

# SOIL ECOSYSTEM DYNAMICS

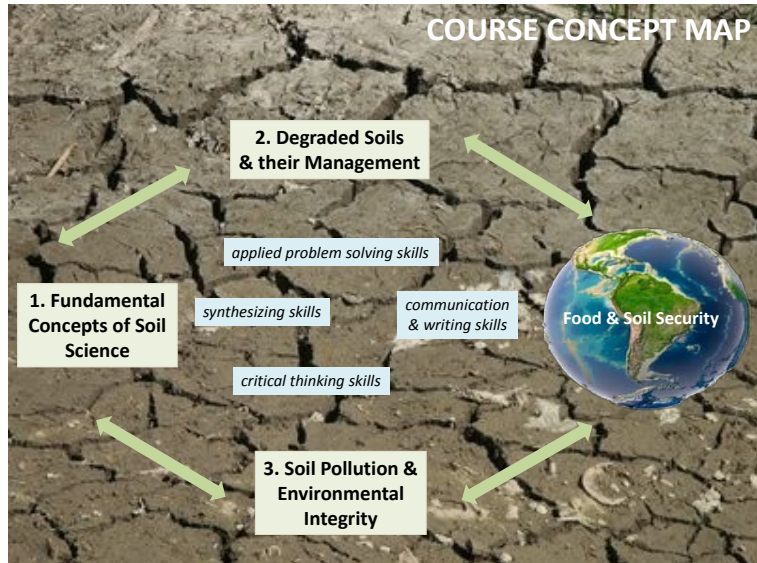
## ERS 484 / GEOG 404

Course Outline: September 2016

*"The soil does not stay the same, but like anything alive, is always changing and telling its own story. Soil is the substance of transformation" –C. Williams*

### COURSE OVERVIEW

This course examines the role of soil the environment and its importance as a natural resource in agricultural and forest productivity and the effects on soil due to mismanagement. This course is divided into three sections. The first section introduces fundamental concepts of soil looking in detail at soil composition, formation, and soil physical, chemical and biological characteristics. The second section of this course will discuss soil degradation and management approaches used to rehabilitate acidic soil, salinization/sodicity and soil erosion. The third section will focus on soil pollution, and the role of soil in maintaining environmental integrity. This course is available on Learn. Prerequisite: EnvS 200.



### COURSE GOAL & INTENDED LEARNING OUTCOMES

#### Goal:

- To introduce the fundamental concepts of soil sampling, soil physical, chemical and biological characteristics; and to introduce the major factors affecting soil degradation and using sustainable management practices and rehabilitation for their remediation.

#### Learning Outcomes:

1. Fundamental Concepts of Soil Science
  - Identify different methods of soil sampling, processing and analyses
  - Apply the fundamental concepts of soil science
  - Describe different systems of soil classification
2. Degraded Soils & their Management
  - Recognize sustainable soil management practices and provide examples using case studies
  - Explain how degraded soils can be remediated or restored
3. Soil Pollution & Environmental Integrity
  - Show how soil and soil pollution can influence atmospheric and hydrologic processes

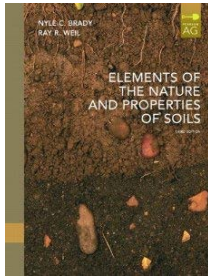
## COURSE MEETINGS TIMES & LOCATION

Lecture Times	Location
Friday 8:30 am to 11:20 am	EV 3, room 3412

## INSTRUCTIONAL TEAM

	PROFESSOR	TEACHING ASSISTANT
NAME	Prof. Dr. M. Oelbermann	Shefaza Esmail
CONTACT INFORMATION	Office: EV-2, room 2008 E-mail: <a href="mailto:moelbermann@uwaterloo.ca">moelbermann@uwaterloo.ca</a> Phone: 519-888-4567 Ext. 37552	Office: TBD E-mail: <a href="mailto:Shefaza.esmail@uwaterloo.ca">Shefaza.esmail@uwaterloo.ca</a> Phone: TBD
OFFICE HOURS	TBD	TBD

## REQUIRED MATERIALS



### This textbook available in UW Bookstore:

*N.C. Brady, Weil, R.R. 2010. Elements of the Nature and Properties of Soils. 3<sup>rd</sup> Edition, Pearson-Prentice Hall Publishing.*

Additional (*but not required for the course*) readings to supplement the textbook will be available on Learn. These readings will be relevant to the material discussed in class; help with the assignment and provide further insight for interested students.

