Biogeochemistry data from Maunalua Bay, Hawaii measured on four dates between April and October 2015

Website: https://www.bco-dmo.org/dataset/860857
Data Type: Other Field Results
Version: 1
Version Date: 2021-09-15

Project
» RUI: Collaborative Research: Defining the biogeochemical context and ecological impacts of submarine groundwater discharge on coral reefs (Moorea SGD)

Contributors	Affiliation	Role
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Abstract
This dataset contains biogeochemistry measurements from Maunalua Bay, Hawaii collected to assess the effects of submarine groundwater discharge on ecosystem functioning.

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Coverage

Spatial Extent: **N**:21.27531 **E**:-157.76073 **S**:21.2578421 **W**:-157.79053
Temporal Extent: 2015-04-18 - 2015-10-26

Methods & Sampling

Sampling locations:
Wailupe, Hawaii 21.275, -157.762 depth 2m
Black Point (Kupikipiki'o), Hawaii 21.2598, -157.789 depth 2m

Methodology:
Twenty water sampling locations were established at each site (n = 40 total) in an approximate grid, scaled to the width of the reef flat, for biogeochemistry measurements. At each location, we collected discrete diel water samples across four timepoints (during daytime and nighttime high and low tides) in the spring and fall (totaling eight samples per location, 320 samples overall). Sampling dates were 18 April 2015 and 28 September 2015 at Wailupe, and 2 May 2015 and 26 October 2015 at Kupikipiki'o. All sampling events happened during spring tide events.

Sampling and analytical procedures:
Water samples for pH, TA, nitrate + nitrite (NO_3^- + NO_2^-), phosphate (PO_4^{3-}) and silicate (SiO_4^{2-}) were hand

collected directly above the benthos within 30 min of high or low tide in acid-washed HDPE bottles. pH was measured immediately using a tris calibrated Orion ROSS Ultra pH/ATC Triode following Dickson SOP 6a. TA samples were immediately preserved with 50% saturated HgCl2 in deionized water, stored in a cool dark place and later analyzed on a Mettler Toledo T-50 autotitrator following Dickson SOP 3b (precision = 2.68 µEq, accuracy = 0.48% ± 0.33% SD). Inorganic nutrient samples (SiO_4^{2-}, NO_3^- + NO_2^-, PO_4^{3-}) were immediately filtered through pre-combusted GF/F filters (0.7 µm) and stored in a −20°C freezer until further processing. Nutrient samples were processed at the SOEST Laboratory for Analytical Biogeochemistry at the University of Hawai'i at Manoa using a Seal Analytical AA3 nutrient autoanalyzer (reported error [coefficient of variance]: 0.5% for SiO_4^{2-}, 0.3% for NO_3^- + NO_2^-, and 0.2% for PO_4^{3-}). Temperature was recorded every 15 min on HOBO TidbiT v2 loggers and temperature values were extracted to match the time-discrete water samples were collected.

Data Processing Description

Data processing:
All data were processed using R statistical program and code is available at https://github.com/njsilbiger/MaunaluaSEM and Zenodo (https://zenodo.org/record/4281383#.YQGrk-hKj-g) DOI:10.5281/zenodo.4281383

BCO-DMO Processing:
- renamed fields to comply with BCO-DMO naming conventions.

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Data Files

File	
Maunalua_Bay_Biogeochem.csv	(Comma Separated Values (.csv), 109.64 KB) MD5:38b38d9a0cf0c6503c31baa780486c49
Primary data file for dataset ID 860857	

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Related Publications

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to Best Practices for Ocean CO2 Measurements. PICES Special Publication 3, 191 pp https://isbnsearch.org/isbn/1-897176-07-4
Methods

Lubarsky, K. A., Silbiger, N. J., & Donahue, M. J. (2018). Effects of submarine groundwater discharge on coral accretion and bioerosion on two shallow reef flats. Limnology and Oceanography, 63(4), 1660–1676. doi:10.1002/lno.10799
Results

