmo.org/dataset/833824>

Data Type: Other Field Results

Version: 1

Version Date: 2020-12-16

Project

» [Fate of Coastal Wetland Carbon Under Increasing Sea Level Rise: Using the Subsiding Louisiana Coast as a Proxy for Future World-Wide Sea Level Projections](#) (Submerged Wetland Carbon)

Contributors	Affiliation	Role
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Abstract

Eleven soil cores (~2 m deep) were collected, one meter inland from the marsh edge, from four sites within Barataria Basin, LA, USA in Sept. 2018 and Aug. 2019. In addition, three soil cores (0.5 m deep) taken from the estuarine bottom 25 m offshore from the edge of a marsh site. During sampling, the depth of the estuary was 1 m relative to the marsh surface. The cores were sectioned into 10 cm intervals and analyzed for soil biogeochemical properties with depth.

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Coverage

Spatial Extent: N:29.446837 E:-89.899836 S:29.443585 W:-89.90633

Temporal Extent: 2018-09 - 2019-08

Dataset Description

Eleven soil cores (~2 m deep) were collected, one meter inland from the marsh edge, from four sites within Barataria Basin, LA, USA in Sept. 2018 and Aug. 2019. In addition, three soil cores (0.5 m deep) taken from the estuarine bottom 25 m offshore from the edge of a marsh site. During sampling, the depth of the estuary was 1 m relative to the marsh surface. The cores were sectioned into 10 cm intervals and

analyzed for soil biogeochemical properties with depth.

Acquisition Description

Soil Sampling:

Eleven soil cores (~ 2 m deep) were collected 1 m inland from the marsh edge two marsh islands in Barataria Basin, Louisiana. A polycarbonate core tube (2.6 m x 7.6 cm diameter) was used to extract soil samples via the push core method. In addition, triplicate cores (50 cm deep) were collected using a piston corer from the estuarine bottom, at 25 m from the edge of a island at a water depth of 1 m. Soils were extruded in the field, sectioned into the 10-cm intervals and placed and sealed in zip-lock bags. Samples were stored on ice, immediately transported to Louisiana State University (LSU), and stored at 4 degrees C until analysis

Moisture Content:

Drying a subsample of soil using a gravimetric oven at 60 °C until a constant weight was achieved. Dried soils were ground using a mortar and pestle.

Bulk Density:

The bulk density of each sample was determined by calculating the total dry weight of the sample and then dividing by the volume of the 10 cm section of the core (384.85 cm³).

Organic Matter Content:

Dried, ground sub- samples were burned at 550°C in a muffle furnace for 4 h to determine percent organic matter using the loss-on ignition technique (Sparks, 1996).

Total Carbon:

Total Carbon content was determined on ground samples using elemental combustion system (Costech Analytical Technologies, Valencia, CA).

Carbon Density:

The volumetric concentration of the TC (g cm⁻³; carbon density) was determined by dividing the amount of TC in 10 cm section of the core by the volume of the 10 cm section of the core.

Labile Carbon:

The molecular complexity of the organic matter was determined from dried and ground soil subsamples through a H₂SO₄ extraction following Rovira & Vallejo (2002) and Oades et al. (1970) with modifications by Steinmuller & Chambers (2019). The organic matter was fractionated into two groups-1) Labile pool (LPC) consisting of plant or microbially derived non-cellulosic polysaccharides, hemicellulose, and cellulose and 2) Refractory pool (RPC) consisting of klason lignin, fats, waxes, resins, and suberins (Rovira & Vallejo, 2002). To extract LPC, 2 mL of 26 N H₂SO₄ was added to a flask containing ~0.5 g of dried and ground soil. The solution was shaken in an orbital shaker at 100 rpm for 14 h and diluted to a concentration of 2 N H₂SO₄ by adding 26 mL of nanopure water. The resulting solution was heated at 105 degrees C for 3 h, allowed to cool, filtered through Watman #41 filters, and then diluted to a final volume of 50 mL. The concentration of LPC carbon was determined using Shimadzu TOC (Shimadzu, Kyoto, Japan).

Refractory Carbon:

The amount of refractory carbon was calculated by deducting the labile pool of carbon from the total carbon content of the soil.

Total Nitrogen:

Total Carbon content was determined on ground samples using elemental combustion system (Costech Analytical Technologies, Valencia, CA).

