



### Course Description

This course focuses on the relationship between the economy, the environment and policy. It studies the causes of environmental problems and policies to address them. The importance of production, consumption, externalities, property rights and public goods in environmental issues is examined. The effectiveness of environmental standards, taxes, cap and trade, deposit-refund, and liability in improving environmental quality is considered. Classroom games/experiments explore the role of incentives. Class debates will examine important and controversial environmental policy issues.

### Learning Outcomes

After successfully completing this course you will be able to:

- identify important environmental policy issues of the day and think critically about the role of incentives in creating environmental problems and in the design of alternative policies to improve environmental quality.
- comprehend the basic terms, concepts and approaches used to analyze environmental problems, value changes in environmental quality, and design policies to improve environmental quality.
- demonstrate how basic economic principles can be used to improve our understanding of environmental problems, estimate the impacts on society and help design better policies.
- use data and evidence to analyze important, contemporary environmental problems.

### Prerequisites and Expectations:

This course is open to students of all majors and there are no prerequisites. Course material spans the social and natural sciences with a focus on the economic causes and consequences of environmental problems. Throughout the course graphical analysis will be used to present mathematical concepts typically covered in higher level economics courses. It is expected that all students can understand and analyze two-dimensional graphs. Knowledge of basic algebra is also assumed. You may be required to use basic algebra on the exams without the assistance of a calculator. No prior coding experience is required or assumed. Access to a laptop with the capability to install the required software and internet access is recommended

### Carillon Mission

Carillon Communities creates an inspiring and supportive living and learning environment for first year students. Carillon promotes an environment where students develop a sense of belonging and trust to support their academic success and innovative thought. In Carillon, students consider their own interests and knowledge, and become more active agents in their own education.

### Tips for Success in this Course:

1. Participate. Discussions and peer learning are a critical part of the course. You can learn a great deal from discussing ideas and perspectives with your peers and professor. Participation can also help you articulate your thoughts and develop critical thinking skills. This course has a number of graded participation activities.

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301-405-7180

### Office Hours

SYM 2113

To be determined  
and by appointment

### Class Sessions

Tuesdays & Thursdays

2:00 – 3:15pm

MMH 1304

### Discussion Sections

W: 2:00-3:00

SQH 1117

### Teaching Assistant

To be determined

### TA Office Hours

To be determined and by  
appointment

2. Manage your time. Make time for your out-of-class learning, participation in course activities and discussions each week. Give yourself plenty of time to complete assignments including extra time to handle any technology related problems.
3. Login regularly to ELMS-Canvas to view the syllabus, lecture notes, announcements, and assignments.
4. Use ELMS-Canvas notification settings. ELMS-Canvas can ensure you receive timely notifications in your email or via text. Be sure to enable announcements to be sent instantly or daily.
5. Do not fall behind. This class moves at a quick pace and each week builds on the previous. It will be hard to keep up with the course content if you fall behind in the pre-work or post-work.
6. Ask for help if needed. If you need help with ELMS-Canvas or other technology, IT Support. If you are struggling with a course concept, reach out to the TA or me and your classmates, for support.

### Course Organization and Online Resources:

The course is organized into modules focused on key topics. Each module consists of readings, videos, online resources, and learning activities and assessments. The course calendar identifies when each module will be covered. Required learning materials for each module are listed in the course outline below. Listed readings are either linked in the syllabus or available on ELMS and should be completed by the indicated date. This syllabus is a working document and learning material may be modified throughout the semester.

Selected portions of the following textbook will supplement the course material.

Harris, J.M. and B. Roach. Environmental and Natural Resource Economics: A Contemporary Approach (4<sup>th</sup> ed.), New York: Routledge, 2018.

The textbook can be accessed **free** as an eBook through the [UMD library](#). A direct link to the library eBook is: <https://umaryland.on.worldcat.org/oclc/1005017417>. You will be prompted for your UMD credentials when you click “view eBook”. The eBook allows unrestricted read-online privileges, or downloading up to 167 pages of pdf chapters/sections for off-line reading, more than sufficient to download the sections of the text that supplement this course. If you choose to download sections for offline reading it is recommended you download those sections listed in the course modules first, to avoid exceeding page limits. There is no need to purchase the textbook but if you wish to do so it is available for purchase through the UMD bookstore or independent sellers.

The following open-source, online textbooks will support data analytics and visualization modules.

