BIOGEOCHEMISTRY OF WETLANDS & AQUATIC SYSTEMS
SWS 6448
Fall 2016, Credits: 3

Campus Section 4357

CLASS PERIOD
Tuesday and Thursday 4th Period
Thursday 7th and 8th Period (Discussion and Guest Lectures)
Room 3124 McCarty Hall A

INSTRUCTORS
Campus Section 4357
Instructor: Dr. K. R. Reddy
Office: 2181 McCarty Hall A
Telephone: 294-3154
Email: krr@ufl.edu

Instructor: Dr. Kanika Inglett
Office: 3161 McCarty Hall A
Telephone: 294-3164
Email: kanika@ufl.edu

COURSE COMMUNICATIONS:
OFFICE HOURS: By appointment only or by email.

COURSE DESCRIPTION: Environmental and ecological significance of biogeochemical properties of wetlands and aquatic systems in relation to elemental cycling as related to water quality, carbon sequestration, greenhouse gas emissions, and sea level rise.

OVERALL COURSE OBJECTIVES: 1) To provide students with the basic concepts of biogeochemical cycling of macro and trace elements including carbon, nitrogen, phosphorus, iron and sulfur. 2) To discuss the environmental and ecological significance of these biogeochemical processes as they relate to environmental elemental cycling, water quality, carbon sequestration, climate change, and sea level rise.

COURSE FORMAT: Hybrid with In class lectures and invited guest lectures. All modular quizzes will be on the Course website that is located at the following address.
http://elearning.ufl.edu/
Log in with your Gatorlink Id and password

FREQUENCY TAUGHT: Fall Term

CLASS ATTENDANCE: Required.

GRADING SYSTEM:

QUIZZES	30%
EXAMS	50% (25% x2)
PRESENTATIONS and ATTENDANCE	10%
CALCULATIONS	10%

Passing Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	E
Points (%)	93-100	90-92	87-89	84-86	80-83	77-79	74-76	70-73	65-69	60-64	59 or less

MODULAR QUIZZES: (30% of final grade**):** Module (1-8) are associated with chapters 3 to 11 and they will be covered in regular lectures. All students are expected read these chapters. Associated with each module will be quizzes that must be completed within specified time period (as directed by the instructors and the teaching assistant).

EXAMS**:** (50% of final grade): Your understanding of the material will be assessed with **two exams** (25% each) during the semester. Exam format is primarily as a few short objective type questions (multiple choice, fill in the blanks), short answers (4-5 sentences) and long discussion type questions. However, this can be modified as per the discretion of the instructor and will be explained at appropriate time.

PRESENTATIONS and ATTENDANCE: (10% of final grade**):** will be *required* of the students. Each student is expected present a concept (list of topics will be provided by the instructor, and will be either from reading assignments or from current literature pertinent to this course) by developing a 15-18 minute presentation in class lecture format. This will be presented to the class. Each presentation will reviewed by the whole class. All presentations are considered are part of final exam and scheduled during the final exam week. One absence will not be penalized

CALCULATIONS: (10% of final grade):
To understand the concepts better, assignments with calculations will be given to the students. Examples of the problems will be discussed in class. However, Students are expected to review the first 2 chapters of the text to refresh some basic calculations.

TEXTBOOK (Highly recommended but not required)
Biogeochemistry of Wetlands: Science and Applications. K. R. Reddy & R. DeLaune. 2008.

CRC Press

UF POLICIES

UNIVERSITY POLICY ON ACCOMMODATING STUDENTS WITH DISABILITIES
Students requesting accommodation for disabilities must first register with the Dean of Students Office (http://www.dso.ufl.edu/drc/). The Dean of Students Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation. You must submit this documentation prior to taking assignments or taking the quizzes or exams. Accommodations are not retroactive, therefore, students should contact the office as soon as possible in the term for which they are seeking accommodations.