Total Phosphorus:

A 0.2-0.5 g subsamples were weighed in 50 ml glass beakers and burned in a muffle furnace at 550 degrees C for 4 h. Total phosphorus was determined by acid digesting ashed samples following Andersen

(1976) and analyzed colorimetrically using a SEAL AQ2 Automated Discrete Analyzer (SEAL Analytical Inc, Mequon, Wisconsin) with a detection limit of 0.002 mg P L⁻¹ (USEPA 1993).

Total Inorganic Phosphorus:

Total inorganic phosphorus (TIP) was extracted from dried and ground samples following Richardson and Reddy (2013). Samples of 0.3-0.5 g were weighed in centrifuge tubes, and equilibrated with 25 ml of 1 M HCl for 3 hours in a longitudinal shaker, centrifuged for 10 minutes at 5000 g, and vacuum filtered through a 0.45 µm filter. The filtered solution was analyzed for TIP colorimetrically using a SEAL AQ2 Automated Discrete Analyzer (SEAL Analytical Inc, Mequon, Wisconsin) with a detection limit of 0.002 mg P L⁻¹ (USEPA 1993).

Total organic Phosphorus:

Total organic phosphorus (TOP) was determined by difference of total inorganic phosphorus from total phosphorus.

Enzyme Activities (β-glucosidase, β-xylosidase, and alkaline phosphatase):

Extracellular enzyme assays were performed within 48 hours of the sample collection to determine the activity of β-glucosidase, β-xylosidase, and alkaline phosphatase. Soils from the triplicate marsh and estuary cores were analyzed. Marsh soils were analyzed on a 30 cm depth interval from the surface to the depth of 160-170 cm. The estuary cores were analyzed on alternate depths from the surface to 40-50 cm depth. Enzyme Assays were performed using fluorescent substrate 4-methylumbelliferone (MUF) for standardization and fluorescently labeled MUF-specific substrates (German et al., 2011). A soil slurry was created adding ~1 g of moist soil to 40 mL of deionized water and shaken on an orbital shaker for 1 h at 25 degrees C and 150 rpm. Fluorescence was measured at excitation/emission wavelengths 360/460 on a BioTek Synergy HTX (BioTek Instruments, Inc., Winooski, VT, USA) both immediately after substrate and sample were added and 24 h later to determine a rate of enzyme activity.

Potentially mineralizable nitrogen (PMN) and phosphorus (PMP):

Soils from triplicate marsh and estuary cores (same depth interval as enzyme activity) were incubated following White & Reddy (2000) to determine PMN and PMP rates. Four sets of samples were assigned a time of 0, 2, 5, and 10 days of incubation at 40 degrees C. For zero-day sample, field-moist soil (~5 g) was weighed into 40 mL centrifuge tubes with 25 mL of 2M KCl added, shaken on an orbital shaker at 150 rpm and 25 degrees C for 30 min, and centrifuged at 4,000 g for 10 min at 10 degrees C. Each sample was vacuum-filtered through 0.45 µm membrane filters, acidified to a pH of <2 with sulfuric acid, and stored at 4 degrees C. For 2, 5, and 10 days samples, field moist soil (~10 g) was weighed in to a 40 mL glass serum bottle and sealed with rubber septa and aluminum crimp. Head space was evacuated until -75 kPa, purged with N₂ gas for 10 min, and 15 mL of N₂ purged filtered site water was then added through a syringe to create a slurry. The serum bottles were incubated at 40 degrees C and shaking at 120 rpm in an Incubated Shaker (IS-971, Jeio Tech Lab Companion, Daejeon, Korea). On the designated day, samples were removed from the incubator, added with 25 mL of 2M KCL using a syringe, and placed in a shaker for 30 min. Then samples were transferred to 40 mL centrifuge tubes and centrifuged at 5,000 g for 10 min at 10 degrees C. Each sample was vacuum-filtered through 0.45 µm membrane filters, acidified to a pH of <2 with ultrapure concentrated sulfuric acid, and stored at 4 degrees C. Each sample was analyzed for extractable ammonium (NH₄⁺) and soluble reactive phosphorus (SRP) colorimetrically using a SEAL AQ300 Automated Discrete Analyzer (SEAL Analytical Inc, Mequon, Wisconsin) with a detection limit of 0.01 mg N L⁻¹ and 0.002 mg P L⁻¹ (USEPA, 1993). The PMN and PMP rates were determined by regressing NH₄⁺ and SRP concentrations over incubation time.

