Sediment oxygen demand and ammonium, nitrate plus nitrate, and phosphate flux data from Little Lagoon, Alabama

Website: https://www.bco-dmo.org/dataset/723984

Data Type: Other Field Results

Version: 1

Version Date: 2018-01-16

Project

» Groundwater Discharge, Benthic Coupling and Microalgal Community Structure in a Shallow Coastal Lagoon (LittleLagoonGroundwater)

Contributors	Affiliation	Role
Mortazavi, Behzad	National Science Foundation (NSF-DEB)	Principal Investigator, Contact
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Abstract

Sediment oxygen demand and ammonium, nitrate plus nitrate, and phosphate flux data from Little Lagoon, Alabama from 2010-2013

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Coverage

Spatial Extent: **Lat**:30.241929 **Lon**:-87.773756

Temporal Extent: 2010 - 2013

Dataset Description

Sediment oxygen demand and Ammonium, Nitrate plus Nitrate, and Phosphate flux data.

Acquisition Description

Little Lagoon is a shallow coastal lagoon that is tidally connected to the Gulf of Mexico but has no riverine inputs. The water in the lagoon is replenished solely from precipitation and groundwater inputs primarily on the East end (Su et al. 2012). Because of the rapid development in Baldwin County, a large amount of NO3- enters the Little Lagoon system through SGD (Murgulet & Tick 2008). In this region, there can be rapid changes in the depth to groundwater (Fig. 4.1 inset) and episodic SGD inputs to the lagoon (Su et al.2013). Within the lagoon, three sites were selected (East, Mouth, and West) to represent the gradient that exists across the lagoon from the input of groundwater. Sites were sampled on a near-monthly basis from February 2012 to February 2013.

Benthic fluxes from intact sediment cores

At each site triplicate intact sediment cores (270 mm x 95 mm ID; 190 mm sediment, 50 mm water column) were collected and setup in a flow-through system (Lavrentyev et al. 2000) in a darkened environmental chamber set to the average site temperature within 8 hours of collection. The flow-through system consisted of a multichannel proportioning pump that sent 0.7 micron filtered and ~100 µM $Na^{15}NO_3^-$ (99 atom %) enriched site water ("inflow") at a continuous flow rate (1.2 mL min^{-1}) to the overlying water above the sediment surface. The positive displacement of the overlying water exited the core through an outflow tube ("outflow") and collected in a reservoir. The volume of water overlying each sediment core was exchanged five times during a 24-hour incubation period to equilibrate the cores (Eyre et al. 2002). After the initial 24 hours, triplicate inflow and outflow samples were collected at 36 hours for dissolved gas and nutrient analysis. Dissolved gas analysis followed the modified Isotope pairing technique (IPT) (Nielsen 1992, Risgaard-Petersen et al. 2003). In this approach, rates of $^{29}N_2$ and $^{30}N_2$ production from $^{15}NO_3^-$ are quantified and used to calculate rates of $^{14}N_2$ production (p_{14}) (equation 1, below); when combined with ^{15}N tracer slurry incubations (below), rates of anammox, and the relative contribution of anammox and denitrification to p_{14} can be determined (equations 2-4, below).

Water samples were collected in 12 mL Exetainers, allowing the vial to overflow two times the tube volume prior to preservation with 250 µL of 50% (w/v) $ZnCl_2$ before being capped. Samples were stored under water in the environmental chamber until dissolved gas analysis on a membrane inlet mass spectrometer (MIMS) equipped with a copper reduction column set at 600°C to remove oxygen (O_2) (Kana et al. 1998, Eyre et al. 2002). Benthic nutrient flux samples were filtered (0.7 micron) and immediately frozen until DIN (NO_2^-, NO_3^-, NH_4^+) and PO_4^{3-} analyses as described above.

Sediment oxygen demand (SOD) was measured from oxygen concentrations in inflow and outflow water analyzed with a calibrated microelectrode and a Unisense ® multimeter analyzer. Denitrification and benthic flux calculations (µmol m^{-2} hr^{-1}) determined flux into or out of the sediment using the influent and effluent concentrations, flow rate (1.2 ml min^{-1}), and the surface area of the sediment (0.00708 m^{-2}). All rates and fluxes pertaining to N species are expressed on a N atom basis. A positive flux indicates release from the sediments to the water column and a negative flux indicates uptake by the sediment.

Additional methodology can be found in:

Bernard, Rebecca & Mortazavi, Behzad & A. Kleinhuizen, Alice. (2015). Dissimilatory nitrate reduction to ammonium (DNRA) seasonally dominates NO_3^- reduction pathways in an anthropogenically impacted sub-tropical coastal lagoon. Biogeochemistry. 125. 47-64. 10.1007/s10533-015-0111-6.

Processing Description

Data were flagged as below detection limits if no measurable rates were returned after calculations. See equations in methodology section of:

Bernard, Rebecca & Mortazavi, Behzad & A. Kleinhuizen, Alice. (2015). Dissimilatory nitrate reduction to ammonium (DNRA) seasonally dominates NO_3^- reduction pathways in an anthropogenically impacted sub-tropical coastal lagoon. Biogeochemistry. 125. 47-64. 10.1007/s10533-015-0111-6.

Statistical Analysis

To test the seasonal flux variability between sites in Little Lagoon, two-way ANOVAs with site and date as independent variables were performed. When data could not be transformed to meet ANOVA assumptions, Wilcoxon/Kruskal-Wallis nonparametric tests were used. When significant differences occurred, Tukey HSD or Steel-Dwass post hoc tests were used to determine significant interactions. A Principal component analysis (PCA) was conducted on all biogeochemical parameters to identify underlying multivariate components that may be influencing N fluxes. Spearman's rho correlation analysis was used to examine the relationship between the principal components and fluxes. Statistical significance of the data set was determined at $\alpha=0.05$ and error is reported as standard error. All statistical analyses were performed in SAS JMP 10 (SAS Institute Inc.).

