Multi-'steak'holder sustainability: reduced deforestation and the cattle agreement in Brazil

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Teaching notes: overview of the case-study

Summary

This case-study explores the contemporary challenge of producing food in tropical forest landscapes. The socio-environmental system is the cattle sector in Brazil, which is associated with high levels of deforestation and greenhouse gas emissions. The case-study focuses on the governance of the Brazilian cattle sector, and particularly on a recent (2009) multi-stakeholder agreement that aims to enhance the environmental sustainability of beef production.

The case-study draws on disciplines as broad as ecology, economics, geography, and politics. It provides opportunities for students to engage with a set of real-world sustainability issues in a socio-environmental system of considerable global importance. Included in the case-study are activities that aim to develop students' knowledge and their analytical skills.

The case-study is designed to be taught over seven consecutive lessons. It draws on a variety of case-study teaching methods - including flipped classrooms, two 'jigsaw' case-studies, and an 'interrupted' case-study. A comprehensive set of teaching notes, a student handout, and a short introductory PowerPoint presentation are provided for each of the seven lessons.

What courses is this case appropriate for?

The case was developed for courses in *Global Food Systems and Land Use Change* (upper division in an Environmental Studies Program) and *Environmental Problem Solving* (master's level in an international affairs professional program). It could also be appropriate for courses such as applied ecology, public policy, or environmental social science.

The activities best lend themselves to small classes of fewer than 25 students, since several of them rely either on class discussion or on breaking out into multiple small groups of 4-6 students.

What level is this case appropriate for?

This course was developed for upper-division undergraduate and master's level graduate students. It could be used for students from upper-division undergraduate to Ph.D. level.

Learning goals and objectives

The case study addresses the following Socio-Environmental Synthesis (SES) learning goals:

SES learning goal 1: Understand the structure and behavior of socio-environmental systems.

> ### *Learning objectives*
>
> - Understand common trade-offs between conservation and development objectives
> - Evaluate the roles of private-sector, government, and civil society agencies in solving complex socio-environmental problems
>
> *Lessons*: 1, 2, 4 and 7

SES learning goal 2: Consider the importance of scale and context in addressing socio-environmental problems.

> ### *Learning objectives*
>
> - Understand different disciplinary and policy perspectives and priorities
> - Evaluate the impacts of governance mechanisms over a range of timescales
>
> *Lessons* 3, 5, 6 and 7

SES learning goal 3: Co-develop research questions and conceptual models in inter- or trans-disciplinary teams.

> ### *Learning objectives*
>
> - Understand concepts and methods from land change science, production economics, and supply chain analysis, and linkages between these disciplines
> - Apply concepts and methods from multiple disciplines to solve complex socio-environmental problems
>
> *Lessons* 3, 5 and 7

SES learning goal 4: Find, analyze, and synthesize existing data, ideas (e.g. frameworks or models), or methods.

> ### *Learning objectives*
>
> - Find and synthesize knowledge and ideas, to better understand socio-environmental challenges
> - Analyze data to evaluate policy effectiveness in the context of a complex socio-environmental problem
> - Create a persuasive argument that synthesizes literature and data to define and justify a position
>
> *Lessons* 2, 4, 5, 6 and 7

Introduction

Overview

The case study examines an innovative commitment by four major multinational beef producers not to source cattle from farms associated with deforestation in Brazil. The case introduces a socio-environmental system of global importance: the Amazonian landscape, the agri-businesses that use that landscape, and the global supply chains that rely on those businesses. The case also speaks to various important contemporary environmental and social problems of interest to many students. These include trade-offs between conservation and development policy and outcomes, and the opportunities for consumers and private-sector organizations to influence environmental outcomes.

