Course name: *Tropical Forest Management: Tools for Protecting Rain Forests and Mitigating Climate Change*
Professor*: David Skole, PhD. Michigan State University*
Code: *RCN 504*
Term/Year: Summer 2017
Number of Credits: 3

Course Description:

Costa Rica's policies and programs in tropical forest conservation are leading the world. Not only does Costa Rica have the most "text-book" examples of rain forests and high biodiversity, it is a country that leads the world in its national rain forest conservation policies. In addition, their national efforts to be carbon neutral are leading the world in climate change mitigation. With this field-based course, students are given both academic and very practical information on how to utilize and save these magnificent ecosystems, and manage tropical land sustainably in the face of national needs for resources and agriculture expansion.

This course focuses on the application of climate change science and carbon cycle science to sustainable forest management in the tropical rain forests. It also introduces the concept of livelihoods from tree management systems, poverty alleviation and sustainable development through the methods of carbon management in agro-forestry.

The course is excursion-based, as we visit three important rain forest ecosystems (coastal, upland, and cloud forests) and management systems (sustainable forest management and agro-forestry operations). The course emphasizes hands-on learning; we go over the road and off the trail and bushwhack through the rain forests. We visit farms with agro-forestry, and we see sustainable forest management and harvest operations.

The course will be heavily centered on how carbon conservation in natural forests and carbon sequestration in agro-forestry on farms can be used as development strategies as well as conservation strategies. We explore the concepts of sustainable forest management (SFM), climate change mitigation in forestry, and payments for ecosystem services (PES), which are operational in Costa Rica and uniquely the best examples in the world.

In addition to being dropped down right into the rainforest for its experiential value, students are also practically trained in methods for monitoring forests, including carbon accounting. The course covers both the scientific issues surrounding tropical forests and climate change, and the practical details of how global carbon markets and, specifically, the Costa Rican National Payment for Ecosystem Services Program work as novel ways for conservation.

Learning Objectives:

Students will obtain basic knowledge of climate change science and the role of tropical forests. They will learn practical methods and protocols for forest measurement and monitoring. They will gain an appreciation how carbon value chains in agro-forestry and forest management on farms in developing countries can be twinned with natural product value chains to raise incomes and improve both environmental conditions and livelihoods. They will learn new and novel approaches to conservation using Payments for Ecosystem Services model that made Costa Rica conservation efforts a global leader.

At the end of the course, students should be able to:

1. Understand the concept of climate change and its link to the global carbon cycle

2. Understand the role that tropical forests play a role in the carbon cycle

3. Gain a basic understanding about carbon and climate strategies to conserve existing carbon in tropical forests and enhance carbon sequestration through agro-forestry and SFM

4. Understand the policies of climate change mitigation and adaptation, with particular reference to the role of carbon trading and carbon markets, and the benefits for rural land owners

5. Obtain practical and marketable skills in carbon accounting, carbon reporting, and carbon verification in forests and on farms with trees

6. Become familiar with advanced technologies, including remote sensing and GIS, and how these tools can be used for carbon monitoring and accounting in whole landscapes

7. Understand the linkages between agro-forestry management and rural development; with a focus on linking carbon to rural poverty alleviation using the Carbon2Markets model

Assignments:

Students are assigned the following academic activities on their own or in teams:

1) Lectures, 2) Readings as published science papers, 3) analysis of carbon data collected during field sampling, 4) data analysis and project formulation using the MSU on-line carbon toolbox, 5) keeping a blog and 6) creating videos of their course excursions and activities.

Assigned Readings:

Each year students are assigned a reading list that is used to frame discussion periods. Discussions are led by students and are based on the ideas and methods presented in technical scientific papers. Some examples from recent years are listed below. We have as many papers as students.