Extractable Ammonia and soluble reactive phosphorus (SRP):

Field-moist soil (~5 g) was weighed into 40 mL centrifuge tubes with 25 mL of 2M KCl added, shaken on an orbital shaker at 150 rpm and 25 degrees C for 30 min, and centrifuged at 5,000 g for 10 min at 10 degrees C. Each sample was vacuum-filtered through 0.45 µm membrane filters, acidified to a pH of <2 with sulfuric acid, and stored at 4 degrees C. Each sample was analyzed for extractable ammonium (NH₄⁺) and soluble reactive phosphorus (SRP) colorimetrically using a SEAL AQ300 Automated Discrete Analyzer (SEAL Analytical Inc, Mequon, Wisconsin) with a detection limit of 0.01 mg N L⁻¹ and 0.002 mg P L⁻¹ (USEPA, 1993).

Processing Description

Statistical analyses were performed using R (Version 3.5.3; R Foundation for Statistical Computing, Vienna, Austria) in RStudio (Version 1.1.456; RStudio Inc., Boston, MA, USA). All the soil physiochemical data except carbon density were log-transformed to achieve the condition of normality. An ANOVA was run on soil physiochemical data with site, depth, and interaction as fixed effects. The multiple comparisons were done using the Tukey HSD method and Bonferonni correction was applied to the significance level (alpha value = 0.002). The soil physiochemical properties for marsh edge and submerged soil were compared using Welch two-sample t-test. The plots were prepared as means (\pm standard error) by soil depth using ggplot2 package in R (Wickhm, 2016). The correlation coefficients between soil properties were obtained from JMP (SAS Institute, Carry, NC, USA).

BCO-DMO Processing Notes:

- added conventional header with dataset name, PI name, version date
- in the longitude column, the "-" (hyphen) was replaced with "-" (ascii hyphen)
- precision of moisture_content_pcmt reduced from 8 to 5 decimal places
- precision of bg, xy, ap, extractable_ammonium, and extractable_srp was reduced from a variable number to 2 decimal places.
- precision of bulk_density_g_cm_3, pcmt_organic_matter, total_n_g_kg, labile_c_g_kg, total_p_mg_kg reduced to 4 decimal places.

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Related Publications

ANDERSEN, J. (1976). An ignition method for determination of total phosphorus in lake sediments. *Water Research*, 10(4), 329–331. doi:[10.1016/0043-1354\(76\)90175-5](https://doi.org/10.1016/0043-1354(76)90175-5)

Methods

German, D. P., Weintraub, M. N., Grandy, A. S., Lauber, C. L., Rinkes, Z. L., & Allison, S. D. (2011). Optimization of hydrolytic and oxidative enzyme methods for ecosystem studies. *Soil Biology and Biochemistry*, 43(7), 1387–1397. doi:[10.1016/j.soilbio.2011.03.017](https://doi.org/10.1016/j.soilbio.2011.03.017)

Methods

Methods for the Determination of Inorganic Substances in Environmental Samples. (1993). United States: United States Environmental Protection Agency, Office of Research and Development.

Methods

Oades, J. M., Kirkman, M. A., & Wagner, G. H. (1970). The Use of Gas-Liquid Chromatography for the Determination of Sugars Extracted from Soils by Sulfuric Acid. *Soil Science Society of America Journal*, 34(2), 230–235. doi:[10.2136/sssaj1970.03615995003400020017x](https://doi.org/10.2136/sssaj1970.03615995003400020017x)

Methods

Qualls, R.G. (2013). Dissolved organic matter. In: DeLaune, R.D., Reddy, K.R., Richardson, C.J., Megonigal, J.P. (eds). *Methods in biogeochemistry of wetlands*. Soil Science Society of America, Inc., Madison, Wisconsin, USA <https://isbnsearch.org/isbn/978-0-89118-961-9>

