OCN 401
Biogeochemical Systems

(Welcome!)

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Textbook: *Biogeochemistry, An analysis of Global Change*

by William H. Schlesinger & Emily S. Bernhardt

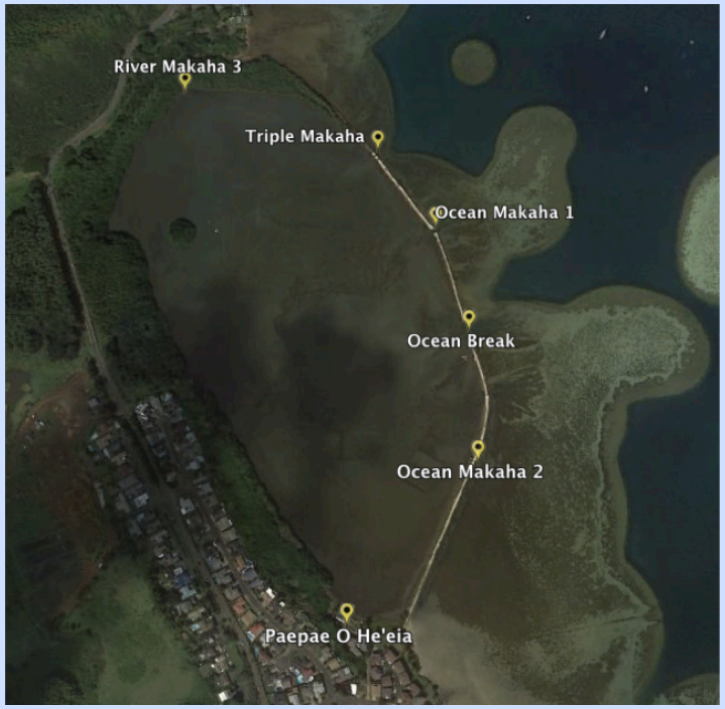
Course Goals (SLOs)

Obj-1

1. Understand the underlying principles of biogeochemical cycling in aquatic and terrestrial systems.
2. Identify the major global pathways of bioactive elements and human perturbations of these pathways.

Obj-2

3. Develop / improve written and oral communication skills focused on biogeochemical processes.
4. Achieve facility using electronic resources.



Quantifiable Metrics

Atmospheric Exchange

River

Biogeochemical processes in the pond

Makahas

Sedimentation

SGD

Course Informational Resources

1. Syllabus with important due dates highlighted

2. Course Info Sheet – your ‘go to’ for ‘how to’

3. Professor Office Hours (by appointment)

4. Writing Assistance.
   - Manoa Writing Center
   - Course hand-outs
   - Meet with professors

LECTURES

Lectures will generally be given using PowerPoint presentations. As a convenience to students, copies of the PowerPoint slides will generally be handed out in class.

However, do not be fooled into thinking that the handouts are a substitute for careful note-taking in class. Much of the useful information in this class will be in the form of classroom discussion of the subject material.

Thus, students are expected to attend all lectures and to actively participate in class discussions.

GRADING

Midterm Exam:	25%
Final Exam:	25%
Homework & Class Participation:	20%
Term Paper & Presentation:	30%

The Text Book

Biogeochemistry, An analysis of Global Change

by William H. Schlesinger & Emily S. Bernhardt

- Read chapter before class

- Subsections generally begin with an overview, and build from the general to the specific

- Almost without exception, very specific examples are given from the literature.

- Important to grasp the overview; understand but no need to memorize specific examples (*with a few exceptions)*.