Yadvinder Malhi. 2012. The productivity, metabolism and carbon cycle of tropical forest vegetation *Journal of Ecology*, 100, 65–75

J. Pablo Arroyo-Mora 1, Sienna Svob 1, Margaret Kalacska 1 and Robin L. Chazdon 2014. Historical patterns of natural forest management in Costa Rica: the good, the bad and the ugly, *Forests* 5, 1777-1797; doi:10.3390/f5071777

M E Fagan1, R S DeFries1, S E Sesnie, J P Arroyo, W Walker, C Soto, R L Chazdon and A Sanchun, 2013. Land cover dynamics following a deforestation ban in northern Costa Rica, *Environ. Res. Lett.* 8 (2013) 034017 (9pp)

Roger Sedjo and Molly Macauley, 2012. Forest carbon offsets: challenges in measuring, monitoring and verifying, *Environment: Science and Policy for Sustainable Development*, 54:4, 16-23

Irene Shaver, Adina Chain-Guadarrama, Katherine A. Cleary, Andre Sanfiorenzo, Ricardo J. Santiago-Garcıa, Bryan Finegan, Leontina Hormel, Nicole Sibelet, Lee A. Vierling, Nilsa A. Bosque-Pe´rez, Fabrice DeClerck, Matthew E. Fagan, Lisette P. Waits, 2015. Coupled social and ecological outcomes of agricultural intensification in Costa Rica and the future of biodiversity conservation in tropical agricultural regions, *Global Environmental Change* 32 (2015) 74–86

Special Report on Tropical Forests, 2010. The Economist, September 23, 2010

Holly K Gibbs, Sandra Brown, John O Niles and Jonathan A Foley. 2007. Monitoring and estimating tropical forest carbon stocks: making REDD a reality, *Environ. Res. Lett.* 2 045023 (13pp)

David B. Clark and James R. Kellner. 2012. Tropical forest biomass estimation and the fallacy of misplaced concreteness, *Journal of Vegetation Science* 23: 1191–1196

Molly K. Macauley & Roger A. Sedjo. 2011. Forests in climate policy: technical, institutional and economic issues in measurement and monitoring *Mitig Adapt Strateg Glob Change*, 16:499–513 DOI 10.1007/s11027-010-9276-4

Gullison, R.E. et al. 2007. Tropical forests and climate policy. *Science* 316: 985-986

Andrea Sabelli. 2011. A new solution to a persistent problem: addressing tropical deforestation with carbon offset projects, *Journal of Latin American Geography*, 10, 1; PRISMA (Publicaciones y Revistas Sociales y Humanísticas)

Florencia Montagnini and Christopher Finney. 2011. Payments for Environmental Services in Latin America as a Tool for Restoration and Rural Development, *AMBIO* 40:285–297 DOI 10.1007/s13280-010- 0114-4

Robert Fletcher and Jan Breitling. 2012. Market mechanism or subsidy in disguise? Governing payment for environmental services in Costa Rica, *Geoforum* 43: 402–411

Classroom Lecture Topics:

Each lecture period is 3 total hours – 2 lectures, with discussion and breaks. The lectures take place at EARTH University, taking advantage of the excellent classroom facilities. Students also have a chance to interact with EARTH students during breaks, meals, and after class.

Lecture 1: Course Overview; Overview of the Professor's Area of Research

Lecture 2: Forest of the World; Tropical Forest Ecology

Lecture 3: Tropical Forests and the Climate System

Lecture 4: Global Climate Change

Lecture 5: Carbon, Forest Conservation, Sustainable Management and Livelihoods

Lecture 6: Carbon Markets and Payments for Ecosystem Services

Field Instruction:

During the first week of the course, the students are given field-based instruction. Most of this occurs on the EARTH University campus, including its primary forest reserve, agroforestry fields, carbon sequestration plantations, secondary forest complexes, and ethnobotanical gardens. Each instruction is 3 hours total.

Field instruction 1: The Tropical Rain Forest Ecosystem (guided instruction at the Bio-Reserve)

Field Instruction 2: Carbon Sequestration in plantation systems, native and commercial

Field Instruction 3: Forest Fieldwork Safety, Biomass and Measurement Basics (Plantations)

Field Instruction 4: Forest Biomass and Carbon Measurement (Primary Forest)

Field Instruction 5: Agroforestry system of cacao and bananas

Field Instruction 6: Ethnobotanical gardens

Field Excursions and Instruction

A significant part of the course is dedicated to venues outside of EARTH University at unique and significant locations. The primary structure of the excursions is an ecological transect across three important tropical forest ecosystem types: lowland coastal rainforests, upland or *terre firme* forests, and cloud forests. Through the ecological transect framework they are introduced to the variation in structure, flora and fauna that one gets through these geographic, edaphic and climatic gradients. One of the unique aspects of Costa Rica is its ecological diversity and variation over rather short distances.

