ARE 703: Advanced Natural Resource Economics
Course Syllabus

April 15, 2014

Instructor

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Schedule

Tuesday/Thursday, 3-4:15pm
Agricultural Sciences Building, Room 2023 Office Hours: Wednesday, 2:00-3:00pm (or by advance appointment)

Rationale for Course

This is a Ph.D. field-level course covering the optimal economic management of natural resources. We will cover both exhaustible and renewable natural resources. Optimal management of natural resources involves allocating their use over time to maximize economic social welfare. Such an allocation problem is dynamic in nature, so we will spend a considerable part of the course on the methods of dynamic optimization, including optimal control theory and dynamic programming. The primary focus of the course is theory, so we will review some important institutional issues at the beginning of each topical section. Particular economic issues we will address include:

- The efficiency of markets

- The effects of market structure on the allocation of natural resources
- Optimal policies for use of natural resources
- The choice of social discount rate
- The effects of irreversible development and extinction on allocation decisions
- Growth theory, intergenerational allocation of resources, and sustainability

Readings

We only have no required texts for this class because I will use multiple sources, but Chiang (1992) *Elements of Dynamic Optimization* is recommended because it offers a fairly comprehensive coverage of the material. I will try to put a copy of Chiang (1992) on reserve at the library. Other suggested readings include *Natural Resource Economics* by Conrad and Clark (1978), *Fundamental Methods of Mathematical Economics* by Chiang and Wainwright (2005), *Mathematical Optimization and Economic Theory* by Intriligator (2002), *Dynamic Economics: Quantitative Methods and Applications* by Adda and Cooper (2003), and *Applied Computational Economics and Finance* by Miranda and Fackler (2002). We will also have Web sources such as Resource for the Future at www.rff.org. Copies of chapters from supplemental texts will be available from me upon request. These texts will be supplemented with readings that will provide information that we will not have time to cover in class.

Course Format

The course is divided into three sections. In the first section we will develop the mathematical tools for analyzing natural resource allocation issues. These include difference and differential equations, dynamic programming, and optimal control theory. In the second section we will develop the basic models of exhaustible and renewable natural resources. In the third section we will deal with special topics such as, but not limited to, renewable and exhaustible resource industry studies, optimization over time and space, irreversibility, sustainability, and uncertainty.

The lecture periods will be used to present the main themes, develop the conceptual material, and explore computational examples. This is a second-year Ph.D. course and the literature on natural resources is vast, so students will be expected to show considerable initiative in seeking out and reading additional materials. Active student participation in the class is required.

Prerequisites

All students must have at least one course in graduate-level microeconomic theory, such as Econ 701, and preferably one course in resource economics such as ARE 632. It would be useful if you have had a class in welfare economics such as ARE 633 or Econ 711. Some familiarity with difference and differential equations would be nice but it not required.

Grades

Grades will be determined as follows:

- Problem sets (10%)
- Mid-term exam (50%)
- Term paper & class presentation (40%)
- There is no final exam in this class.

Grades will be assigned as follows:

- A:100-90%
- B: 89-80%
- C: 79-70%
- D: 69-60%
- F Below 60%.

Term paper/class presentation

Each of you will choose a *dynamic* resource topic, subject to my approval, and present a single class lecture. You will be expected to prepare a reading list at least one week before the lecture. To receive an A you will need to be research your topic area and present it in a way that draws on several seminar articles or books, is policy relevant, and real world example or two. It is not sufficient to just choose a couple of articles and work through the equations in front of class. Your grade will be based on your ability to identify and synthesize the relevant literature; the quality of your presentation; and the quality of your presentation.

Possible subjects include:

- Sustainable management of agricultural land
- Sustainable social investment (Solow, Arrow, etc.)
- Fully-dynamic fisheries model
- Optimization over space and time
- Intergenerational equity and the choice of the social discount rate
- Predator/prey models
- Irreversible development and preservation of unique natural systems
- Economic growth and natural resources
- Extensions of Hotelling's Model
- Models of a particular natural resource industry
- Energy markets, energy policy, renewable energy, hydrogen, synfuels, biofuels, etc.

Academic Integrity Statement

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code at http://studentlife.wvu.edu. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me *before* the assignment is due to discuss the matter.

Social Justice Statement

West Virginia University is committed to social justice. I concur with that commitment and expect to maintain a positive learning environment based upon open communication, mutual respect, and nondiscrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national orientation. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration.

If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class. Please advise me and make appropriate arrangements with Disability Services (293-6700).

Tentative Course Schedule

Please note that the Schedule is subject to change.

I Introduction to Natural Resource Economics – One lecture

II Dynamic Optimization – Five weeks

- A Differential and Difference Equations – Two lectures
  - 1 Chiang (2005), Chapters 13 – 18
- B Dynamic Programming (Bellman's Principle) – One lecture
  - 1 Chiang (1992), Conrad and Clark, Chapter 1
- C Calculus of Variations – Two lectures
  - 1 Chiang (2002), Chapter 2 and sections 4.2 and 5.2
- D Optimal Control – Five lectures
  - 1 Chiang (2002), Chapter 7–10, Conrad and Clark, Chapter 1
  - 2 Dorfman (1969), "An Economic Interpretation of Optimal Control Theory", AER 59(5): 817-831
  - 3 Benavie (1970), "The Economics of the Maximum Principle", Western Journal of Agricultural Economics 8: 381-393

III Exhaustible Resources – Three weeks

- A Background
  - 1 Barnett and Morse (1962), Scarcity and Growth, John Hopkins
  - 2 Smith (1979), Scarcity and Growth Reconsidered, John Hopkins, Chapters 1,8,10, and 11
- B Classical Model
  - 1 Conrad and Clark, Ch. 3
  - 2 Hotelling (1931), The economics of exhaustible resources, JPE 39: 137-175

3 Solow (1974), The economics of resources or the resources of economics, AER May: 1-14

4 Dasgupta and Heal, Ch. 6, 11

5 Burt and Cummings, Production and investment in natural resource industries, AER 60: 576-590

C Nonrenewable Resource Supply and Demand

1 Bohi and Toman (1984), Analyzing Nonrenewable Resource Supply, RFF

D Extensions of Classical Model

1 Dasgupta and Heal, Ch. 13, 14

2 Pindyck (1980), Uncertainty and exhaustible resource markets, JPE 88(6): 1203-1225

IV Renewable Resources – Three weeks

A Fisheries

1 Conrad and Clark, Ch. 3

2 Clark, Mathematical Bioeconomics, Ch. 1–3

3 Smith (1968), Economic production from natural resources, AER 58: 409-431

B Forestry

1 Clark, Mathematical Bioeconomics, Ch. 8

2 Samuelson (1976), Economics of Forestry in an Evolving Society, Economic Inquiry 14: 466-492

C Soil

1 Burt (1981), Soil conservation economics in the Palouse, AJAE 63: 82-92

2 McConnell (1983), An economic model of soil conservation, AJAE 65(1): 83–89

V Student Presentations – Two weeks