Background to the case

Cattle ranching in Brazilian Amazonia is associated with high levels of deforestation and greenhouse gas emissions. In 2009, the environmental NGO Greenpeace released a report 'Slaughtering the Amazon', which accused large multinational beef producers of sourcing cattle from farms that had illegally cleared Amazonian forest. Greenpeace 'named and shamed' prominent, consumer-facing retailers in the US, Europe, and Brazil, including Nike, Adidas, McDonalds, Tesco, Walmart, and Timberland. Many of these brands quickly agreed to support an approach to prevent the sale of beef and leather products sourced from farms associated with deforestation. The support from these actors helped Greenpeace to ink a deal known as the 'cattle agreement' with the major beef producers in Brazil. In subsequent years, a coalition of NGOs, business representatives, government officials, and scientists have worked together to develop and implement the agreement. The implementation of the agreement has coincided with a substantial and thus-far-sustained decline in the rates of deforestation in the Brazilian Amazon. The agreement may have played a role, but so too did other market and governance factors. The cattle agreement was implemented at a time as a number of institutional changes in the governance of the agricultural landscapes of Brazilian Amazonia. Land use policies have been updated, new lines of credit launched, certification programs established, and transparency schemes put in place. This case-study revisits the lead up to the cattle agreement, its implementation, and its outcomes as a way of introducing students to the complex challenges involved in researching the environmental governance of agricultural systems in tropical forest landscapes.

Summary of activities

The case-study is comprised of seven lessons, which variously utilize learning approaches that include: a flipped classroom (lessons 1 and 2), jigsaw case-studies (lessons 3 and 7), guided research (lesson 4), an interrupted case-study (lesson 5), and a methods class (lesson 6). Formative assessments are suggested for each lesson, as is a final end-of-case-study evaluation assignment. Required and optional reading materials for each lesson are listed.

Classroom management summary

Separate *Teaching Notes* and *Student Handouts* are provided for each lesson. The teaching notes contain individual classroom management summaries, including assessments and reading materials. In summary, the case study is designed to be taught over seven consecutive lessons. Each lesson contains material and activities for 60-75 minutes of small-group and whole-class activities and discussion.

Lesson titles

Lesson 1 - Introduction to the cattle agreement in Brazil

Lesson 2 - Supply chain governance

Lesson 3 - Perspectives on tropical agriculture and forest tradeoffs

Lesson 4 - The governance of cattle production in Brazil

Lesson 5 - Evaluating avoided deforestation

Lesson 6 - Spatial analysis of agriculture and deforestation

Lesson 7 - Synthesis: roundtable discussion

Suggested Modifications

In each lesson, the final activity described can often be considered optional; that is, if allocated class time is less than required to teach the class, or if previous activities take longer than expected, this last activity can often be dropped, without repercussions for the next lesson.

While the case-study will be more comprehensive if all seven lessons are taught in the order presented, most of the lessons could be re-ordered or dropped to best fit the demands and scope of different courses. However, the first lesson is essential background material to the case.

Instructors who are teaching courses that demand a greater focus on cattle, agronomy, or food may wish to incorporate an additional lesson that examines the environmental trade-offs between grass-fed and feed-lot produced beef. In the context of Brazilian Amazonia, these trade-offs are significant and interesting. A lesson that tackles this issue may be developed by the authors for a later version of this case-study.

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N.B. This list contains all references used throughout the seven lessons of the case-study.

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Teaching notes: Lesson 1 - Introduction to the cattle agreement in Brazil

Summary

This lesson introduces the key concepts, history, and actors associated with the case-study, and brings students up-to-speed with the background knowledge needed to understand and engage with the case study throughout the remaining six lessons. It uses a 'flipped classroom' approach to do so, requiring students to read and watch background material before coming to class, and using the classroom time to discuss and explore the case in greater depth.

Learning objectives

- Understand common trade-offs between conservation and development objectives
- Evaluate the roles of private-sector, government, and civil society agencies in solving complex socio-environmental problems

Key messages & skills

By the end of the lesson, students should understand that:

- Commodity production in tropical forest and agricultural landscapes presents complex environmental, social, and economic challenges

Students should be able to:

- Synthesize information from a range of popular media, to understand the context and key concepts of a previously-unfamiliar case study

Formative assessments

- Participation in a small-group quiz

Classroom management summary

Student preparation for class

Students watch a short video and read a set of assigned materials that introduce the cattle agreement in Brazil (Barrionuevo 2009, Greenpeace 2009a, Greenpeace 2009b, Mongabay 2009, Schwartz 2010a). For more in-depth understanding, additionally read Schwartz (2010b).