## COURSE ASSESSMENT

LEARNING OUTCOME	ASSESSMENT METHODS (FORMATIVE & SUMMATIVE)	% OF OVERALL GRADE	TEACHING & LEARNING METHODS
1. Fundamental Concepts of Soil Science	<ul style="list-style-type: none"> <li>• Class discussions</li> <li>• Midterm                             <ul style="list-style-type: none"> <li>▪ lectures 1 to 5</li> <li>▪ held in class</li> </ul> </li> </ul>	0 30	<ul style="list-style-type: none"> <li>• Interactive lectures</li> <li>• Case studies</li> <li>• Video presentation</li> <li>• Textbook readings</li> <li>• Course website</li> <li>• PowerPoint slides</li> </ul>
2. Degraded Soils & their Management	<ul style="list-style-type: none"> <li>• Class discussions</li> <li>• Assignment (see assignment outline)</li> </ul>	0 30	<ul style="list-style-type: none"> <li>• Interactive lectures</li> <li>• Case studies</li> <li>• Textbook readings</li> </ul>
3. Soil Pollution & Environmental Integrity	<ul style="list-style-type: none"> <li>• Final Exam (lectures 6 to 11)</li> </ul>	40	<ul style="list-style-type: none"> <li>• Course website</li> <li>• PowerPoint slides</li> </ul>

## SUMMARIZED SCHEDULE OF COURSE ACTIVITIES

MODULE #	DAY OF LECTURE	LECTURE #	TOPIC	READING MATERIAL
1. Fundamentals of Soil Science	Sept. 9 <sup>th</sup> , 2016	1	- Introduction - The soil around us: composition & importance - <b>DVD – Dirt: The Movie</b>	Chapter 1
	Sept. 16 <sup>th</sup> , 2016	2	- Soil sampling methods - Soil physical properties	Chapters 4, 7
	Sept. 23 <sup>rd</sup> , 2016	3	- Soil chemical properties	Chapter 8
	Sept. 30 <sup>th</sup> , 2016	4	- Soil water	Chapters 5, 6
	Oct. 7 <sup>th</sup> , 2016	5	- Soil biology and soil organic matter	Chapters 10, 11
	Oct. 10 <sup>th</sup> , 2016	--	- <b>Thanksgiving Holiday</b>	
	Oct. 14 <sup>th</sup> , 2016	--	- <b>Midterm (in class)</b>	
	Oct. 21 <sup>st</sup> , 2016	6	- Soil formation & classification	Chapter 2 Chapter 3 (pp.58-68)
2. Degraded Soils & their Management	Oct. 28 <sup>th</sup> , 2016	7	- Acidic soils - Soil tillage systems	Chapter 9 (pp. 270-298)
	Nov. 4 <sup>th</sup> , 2016	8	- Soil salinity - Soil sodicity - <b>Assignment due</b>	Chapter 9 (pp. 301-318)
	Nov. 11 <sup>th</sup> , 2016	9	- Soil erosion & erosion control measures	Chapter 14
3. Soil Pollution & Environmental Integrity	Nov. 18 <sup>th</sup> , 2016	10	- Soil pollution - Environmental integrity	Chapter 15
	Nov. 25 <sup>th</sup> , 2016	11	- Overflow lecture - Final exam review	

## DETAILED SCHEDULE OF COURSE ACTIVITIES

### MODULE 1: FUNDAMENTAL SOIL CHARACTERISTICS

#### LECTURE 1:

##### Introduction

- Introduction to ERS 484/GEOG 404: Soil Ecosystem Dynamics
- Course Syllabus
- Course Expectations

##### The Soil around Us: Composition and Importance (Chapter 1)

- What is Soil?
- The Functions of Soil
- Components of Soil: Mineral and Organic
- The Soil Profile
- Soil: A Precious Resource
- Soil: Degradation, Misuse and Quality

## **LECTURE 2:**

### **Soil Sampling Methods (not in textbook)**

- Methods of Soil Sampling: Agriculture, Forestry and Ecosystems
- Soil Sample Preparation
- Soil Sample Analysis

### **Soil Architecture and Physical Properties (Chapters 4 and 7)**

- Soil Texture (size distribution of soil particles) and Soil Textural Classes
- Soil Structure and Soil Aggregates
- Soil Bulk Density
- Soil Porosity and Permeability
- Soil Air
- Soil Color
- Soil Temperature

## **LECTURE 3:**

### **Soil Chemical Properties (Chapter 8)**

- The Soil Colloid: Properties and Types
- Clay: Silicate clay structure, Clay Types and Mineralogical Organization, Role of Clay
- Soil Humus
- Cation and Anion Exchange
- Soil pH: Its Role in Cation/Anion Exchange