Methods

Richardson, C.J., & Reddy, K. R. (2013). Phosphorus characterization and analysis of wetland soils. In: DeLaune, R.D., Reddy, K.R., Richardson, C.J., Megonigal, J.P. (eds). *Methods in Biogeochemistry of Wetlands*. Soil Science Society of America, Inc., Madison, Wisconsin, USA doi:[10.2136/sssabookser10.c32](https://doi.org/10.2136/sssabookser10.c32)

Methods

Rovira, P., & Vallejo, V. R. (2002). Labile and recalcitrant pools of carbon and nitrogen in organic matter decomposing at different depths in soil: an acid hydrolysis approach. *Geoderma*, 107(1-2), 109–141. doi:[10.1016/S0016-7061\(01\)00143-4](https://doi.org/10.1016/S0016-7061(01)00143-4)

Methods

Sapkota, Y., & White, J. R. (2021). Long-term fate of rapidly eroding carbon stock soil profiles in coastal

wetlands. *Science of The Total Environment*, 753, 141913. doi:[10.1016/j.scitotenv.2020.141913](https://doi.org/10.1016/j.scitotenv.2020.141913)

Results

Sparks, D. (Ed.), 1996. *Methods of soil analysis. Part 3. Chemical methods.* Book Ser vol. 5. Soil Science Society of America, Inc., Madison, Wisconsin, USA <https://isbnsearch.org/isbn/0891188258>

Methods

Steinmuller, H. E., & Chambers, L. G. (2019). Characterization of coastal wetland soil organic matter: Implications for wetland submergence. *Science of The Total Environment*, 677, 648–659.

doi:[10.1016/j.scitotenv.2019.04.405](https://doi.org/10.1016/j.scitotenv.2019.04.405)

Methods

White, J. R., & Reddy, K. R. (2000). Influence of Phosphorus Loading on Organic Nitrogen Mineralization of Everglades Soils. *Soil Science Society of America Journal*, 64(4), 1525–1534.

doi:[10.2136/sssaj2000.6441525x](https://doi.org/10.2136/sssaj2000.6441525x)

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Parameters

Parameter	Description	Units
Site_id	Site identifier (four marsh site and a estuary site)	unitless
lat	Latitude of observations with positive values indicating North	decimal degrees
lon	Longitude of observations with negative values indicating West	decimal degrees
ap	Alkaline phosphatase activity under aerobic conditions	nmol MUF g ⁻¹ min ⁻¹
sampling_date	sampling date; formatted as yyyy-mm-dd	unitless
depth	Depth in core	centimeters (cm)
moisture_content_pcmt	percent moisture content	percent
bulk_density_g_cm_3	bulk density	g cm ⁻³
pcmt_organic_matter	Organic matter content	percent
total_c_g_kg	Total carbon	g kg ⁻¹
carbon_density_g_cm_3	Carbon density	g cm ⁻³
total_n_g_kg	Total nitrogen	g kg ⁻¹
labile_c_g_kg	Labile carbon	g kg ⁻¹
refractory_c_g_kg	Refractory carbon	g kg ⁻¹
total_p_mg_kg	Total phosphorus	mg kg ⁻¹
total_ip_mg_kg	Total inorganic phosphorus	mg kg ⁻¹
total_op_mg_kg	Total organic phosphorus	mg kg ⁻¹
bg	beta-glucosidase activity under aerobic conditions	nmol MUF g ⁻¹ min ⁻¹
xy	beta-xylosidase activity under aerobic conditions	nmol MUF g ⁻¹ min ⁻¹
extractable_ammonium	Extractable ammonium under aerobic conditions	mg kg ⁻¹
extractable_srp	Extractable soluble reactive phosphorus under aerobic conditions	mg kg ⁻¹
potentially_mineralizable_ammonium	Rate of ammonium mineralization (potential) under anaerobic conditions	mg NH ₄ ⁺ -N kg ⁻¹ d ⁻¹
potentially_mineralizable_phosphorus	Rate of ammonium mineralization (potential) under anaerobic conditions	mg PO ₄ -P kg ⁻¹ d ⁻¹
replicate	Replicate identifier	unitless

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Instruments

Dataset-specific Instrument Name	Costech Elemental Combustion System (Costech Analytical Technologies, Valencia, CA)
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	Total Carbon and Total nitrogen was determined on dried, ground subsamples using elemental combustion system (Costech Analytical Technologies, Valencia, CA)
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