- [\*Data Science in R: A Gentle Introduction\*](#), by Scott. This book is free and published online using bookdown.
- [\*R for Data Science\*](#), by Wickham and Grolemund. The book is free and open source and licensed under a [Creative Commons license](#).
- [\*ggplot2: Elegant Graphics for Data Analysis\*](#), by Wickham, Navarro and Pederson. This book is free and open-source.

### Course website: [elms.umd.edu](https://elms.umd.edu)

[ELMS](#) is the main hub for course materials, announcements, assignments and due dates. To help you get started please see the [Orientation to ELMS for Students](#). The online course materials can be accessed from any device with an internet connection. Your fellow students or the consultants at the University computer Help Desk can help you if you have questions about accessing the campus network and ELMS.

### PointSolutions

This course will utilize PointSolutions Classroom Response System to support interactive questions and responses during class. Visit the Students section of [Classroom Response System: Students](#) for details about how to sign up. Classroom Response works in conjunction with your mobile device (smartphone, tablet or laptop). As an alternative to using a mobile device, you may purchase a physical clicker from the University Book Center.

### Piazza class discussion board

We will use Piazza for class discussion. Piazza may be accessed through the course menu on ELMS. The system is designed to strengthen peer learning and provide fast and efficient help from your classmates; and if necessary from the TA or myself on a delayed basis. Rather than emailing questions to me or the TA, you should post your questions on Piazza.

## Learning Economics Through Classroom Games and Exercises

Economic incentives can be explored using interactive classroom games or experiments where students participate as economic agents. This course will use classroom games/experiments and exercises to provide a hands-on learning experience.

- Consumer demand from eBay data
- Trading in a pit market
- Public goods
- Discounting and the economics of energy saving devices
- Cap and trade - a market for pollution emissions
- Heuristics and biases in decision-making under uncertainty

The goal is to reinforce the principles taught in the course through in-class experiments that allow you to make decisions under similar incentives to those facing actual decision makers (consumers, firms, regulators, etc). The only way you can learn from these experiments is if you participate in them.

## DataCamp Modules:

DataCamp has developed a set of outstanding course modules that combine short video tutorials with interactive coding exercises in R. Students will be enrolled by the instructor in a course organization on DataCamp at no cost. AREC241 uses chapters from DataCamp modules to teach concepts and help you learn how to code in R. DataCamp chapters will be assigned for each Data Module. Completing these will help prepare you for the modules. DataCamp modules will be graded as 1=credit, 0=no credit check-ins. Chapters are divided into sections with “XP” points. To receive credit for a weekly check-in you must earn at least 75% of the total XP for that week’s chapters. **Note your XP before you begin the chapters for each week.** This will allow you to keep track of the XP earned during the week by calculating the difference between the current value and the XP you started the week with. Most check-ins will require several hours to complete so allocate your time appropriately. If you receive less than 75% on assigned chapters you can make up the deficit by earning additional XP on supplementary chapters for that week. Motivated students may also want to work through these supplementary chapters to build their skills.

## Data Analytics Software:

This course utilizes open source R (<https://www.r-project.org/>) and R Studio Desktop (<https://www.rstudio.com/products/rstudio/download/>). These applications are free and available for Windows, Mac, Linux, and many versions of Unix. They should be installed before the start of class following the steps outlined in “Installing R and R-Studio” at: [Chapter 1 Getting Started with Data in R | Statistical Inference via Data Science \(moderndiver.com\)](#)

We will use open-source R packages available on the CRAN repository. Packages can be installed directly through RStudio following the steps outlined in “Installing additional packages using the packages tab” at the bottom of [Before we Start – R for Social Scientists \(datacarpentry.org\)](#). The **tidyverse** package should be installed before the start of class. This is a collection of packages designed to create and work with tidy data (see [Tidyverse packages](#)). Among them are:

- readr and readxl (for reading and writing data including excel workbooks)
- dplyr and tidyr (for data manipulation and tidying)
- ggplot2 (for plotting and visualizing data)
- lubridate (for working with dates and times)
- stringr (for working with text)

## AREC241 Shared Google Drive

All data and team projects will be housed on a Shared Google Drive folder for the course: AREC241 F24. Shared folders are shared spaces where teams can easily store, search, and access their files anywhere, from any device. You should install Google Drive for Desktop which has options for local and online folder and file access and automatically syncing of local files to the cloud. Google Drive for Desktop will enable you to access course shared data directly from R/RStudio. The Drive web interface is not a good alternative. See: [Drive for desktop cheat sheet](#) for more information including installation instructions for PCs and Macs.