			Part I: Processes and Reactions				
1	Tu	22-Aug	Course Introduction. Discuss homework and term paper. Tree of life. Metabolic pathways. Calculation of energy yields.	1, 2		KCR, FS	*Assign 1st mini-essay*
2	Th	24-Aug	Atmospheric deposition, atmospheric models	3		CM	
3	Tu	29-Aug	Rock weathering and soil development	4		KCR	*1st mini-essay due*
4	Th	31-Aug	Photosynthesis and net primary production	5		CM	*Return graded 1st mini-essay; Assign 2nd mini-essay*
5	Tu	5-Sep	Net primary production and global change	5		CM	
6	Th	7-Sep	Nutrient cycling in land plants	6		FS	*2nd mini-essay due; Assign peer reviewers*
7	Tu	12-Sep	Discussion of Peer Reviewed mini-essays; Assign Extended Essay Topics; Review of Rubrics; Library research methods	-	**Review of Electronic Library Research Methods**	KCR, FS	*Peer reviews due; Discuss Peer review of 2nd mini-essay in class; Assign Extended Essay Topics to students; BRIEF review of rubrics for*
8	Th	14-Sep	Nutrient cycling in land vegetation and soils	6		FS	
9	Tu	19-Sep	Cycling and biogeochemical transformations of N, P and S	6		FS	*1st draft Extended Essay due; Assign peer reviewers*
10	Th	21-Sep	Ecosystem mass balances and models of terrestrial nutrient cycling	6		FS	
11	Tu	26-Sep	***Peer review of extended essays in class***	-	**Discuss Term Paper Topic mini-presentation & Outline Rubric**	KCR	*Discuss peer review of essay drafts in class; Draft revision plans in class*
12	Th	28-Sep	Lakes, primary production, budgets and cycling	8		KCR	
13	Tu	3-Oct	Wetlands, and biogeochemical redox reactions in aquatic systems	7		BG	*Final draft Extended Essay due*
14	Th	5-Oct	Wetlands, and biogeochemical redox reactions in aquatic systems	7			
15	Tu	10-Oct	**MID-TERM EXAM**	-	*****Term Paper Topic Due at the Beginning c**	KCR	*Return Graded Extended Essay*
16	Th	12-Oct	River transport and chemistry	8	*****Term Paper Topic mini-presentation *** (2 minute, 1 to 3 slide summary)**	KCR	
17	Tu	17-Oct	Estuarine and coastal ocean environments	8		BG	
18	Th	19-Oct	Oceanic composition, circulation	9	***** Outline Due; Assign Peer Reviewers *****	KCR	
19	Tu	24-Oct	Oceanic production, carbon regeneration, nutrient cycling in the ocean - Part I (plus Peer Review	9	*****Peer reviews due; Discuss Outline Peer Reviews in class; Draft revision plans in**	KCR	
20	Th	26-Oct	Oceanic production, carbon regeneration, nutrient cycling in the ocean - Part II	9		KCR	
21	Tu	31-Oct	Oceanic production, carbon regeneration, nutrient cycling in the ocean - Part III	9	***** Final Outline Due *****	KCR	
22	Th	2-Nov	Hydrothermal vents	9		BG	
23	Tu	7-Nov	Oceanic sedimentary records	9	***** Outline Returned *****	BG	
			Part II: Global Cycles				
24	Th	9-Nov	The Global Water, Sulfur and Mercury cycles	10, 13		BG	
25	Tu	14-Nov	The Global Carbon cycle - I	11		CM	
26	Th	16-Nov	The Global Carbon cycle - II	11		CM	
27	Tu	21-Nov	The Global Phosphorus and Nitrogen cycles	12	***** First Draft and Revised Outline Due *****	KCR	
28	Th	23-Nov	***HOLIDAY: Thanksgiving (no class)***				
29	Tu	28-Nov	***Student Presentations-I***	-	***** First Drafts Returned*****	BG	
			Student Presentations	-			
30	Th	30-Nov	***Student Presentations-II***		***** Meet with Prof to Discuss Edits & Revision Plan (OUTSIDE CLASS TIME: optional)*****	(ALL)	
31	Tu	5-Dec	***Student Presentations-III***			(ALL)	
32	Th	7-Dec	***Student Presentations-IV, course evaluations***		***** Final Draft Due *****	(ALL)	
	Tu	12-Dec	**FINAL EXAM: 12:00 - 2:00**			KCR	

Homework

i) Mini-essays (2) ⟶ writing mechanics (2-3 pp)

ii) Extended essay ⟶ critically review literature on a technical subject, organize arguments (3-5 pp)

Term paper and presentation ⟶ synthesize skill sets emphasized in homework categories (i) and (ii)

Term Project

Products:

- Term paper (70% of term project grade)
- Oral presentation (30% of term project grade)

Component parts of project:

- Choose a topic (*must get instructor's approval!*)
- Mini-presentation of topic (1 to 2 slides / 2 minutes)
- Detailed, annotated outline for term paper; peer review
- Submit a ***complete*** draft of your term paper for instructor comments
- Submit corrected final draft of term paper
- In-class oral presentation of paper with peer review

Term Project Due Dates

Due dates are *FIRM*. Late assignments will be docked points (*10% per day*). See me *in advance* if you are unable to meet deadlines to arrange extension. Extensions will be granted only for emergency situations.

