Barataria Bay carbon mineralization and biogeochemical properties from nine soil cores

Website: https://www.bco-dmo.org/dataset/775547
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2019-09-05

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
Nine soil cores (1 m deep) were collected from three sites within Barataria Bay, LA (USA). Both the biogeochemical properties of the soils with depth were determined, as well as the impacts of the introduction of oxygenated seawater on carbon mineralization rates.

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Coverage

Spatial Extent: **N**:29.4436 **E**:-89.8998 **S**:29.4414 **W**:-89.9026

Dataset Description

Nine soil cores (1 m deep) were collected from three sites within Barataria Bay, LA (USA). Both the biogeochemical properties of the soils with depth were determined, as well as the impacts of the introduction of oxygenated seawater on carbon mineralization rates.

Acquisition Description

Moisture Content:
Drying a subsample of soil using a gravimetric oven at 70 °C after 3 days or until a constant weight was achieved. Dried soils were ground using a SPEX Sample Prep 8000M Mixer/Mill (Metuchen, NJ).

Bulk Density:
Drying a subsample of soil using a gravimetric oven at 70 °C after 3 days or until a constant weight was achieved. Dried soils were ground using a SPEX Sample Prep 8000M Mixer/Mill (Metuchen, NJ).

pH:
Soil pH was determined by creating a 1:5 slurry of soil to distilled, deionized water, and subsequent measurement using an Accument bench top pH probe (Accumet XL200, ThermoFisher Scientific, Waltham, MA, USA).

Total Carbon:
Total Carbon content was determined by use of a Vario Micro Cube CHNS Analyzer on dried, ground subsamples.

Total Nitrogen:

Total Nitrogen content was determined by use of a Vario Micro Cube CHNS Analyzer on dried, ground subsamples.

Total Phosphorus:
Dried, ground sub- samples were used to determine percent organic matter using the loss- on-ignition method, where soils were burned at 550 °C in a muffle furnace for a total of 3 h, then soils were digested with 50 mL of 1 N HCl at 100 °C for 30 min, and filtered through Whatman #41 filter paper for total P analysis (Andersen, 1976). Total P content was then determined colorimetrically via an AQ2 Automated Discrete Analyzer (Seal Analytical, Mequon, WI) in accordance with EPA method 365.1 Rev. 2.

Organic Matter Content:
Dried, ground sub- samples were used to determine percent organic matter using the loss- on-ignition method, where soils were burned at 550 °C in a muffle furnace for a total of 3 h.

Extractable Dissolved Organic Carbon:
1 g dry weight of field-moist soil were weighed into 40 mL centrifuge tubes and extracted with 25 mL of 0.5 M K_2SO_4, placed in an orbital shaker for 1 h at 25 °C and 150 rpm then immediately centrifuged for 10 min at 10 °C and 5000 rpm. The supernatant was vacuum filtered through Supor 0.45 µM filters, acidified with double distilled H_2SO_4 for preservation, and stored at 4 °C until analysis. Dissolved organic carbon (DOC) was determined by use of a Shimadzu TOC-L Analyzer (Kyoto, Japan).

Extractable Nitrate:
2.5 g of wet soil (both from the field and from the bottle incubation) into 40 mL centrifuge tubes and adding 25 mL of 2 M KCl. Samples were then shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm, then centrifuged for 10 min at 10 °C and 5000 rpm. Following the centrifuge, samples were immediately filtered through Supor 0.45 µM filters and acidified with double distilled H_2SO_4 to a pH of < 2 for preservation. Extractable nutrients samples were then analyzed 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).

Extractable Ammonium:
2.5 g of wet soil (both from the field and from the bottle incubation) into 40 mL centrifuge tubes and adding 25 mL of 2 M KCl. Samples were then shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm, then centrifuged for 10 min at 10 °C and 5000 rpm. Following the centrifuge, samples were immediately filtered through Supor 0.45 µM filters and acidified with double distilled H_2SO_4 to a pH of < 2 for preservation. Extractable nutrients samples were then analyzed 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).