**Important: To connect to the AREC241 Shared Google Drive you should use your [login-id@terpmail.umd.edu](#) id to authenticate. The course shared folder will not be accessible from non-umd ids. See the instructions on ELMS for more information.**

## Course Requirements and Grading:

Pre-class, in-class and post-class check-ins (low score dropped)	10%
Assignments/problem sets (3% each for highest 6 of 7)	18%
DataCamp check-ins	6%
Data Module check-ins	5%
Debate topic fact sheet (due date to be determined)	10%
Constructive review of a peer's fact sheet (due date to be determined)	5%
Exam	15%
Debate topic research paper (due date to be determined)	15%
Debate presentation/slides	9%
Debate check-ins (low score dropped)	5%
Your peer evaluation of your teammates	1%
Carillon Showcase (date/time to be announced)	1%

Assignments and problem sets emphasize critical thinking in the analysis of environmental policy problems.

There will be regular, in-class check-ins for class and discussion sections. You cannot contribute to your team if you are absent and you disrupt the class and your team if you arrive late. Absent and late arriving students will not receive check-in credit.

Behavior that disrupts the class and learning experience of other students will lower your grade. Disruptive behavior includes the use of cell phones during class, the use of laptops for non-class related activities and arriving late to class. Cell phones should be muted and put away for the duration of the class.

## Debates:

The final portion of the course will center around class debates on important and controversial environmental policy issues. Each student will participate as a panelist in one debate. This involves an oral presentation, a 1-2 page fact sheet on your debate topic and a 5 page research paper that analyzes your side of the debate issue. 2-3 students will be assigned to each side of the issue for each debate.

Potential debate topics include:

- Nuclear energy
- Genetic engineering and the environment
- Antibiotic use in agriculture and antimicrobial resistance
- Fracking
- Plastic pollution
- Light pollution and the night sky
- Bioenergy, food and the environment
- Natural resource exploitation on public lands
- Population and the environment
- Free trade and the environment
- Satellites and space debris

- Property rights and endangered species
- Additional topics suggested by the class (The best topics are those that can be divided in two well-defined sides for debate (e.g. pro-nuclear energy -- anti-nuclear energy)).

**Debate Presentations:** Each student will make an individual, 5 minute presentation. Each student will conduct their own research to prepare for their presentation in the debate (see papers below). The debates are not a joint research project; however, the presentations are a team effort and it is up to each panel to coordinate their presentations so that individual presentations are well-organized and do not overlap. The objective of each panel is to make a compelling and persuasive argument to the class for your side of the issue. The professor and TA will grade each student's debate presentation based on the following criteria:

- organization of your presentation
- information provided including supporting statistics and/or published research
- ability to speak clearly and to the class
- how well you argue your case
- participation in the open debate after individual presentations.

A rubric will be provided. Your presentation slides should be uploaded on ELMS after your debate. You will receive a peer evaluation of your contribution to the group from other members of your debate team.

**Debate Fact Sheet:** Debate fact sheets should be an informative, factual summary of your debate topic, supported by scientific evidence and data. Fact sheets can cover both sides of the issue and should be 1-2 pages. A rubric and examples will be provided.

### Research Papers:

Each student is required to turn in a 5 page typewritten paper analyzing **only your** side of the debate issue. The paper should provide a complete analysis of **your** side of the issue, not just the aspect presented in your verbal presentation. Arguments supporting the other side of the debate will lower your grade. Each paper should include: some analysis of economic aspects related to the issue, supporting data or statistics accompanied by original source citations, supporting evidence or arguments from at least two papers indexed in the Web of Knowledge citation index. A rubric will be provided.

The papers are individual research papers. They are not collaborative efforts between members of a debate team. The following guidelines should be followed in writing the papers. The papers should be 5 pages, typed, double-space in a 12 pt font, with 1" margins. The title page and reference list do not count toward the 5 page limit.

