CASE TEACHING NOTES

for

"His lips drink water but his heart drinks wine": Groundwater availability, access, and governance in the Guadalupe Valley, Mexico

by

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ABSTRACT

This case explores the complex world of groundwater management in the Guadalupe Valley of Baja California - also known as the Napa Valley of Mexico - where geology, climate, history, politics, and economics culminate to form a convoluted social-ecological system that is expressed and experienced uniquely by different stakeholders. The case is used to demonstrate the importance of understanding the biophysical and social components of the system, and the interactions between and within them, to generate and resolve water-related problems in the region. It introduces students to a systematic approach for dismantling the complexity in Guadalupe Valley that they can then apply to any other natural resource management problem. Important tools and concepts such as conceptual modeling, stakeholder analysis, and Ostrom's (2009) Social Ecological Systems (SES) framework for common pool resource management are introduced. The case study combines the interrupted case method with the jigsaw approach and problem based learning. It is designed to be implemented in an interactive classroom setting consisting of minimal lecturing time and a series of group work activities.

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PRELUDE

DOLL'S BOY'S ASLEEP

By

E. E. Cummings

(1894 - 1962)

Doll's boy's asleep
under a stile
he sees eight and twenty
ladies in a line

the first lady
says to nine ladies
his lips drink water
but his heart drinks wine

the tenth lady
says to nine ladies
they must chain his foot
for his wrist's too fine

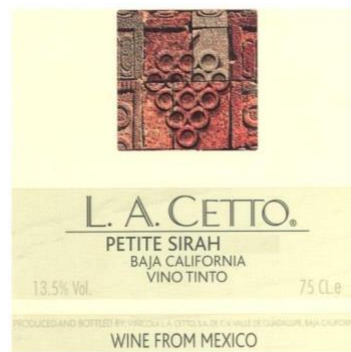
the nineteenth
says to nine ladies
you take his mouth
for his eyes are mine.

Doll's boy's asleep
under the stile
for every mile the feet go
the heart goes nine

INTRODUCTION & BACKGROUND

The presence or absence of groundwater in any given place or the quantity and quality of available water is a function of above- and below-ground biophysical conditions such as precipitation, geology, soil composition, and vegetation coverage. Current and historical socio-political conditions, economic drivers, technological advances and other social 'factors', however, also play an important role - they interact in complex ways to determine the formal and informal rules that govern access, whether rules are respected, and whether water is a 'problem' or not. Consequently, groundwater presents an interesting common pool resource to explore, especially when numerous actors have a stake in its continued availability and when access is contested. Groundwater also entails many of the elements that make natural resources - in general - difficult to manage across multiple stakeholders. Using a groundwater case study permits the exploration of the interplay between social and biophysical factors that are both the source and solutions to problems related to quality, access and distribution of natural resources.

In this case study, we start the exploration of the groundwater situation in the Guadalupe Valley of Baja California, Mexico, through the eyes of Don Angelo Cetto, a young Italian man who moves to the Valley in 1926 to found L. A. Cetto, a wine company that, three generations later, continues to be produce one of the most lauded wines in Mexico. The story of Angelo Cetto is one of adventure and pursuing big dreams, but it foreshadows the changes awaiting the Valley. Once an 'empty landscape', today the region is a rapidly growing urban and agricultural (mostly viticulture) area that continues to grow even as groundwater levels drop. Starting off with an introduction to Don Cetto's story and some basic understanding of groundwater hydrology, students begin to develop a conceptual model of what might be going on in the Valley today, and - in so doing - gain an appreciation for the importance of incorporating multiple disciplines to reveal the numerous dimensions of the problem. Indeed, "the problem" is only fully comprehended once students have gone through the exercise of first dissecting and then piecing back together the components of the system.



The case study is demonstrative of a glob al approach to water management that entails local governance as the primary mechanism to ensure cooperation among users, and increasing groundwater regulations. In Mexico, regions where groundwater is overexploited, new regulations prohibit further well development and they require groundwater users to register their wells in order to receive volumetric water use rights. The combination of juxtapositioned factors come together in the Guadalupe Valley to present a typical socio-ecological challenge: an increasingly diminishing resource, old and new access and rights rules, powerful and powerless stakeholders, and strong pressure for economic growth. Structured as a problem-solving case study, students are motivated to first gain a thorough understanding of the system before they are required to define and then subsequently zone in to a specific problem. Once they have characterized the problem and the reasons for its existence, they are encouraged to generate viable solutions. Consequently, the problem that is explored in the course of the case study might vary across groups.

It is hoped that by developing these skills with a real case, students will be less overwhelmed by the numerous environmental problems facing humanity today and feel more equipped to address them.

This Case Study is intended primarily for use in a course on natural resource management where the concept of socio-ecological systems is introduced and subsequently explored. In such a course, the case study can be used to develop the skills for exploring socio-ecological systems, for understanding their behavior and characteristics, and for exploring how they are governed. This is a case that is useful for introducing students to the management challenges posed by natural resources which - due to their nature – are mostly 'invisible' to stakeholders and thus there is limited understanding of their abundance and behavior at larger spatial scales and under changing conditions. The case study can be adapted for use in different courses, depending on the interests and focus of the instructor. We envision its use in hydrology, environmental policy, and interdisciplinary science courses.