Extractable Soluble Reactive Phosphorus:
2.5 g of wet soil (both from the field and from the bottle incubation) into 40 mL centrifuge tubes

and adding 25 mL of 2 M KCl. Samples were then shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm, then centrifuged for 10 min at 10 °C and 5000 rpm. Following the centrifuge, samples were immediately filtered through Supor 0.45 µM filters and acidified with double distilled H_2SO_4 to a pH of < 2 for preservation. Extractable nutrients samples were then analyzed 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).

Microbial Biomass Carbon:
Microbial biomass C (MBC) was determined on soils both immediately after the field sampling and soils from the bottles after the incubation period following the method outlined in Vance et al. (1987). Duplicates of approximately 1 g dry weight of field-moist soil were weighed into 40 mL centrifuge tubes and assigned to either a fumigate or non-fumigate treatment. The fumigated samples were exposed to gaseous chloroform for 24 h in a glass desiccator. After 24 h, the sam- ples were extracted with 25 mL of 0.5 M K_2SO_4, placed in an orbital shaker for 1 h at 25 °C and 150 rpm. After incubation, samples were immediately centrifuged for 10 min at 10 °C and 5000 rpm. The supernatant was vacuum filtered through Supor 0.45 µM filters, acidified with double distilled H_2SO_4 for preservation, and stored at 4 °C until analysis. Non-fumigate samples were processed in the same manner, excluding the chloroform fumigation. Dissolved organic carbon (DOC) was determined by use of a Shimadzu TOC-L Analyzer (Kyoto, Japan). Microbial biomass C was calculated as the difference between the fumigated samples and the non-fumigated samples.

B-glucosidase activity:
Assays were conducted using fluorescent substrate 4- methylumbelliferone (MUF) for standardization and fluorescently labeled MUF-specific sub- strates (German et al., 2011). To create a 1:100 slurry, 0.5 g of soil was added to 39 mL of autoclaved distilled deionized water and shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm. Fluor- escence 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.

N-acetyl-beta-D-glucosaminidase activity:
Assays were conducted using fluorescent substrate 4- methylumbelliferone (MUF) for standardization and fluorescently labeled MUF-specific sub- strates (German et al., 2011). To create a 1:100 slurry, 0.5 g of soil was added to 39 mL of autoclaved distilled deionized water and shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm. Fluor- escence 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.

Alkaline phosphatase activity:
Assays were conducted using fluorescent substrate 4- methylumbelliferone (MUF) for

standardization and fluorescently labeled MUF-specific sub- strates (German et al., 2011). To create a 1:100 slurry, 0.5 g of soil was added to 39 mL of autoclaved distilled deionized water and shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm. Fluor- escence 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.

Xylosidase activity:
Assays were conducted using fluorescent substrate 4- methylumbelliferone (MUF) for standardization and fluorescently labeled MUF-specific sub- strates (German et al., 2011). To create a 1:100 slurry, 0.5 g of soil was added to 39 mL of autoclaved distilled deionized water and shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm. Fluor- escence 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.

Cellobiosidase activity:
Assays were conducted using fluorescent substrate 4- methylumbelliferone (MUF) for standardization and fluorescently labeled MUF-specific sub- strates (German et al., 2011). To create a 1:100 slurry, 0.5 g of soil was added to 39 mL of autoclaved distilled deionized water and shaken continuously on an orbital shaker for 1 h at 25 °C and 150 rpm. Fluor- escence 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.

Rate of carbon dioxide production (potential):
Duplicate subsamples (approximately 7 g) from each depth segment of each core were weighed into 100 mL glass serum bottles, capped with a rubber septa and aluminum crimp and evacuated to –75 mm Hg. Replicate bottles were randomly assigned to one of two treatments: anaerobic (purged with 99% O2-free N2 gas for 3 min), or aerobic (purged with Breathing Grade air containing 21% O2 for 3 min). Anaerobic bottles were injected with 14 mL of filtered, N2-purged site water, while aerobic bottles were injected with 14 mL of filtered, breathing air-purged site water. Bottles were then placed on an orbital shaker at 150 rpm and 25 °C. Headspace samples were taken at 1, 2, 4, 7, 10, and 14 day time points, and injected into a GC-2014 gas chromatograph (Shimadzu Instrument, Kyoto, Japan) equipped with a flame ionization detector. Respiration rates were calculated as the change in CO2 production over time. After each gas sample was extracted from the bottles' headspace, the bottle was purged with either 99% O2- free N2 gas or Breathing Grade air for 3 min, depending on treatment.