Date	**Assignment**
10/10	Term project topic due
10/12	Mini-presentations of topics
10/19	Outline due
10/24	Outline peer reviews due
10/31	Final Outline due
11/21	*1st draft of paper due*
11/28	1st draft returned
11/28	Oral presentations
	Meet with KCR to discuss paper revisions
11/30	Oral presentations
12/5	Oral presentations
12/7	Oral presentations; Final paper due

Past Term Paper Topics

(Note: These examples cannot be used this year)

2016

- Cattle farming management effects on C & N
- Greenhouse gases from thawing permafrost
- Cryoconite hole biogeochemistry
- Impacts of natural resource harvesting on small island nations
- Hypoxia in the Yangtze River Estuary
- Aerosols, radiative balance, cloud formation in the Amazon
- Ocean acidification in coastal margins vs. pelagic ocean
- Coastal innundation & urban infrastructure
- Cycling of nitrogen in a post-fire coniferous forest
- Glacial change & effect on local & global systems

Past Term Paper Topics

(Note: These examples cannot be used this year)

2016

• Net effects of warming, groundwater discharge, damming on salinization of the Aral Sea

•Coastal pollution: excess nutrients from runoff

•Effects of agriculture on soil chemistry and biodiversity

•Carbonate compensation depth in relation to geologic history

•Iron fertilization & carbon sequestration

•Impacts of harmful algal blooms on organisms and economy

Past Term Paper Topics

(Note: These examples cannot be used this year)

2015

- Soil organic carbon and tillage
- Ice algae and climate change
- Glacial-interglacial carbon dioxide variations
- Sulphur dioxide emissions in China: the acid rain issue and abatement solutions
- How diatoms influence the biogeochemistry of the Sargasso Sea
- Allocthonous fluxes of iron to the ocean
- The role of biogeochemistry on color formation in Champagne Pool, NZ
- Storm runoff influence on nutrient and phytoplankton dynamics in Kaneohe Bay
- How Lake Constance total suspended matter is affected by spring alpine snowmelt

Past Term Paper Topics

(Note: These examples cannot be used this year)

2015 (cont)

• Past & present methane production from Holocene wetlands as an indicator of spatial and temporal methane abundance under a future climate regime

•Invasive plants in Hawaii: impacts on nutrient cycling

•Global carbon fluxes to the coastal ocean

•Effects of climate change on carbon accumulation in peatlands

Past Term Paper Topics

(Note: These examples cannot be used this year)

2014

- El niño southern oscillation and subsequent effects on weathering and nutrient distributions along the eastern pacific
- Effects of anthropogenically induced change on salt marsh ecosystems in california
- Acid rain: effects on lake and terrestrial ecosystems
- Sedimentation on coral reefs: A comparison of reefs in the hawaiian islands and puerto rico
- An analysis of the physical and biogeochemical impacts of heinrich events
- Influence of jellyfish blooms on nutrient cycles
- Redox regime of biogeochemical successions in he'eia fishpond
- Future changes in oceanic dissolved oxygen concentrations

Past Term Paper Topics

(Note: These examples cannot be used this year)

2014 (cont'd)

- High Temperature Geothermal Sources of Hawaii and New Zealand: Water Chemistry and Associated Microbial Communities
- Picoplankton Photoheterotrophic Production in the Subtropical North Pacific Ocean
- Methane Hydrates: Formation, Distribution and Potential Effects on Climate
- The Effects of Urban Runoff on Coral Communities