**Citing source material.** As with any research paper, you need to reference all your sources including books, journals, magazines and online material. Anything quoted directly from a source should be identified by surrounding quotes and an appropriate reference. Facts and material that is taken from another source and paraphrased in your own words should be cited using an appropriate reference. **A failure to cite your source material constitutes plagiarism** (see policy on academic integrity below). Use APA citation format:

[APA Style Common Reference Examples Guide, APA Style 7th Edition.](#)

There should be a Reference section at the end of the fact sheet with your list of references. In the text you can cite using last name and year, or if you use a numbered reference list you can cite using numbers in the text that match the numbered references.

**Cutting and pasting from online materials without proper citation is plagiarism** (see policy on academic integrity).

Plagiarism is a serious matter at any university and previous plagiarism cases in this class have been referred

to the honor council and have resulted in a grade of XF, failure due to academic dishonesty. The best policy to follow if you are not sure is to cite your sources.

**If you have any questions about citing your sources please see me.**

### **Data Analysis Modules:**

As the amount of publically available environmental data expands it is increasingly important to be able to analyze and interpret this data. Data visualization learning modules will teach you how the open source software platform R can be used for data analytics and visualization to improve our understanding of environmental problems using large, publically available data sets on environmental quality. No prior knowledge of software is required but you must be willing to learn new systems.

### **Policy Regarding Late or Missed Assignments:**

Assignments are due at date and time listed on ELMS. The assignment with the lowest score will not be counted in the grade. For this reason, late assignments will generally not be accepted. Exceptions must be approved by the professor or TA and may be subject to a grade penalty. Be responsible. Chances for approval of a late assignment are significantly higher if you contact me in advance by email or using the messaging feature in ELMS. In the case of religious observances, athletic events, and planned absences known at the beginning of the semester, university policy requires that you inform your instructor during the schedule adjustment period.

### **Policy on Electronic Devices:**

**Cell phones and laptops:** Research has shown that electronic devices present an irresistible distraction that detracts from the classroom environment and interferes with learning and active participation. The bottom line is that cell phone or laptop use during class disrupts the learning experience for other students and shows disrespect for everyone. **It is expected that all cell phones and laptops will be silenced and put away for the duration of each class except (a) for use during an interactive classroom response activity, (b) for use in data analytics and visualization modules, and (c) when required for ADS accommodations. Other use may result in a deduction off your final grade that will escalate with each violation. No electronic devices are allowed during exams, including calculators and electronic dictionaries. The only exception is if you have a UMD approved ADS accommodation for such use.**

### **Policy on Academic Integrity:**

The University has a nationally recognized Honor Code, administered by the Office of Student Conduct. The Honor Code sets high standards for academic integrity for all students at the University of Maryland. Every student in this class is expected to read and understand [university policy on academic dishonesty](#), and to adhere to the Honor Code. Any suspected cases of academic dishonesty (cheating, fabrication, facilitating academic dishonesty, or plagiarism) will be dealt with in accordance with the provisions of this code. The standard sanction under the Code of Academic Integrity is a grade of "XF". The grade appears on the student's transcript with the notation "Failure due to academic dishonesty." **As future professionals, you should pursue a commitment to high ethical standards and honesty during your time at the University of Maryland.** It is your responsibility to read the Honor Code and know what it says, so you can start your professional life on the right path.

Course assistance websites, such as CourseHero, are not permitted sources and using material from these sources constitutes a violation of academic integrity.

Additionally, it is understandable that students may use a variety of online or virtual forums for course-wide discussion (e.g., GroupME or WeChat). Collaboration in this way regarding concepts discussed in this course is permissible. However, collaboration on graded assignments is strictly prohibited unless otherwise stated. Examples of prohibited collaboration include: asking classmates for answers on quizzes or exams, asking for access codes to clicker polls, etc.

### **Copyright:**



Class lectures, exams, assignments answer keys, handouts and other materials are protected by copyright. A faculty member is the exclusive owner of copyright in the materials they create. You may take notes and make copies of course materials for your own personal use. You may not record, reproduce or distribute lecture or other course materials without my express written consent. Persons who distribute or display or help others publicly distribute or display copies or modified copies of an instructor's course materials may be considered in violation of the University Code of Student Conduct, Part 10(m), Theft of Property or Services. Such conduct is subject to disciplinary action and can potentially result in suspension from the University. All suspected cases of copyright infringement will be referred to the Office of Student Conduct.

### **Students with Disabilities:**

If you have a documented disability and wish to discuss academic accommodations with me, please contact me as soon as possible.