Dataset-specific Instrument Name	Shimadzu TOC-L Analyzer
Generic Instrument Name	Shimadzu TOC-L Analyzer
Dataset-specific Description	The labile pool of carbon was determined, as dissolved organic carbon (DOC) on a solution extracted by 26 N H ₂ SO ₄ , using a Shimadzu TOC-V Analyzer (Kyoto, Japan).
Generic Instrument Description	A Shimadzu TOC-L Analyzer measures DOC by high temperature combustion method. Developed by Shimadzu, the 680 degree C combustion catalytic oxidation method is now used worldwide. One of its most important features is the capacity to efficiently oxidize hard-to-decompose organic compounds, including insoluble and macromolecular organic compounds. The 680 degree C combustion catalytic oxidation method has been adopted for the TOC-L series. http://www.shimadzu.com/an/toc/lab/toc-l2.html

Dataset-specific Instrument Name	AQ2 Automated Discrete Analyzer
Generic Instrument Name	Discrete Analyzer
Dataset-specific Description	Total P, Total inorganic P, and extractable soluble reactive P content was determined colorimetrically via an AQ2 Automated Discrete Analyzer (Seal Analytical, Mequon, WI) in accordance with EPA method 365.1 Rev. 2. Extractable ammonia was determined using an AQ2 Automated Discrete Analyzer (Seal Analytical, Mequon, WI, EPA methods 231-A Rev.0, 210-A Rev.1, and 204-A Rev.0).
Generic Instrument Description	Discrete analyzers utilize discrete reaction wells to mix and develop the colorimetric reaction, allowing for a wide variety of assays to be performed from one sample. These instruments are ideal for drinking water, wastewater, soil testing, environmental and university or research applications where multiple assays and high throughput are required.

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Project Information

Fate of Coastal Wetland Carbon Under Increasing Sea Level Rise: Using the Subsiding Louisiana Coast as a Proxy for Future World-Wide Sea Level Projections (Submerged Wetland Carbon)

Coverage: Coastal Louisiana

Description from NSF award abstract:

Coastal Louisiana is currently experiencing net sea level rise at rates higher than most of the world's coastlines and within the global range predicted to occur in the next 65 - 85 years, making Louisiana an ideal site to study potential future impacts of rising sea level on coastal systems. This project will use field collection and controlled tank experiments to study the changing organic carbon cycle resulting from erosion of marsh soils along with its impact on associated biogeochemical processes. The hypothesis tested in this study is that the majority of eroded soil organic carbon is converted to carbon dioxide (CO₂) and released to the atmosphere, representing an addition to the anthropogenic input of CO₂. This process has not been quantified and could be an important missing component in predictive models of atmospheric CO₂ changes. While this process may be of only regional importance today in comparison to other sources of CO₂, this study of the Louisiana coast will greatly enhance our full understanding of the potential impacts on the global carbon cycle that may result from coastal erosion as global sea level continues to rise.

The project will train graduate and undergraduate students in interdisciplinary research involving marine and wetland biogeochemistry, microbiology, and ecological modeling. It will also fund development of an interactive, educational display on the loss of coastal wetlands for the Louisiana Sea Grant's annual Ocean Commotion educational event attended by area middle and high school students, teachers, and parents. Results from this study may also inform community planners both regionally and worldwide as they prepare for sea level rise in coastal communities.

Eustatic sea level rise and regional subsidence have created a much greater rate of coastline loss in Louisiana than is being experienced in most of the world's coastal regions, reaching global rates that are predicted to occur worldwide in 65 - 85 years. This provides a unique potential to extrapolate data from Louisiana's changing coastal carbon cycle to both regional and global models of the future impact of sea level rise and coastal erosion. By quantifying and modeling the importance of CO₂ emissions resulting directly from mineralized soil organic matter from eroding coastlines, a missing element can be added to climate change models. The PIs here plan to investigate the fate of the coastal wetland carbon pool as it erodes using field sampling, laboratory analysis, mesocosm manipulations, and the creation of a coupled physical-biogeochemical model for the basin being studied. Beyond quantifying increased CO₂ emission, the PIs will also address the potential for increased eutrophication due to input of nutrients from eroded soils, as well as the potential for future contribution to existing hypoxic zones in the northern Gulf of Mexico that result from excessive nutrient input from the Mississippi River watershed.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635837

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