Past Term Paper Topics

2013

- Biochar Addition and Greenhouse Gas Emissions from Soil
- The Sulfur Cycle in Marine Environments
- Oceanic anoxic events of the Cretaceous Period Methane formation and oxidation in continental margin sediments
- Impacts of Land Use on Coastal pH
- Contrasting the Impact of Ocean Acidification on Coral Reef Organisms vs. Sea Anemones
- The Roles of Macro-scale, Meso-Scale, and Micro-scale fauna and flora in soil formation and carbon cycling
- How Did Coral Reefs Affect CO_2 Levels During Deglaciation?
- Paleoclimate Reconstruction with Coccolith Vital Effects

Past Term Paper Topics

2012

- Increase in nutrient loads and how that affects corals
- Arsenic in the marine environment
- Biochar, a way to improve soil quality and plant productivity
- Methane formation and oxidation in continental margin sediments
- Increasing CO_2 and the affect on trees
- Changes in calcification rates of marine invertebrates in response to increased atmospheric CO_2
- Urban runoff effects on microbial communities in receiving bodies
- Physical enrichment of nutrient uptake in corals
- How the hydrological cycle of wetlands affects the release of greenhouse gases
- Tracer transport in oceanic crust on the Juan de Fuca Ridge

2012 (cont'd.)

- Consequences of carbon enrichment on nitrogen biogeochemistry in subtropical oceans
- Carbon budgets in estuaries
- From Mississippi to the Gulf of Mexico: Runoff, leaching and the dead zone
- Origination of sequestered carbon in northern cryosphere and potential releases
- Anthropogenic influences on silicate weathering rates in river basins and the implications for atmospheric CO_2 concentrations
- Environmental impacts of a geothermal power plant
- Soil development in the North American Prairies in the last 100 years
- Precambrian stromatolite formations: Biogeochemical processes of early archaic life forms
- Carbon cycle in coastal upwelling regions
- The biochemical effects on chalcopyrite leaching
- Diapycnal and isopycnal mixing

2011

- Arctic sea ice: Adaptations and ecological ramifications.
- Delivery of anthropogenic nitrogen to the coastal ecosystem on basaltic shorelines by submarine groundwater discharge.
- Biochar double whammy: Carbon sequestration and increased food production.
- Methane formation and oxidation in continental margin sediments.
- Sediment redox chemistry in mangrove forests: He'eia Fishpond as a case study.
- Soil acidity and agricultural productivity of oxisols and ultisols in the tropics.

2010

- Environmental and biogeochemical changes associated with the evolution of eukaryotes.
- Spatial and temporal variability of the biogeochemical response to storm runoff in southern Kaneohe Bay, Oahu, Hawai'i.
- Lake Kivu: Catastrophe or gift of energy?
- Methane hydrates: Formation, stability, and effects on global climate.
- Effects on coral growth due to increased atmospheric CO_2.
- Mercury methylation in the marine environment.
- The effects of ocean acidification on the benthos.
- The generation, migration and climatic effects of coastal methane seeps.
- Oxygen minimum zones: Understanding the global biogeochemical characteristics of OMZs.
- The formation of biogenically derived marine aerosols, air-sea transport, and ecological effects.
- Factors influencing organic carbon sequestration in marine environments.
- The role of submarine groundwater discharge in coastal nutrient dynamics.
- Dammed nations, or damned ocean? The effect of dams on the coastal zone.
- Carbon capture and sequestration: Deep-sea CO_2 injection.

2009

- Agricultural soil erosion: Carbon sink or source?
- Beachrock: Evidence of shoreline change.
- Bioaccumulation of toxic metals in fresh water and coastal marine systems: Arsenic, mercury and lead.
- Effect of agriculture on nutrient loading in the Mississippi River: The Gulf of Mexico Dead Zone.
- Forest fires and nutrient cycling.
- New hypoxic zone: A comparison with other dead zones and implications of ocean current changes in the northwest Pacific Ocean.
- Nutrient cycling within subsurface chlorophyll maximum and plankton thin layers.
- Carbon sequestration: A comparison between biological and geological approaches.
- Air pollution and atmospheric deposition in Istanbul.
- Nitrogen fixation in the North Pacific Ocean.
- Effects of submarine groundwater discharge on nutrient cycling and ecosystems.