In class

1. The instructor **introduces the case-study**: a brief background to the case, the case-study objectives, and a lesson-by-lesson outline of the seven lessons. [*10 mins*]

2. The instructor **introduces the lesson**: a brief background to a) the cattle sector in Brazil, deforestation, and the cattle agreement; and b) the lesson objectives. [*10 mins*]

3. Students are divided into small groups (3-5 students per group) and tested on their comprehension of the background reading material, using a **short (3 question) quiz** (see below). [*15 mins*]

4. The range of responses, and any uncertainties, are **discussed as a class**. Suggestions for class discussion: a) cover the basics of the case-study to ensure comprehension of the key ideas by all students; b) ask each group to report back on the discussion point that they consider most likely to have been unique to their group. [*20-40 mins*]

Questions

a. What are the key environmental impacts of cattle production in Brazilian Amazonia?

Suggested answers: Pasture expansion in Brazil is associated with high rates of deforestation, which in turn are related to biodiversity loss and greenhouse gas emissions (especially carbon dioxide). Cattle production is also related to methane emissions. Methane is a potent greenhouse gas. Additional environmental impacts include soil degradation and erosion, and the pollution of surface and groundwater.

b. What were the roles of a) civil society, b) private sector, and c) government individuals and organizations in the events leading up to the signing of the cattle agreement?

Suggested answers: The agreement was catalyzed by pressure from environmental NGOs, particularly Greenpeace, on private-sector organizations including meat processors (e.g. Bertin, JBS-Friboi, Marfrig, and Minerva) and retailers (e.g. Nike, Timberland, Adidas, McDonald's, Walmart, the Brazilian Association of Supermarkets), who were motivated to clean up their supply chains. The beef producers signed the cattle agreement. The Brazilian government vowed to support the agreement (e.g. by providing satellite imagery).

c. What are the key commitments made by signatories to the cattle agreement?

Suggested answers: i) zero deforestation on lands providing their cattle, ii) protection of protected areas and indigenous lands, iii) no slavery, iv) no land-grabs or land-conflicts, v) implementation of a tracking system, and vi) implementation of supply chain commitments. See Greenpeace (2009b) for more details.

4. The instructor **wraps up the class**: reiterate the key take-home messages; explain the reading and assignments due before the next lesson. [*5 mins*]

Total: *60-80 mins*

References

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Schwartz, J. (2010a) CEO of Timberland Credits Greenpeace. Available at: https://www.youtube.com/watch?v=wSizpj-7seg

Suggested additional reading

Schwartz, J. (2010b) How I Did It: Timberland's CEO on Standing Up to 65,000 Angry Activists. Harvard Business Review. Available at: http://hbr.org/2010/09/how-i-did-it-timberlands-ceo-on-standing-up-to-65000-angry-activists/ar/5. *NB to access this article online, you will need to subscribe (for free) with Harvard Business Review.*

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Teaching notes: Lesson 2 - Supply chain governance

Summary

This lesson introduces the concepts and actors involved in the functioning and governance of agricultural commodity supply chains. It empowers students to apply general principles of supply chain governance to the particular case of the cattle sector in Brazil.

Learning objectives

- Evaluate the roles of private-sector, government, and civil society agencies in solving complex socio-environmental problems
- Find and synthesize knowledge and ideas, to better understand socio-environmental challenges

Key messages & skills

By the end of the class, students should understand that:

- Supply chains connect different actors across space and time
- Supply chain governance interventions can thus affect where and how commodity production occurs

Students should be able to:

- Synthesize information from a range of sources (e.g. academic journals; popular media)

Formative assessments

- Completion of a diagram of a cattle supply chain (group exercise)

Classroom management summary

Student preparation for class

Students read a set of assigned readings that introduce 1) supply chains (O'Rourke 2014) and 2) the organization of cattle systems in Brazil (Walker et al. 2013).