BCO-DMO Data Processing Notes:

- Data reorganized into one table under one set of column names from both original data files
- Units removed from column names
- Column names reformatted to meet BCO-DMO standards
- Information captured in original column names entered under column "Value_Description" where units are also described
- Created column Year to describe to capture the metadata in the file name

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Related Publications

Bernard, R. J., Mortazavi, B., & Kleinhuizen, A. A. (2015). Dissimilatory nitrate reduction to ammonium (DNRA) seasonally dominates NO3 – reduction pathways in an anthropogenically impacted sub-tropical coastal lagoon. Biogeochemistry, 125(1), 47–64. doi:10.1007/s10533-015-0111-6

Eyre, B. D., Rysgaard, S., Dalsgaard, T., & Christensen, P. B. (2002). Comparison of isotope pairing and N2:Ar methods for measuring sediment denitrification—Assumption, modifications, and implications. Estuaries, 25(6), 1077–1087. doi:10.1007/BF02692205

Murgulet, D., & Tick, G. R. (2008). Assessing the extent and sources of nitrate contamination in the aquifer system of southern Baldwin County, Alabama. Environmental Geology, 58(5), 1051–1065. doi:10.1007/s00254-008-1585-5

Nielsen, L. P. (1992). Denitrification in sediment determined from nitrogen isotope pairing. FEMS Microbiology Letters, 86(4), 357–362. doi:10.1111/j.1574-6968.1992.tb04828.x

Risgaard-Petersen, N., Nielsen, L. P., Rysgaard, S., Dalsgaard, T., & Meyer, R. L. (2003). Application of the isotope pairing technique in sediments where anammox and denitrification coexist. Limnology and Oceanography: Methods, 1, 63-73.

Su, N., Burnett, W.C., Eller, K.T., MacIntyre, H.L., Mortazavi, B., Leifer, J., Novoveska, L. (2012). Radon and radium isotopes, groundwater discharge and harmful algal blooms in Little Lagoon, Alabama. Interdisciplinary Studies on Environmental Chemistry, 6, 329–337.

Su, N., Burnett, W.C., MacIntyre, H.L., Liefer, J.D., Peterson, R.N., Viso, R. (2013). Natural radon and radium isotopes for assessing groundwater discharge into Little Lagoon, AL: implications for harmful algal blooms. Estuaries Coasts, 1–18

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Parameters

Parameter	Description	Units
Year	Year ID that samples were taken	unitless
Value_Description	Description of the measurment taken; description includes relevant units for each sample taken.	unitless
Date	Month and day that samples were taken; MMM-DD	unitless
East	Benthic flux values from the East site; location of site is 30.253347, -87.724729	umol m-2 hr-1; umol m-2 d-1
East_SE	Standard error of the benthic flux values from the East site	umol m-2 hr-1; umol m-2 d-1
Mouth	Benthic flux values from the Mouth site; location of site is 30.243683, -87.738407	umol m-2 hr-1; umol m-2 d-1
Mouth_SE	Standard error of the benthic flux values from the Mouth site	umol m-2 hr-1; umol m-2 d-1
West	Benthic flux values from the West site; location of site is 30.247181, -87.767856	umol m-2 hr-1; umol m-2 d-1
West_SE	Standard error of the benthic flux values from the West site	umol m-2 hr-1; umol m-2 d-1

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Instruments

Dataset-specific Instrument Name	Unisense multimeter analyzer
Generic Instrument Name	Gas Analyzer
Dataset-specific Description	Used to analyze sediment oxygen demand
Generic Instrument Description	Gas Analyzers - Instruments for determining the qualitative and quantitative composition of gas mixtures.

Dataset-specific Instrument Name	Multichannel proportioning pump
Generic Instrument Name	Pump
Dataset-specific Description	Used to filter sediment cores
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

Dataset-specific Instrument Name	MIMS
Generic Instrument Name	Membrane Inlet Mass Spectrometer
Dataset-specific Description	Used for dissolved gas analysis
Generic Instrument Description	Membrane-introduction mass spectrometry (MIMS) is a method of introducing analytes into the mass spectrometer's vacuum chamber via a semipermeable membrane.

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Deployments

LittleLagoon

Website	https://www.bco-dmo.org/deployment/528089
Platform	SmallBoat_FSU
Start Date	2010-04-05
End Date	2013-08-17
Description	The sampling sites were all accessed from small boats, here amalgamated to one deployment called LittleLagoon.

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Project Information

Groundwater Discharge, Benthic Coupling and Microalgal Community Structure in a Shallow Coastal Lagoon (LittleLagoonGroundwater)

Coverage: southern Alabama, east of Mobile

This project investigated the link between submarine groundwater discharge (SGD) and microalgal dynamics in Little Lagoon, Alabama. In contrast to most near-shore environments, it is fully accessible; has no riverine inputs; and is large enough to display ecological diversity (c. 14x 0.75 km) yet small enough to be comprehensively sampled on appropriate temporal and spatial scales. The PIs have previously demonstrated that the lagoon is a hot-spot for toxic blooms of the diatom Pseudo-nitzchia spp. that are correlated with discharge from the surficial aquifer. This project assessed variability in SGD, the dependence of benthic nutrient fluxes on microphytobenthos (MPB) abundance and productivity, and the response of the phytoplankton to nutrient enrichment and dilution. The work integrated multiple temporal and spatial scales and demonstrated both the relative importance of SGD vs. benthic recycling as a source of nutrients, and the role of SGD in structuring the microalgal community. (paraphrased from Award abstract)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0962008

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