Silbiger, N. J., Donahue, M. J., & Lubarsky, K. (2020). Submarine groundwater discharge alters coral reef ecosystem metabolism. Proceedings of the Royal Society B: Biological Sciences, 287(1941), 20202743. doi:10.1098/rspb.2020.2743
Results

Silbiger, N.. (2020). njsilbiger/MaunaluaSEM: SGD alters coral reef ecosystem metabolism (Version v1.0) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.4281383
Software

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Parameters

Parameter	Description	Units
Waypoint	GPS waypoint number	unitless
Zone	Zone: Transition, Diffuse, or Ambient	unitless
Lat	Latitude	decimal degrees North
Long	Longitude	decimal degrees East
Site	Site Name: W = Wailupe; BP = Black Point	unitless
Tide	Tide: L= low; H: high	unitless
Season	Season: SPRING or FALL	unitless
Temp_in	Temperature	degrees Celsius
Salinity	Salinity	PSU
Phosphate	Phosphate (coefficient of variance in analysis is 0.2%; level of detection is 0.008)	micromoles per liter (umol L-1)
Silicate	Silicate (coefficient of variance in analysis is 0.5%; level of detection is 0.065)	micromoles per liter (umol L-1)
NN	Nitrate + Nitrite (coefficient of variance in analysis is 0.3%; level of detection is 0.009)	micromoles per liter (umol L-1)
Ammonia	Ammonia	micromoles per liter (umol L-1)
pH	pH	unitless (pH scale)
TA	Total Alkalinity	micromoles per kilogram (umol kg-1)
Chlorophyll	Chlorophyll	micrograms per liter (ug/L)
Arag	Aragonite	unitless (saturation state)

percent_sgd	Relative percent of submarine groundwater discharge	unitless (percent)
Day_Night	Day or Night	unitless
CO2	CO2	micromoles per kilogram (umol kg-1)
HCO3	HCO3	micromoles per kilogram (umol kg-1)
CO3	CO3	micromoles per kilogram (umol kg-1)
DIC	DIC	micromoles per kilogram (umol kg-1)
OmegaArag	Aragonite saturation state	unitless
OmegaCalcite	Calcite saturation state	unitless
pCO2	Partial pressure of CO2	microatmospheres (uatm)
fCO2	Fugacity of CO2	microatomspheres (uatm)
TA_pred	Predicted total alkalinity	micromoles per kilogram (umol kg-1)
DIC_pred	Predicted DIC	micromoles per kilogram (umol kg-1)
TA_diff	TA residuals from mixing line	micromoles per kilogram (umol kg-1)
DIC_diff	DIC residuals from mixing line	micromoles per kilogram (umol kg-1)

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Instruments

Dataset-specific Instrument Name	Seal Analytical AA3 nutrient autoanalyzer
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Nutrients were measured on a Seal Analytical AA3 nutrient autoanalyzer a the SOEST Laboratory for Analytical Biogeochemistry at the University of Hawai'i at Manoa.
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

Dataset-specific Instrument Name	HOBO TidbiT v2 loggers
Generic Instrument Name	Onset HOBO TidbiT v2 (UTBI-001) temperature logger
Dataset-specific Description	HOBO TidbiT v2 temperature loggers (accuracy: ±0.2°C, resolution: 0.02°C at 25°C)
Generic Instrument Description	A temperature logger that measures temperatures over a wide temperature range. It is designed for outdoor and underwater environments and is waterproof to 300 m. A solar radiation shield is required to obtain accurate air temperature measurements in sunlight (RS1 or M-RSA Solar Radiation Shield). With an operational temperature range between -20 degrees Celsius and +70 degrees Celsius, the TidbiT v2 has an accuracy of +/-0.21 and a resolution of 0.02 degrees Celsius.

Dataset-specific Instrument Name	Orion ROSS Ultra pH/ATC Triode
Generic Instrument Name	pH Sensor
Dataset-specific Description	pH on the total scale (pHTot) was measured using an Orion ROSS Ultra pH/ATC Triode calibrated against a Tris buffer of known pH from the Dickson laboratory at the Scripps Institution of Oceanography (Dickson et al. 2007).
Generic Instrument Description	An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H+) or basic (less H+).