In class

1. The instructor **introduces the lesson**: a brief background to the lesson objectives and the importance of supply-chain analysis. [*10 mins*]

Depending on the course focus, and the prior knowledge of the students, this introduction could include an emphasis on the global nature of agricultural commodity supply chains (e.g. Nepstad et al. 2006), a recap of the principal actor groups involved in supply chains, and a short commentary on the different points in the supply chain affected by different supply chain interventions (Newton et al. 2013).

2. Students **sketch a commodity supply chain** for cattle products in their small groups. They use Fig. 1 in O'Rourke (2014) as a template, and elements of Walker et al. (2013) as a source of information on the cattle sector in Brazil. They are asked to synthesize the two, and to add other elements of the socio-environmental system to this supply chain diagram - including elements of the biophysical system (e.g. forested land, agricultural land, different biomes); impacts (e.g. deforestation, greenhouse gas emissions (methane, carbon dioxide)); and an indication of the stage(s) in the supply chain where the cattle agreement affects the supply chain (refer to Newton et al. 2013) [*20-30 mins*]

3. Each group **presents and justifies their diagram** to the entire class. Other groups and the instructor ask critical questions that address the comprehensiveness and clarity of the diagrams. [*25-35 mins*]

4. The instructor **wraps up the class**: reiterate the key take-home messages; explain the reading and assignments due before the next lesson. [*5 mins*]

Total: *60-80 mins*

References

O'Rourke D. (2014) The science of sustainable supply chains. Science 344, 1124-1127.

Walker N.F., Patel S.A., Kalif K.A. (2013) From Amazon pasture to the high street: deforestation and the Brazilian cattle product supply chain. Tropical Conservation Science 6, 446-467.

Suggested additional reading

Nepstad, D.C., Stickler, C.M., Almeida, O.T. (2006) Globalization of the Amazon soy and beef industries: opportunities for conservation. Conservation Biology 20, 1595-1603.

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Teaching notes: Lesson 3 - Perspectives on tropical agriculture and forest tradeoffs

Summary

The transformation of tropical forest landscapes for agriculture is a topic of high policy relevance and active scientific research. However, the framing of the problems created and the solutions suggested varies greatly across fields of study.   This lesson introduces and contrasts three literatures examining deforestation—agricultural economics, political ecology, and environmental science. Each student is assigned one literature to read. During the class meeting, a 'flipped classroom' is employed, requiring students to read background material before coming to class, and using the classroom time to discuss and explore the case in greater depth.

Learning Objectives

- Understand different ways science frames deforestation

- Get better at reading scholarship from outside your comfort zone

- Learn to communicate (and critique) scientific arguments

Take home messages /skills

- Synthesize and succinctly present a literature on a complex environmental problem that was previously unfamiliar to you.
- Learn to engage your classmates representing other perspectives to better understand these perspectives, and why they differ with the perspective that you represent.

Classroom management summary

Student preparation for class

Students will be divided into three groups. Group (1) will read articles from Field 1, Political Ecology. Group (2) will read articles from Field 2, Environmental Science, and Group (3) will read articles from Field 3 on Development and Agriculture.

In class

1. The instructor **introduces the lesson**: a very brief background to the study of agriculture and deforestation, the lesson objectives, and the value of comparing, contrasting, and combining literatures to research a particular environmental policy topic. [*10 mins*]

2. Students are divided into three groups according to the readings that they completed. These groups prepare answers to a series of questions on how the field frames problems and solutions associated with tropical deforestation and agriculture. Each group elects a pair of representative who will present the group's insights to the rest of class. [*30 mins*]

Each group will answer the following questions from the perspective of the literature that they read:

1) What are the key drivers of land use change in the region?

2) Compared to business as usual what outcomes are desirable?

3) What are barriers/obstacles preventing improvement?

4) What opportunities are there for positive change?