The other unique aspect of Costa Rica is its multi-institutional system of conservation units. In the process of visiting these different ecosystem the students also are introduced to different institutional mechanisms for their management and conservation. The coastal rainforest is managed in the National Park System. The upland forests are privately owned conservation areas and working (production) forests, including private land managed for production under SFM protocols with the assistance of the national governments PES programs. The cloud forest is a public trust arrangement.

Lastly, each of these locations has had an interesting and important history and we view these places in their historical and social contexts as well as ecological. As a human interest, each of the histories also involves a story about a significant American naturalist or scientist who had a significant role in developing the conservation areas in association with Costa Rican colleagues. This association of a visionary Americans working with peers in Costa Rica portray the real art of the possible and the value of international cooperation.

Field Excursion 1: *Lowland coastal rain forest at the Tortuguero National Park.* This national park is only accessible by a 2 hour boat ride. We stay at the unique Laguna Lodge where students have access to both the Caribbean coast and the lagoon system. An example of a wet lagoon forest, this place was extensively logged at the turn of the century until the 1960s. It's a fine example of the effectiveness of conservation and restoration at restoring tropical forests. The work of the ecologist Archie Carr from the University of Florida is highlighted. While at the Lodge we have guided tours by boat through the lagoon rain forests, tours of the local communities, discussions in the evenings based on the papers, and project-based work.

Field Excursion 2a: *Upland terre firme forests at the La Selva Biological Station*. The La Selva Biological Station provides a unique opportunity to visit an internationally-renown tropical ecosystem research facility and forest reserve, where because of their association with this course students have complete access to the rain forest reserve both day and night. The highlight is a night tour of the rainforest. During the day we have lectures and assignments. Las Selva is very rustic lodging, and we usually stay overnight at River House, the original site of the biological station deep into the *la selva*, or jungle. The work and life of Leslie Holdridge, the developer of the famous Holdridge Life Zone System is highlighted.

Field Excursion 2b: *Working forests and sustainable tropical forest management on private land managed under the national PES conservation program.* From La Selva Biological Station we join with FUNDACOR, a non-profit pioneer in tropical forest sustainable forest management methods, and venture to sites where active management is being implemented in working forests. Every year we plan to see actual operations in place and have forest engineers and practitioners from FUNDECOR guide us. This gives students a chance to see how utilization can occur as a conservation strategy, and how payments for

ecosystems services is being deployed by the Costa Rican government – a positive science-based approach to solving an important problem.

Field Excursion 3: *Cloud rain forests at the Monteverde Reserve and Tropical Science Center.* We conclude the course with a trip to the unique and world famous cloud forests in the central cordillera. This wet ecosystem is the canonical rain forest that all students read about. We stay at the Tropical Science Center inside the reserve. We have a chance to walk on the 200 meter-high canopy bridges to provide in-situ expert instruction on the canopy structure of tropical rain forests, and see the extraordinary free living Bromeliad ecosystem, where 50% of the forests biomass is high in the canopy attached to the branches extremely large trees. The wildlife in these rich eutrophic systems is abundant and diverse. To cement the canopy experience, we take a skyline up the mountain above the canopy and return by zipline through the canopy. We review the work and life of Joe Tosi and George Powell, two ecologists who worked with land owners to establish the protected area.

Estimated Course Contact Hours:

Classroom lectures: 18
Field Instruction: 18
Excursions: 68
Assignments outside of class time: 8

Grading:

Students are graded on the basis of the following areas. Note that there is a heavy emphasis on hands-on, excursion and experiential learning modalities. The scoring is on a 4-point scale. The numerical system consists of the following scale: 4.0 - 3.5 - 3.0 - 2.5 - 2.0 - 1.5 - 1.0 - 0.0.

Class Participation 20%
Field Work Participation 20%
Excursion Participation 20%
Readings and Discussions 10%
Carbon Project 25%
Video and Blog Projects 05%