Dataset-specific Instrument Name	Mettler Toledo T-50 autotitrator
Generic Instrument Name	Titrator
Dataset-specific Description	Total Alkalinity was measured on a Mettler Toledo T-50 autotitrator and calibrated against a certified reference material from Andrew Dickson's Lab. Sample accuracy was 0.48%.
Generic Instrument Description	Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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Project Information

RUI: Collaborative Research: Defining the biogeochemical context and ecological impacts of submarine groundwater discharge on coral reefs (Moorea SGD)

Coverage: Mo'orea, French Polynesia

NSF Award Abstract:
Submarine groundwater discharge (SGD) is the flow of water from land through the coastal seafloor into the nearby ocean. Approximately 13,000 cubic kilometers of groundwater is discharged into coastal environments every year, yet the effects of this fresh and often nutrient rich SGD are still poorly understood for coral reefs. This SGD input is driven by changes in precipitation, human land use, sea-level rise, tidal amplitude, and groundwater usage, many of which are rapidly changing with climate and human impacts. This project improves our understanding of SGD effects on coral reefs to better predict how both natural and human-induced changes will affect coastal ecosystem functioning in the future. Working in one of the most comprehensively studied coral reef ecosystems in the Pacific (Mo'orea, French Polynesia, home of the Mo'orea Coral Reef Ecosystem LTER); this project tests the influence of SGD on individual, community, and ecosystem-scale coral reef processes. Using mensurative studies, caging experiments, and a synthetic model, the investigators: 1) characterize SGD gradients and relate it to high resolution coral reef cover data, 2) determine how individual to ecosystem processes are influenced by SGD, and 3) develop a synthetic model to show how changes in SGD fluxes will alter reef ecosystem functioning. As SGD is a common feature on nearshore coral reefs worldwide, the results of this study have global implications for understanding the performance of coral reefs, which are essential economic, cultural, and scientific resources. This project is structured to provide training across multiple career levels, linking 13 undergraduate students, 2 graduate students, 2 senior personnel, 1 postdoctoral researcher, 1 female beginning lead investigator, and 2 senior co-investigators, with a focus on encouraging participation from underrepresented groups (e.g., through the Alaska Native and Native Hawaiian, Asian American and Native American Pacific Islander, and Hispanic-Serving Institutions of California State University Northridge, the University of Hawai'i at Mānoa, and California State University Long Beach). The investigators work with local K-12 students and teachers in Mo'orea and collaborate with an artist-in-residence to communicate science to the broader public through interactive and immersive art experiences in Mo'orea, Miami, and Los Angeles.

SGD is a natural and understudied feature of many nearshore coral reef ecosystems, which can contribute substantial changes to marine biogeochemistry, with impacts for coastal organisms such as reef-building corals, macroalgae, and bioeroders. SGD may play a key role in coral reef ecosystem functioning because it alters key physicochemical parameters (e.g., temperature, salinity, and nutrient and carbonate chemistry) that substantially affect both biotic and abiotic processes on coral reefs. This project (i) characterizes the spatial extent and biogeochemical signal of SGD in Mo'orea, French Polynesia, (ii) identifies how SGD influences microbial processes, benthic organism growth rates and physiology, species interactions between corals, macroalgae, and herbivores, and net ecosystem calcification and production rates, and (iii) quantitatively assesses how changes in SGD fluxes will alter reef biogeochemistry and ecosystem functioning through an integrative modelling effort. Specifically, the hydrogeological, biogeochemical, and ecological data collected in this study are synthesized in a Bayesian structural equation model. This project characterizes and quantifies how SGD directly and indirectly affects ecosystem functioning via changes in biogeochemistry and altered individual to ecosystem responses, thereby providing a better capacity to track and predict alterations in reef ecosystem function.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1924281

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