### **Learning Assistance Resources:**

I encourage you to visit [tutoring.umd.edu](https://tutoring.umd.edu) to learn more about the wide range of campus resources available to you. Everyone can benefit from help to sharpen their communication skills (and improve their grade). Visit <https://english.umd.edu/writing-programs/writing-center> and schedule an appointment for a virtual session with the campus Writing Center. There are a wide range of resources to support you with whatever you might need (see [go.umd.edu/assistance](https://go.umd.edu/assistance)), and if you just need someone to talk to, visit [counseling.umd.edu](https://counseling.umd.edu) or [one of the many other resources on campus](#). Most services are free because you have already paid for them, and everyone can benefit from these resources... all you have to do is ask.

### **Campus Policies**

It is our shared responsibility to know and abide by the University of Maryland's policies that relate to all courses, which include topics like:

- Academic integrity
- Student and instructor conduct
- Accessibility and accommodations
- Attendance and excused absences
- Grades and appeals
- Copyright and intellectual property

Please visit <https://www.ugst.umd.edu/courselatedpolicies.html> for the Office of Undergraduate Studies' full list of campus-wide policies and follow up with me if you have questions.

### **Majoring in Environmental Economics:**

The Department of Agricultural and Resource Economics offers a [major in Environmental Economics](#) and advanced courses on topics such as Economics of Climate Change, Natural Resources and Public Policy, Energy and Environmental Economics, Economics of Land Use, Environmental Economics, and Data Science for Environmental and Resource Economics. If you are interested in becoming an AREC major please talk to me.

### **Careers in Environmental Fields:**

Some of you may be interested in a career in an environmental field. The following resources may be useful.

- [U.S. EPA Careers and Internships for Environmental Economists](#).

### **UMD software licenses for students:**

The UMD has agreements that provide software licenses for students. Among these are free licenses for the Microsoft Office 365 Suite (Word, Excel, Powerpoint, etc) and Adobe Acrobat and Adobe Creative Cloud (Photoshop, Illustrator, Rush, etc.) for as long as you are a UMD student. Information on the various software products and the license terms can be found here:

- <https://terpware.umd.edu>

## Course Modules:

1. Fundamentals of Materials Balance
  - Harris and Roach, pp. 3-9.
  - C.W. Tessum, J.D. Hill and J.D. Marshall, [Life cycle air quality impacts of conventional and alternative light-duty transportation in the United States](#), *Proceedings of the National Academy of Sciences*, 2014, 111(52): 18490-18495, doi: 10.1073/pnas.1406853111.
  - [Analysing environmental benefits from driving electric vehicles](#), S.P. Holland, E.T. Mansur, N.Z. Muller, and A.J. Yates, Center for Economic Policy Research Policy Portal, 2015 (summary of Holland, S, E Mansur, N Muller, and A Yates. 2016. "[Are There Environmental Benefits from Driving Electric Vehicles? The Importance of Local Factors](#)," *American Economic Review*, 106 (12): 3700-3729.
  - Concrete: the most destructive material on earth, *The Guardian*, Feb. 25, 2019.
  - Concrete, a Centuries-Old Material, Gets a New Recipe, *NY Times*, Aug. 11, 2020.
  - From no recycling to zero waste: how Ljubljana rethought its rubbish, *The Guardian*, May 23, 2019.
  - "[Safeguarding our water: making every drop count](#)," Peter H. Gleick, *Scientific American*, February 2001, 40-45 and "[How can we do it?](#)" Diane Martindale and Peter H. Gleick, *Scientific American*, February 2001, 52-55.
  - University of Maryland [sustainability](#) efforts
2. Economic Incentives, Benefits and Costs, Demand and Supply
  - Harris and Roach, 68-76.
  - **classroom application** - consumer demand from eBay data
  - **classroom game** - trading in a pit market
  - American recycling is stalling and the big blue bin is one reason why, *Wash. Post*, June 20, 2015.
  - France has too much wine. It's paying millions to destroy the leftovers, Caroline Anders, *Wash. Post*, August 26, 2023.
  - Allocation of scare resources among competing uses: Colorado River water transfers
    - "[The 100-year war for water](#)", Alec MacGillis, *Baltimore Sun*, August 17, 2003.
    - San Diego County Water Authority [Colorado River water transfer fact sheet](#)
  - **video** - [The high cost of free parking](#)
3. Environmental Externalities and Public Goods
  - Harris and Roach, 43-55 and 101-102.
  - [Transaction costs](#) (R.O. Zerbe and H. McCurdy, 2000, The end of market failure, *Regulation*, 23(2), 10-14.)
  - **classroom game** - public goods
4. Congestion
  - Traffic congestion
    - [The fundamental law of road congestion and its implications for transportation policy](#), MA Turner, RFF Weekly Policy Commentary, 2010 (summary of Duranton, G, and MA Turner. 2011. "The Fundamental Law of Road Congestion: Evidence from US Cities." *American Economic Review*, 101(6): 2616-52.)
    - The streets were never free. Congestion pricing finally makes that plain. Emily Badger, *NY Times*, April 4, 2019.
    - [Gridlock and growth: the effect of traffic congestion on regional economic performance](#), D Hartgen and G. Fields, Policy summary of study 371, Reason Foundation, 2009.
    - Traffic congestion in the US: [Texas Transportation Institute 2019 Urban Mobility Report](#), read pp. 5,11-14.
    - Principles of [efficient congestion pricing](#), Nobel Laureate William Vickery, Columbia U., June, 1992.