3. Group representatives will report back to the entire class. Presentations should last 3 to 5 minutes [*15 mins*].

4. Class closes with a synthetic discussion *highlighting similarities and differences across and within these fields [20 minutes].*

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Teaching notes: Lesson 4 - The governance of cattle production in Brazil

Summary

This lesson moves beyond the cattle agreement to introduce the wider governance landscape of the Brazilian cattle sector and agricultural industry. Before class, students learn about a single governance intervention and deliver a concise summary presentation about this intervention to their peers in class. By exploring different policies and incentives and their interactions, the complexity of supply chain governance will become apparent, and students will be challenged to think about detecting policy impacts in a complex world.

Learning objectives

- Understand common trade-offs between conservation and development objectives
- Evaluate the roles of private-sector, government, and civil society agencies in solving complex socio-environmental problems
- Find and synthesize knowledge and ideas, to better understand socio-environmental challenges

Key messages & skills

By the end of the class, students should understand that:

- A diverse array of interrelated interventions is operating in the same sector (the cattle supply chain in Brazil) and the same landscape (forest, agricultural, and development policy operate in the same space and time).
- Different interventions variously support different environmental, social, and economic goals. Interactions between interventions therefore represent both trade-offs and synergies.

By the end of the class, students should be able to:

- Succinctly summarize and clearly present information to their peers.

Formative assessments

- PowerPoint presentation prepared and delivered

Classroom management summary

Student preparation for class

All students read Nepstad et al. (2014) and The Economist (2013). Pairs of students are allocated ONE governance intervention (a single policy or incentive) from Table 1 below (N.B. this is a selected subset of the suite of interventions outlined in Table S2 in Nepstad et al. (2014)). Depending on the size of the class, not all interventions will be covered. Six key interventions are thus listed first. For their allocated intervention, each pair of students should review the literature to learn more about the intervention, and prepare a short (2-slide, 2-minute) PowerPoint presentation that summarizes: a) the principal objectives, activities, and actors associated with that intervention; and b) one or more ways in which the intervention supports or constrains the cattle agreement. Students are encouraged to be clear and succinct.

In class

1. The instructor **introduces the lesson**: the lesson objectives; and a brief introduction on the importance of understanding complex institutional contexts. [*10 mins*]

2. Pairs of students take turns to **present their 2-minute PowerPoint presentation**. Other students take notes, and ask 1-2 questions per intervention. The instructor fills in any critical missing information (see Table 1 below). Presentations should be shared digitally after the class. [*40 mins*]

3. The instructor facilitates a **class discussion** to synthesize the broad array of interventions presented. Discussion questions could include:

a. How do these policies and incentives interact? A useful framework for analysis highlights the range of possible interactions between governance interventions (i.e. complementarity, substitution, or antagonism) (Lambin et al. 2014).

More applied questions include:

b. What are some of the challenges for achieving enhanced sustainability in forest and agricultural landscapes in Brazil?

c. What needs to be changed to better-enforce the cattle agreement? [*15 mins*]

Optional: If there is time, an additional dimension can be introduced: to think about the challenges of studying the impacts of single governance interventions, and isolating effects from the broader context. This will lead into the next lesson.

4. How can we possibly begin to detect an effect of an individual intervention, given the complexity of the governance landscape? [*15 mins*]

5. The instructor **wraps up the class**: reiterate the key take-home messages; explain the reading and assignments due before the next lesson. [*5 mins*]

Total: *70 - 85 mins*.

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Table 1. Cattle sector and Brazilian forest and agricultural landscape governance interventions

Intervention	Suggested references (intended as an entry point only)	Key points	Interactions with/relevance for the cattle agreement
Essential interventions (ensure that these interventions are assigned to one pair of students)			
Forest Code	Soares-Filho et al. 2014 Tollefson 2012	National environmental policy Legal Reserves and Permanent Protected Areas Recent revisions	Many farms are not compliant with the Forest Code. Does the cattle agreement prevent beef-producers buying from such farms?
Cadastro Ambiental Rural (CAR)	CAR 2014 Mongabay 2012	Ensures compliance with the Forest Code. A policy, but an incentive is that rural credit schemes can only be accessed by registered farms. Recent (2012-14) rapid growth in number of properties registered.	Enables identification of compliant farms.
Public prosecutor and Terms of Adjustment of Conduct	Tollefson 2014	Enforcement of policies	Catalyzes compliance. An important legal 'stick'.
DETER	Hansen et al. 2008 Hansen et al. 2013	High-resolution, publicly-available (transparent), geo-referenced data	A key tool for monitoring, reporting, and verification of compliance.
Amazon Region Protected Areas (ARPA) program	Soares Filho et al. 2008	Strictly protected areas, multiple-use reserves, indigenous territories	Cattle ranching and deforestation not permitted in most protected areas.