UNIVERSITY POLICY ON ACADEMIC MISCONDUCT
Academic honesty and integrity are fundamental values of the University community. Students should be sure that they understand the UF Student Honor Code at http://www.dso.ufl.edu/students.php.

NETIQUETTE: COMMUNICATION COURTESY: All members of the class are expected to follow rules of common courtesy in all email messages, threaded discussions and chats. **Failure to do so can lead to disciplinary action to be taken as decided by the instructor.

HELPFUL RESOURCES

WEB RELATED
For issues with technical difficulties for E-learning in Canvas, please contact the UF Help Desk either by going to http://elearning.ufl.edu and use the "**Message Us**" link (located on top right) or by contacting them at (352) 392-4357 x 2

** Any requests for make-ups due to technical issues MUST be accompanied by the ticket number received from LSS when the problem was reported to them. The ticket number will document the time and date of the problem. You MUST e-mail your instructor within 24 hours of the technical difficulty if you wish to request a make-up.

Software use: All faculty, staff and students of the University are required and expected to obey the laws and legal agreements governing software use. **Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.

PERSONAL
Other resources are available at http://www.distance.ufl.edu/getting-help for:

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Counseling and Wellness resources at

- University Counseling & Wellness Center, 3190 Radio Road, 352 -392-1575, www.counseling.ufl.edu/cwc

Library Help Desk support can be found at http://www.ufl.edu/academics/libraries/

Career Resource Center, Level 1 J Wayne Reitz Union, 392-1601, www.crc.ufl.edu

Resources for handling student concerns and complaints: Should you have any complaints with your experience in this course please visit http://www.distance.ufl.edu/student-complaint-process to submit a complaint.

Should you have any complaints with your experience in this course please visit http://www.distance.ufl.edu/student-complaints to submit a complaint.

COURSE OUTLINE

Module – I: Characteristics of Soils and Sediments

1. The extent and nature of wetland ecosystems in the earth's biosphere.
2. Relationship between wetlands and adjacent aquatic ecosystems
3. Overview of the significance of wetlands and the role of soils as a key component of wetlands.
4. Importance of wetland soils in the context of agronomic, ecological, limnological and environmental conditions.
5. Importance of biogeochemical cycles and their role in the overall function of wetlands and aquatic ecosystems.
6. A discussion of the general properties of wetland soils and aquatic sediments as compared to upland soils.
    - Accumulation of organic matter.
    - Absence of molecular oxygen.
    - Restricted gaseous exchange.
    - Presence of marsh plants.
    - Changes in electrochemical properties (pH, redox potential and conductivity) of soils.
    - Presence of reduced chemical species.
    - Criteria used to classify wetland (hydric) soils.

Module– II: Electrochemical Properties

1. A discussion on key physico-chemical properties that are influenced by hydrologic fluctuations of (temporary or permanent flooding) of wetlands and hydrodynamics of aquatic systems.
2. Ranges in values of pH and redox potential, in natural systems. Principles, theory and techniques involved in the measurement of these properties.
3. Soil reductive processes showing the sequential reduction of oxidized compounds. The intensity and capacity aspects of energy yields due to reductive processes. Relationship between pH and Eh and concentrations of oxidized and reduced species of inorganic redox systems. Eh-pH stability fields for select redox couples.
4. The role of oxidized redox components as electron acceptors in microbial metabolic pathways. Vertical stratification of oxidized and reduced species and their importance in digenetic processes.
5. Experimental techniques to measure soils reductive processes. Reactors to control Eh and pH of soils/sediments and techniques to measure vertical stratification of redox species.
6. Characteristics of wetland and aquatic plants. Development of aerenchyma and role in gas exchange through plants.