## **LECTURE 4:**

### **Soil Water: Characteristics and Behavior (Chapters 5 and 6)**

- Water Chemistry
- Soil Water Content
- Soil Water Potential, Availability and Flow
- Soil Water Infiltration and Percolation
- Water Uptake by Plants
- Water Use Efficiency
- Reducing Water Loss

### **Plant Nutrients: Nitrogen, Phosphorus and Potassium (Chapter 12)**

- Essential Macronutrients for Plant Productivity
- Mechanisms of Nutrient Uptake
- Soil Nitrogen
- Soil Sulfur
- Soil Phosphorus
- Soil Potassium

## **LECTURE 5:**

### **Soil Biological Properties and Soil Organic Matter (Chapters 10 and 11)**

- Diversity of Organisms in Soil
- Soil Organisms (macro-, meso- and micro-fauna)
- Factors Affecting Soil Microorganism Growth and Ecological Relationships
- Soil Organisms and Plant Communities: The Good and Bad
- Soil Organic Matter (and the Carbon Cycle)
- The Process of Decomposition and Factors Controlling Decomposition

- Formation of Humus
- Soil Organic Matter and Climate Change
- The Importance of Long-Term Research: Example from Rothamsted, England

#### **LECTURE 6:**

##### **Soil Formation and Soil Classification [Chapters 2 and 3 (pages 58 to 68 only)]**

- Formation of Soil from Parent Material: Weathering of Soil Minerals
- Soil Formation: The Factors that Influence the Formation of Soil
- Landforms and Soil Development
- Soil Horizons
- Factors Used in Soil Classification
- Canadian System of Soil Classification (not in textbook)
- FAO and U.S.A. System of Soil Classification (not in textbook)

## **MODULE 2: DEGRADED SOILS & THEIR MANAGEMENT**

#### **LECTURES 7:**

##### **Acidic Soils (Chapter 9: pages 270 to 298)**

- Processes of Soil Acidity and Alkalinity
- The Role of Aluminum in Soil Acidity
- Sources of Soil Acidity
- Buffering of pH in Soils
- Biological Effects on Soil pH
- Human Influenced Soil pH
- Amending Soil pH and Maintaining Soil Productivity

##### **Soil Tillage Systems (not in textbook)**

- Why Till the Soil?
- Tillage Terminology
- Alternatives to Conventional Tillage Systems
- Tillage and Environmental Sustainability

#### **LECTURE 8:**

##### **Soil Salinization and Sodicty (Chapter 9: pages 301 to 318)**

- Characteristics and Problems of Dry Regions Soils
- Development of Salt-affected Soils
- Measuring Salinity and Sodicty
- Classes of Salt-affected Soils
- Growth of Plants on Salt-affected Soils
- Physical Degradation of Soil by Sodic-Chemical Conditions
- Recognizing Salty and Sodic Soils
- Restoration of Saline and Sodic Soils

#### **LECTURE 9:**

##### **Soil Erosion (Chapter 14)**

- The Extent of the Problem
- Erosion by Water, Universal Soil Loss Equation
- Water Erosion Control
- Erosion by Wind
- Wind Erosion Control

## MODULE 3: SOIL POLLUTION & ENVIRONMENTAL INTEGRITY

### LECTURE 10:

#### Soil Pollution (Chapter 15)

- Threats to the Environment
- Organic Wastes
- Pesticides
- Heavy Metals and Natural Toxins
- Particulates and Gases

#### Soil and Environmental Integrity (not in textbook)

- Environmental Law and Soil
- Best Management Practices (BMP)
- Water and Soil Quality
- Remediation of Contaminated Soil

### LECTURE 11

#### Overflow Lecture

#### Final Exam Review

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### STUDENT CONDUCT AND APPROPRIATE BEHAVIOUR

I encourage students to study together, however each student is expected to individually fulfill the requirements of the assignment, presentation, and exams. It is the responsibility of each student to be aware of what constitutes responsible behaviour in class, what constitutes plagiarism, and your rights and responsibilities with respect to these issues.

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/). Students who are unsure what constitutes an academic offence are requested to visit the on-line tutorial at: <http://www.lib.uwaterloo.ca/ait/>

**Note for students with disabilities:** The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt, please contact your Undergraduate Advisor for details.

**Discipline:** A student is expected to know what constitutes academic integrity, to avoid committing academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. For

information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, [www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm). For typical penalties, check [Guidelines for Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm](http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm)

**Appeals:** A decision made or penalty imposed under Policy 70 - Student Petitions and Grievances (other than a petition) or Policy 71 – (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals). See: [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm)

**Consequences of Academic Offences:**

ENV students are strongly encouraged to review the material provided by the university's Academic Integrity office (see: <http://uwaterloo.ca/academicintegrity/Students/index.html>).