2008

- Sediment transport in coastal areas
- As cycling in marine environments
- Nutrient supply in Pacific versus Atlantic eddies
- Biogeochemical interactions between the benthos & sediments
- CO_2 sequestration in deep sea, acidification effects
- Estuarine nitrification & denitrification
- Nutrient uptake ratios & phytoplankton selection
- Biogeochemical changes during PETM
- Environmental causes of ciguatera outbreaks
- Role of nutrients in HABs
- CH_4 production in natural systems
- Eutrophication: causes & oyster remediation
- Anoxic conditions related to nutrient input

Exams

There will be a 75-minute mid-term exam on **October 10** and a 2-hour final exam on **December 12**. The final exam will cover all of the semester's course material. Exams will cover the readings, lectures, and topics discussed in class.

Exams will be open book. Please bring a calculator.

Copies of previous exams can be examined in the Oceanography Office (MSB 205); these can give you an idea of the types of questions to be expected. However, it is **very** unlikely that any exam questions will be repeated!

No absences are allowed from any exam, except under circumstances totally beyond your control. **Except for medical emergencies, excuses must be submitted and approved before the day of the exam.**

Mini-Essay #1 Assignment Sheet

Overview of assignment:

Read the assigned article: *The Asian summer monsoon launches pollutants around the globe* (EOS Buzz Newsletter; 09 June 2017), and write a 2 to 3 page Mini-Essay on some aspect of the article. The objective of this writing assignment is to employ excellent writing mechanics and style, and to compose a brief, easily readable essay.

Assignment Due Date: August 29 (Tuesday)

Instructions:

1.Read over the Mini-Essay writing rubric to familiarize yourself with the criteria that will be used to evaluate the essay.
2.Read over the Mini-Essay grading template to see how points will be distributed among the different assessment criteria.
3.Read the assigned article and compose a mini-essay on some aspect of the article. The essay need not be a strict summary of the article – feel free to take literary license, as long as your essay is well written.
4.You must use 11 pt (PC) or 12 pt (Mac) font.
5.Text must be double-spaced.
6.You must number the pages.
7.Give your essay a title, and put your name, the date, the assignment type and the course # in the header.
8.You *must* underline the topic sentence of EACH paragraph!
9.You *must not* exceed the page limit!

See handout: Paragraphs & Topic Sentences

Writing Rubric for Mini-Essays

Strong	Satisf	Weak	Criteria	Comments
			Content:	
			Is the topic adequately summarized and discussed?	
			Are the facts reported accurate?	
			Are the ideas and concepts presented clearly described and articulated?	
			Organization:	
			Is the essay topic and/or objective clearly stated in the 1st paragraph?	
			Does each paragraph have a topic sentence?	
			Are ideas ordered logically, so that the thread of the essay is clear and easy to follow?	
			Are transitions made between sentences/ideas within paragraphs, and between paragraphs?	
			Structure and Style:	
			Are paragraphs the right length (not too long or too short)?	
			Is appropriate word choice used?	
			Are sentences and words varied to make the writing interesting?	
			Is the writing style clear? Are sentences & paragraphs cohesive?	
			Mechanics:	
			Are there grammatical or spelling problems?	

Mini-Essay Grading Template

Student:

% of Grade	Category	Criteria	possible points	actual earned points
25	Content	• central focus is on assigned topic, which is clearly stated in 1st paragraph	10	
		• coverage of topic is sufficient to make a well-rounded essay	10	
		• facts reported are accurate	5	
30	Organization	• Each paragraph has a clear topic sentence	10	
		• Ideas are ordered logically	10	
		• Transitions from paragraph to paragraph are explicitly made	10	
30	Stucture and Style	• Paragraph length is balanced	5	
		• Word choice is appropriate	5	
		• Writing is interesting, varied	5	
		• Sentences and paragraphs are cohesive	5	
		• synthesis of information is seamless	10	
15	Mechanics	• correct grammar is used	7	
		• spelling is error-free	6	
		• writer followed instructions*	2	
100		**Total Points:**	100	

* Typed in correct font size, double-spaced, page limit for essay.

GES Capstone Course: Global Cycles and Underlying Processes

- Utilize the knowledge base you have built over the past semesters as a GES student
- Apply this knowledge to the understanding of biogeochemical processes in different Earth environments
- End with synthesizing into an overview of global cycles of elements, emphasizing processes and coupled cycles
- Venture into discussions of extrapolating knowledge of current Earth biogeochemical cycles to the Earth's past and future