Amazon Fund	Tollefson 2009	Mechanism for disseminating REDD+ funding	Funding other interventions occurring in the same time and place as the cattle agreement.
Optional interventions (pairs of students can choose to study none, some, or all of these)			
Low-Carbon Agriculture (ABC) program	IPAM 2012	Access to credit for farmers	Creates an incentive for environmental compliance (via the CAR).
Green Municipalities Program, Pará	Viana et al. 2014	>80% of properties per municipality must achieve the CAR	Creates an incentive for environmental compliance, on a jurisdictional-wide scale.
Brazilian Working Group on Sustainable Beef (GTPS) and Global Roundtable on Sustainable Beef (GRSB)	GTPS 2014	Multi-stakeholder group to collaborate on more sustainable cattle production	Could lead to more comprehensive sustainability (social and environmental; more than just zero deforestation).
Cattle certification	Newton et al. 2014	New; small-scale Third-party verification Expensive and/or difficult to achieve	A longer-term governance option (e.g. for when the cattle agreement expires). More comprehensive sustainability (social and environmental; more than zero deforestation).

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Teaching notes: Lesson 5 - Evaluating a deforestation policy

Summary

This lesson equips students to critically read a paper evaluating the efficacy of a deforestation policy. The lesson emphasizes a framework for reading scholarly works employing the scientific methods and encourages students to think about challenges and opportunities for evaluating the efficacy of environmental policies.

Learning Objectives

- Learn a system for readings papers using the scientific method
- Apply the system to an evaluation of the role of a Brazilian government deforestation policy in preventing deforestation
- Consider standards of evidence for evaluating policies.

Key Messages/Skills

- Use of a framework for critically evaluating research employing the scientific method
- Evaluation of policies is crucial and complex

Formative Assessments

None

Preparation for Class

After Lesson 4, ask students to think about how they would evaluate the impact of their chosen intervention

       - what data would be needed?

       - how would it be collected?

- what would be the control?

Student groups will then summarize the thoughts on impact evaluation as part of an improved summary of the intervention. These updated summaries must be submitted to the instructor and shared with the group prior to Lesson 5.

In addition, students will be encourage to watch a brief video making the case for causal inference of development policies - http://www.ted.com/talks/esther_duflo_social_experiments_to_fight_poverty?language=en.

In class

1. The instructor **introduces the lesson**: the lesson objectives; and a brief introduction on evaluating governance interventions. [*10 mins*]
2. The instructor gives a brief **overview of an approach for critically assessing empirical research articles** (including impact evaluations). Specifically, the instructor goes step by step through the following list [*15 mins*]:

Step 1: Find the "Empirical Puzzle" In positive social science, we are often motivated by some "real-world" phenomena that is not explained well.

Step 2: Identify the Topic and Research Question. Not all work will include a well specified research question, per se. Yet all of the readings will address a debate, or an issue of general concern that could be posed in the form of a question.

Extra Step: List and Define New Terms and Concepts. *This is not a required component of the Critical Response Essay.* It is helpful to look up things that you are unfamiliar with. For example, in Political Science – "Democratic Consolidation" "Endogeneity" "Trade Liberalization". These are all concepts that the authors assume their audience already knows. In order for you to respond critically to this work, you may want to spend some time identifying and defining these.

Step 3: Dependent Variable What is the object, phenomena or outcome that the author is trying to explain?

Step 4: Independent Variable. What is it that the author employs to explain what happens to the dependent variable? In some cases, the study contains many independent variables that are believed to influence the dependent variable. Which of these variables is the key "predictor"? Does the author make a claim that one variable is more important than others? Are the variables objective (ex. GDP per capita) or subjective (ex. Globalization)?