- [Congestion pricing: a primer](#) Federal Highway Administration, December, 2006.
- Road congestion pricing in the U.S.:
  - Md Intercounty Connector [toll rates](#)
  - Va I-495 Express Lanes [dynamic pricing](#)
  - S. Calif. 91 Express Lanes [toll schedules](#).
- Zone pricing
  - [London congestion charge fact sheet](#) + [London congestion zone map](#)
  - [Milan congestion charge - Area C](#)
- **video** - [TED Talks: How to solve traffic jams](#), Jonas Eliasson (Director of the Centre for Transport Studies at Sweden's Royal Institute of Technology)
- **video** - [Economics of Land Transport in Singapore: Managing Traffic Congestion](#) (Singapore Land Transport Authority)

## 5. Property Rights

- Harris and Roach, 55-61.
- Are there laws to limit excessive light?, *NY Times*, Feb. 11, 2017
- With new EPA water rule, Obama again takes executive action on environment, *Wash. Post*, May 25, 2015.
- [Property rules vs. liability rules](#), MI Krauss, *Encyclopedia of Law and Economics*.

## 6. Discounting

- [Discounting – an eye on the future](#), L.H. Goulder and R.N. Stavins, *Nature*, 419, 673-74.
- [Determining Benefits and Costs for Future Generations](#), K. Arrow et.al., *Science*, 341(6144), 349-350, 2013.
- [Discounting 101](#), B. Prest, Resources for the Future, 2020.
- Harris and Roach, 153-156, 163-166.
- **classroom exercise** - discounting and the economics of energy saving devices

## 7. Regulatory Standards

- Ambient environmental quality standards
  - [Air Quality Index](#) - a guide to air quality and your health
  - National ambient [air quality standards](#) (U.S. EPA)
  - National [primary](#) and [secondary](#) drinking water standards (U.S. EPA)
  - Annual [drinking water quality reports](#) for Maryland
- Emission standards
  - [Vehicle emission standards](#) in different countries around the world
- Input standards
  - [Gasoline standards](#)
- Corporate Average Fuel Economy (CAFE) standards
  - [History of CAFE standards, 1978-2011](#)
  - [History of fuel economy](#): one decade of innovation, two decades of inaction
  - [6 clever ways the car industry has gamed the CAFE fuel economy standards](#) (*Popular Mechanics*) – click View Gallery and navigate through the slide show
  - [Proposed 2025 standards](#). The CAFE Numbers Game: Making Sense of the New Fuel-Economy Regulations (*Car and Driver*)
- Technology standards
  - Taking toxics out of the air, EPA 2000. Read: The Pre-1990 "Risk-Only" Approach; The 1990 Clean Air Act Amendments: A "Technology First, Then Risk" Approach - including the box on Maximum Achievable Control Technology; What Progress Has Been Made in Reducing Toxic Air Pollution?
- Measuring the Environmental Quality Impacts of Environmental Regulation
  - **video** - [Human Fingerprint on Global Air Quality](#) (NASA)
- Harris and Roach, 179-182, 198-203.