Module– II: Electrochemical Properties

1. Sources and nature of soil organic matter
2. The role of soil organic matter as electron donor in the microbial respiratory activities.
3. Mechanisms regulating organic matter accumulation in wetland soils. Role of plants in accumulation of organic matter under various ecosystems. Techniques to measure historical organic accumulation rates.
4. Decomposition of organic matter and the role of different electron acceptors (oxygen, nitrate, manganese, iron, sulfate and CO2). Kinetics of organic matter decomposition. Turnover rates of organic matter as influenced by different climatic and hydrologic regimes.
5. Methanogenesis - role in organic matter decomposition. Mechanisms involved in methanogenesis

in wetlands. Influence of plants and methane fluxes from wetlands.

Module- III: Biogeochemistry of Carbon

1. Sources and nature of soil organic matter
2. The role of soil organic matter as electron donor in the microbial respiratory activities.
3. Mechanisms regulating organic matter accumulation in wetland soils. Role of plants in accumulation of organic matter under various ecosystems. Techniques to measure historical organic accumulation rates.
4. Decomposition of organic matter and the role of different electron acceptors (oxygen, nitrate, manganese, iron, sulfate and CO2). Kinetics of organic matter decomposition. Turnover rates of organic matter as influenced by different climatic and hydrologic regimes.
5. Methanogenesis - role in organic matter decomposition. Mechanisms involved in methanogenesis in wetlands. Influence of plants and methane fluxes from wetlands.

Module – IV: Biogeochemistry of Oxygen

1. Oxygen/H_2O redox couple
2. Soil aeration
3. Establishment of aerobic (oxygen reduction zone) zone at the soil/sediment and floodwater interface and plant root-soil water interface.
4. Oxygen transport through the floodwater and consumption by soils and sediments. Oxygen production benthic photosynthetic algae and its role in oxygen diffusion and consumption.
5. Oxygen transport through wetland plants and its role in rhizosphere oxidation. Mechanisms (diffusion and mass flow) governing oxygen through the plants.
6. The role of aerobic zone on exchange of nutrients and gases between soil/sediments and the overlying water column.

Module – V: Biogeochemistry of Nitrogen

1. Distribution, sources and forms of nitrogen. Describe in detail nitrogen cycle in different wetlands and aquatic ecosystems.
2. Mineralization and immobilization processes under different redox (aerobic, facultative and anaerobic) conditions.
3. Aerobic ammonium oxidation (Nitrification) and anaerobic ammonium oxidation (anammox) at the aerobic -anaerobic interface at the soil/sediment surface of wetlands and aquatic systems and in the rhizosphere of wetlands and aquatic plants.
4. Ammonia volatilization as a nitrogen loss mechanism in wetlands and aquatic systems. Influence of photosynthetic algae and other submerged macrophytes on floodwater pH and ammonia volatilization. Conditions under which this loss mechanism is minimized and maximized.
5. Nitrate reductive pathways under various conditions including the influence of both organic and inorganic electron donors. Relative importance of denitrification, dissimilatory nitrate reduction to ammonia will be discussed.
6. Biological nitrogen fixation in wetlands. Significance of this process to supply the nitrogen requirements of wetland plants and its contribution to overall nitrogen budget.
7. Exchange (diffusion and mass flow) of dissolved nitrogen species between soil and water column. Discuss the significance of these processes in nitrogen biogeochemistry.
8. Role of plants in nitrogen cycling (storage by assimilation and release during decomposition).

9. Nitrogen budget in different wetland ecosystems.

Module - VI: Biogeochemistry of Phosphorus

1. Distribution, sources and forms of phosphorus.
2. Mineralization of organic phosphorus in soil/sediments and the overlying water column. Role of phosphatase on breakdown of soil organic P.
3. Inorganic phosphate reactions including adsorption, desorption and precipitation.
4. Phosphorus solubility as influenced by redox potential and pH.
5. Exchange (diffusion and mass flow) of dissolved phosphorus species between soil and water column. Discuss the significance of these processes in phosphorus biogeochemistry.
6. Role of wetland plants in phosphorus cycling (storage through assimilation and release during decomposition.
7. Legacy phosphorus in soils and sediments and the influence biogeochemical processes on internal load will be discussed.