Step 5: Hypothesis: What does the author think the answer to the problem may be? A Hypothesis is a stated answer to a problem. The hypothesis statement connects explanatory factor(s) (Independent Variables) to specific outcome(s) (Dependent Variables)

Step 6: Data- the evidence that the author utilizes to "test" their hypothesis.

Step 7: Research Design. Systematic blueprint for "testing" a potential answer to a specified problem. Notice that a problem solver may use multiple methods to answer the same question. For example, a study may employ a survey, argumentative analysis, anecdotal evidence and historical analysis all at once. Using multiple methods to "test" your understanding helps us to arrive at more "robust results" and thus more effective solutions.

Step 8: Methods: What are the method(s) that the author employs as part of their research design? Do you think this is an appropriate method to address the question at hand?

Step 9: Summary of findings . Identify the main points and arguments presented by the author. What is the main "take-away" from reading this piece? What did the author intend to have you learn when he or she wrote the piece?

Step 10: Evaluation. You should comment critically on the text! Discuss the importance of the points raised. What did you learn from this work? Question the approach and methods by which the author makes his or her claims. What are the work's limitations or possible extensions? How does this work relate to other "big questions" raised in class? Do you believe that the author is convincing? How would you suggest addressing the author's topic more effectively?

3. Instructor leads an interrupted case study of the assigned reading, Assunção et al. (2013). During the case study the students help the instructor to complete each of the 10 steps for critically assessing the article [rest of class].

Readings

Assunção, J., Gandour, C., & Rocha, R. (2013). DETERring Deforestation in the Brazilian Amazon: Environmental Monitoring and Law Enforcement. *Climate Policy Initiative Report, PUC-Rio, May*.

Optional Readings

http://greedgreengrains.blogspot.com/2013/11/fixed-effects-infatuation.html

http://blogs.worldbank.org/impactevaluations/often-unspoken-assumptions-behind-difference-difference-estimator-practice

Hargrave, J., & Kis-Katos, K. (2013). Economic causes of deforestation in the Brazilian Amazon: A panel data analysis for the 2000s. *Environmental and Resource Economics, 54*(4), 471-494.

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Teaching notes: Lesson 6 - Spatial analysis of agriculture and deforestation

Summary

Spatial analysis tools are a vital component of emerging efforts to monitor and govern the influence of tropical agricultural supply chains on deforestation. This Lesson consists of a practicum that introduces students to the task of monitoring deforestation using Google Earth Engine. The practicum requires that students register for the Google Earth Engine Trusted Tester program. Please ask the students to start registration process at least two weeks before the lesson. Earth Engine is a website based spatial analysis platform. It can be used on any computer with an internet connection.

Learning Objectives

- Gain familiarity with Google Earth Engine, a powerful, free online platform for conducting spatial analysis
- Consider how spatial data and analysis might influence the ability to govern tropical agriculture and deforestation
- Think about the limits, the uncertainty, and the unintended consequences associated with spatial data and spatial analysis.

Key messages & skills

- Become a user of Google Earth Engine
- Have a grasp of how spatial analysis and data influence environmental governance

Formative Assessments

Completion of Google Earth Engine tutorial on mapping agriculture and deforestation (included as an attachment).

Classroom management summary

Student preparation for class

All students should register for the Google Earth Engine Trusted Tester program prior to coming to class for the lesson. Go to https://earthengine.google.org/#workspace , login and make sure that you see the add data and add computation options on the left side of your screen. If not, send

an email containing your Google ID and explaining that you need access to the Trusted Tester program to -   earthengine-beta@google.com

In class

This lesson takes place in a computer laboratory with computers with internet access. It opens with a ten to fifteen minute introduction from the professor on the role of spatial analysis in agriculture and deforestation governance, the technologies and tools required to perform spatial analysis, and the learning objectives for the exercises to be performed. For the bulk of the class the students complete a series of tasks employing Google Earth Engine, a newly developed platform for geospatial analysis. In a subsequent homework assignment, students will complete the Earth Engine tasks and answer questions on the opportunities and challenges of geospatial analysis for land use governance.