## 8. Measuring Environmental Benefits

- **video** - [TED Talks: Put a value on nature](#), Pavan Sukhdev (McCluskey Fellow at Yale University, Chair of the Global Agenda Council on Biodiversity and Ecosystems for the World Economic Forum, former Special Advisor and Head of United Nations Environment Programme's Green Economy Initiative)
- [Introduction to economics for coastal managers](#) (NOAA Coastal Services Center)
- Direct measures
  - Market price
  - Productivity
  - Damage cost avoided, replacement cost, and substitute cost
- Willingness to pay measures
  - Hedonic pricing
    - Harris and Roach, 135-136.
  - Travel cost
    - Harris and Roach, 133-135.
  - Contingent valuation
    - [Putting a value on injuries to natural assets: The BP oil spill](#), Bishop et.al., *Science*, 356(6335), 253-54, 2017.
    - Harris and Roach, 137-143.
- The value of a statistical life.
  - [No one values your life more than the federal government](#), D. Merrill, *Bloomberg*, Oct. 19, 2017.
  - The not-so-invisible damage from VW diesel cheat: \$100 million in health costs, Noelle Eckley Selin, *The Conversation*, September 29, 2015.
  - Harris and Roach, 157-159.

## 9. How Much Pollution? Allocating Emissions Abatement across Multiple Sources

- Harris and Roach, 177-178
- Example: California's South Coast Air Quality Management District. [Wide-ranging controls will be costly: businesses not breathing easily](#), (*LA Times*, April 24, 1989)
- Example: Chesapeake Bay nutrient pollution

## 10. Incentive-Based Strategies: Environmental Taxes

- Environmental taxes and the double dividend
  - [Gas tax now](#) (N. Gregory Mankiw, *Fortune*, May 24, 1999)
- [Environmental taxes](#), D. Fullerton, A. Leicester and S. Smith, 2010.
- [Carbon pricing 101](#), Marc Hafstead, Resources for the Future, 2019
- [Carbon pricing 102 – Revenue Use Options](#), Marc Hafstead, Resources for the Future, 2019.
- [How to Set a Price on Carbon Pollution](#), G. Metcalf, *Scientific American*, June 2020.
- [Controlling pollution using taxes and tradeable permits](#), International Monetary Fund, *Economic Issues*, n. 25, 2000.
- Harris and Roach, 182-185.

## 11. Incentive-Based Strategies: Cap and Trade (Transferable Emission Permits)

- **classroom game** - cap and trade
- Environmental brokerage services for emissions trading
  - [BGC Environmental Brokerage Services](#)
    - [U.S. emission trading programs](#)
  - [Evolution Markets](#)
- EPA SO2 allowance trading program
  - The politics of pollution (*Boston Globe Magazine*, 1998)
  - [Changes choke cap and trade](#) (*Wall Street Journal*, July 12, 2010)

- [The SO2 Allowance Trading System: The Ironic History of a Grand Policy Experiment](#), Richard Schmalensee and Robert N. Stavins, *Journal of Economic Perspectives*, Vol. 27, No. 1, Winter 2013, pp. 103-122, 2013
- [RECLAIM](#), LA basin **REgional Clean Air Incentives Market**.
- Cap and trade for water, In Australia dead kangaroos and a scandal called Watergate are results of flawed plan for water market, *Wall St. Journal*, Sept. 3, 2019.
- Harris and Roach, 185-189.

## 12. Global Climate Change Policies

- S. Hsiang and R. Kopp, An economists guide to climate change science, *Journal of Economic Perspectives*, v. 32(4), Fall 2018, 3-32.
- Your biggest carbon sin may be [air travel](#) (*NY Times*, Jan. 26, 2013)
- European Union [emission trading system](#)
- Northeast [Regional Greenhouse Gas Initiative](#)
- [Policy Basics: Policies to Reduce Greenhouse Gas Emissions](#), (The Center on Budget and Policy Priorities, February 5, 2013)
- World Bank [Carbon Pricing Dashboard](#)
- N. Kaufman et.al, A near-term to net zero alternative to the social cost of carbon for setting carbon prices, *Nature Climate Change*, August 17, 2020, <https://doi.org/10.1038/s41558-020-0880-3>.

## 13. Other Incentive Mechanisms: Liability, Deposit-Refund

- Legal Liability
  - Oil spill liability
    - M.A. Cohen, [Deterring Oil Spills: Who should pay and how much?](#), RFF, June 2010.
    - [Superfund liability](#) (U.S. EPA)
- [Deposit-refund systems in theory and practice](#), M. Walls, RFF discussion paper 11-47, November 2011.