Module - VII: Biogeochemistry of Iron and Manganese

1. Distribution, sources and forms of iron and manganese.
2. Reactivity of iron and manganese as influenced by pH and redox potential.
3. Role of iron and manganese as an electron acceptor in organic matter decomposition and nutrient release.
4. Exchange (diffusion and mass flow) of dissolved iron and manganese species between soil and water column. Discuss the significance of digenetic processes in manganese biogeochemistry.

Module – VIII: Biogeochemistry of Sulfur

1. Distribution, sources and forms of sulfur.
2. Reactivity of sulfur forms as influenced by pH and redox potential.
3. Role of sulfate as an electron acceptor (dissimilatory sulfate reduction) in organic matter decomposition and nutrient release.
4. Exchange (diffusion and mass flow) of dissolved iron species between soil and water column. Discuss the significance of digenetic processes in iron biogeochemistry.
5. Formation of metal sulfides and stability of metal sulfides under various physico-chemical environment.
6. Sulfur budget in different wetland ecosystems. Present sulfur models to simultaneously describe the processes involved in sulfur cycling of wetlands and aquatic systems

Guest Lectures

Several guest lectures are planned for this course. Campus seminars that are related to this course will be assigned to students to attend. This will become part of class material.

Reference Books

1. Batzer, D. P and R. R. Sharitz. 2006. Ecology of Freshwater and Estuarine Wetlands. University of California Press. Pp 546.
2. Bianchi, T. Biogeochemistry of Estuaries. 2007. Oxford University Press, Inc. 689 pp.

3. Brady, N. C. and R. R. Weil. 2008. *The Nature and Properties of Soils*. Prentice Hall, New Jersey. 965 pp.
4. Fenchel, T, G.M. King., and H. Blackburn. 2012. Bacterial Biogeochemistry. Oxford Press Inc. 293 pp.
5. Garrels, R. M., and C. L. Christ. 1965. Solutions, Minerals and Equilibria. Harper and Row. Chapter 5 and 7.
6. Likens, G.E. 2010. Biogeochemistry of Inland Waters. Academic Press. 687 pp.
7. Madigan, M. T, J. M. Martinko, D.Stahl, and D. P. Clark. 2010. *Brock Biology of Microorganisms*. 13th Edition. Pearson Prentice Hall, Upper Saddle River, NJ.
8. McBride, M. B. 1994. Environmental Chemistry of Soils. Oxford Univ. Press.
9. Mitsch, W. J., J.G. Gosselink, C. J. Anderson, and L. Zhang. 2009. *Wetland Ecosystems*. Wiley, New York.
10. Pankow, J. F. 1991. Aquatic Chemistry Concepts. Lewis Publishers. Chapter 19.
11. Stumm, W., and J. J. Morgan. 1981. Aquatic Chemistry. John Wiley & Sons.
12. Schlesinger, W. H., and E. S. Bernhardt. Biogeochemistry: An Analysis of Global Change. Academic Press. pp.702.
13. Stevenson, F. J. 1994. Humus Chemistry. John Wiley & Sons. Chapter 1, 5 and 16.
14. Wetzel, R. G. 2001. Limnology. Academic Press. 1006 pp.
15. Wetzel, R. G. and G. E. Likens. 2001. Limnological Analysis. Springer.

Reference Journals [few examples]

1. Aquatic Geochemistry
2. Biogeochemistry
3. Biogeosciences
4. Ecological Engineering
5. Ecosystems
6. Ecological Monographs
7. Environmental Microbiology
8. Environmental Science and Technology
9. Journal of Environmental Quality
10. Limnology and Oceanography
11. Nature
12. Nature-Geosciences
13. Science
14. Soil Science Society of America Journal
15. Wetlands
16. Wetland Ecology and Management