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Teaching notes: Lesson 7 - Synthesis: roundtable discussion

Summary

The final lesson in this case-study provides an opportunity to synthesize much of the knowledge and many of the skills and themes that have been introduced in the previous six lessons. The lesson takes the form of a 'jigsaw case-study' (as used in Lesson 3), requiring students to each become conversant in an issue from a single perspective, and to pool their collective knowledge in the classroom, this time in a roundtable discussion format.

Learning objectives

- Understand common trade-offs between conservation and development objectives
- Evaluate the roles of private-sector, government, and civil society agencies in solving complex socio-environmental problems Understand different disciplinary and policy perspectives and priorities
- Apply concepts and methods from multiple disciplines to solve complex socio-environmental problems
- Create a persuasive argument that synthesizes literature and data to define and justify a position

Key messages & skills

By the end of the class, students should understand that:

- Multiple stakeholders in a complex socio-environmental system have divergent perspectives and objectives.
- Governance interventions may present trade-offs and synergies between different outcomes.

By the end of the class, students should be able to:

- Construct a cohesive argument from a perspective that may differ from their own.
- Respond appropriately when challenged by alternative perspectives.

Formative assessments

- None

Classroom management summary

Student preparation for class

At the end of lesson six, students are each allocated to one of six different actor groups. Before class, students read literature pertinent to the perspective of their designated actor group, and meet with their fellow class members allocated to the same actor group to draft responses to a series of questions that facilitates them in thinking about the cattle agreement from that actor's perspective.

Questions

1. What environmental, social, or economic outcomes are of highest priority to this actor? What are the costs and benefits for this actor of supporting the cattle agreement?

2. What data and/or analyses would enable this actor to make more informed decisions about how to act (with respect to support of the cattle agreement)?

3. Are there other mechanisms that would be a better way to achieve this actor's desired outcomes than the cattle agreement?

In class

1. The instructor **introduces the lesson**: a brief background to the lesson objectives, and the roundtable discussion as a means to synthesize information from the previous six lessons. [*10 mins*]

2. The entire class will **participate in a roundtable discussion**, to help the Whole Foods Sustainability Director understand **whether Whole Foods should buy beef from JBS farms in Brazil**. The discussion is facilitated by the instructor, who represents the Whole Foods Sustainability Director. The discussion format can vary, but one suggestion is that for each of the three questions above:

a. A spokesperson from each group gives a 2 minute statement that outlines their actor's position. [*12 mins x3 questions = 36 mins*]

b. After each round of statements, there is 5-8 mins for questions (posed by any member of any group to any member of another group), responses, and discussion. The Whole Foods Sustainability Director (instructor) can intervene with specific questions to particular groups, to ensure that a representative range of the divergent possible perspectives, synergies, and trade-offs are articulated by the class. [*5-8 mins x3 questions = 15-24 mins*]

NB. The roundtable can be conducted as a role-play, whereby students speak in the first person with the identity and voice of their designated actor, or the students can speak with their own identity and voice, and simply represent the perspectives of the actor(s) that they researched in the third person.

3. The Whole Foods Sustainability Director (instructor) **wraps up the roundtable discussion** with a summary of the key issues, emphasizing trade-offs and synergies. [*5 mins*]

4. The instructor **wraps up the class and the case-study**: reiterate the key take-home messages; reiterate the end-of-case-study evaluation assignment from last week. [*5 mins*]

Total: *70-80 mins*

References

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Table 1. Actor roles to be researched by students

Actor	References (suggested starting points)
Instructor role	
Whole Foods Sustainability Director	Schwartz 2010
Student roles	
Socio-environmental synthesis scientist	Nepstad 2013
JBS representative	Forbes 2011 Gruley & Kassai 2013
Brazilian Environment Minister	Zhouri 2010
Cattle rancher, Pará	Fearnside 2008 Hoelle 2012
Environmental Defence Fund	Deprez & Miller 2014 Smith 2008
Consumer	Butler & Laurance 2008