## 14. Economics of Enforcement

- The economics of crime (excerpt from a lecture by Nobel Laureate Gary S. Becker to the Federal Reserve Bank of Richmond)

## 15. Assessing Uncertainty

- (readings to be provided)

## 16. Assessing Environmental Regulations

- The role of environmental economics in US environmental policy, G. McCarthy, *Review of Environmental Economics and Policy*, 13(2), 299-307, 2019.
- [Economic incentives vs. command and control](#), what's the best approach for solving environmental problems?, W. Harrington and R.D. Morgenstern, *Resources*, Resources for the Future, 2004.
- Benefits of improved environmental quality vs abatement costs
  - [2014 Draft report to Congress on the benefits and costs of federal regulations](#) (read pp. 8-19, 22-25)

## Tentative Course Schedule (Subject to Change):

Welcome • Carillon Ice Cream (August 22)

- Week 1
  - DC trip (August 23)
  - Introduction, Fundamentals of materials balance (August 27)
  - discussion section (**Data module – R, R-Studio, importing data**)
  - Fundamentals of materials balance
- Week 2
  - Economic incentives, benefits, demand
    - **Classroom application - consumer demand from eBay data**
  - discussion section (**Data module – tidy data, grouping, subsetting data**)
  - Economic incentives, costs, profit and supply
    - *Problem Set #1 out*
- Week 3
  - Economic incentives, market equilibrium
    - **Classroom game - trading in a pit market**
  - discussion section (**Data module – data visualization**)
  - Efficiency and markets
    - *Problem Set #1 due*
    - *Problem Set #2 out*
    - *Submit debate topic preferences*
- Week 4
  - Resource allocation with multiple demands
    - Teams assigned
  - discussion section (review PS#1, coding questions)
  - Environmental externalities
    - *Problem Set #2 due*
    - *Problem Set #3 out*
- Week 5
  - Public goods
    - **Classroom game - public goods**
  - discussion section (review PS#2)
  - Congestion
    - *Problem Set #3 due*
    - *Problem Set #4 out*
- Week 6
  - Congestion, Property Rights
  - discussion section (review PS#3)
  - Discounting
    - **Classroom exercise - discounting and the economics of energy saving devices**
    - *Problem Set #4 due*
    - ***Draft of debate topic fact sheet due***
- Week 7
  - Regulatory Standards
  - discussion section (review PS#4)
    - *Problem Set #5 out*
  - Measuring the benefits of improved environmental quality
    - ***Fact sheet review due***
- Week 8
  - Measuring the benefits of improved environmental quality
  - discussion section (**Data module – joining data**)
    - *Problem Set #5 due*
  - Economics of pollution abatement
    - *Problem Set #6 out*
- Week 9
  - Pollution abatement: multiple sources of emissions
  - discussion section (review PS#5)
  - Environmental taxes
    - ***Debate topic fact sheet due*** (Oct. 29)
    - *Problem Set #6 due*
- Week 10
  - Cap and trade policies
    - *Problem Set #7 out*
    - **Classroom game - cap and trade**

- discussion section (review PS#6)
- Global climate change policies
- Week 11 • **Special guest speaker (date to be confirmed)**
  - *Problem Set #7 due*
- discussion section (**Data module – choropleth maps**)
- Assessing uncertainty
  - **Classroom exercise – heuristics and biases under uncertainty**
- Week 12 • Liability, Enforcement
- discussion section (review PS#7, review for exam)
- **Exam**
- Week 13 • Class debate (Nov. 18)
- discussion section - Class debate (Nov. 19)
- Class debate (Nov. 20)
- Week 14 • Assessing environmental regulations – 50 years of the EPA
- Thanksgiving break – no discussion section (Nov. 26)
- THANSGIVING HOLIDAY – no class (Nov. 28)
- Week 15 • Class debate (Dec. 3)
- discussion section - Class debate (Dec. 4)
- Class debate (Dec. 5)
- ***Date of Final Exam – Research Papers Due***
- **Final exam time may be used to make up any debate not held due to campus closure for inclement weather or other reason**

**Note:** This is a tentative schedule, and subject to change as necessary – monitor the course ELMS page for current deadlines. In the unlikely event of a prolonged university closing, adjustments to the course schedule, deadlines, and assignments will be made based on the duration of the closing and the specific dates missed.