Rate of nitrate mineralization (potential):
Following the 14 day incubation, bottles were uncapped, and the remaining soil sample was placed in a 20 mL HDPE scintillation vials

Rate of ammonium mineralization (potential):
for analysis of extractable ammonium (NH4+), nitrate (NO3–), and soluble reactive phosphorus (SRP), microbial biomass C, and enzyme analysis.

Processing Description

All statistical analysis was performed using R (R Foundation for Statistical Computing, Vienna, Austria) within RStudio (RStudio Team, 2015). Prior to determining significance, all parameters were analyzed for homogeneity of variance using Levene's test, and assumptions of normality using the Shapiro-Wilk test. If datasets were not normal, they were transformed using a logarithmic transformation to meet the as- sumptions of normality.

Data was separated into field characteristics (before the incuba- tion), and experimental results (following the incubation). Field characteristics were analyzed using a linear mixed-effect model in R with site and depth as predictor variables. ‘Core’ was included as a random effect to test for effects of replicate cores taken at each site. Post-hoc tests were conducted using package lsmeans via the Tukey method. Pearson product-moment correlations were also performed between all field characteristics. Significance was determined based on an alpha value of 0.05 for all tests, and adjusted with a Bonferroni correction to 0.004.

Experimental results were analyzed via a linear mixed-effect model in R with treatment, depth, the interaction between treatment and depth, and site as predictor variables. Core was again included as a random effect. The lsmeans package was used to determine post-hoc significance based on the Tukey method. Significance was determined based on an alpha value modified by a Bonferroni correction to 0.004.

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- combined the submitted datasheets for anaerobic, aerobic, and field results into one dataset using the site_id, replicate, and depth as a joining key.

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Related Publications

Steinmuller, H. E., Dittmer, K. M., White, J. R., & Chambers, L. G. (2019). Understanding the fate of soil organic matter in submerging coastal wetland soils: A microcosm approach.

Geoderma, 337, 1267–1277. doi:10.1016/j.geoderma.2018.08.020

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Parameters

Parameter	Description	Units
site_id	site identifier	unitless
replicate	replicate identifier	unitless
depth	depth in core	centimeters (cm)
nag_aerob	N-acetyl-beta-D-glucosaminidase activity under aerobic conditions	nmol MUF g–1 min–1
ap_aerob	Alkaline phosphatase activity under aerobic conditions	nmol MUF g–1 min–1
bg_aerob	B-glucosidase activity under aerobic conditions	nmol MUF g–1 min–1
xy_aerob	Xylosidase activity under aerobic conditions	nmol MUF g–1 min–1
cb_aerob	Cellobiosidase activity under aerobic conditions	nmol MUF g–1 min–1
extractable_nitrate_aerob	Extractable Nitrate under aerobic conditions	mg kg-1
extractable_ammonium_aerob	Extractable Ammonium under aerobic conditions	mg kg-1
extractable_srp_aerob	Extractable Soluble Reactive Phosphorus under aerobic conditions	mg kg-1
microbial_biomass_carbon_aerob	Microbial Biomass Carbon under aerobic conditions	mg kg-1
potentially_mineralizable_nitrate_aerob	Rate of nitrate mineralization (potential) under aerobic conditions	mg NH4+ kg -1 d–1

potentially_mineralizable_ammonium_aerob	Rate of ammonium mineralization (potential) under aerobic conditions	mg NH4+ kg -1 d−1
carbon_dioxide_rate_aerob	Rate of carbon dioxide production (potential) under aerobic conditions	mg CO2-C kg−1 h−1
nag_anaerob	N-acetyl-beta-D-glucosaminidase activity under anaerobic conditions	nmol MUF g−1 min−1
ap_anaerob	Alkaline phosphatase activity under anaerobic conditions	nmol MUF g−1 min−1
bg_anaerob	B-glucosidase activity under anaerobic conditions	nmol MUF g−1 min−1
xy_anaerob	Xylosidase activity under anaerobic conditions	nmol MUF g−1 min−1
cb_anaerob	Cellobiosidase activity under anaerobic conditions	nmol MUF g−1 min−1
extractable_nitrate_anaerob	Extractable Nitrate under anaerobic conditions	mg kg-1
extractable_ammonium_anaerob	Extractable Ammonium under anaerobic conditions	mg kg-1
extractable_srp_anaerob	Extractable Soluble Reactive Phosphorus under anaerobic conditions	mg kg-1
microbial_biomass_carbon_anaerob	Microbial Biomass Carbon under anaerobic conditions	mg kg-1
potentially_mineralizable_nitrate_anaerob	Rate of nitrate mineralization (potential) under anaerobic conditions	mg NH4+ kg -1 d−1
potentially_mineralizable_ammonium_anaerob	Rate of ammonium mineralization (potential) under aerobic conditions	mg NH4+ kg -1 d−1
carbon_dioxide_rate_anaerob	Rate of carbon dioxide production (potential) under anaerobic conditions	mg CO2-C kg−1 h−1

lat	Latitude of observations with positive values indicating North	decimal degrees
lon	Longitude of observations with negative values indicating West	decimal degrees
moisture_content_pcnt_field	percent moisture content	precent
bulk_density_g_cm_3_field	bulk density	g cm-3
ph_field	pH	pH scale
pcnt_organic_matter_field	Organic matter content	percent
total_n_g_kg_field	Total Nitrogen	g kg-1
total_c_g_kg_field	Total Carbon	g kg-1
total_n_g_cm_3_field	Total Nitrogen	g cm-3
total_c_g_cm_3_field	Total Carbon	g cm-3
total_p_mg_kg_field	Total Phosphorus	mg kg-1
nag_field	N-acetyl-beta-D-glucosaminidase activity in the field	nmol MUF g–1 min–1
ap_field	Alkaline phosphatase activity in the field	nmol MUF g–1 min–1
bg_field	B-glucosidase activity in the field	nmol MUF g–1 min–1
xy_field	Xylosidase activity in the field	nmol MUF g–1 min–1
cb_field	Cellobiosidase activity in the field	nmol MUF g–1 min–1
extractable_doc_field	Extractable Dissolved Organic Carbon in the field	mg kg-1
extractable_nitrate_field	Extractable Nitrate in the field	mg kg-1
extractable_ammonium_field	Extractable Ammonium in the field	mg kg-1
extractable_srp_field	Extractable Soluble Reactive Phosphorus in the field	mg kg-1

microbial_biomass_c_field	Microbial Biomass Carbon in the field	mg kg-1

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Instruments

Dataset-specific Instrument Name	Vario Micro Cube CHNS Analyzer
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	Total Carbon content was determined by use of a Vario Micro Cube CHNS Analyzer on dried, ground subsamples. Total Nitrogen content was determined by use of a Vario Micro Cube CHNS Analyzer on dried, ground subsamples.
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	GC-2014 gas chromatograph
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	Headspace samples were taken at 1, 2, 4, 7, 10, and 14 day time points, and injected into a GC-2014 gas chromatograph (Shimadzu Instrument, Kyoto, Japan) equipped with a flame ionization detector.
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

Dataset-specific Instrument Name	Accument bench top pH probe
Generic Instrument Name	Benchtop pH Meter
Dataset-specific Description	Soil pH was determined by creating a 1:5 slurry of soil to distilled, deionized water, and sub- sequent measurement using an Accument bench top pH probe (Accumet XL200, ThermoFisher Scientific, Waltham, MA, USA).
Generic Instrument Description	An instrument consisting of an electronic voltmeter and pH-responsive electrode that gives a direct conversion of voltage differences to differences of pH at the measurement temperature. (McGraw-Hill Dictionary of Scientific and Technical Terms) This instrument does not map to the NERC instrument vocabulary term for 'pH Sensor' which measures values in the water column. Benchtop models are typically employed for stationary lab applications.

Dataset-specific Instrument Name	Shimadzu TOC-L Analyzer
Generic Instrument Name	Shimadzu TOC-L Analyzer
Dataset-specific Description	Dissolved organic carbon (DOC) was determined by use of a Shimadzu TOC-L 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 content was determined colorimetrically via an AQ2 Automated Discrete Analyzer (Seal Analytical, Mequon, WI) in accordance with EPA method 365.1 Rev. 2. Extractable nutrients samples were analyzed 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 Lousiana

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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