Student Learning Objectives

At completion of the case study, students will be able to:

1. Understand basic groundwater hydrology
2. Characterize the rules and regulations governing natural resource management by exploring the formal and informal political and legal frameworks of control and management of groundwater
3. Undertake basic stakeholder analysis (or analysis of interest groups)
4. Recognize and characterize the interaction between the biophysical components of the groundwater system and the socio-political system and their contribution to existing challenges in groundwater management in the Guadalupe Valley
5. Simplify complexity by developing conceptual models that represent and communicate complex socio-ecological interactions
6. Understand a complex problem from multiple disciplinary perspectives
7. Synthesize knowledge from natural and social science disciplines to generate potential resolutions to a complex problem, but also recognize that the nature of complex systems implies that no single resolution can solve such problems

Socio-ecological Synthesis Learning Goals

1. Ability to identify, describe and dismantle a socio-ecological system in order to understand and describe its components and the interactions within it.

   Related activity: In-class hands-on activities focused on developing understanding of the hydrological system first, the social system, and then the interactions across systems

2. Understand the importance of scale and context and how social-environmental processes and outcomes can vary because of these.
   Related activity: In module 2 and 3 specifically, temporal and spatial scale are introduced to explore how the groundwater experience of stakeholders varies in accordance to their socio-political histories and their location on the landscape.

3. Ability to co-develop research questions and conceptual models in teams

   Related activity: The whole case study is structured as a series of exercises that are undertaken in groups work and in which students gradually develop an increasingly more comprehensive conceptual model of the hydrological and social system and its interface.

4. Ability to communicate across interdisciplinary boundaries

   Related activity: Students are introduced to concepts and terminologies from different disciplines (hydrology and geology, governance and politics, social science, geography, history) and encouraged to apply the use of their use in classroom discussions and iin written assignments

CLASSROOM MANAGEMENT

Overview

This case study combines the interrupted case method with the jigsaw approach and problem based learning. The jigsaw approach allows students to examine resource management issues from a disciplinary perspective, with an emphasis on the fields of hydrology, governance, and policy, and then to combine those disciplinary elements to develop potential solutions that are informed by a multidisciplinary understanding of the issues.

The case study consists of five modules built upon each other to take students though a steady and systematic process for approaching challenges related to the management of natural resources. Starting with a light introduction to 'the situation' (presented in the form of a non-fiction narrative) students immediately start working on identifying the type of information they would need to better understand the 'problem'. In so doing, they find themselves in the early stages of constructing their own conceptual maps of the groundwater situation in the Valley.

In the second module students are introduced to basic groundwater hydrology, sufficient for them to begin understanding how the physical parameters of the system may be contributing to the problem and to start anticipating how stakeholders' experience of the problem might vary.

In the third module, they explore the problem though the eyes of key stakeholders in the region, and thus begin to appreciate how the Guadalupe Valley can be considered a linked social-ecological system with key interdependencies among the various subsystems.

A lecture on governance of natural resources in the fourth module allows students to delve deeper into the "groundwater problem". In this module they are introduced to the various approaches for analyzing governance of shared resources and go through the exercise of applying Ostrom's (2009) general framework for analyzing the sustainability of SES to Guadalupe Valley. They are encouraged to simplify the complex governance structure revealed to them through the case study by using existing typologies available in the literature.

In the fifth and final module students are encouraged to bring together the learning of all previous models to propose solutions to the identified problem.

The case takes approximately 10 hours to complete, excluding time for preparation, readings, and out-of-class assignments. Each module can be undertaken in a 2 hour time slot. It can also be extended to cover double that time (2 hour x 10 meetings), allowing for longer discussion times and deeper in-class exploration of the case and the methods.

Teaching the Case

Module I: Introduction to Socio-ecological systems and Interdisciplinary science

Estimated time needed:
2 hours 15 minutes

Overview
Students are presented with a short narrative 'hook' on the case that captures the basic 'problem' from the perspective of one stakeholder. With this basic information, they identify the 'problem' facing Guadalupe Valley and the type of information that would be needed to understand the problem better and begin identifying solutions. Systematically through step by step directions, they start developing a preliminary conceptual model that allows them to present causal relationship between different components of the SES system, to identify important interactions between the biophysical and social system, and to appreciate the interdisciplinary nature of the problem. The

conceptual model they generate forms the basis for other group activities programmed for other Modules.

Detailed description

1. Introduction to the case (5 min): Students are presented with a short narrative of Don Angelo Cetto, the founder of L. A. Cetto what is today, one of the largest vineyards in the Valley. This is followed by a short discussion in which instructor asks students what they think the point of the narrative is.

2. Understanding of the problem (20 min): Each student receives one of three handouts (Handout 1 to 3). Each is an internet news article that describes more generally the modern wine industry in the Valley and the challenges it faces. They get 3 minutes to read the article they have been prescribed:

   Handout 1: http://palatepress.com/2013/09/wine/mexicos-wine-woes-attempting-water-into-wine/

   Handout 2: http://www.sandiegoreader.com/news/2011/jun/29/yonder-valle-de-guadalupe/?page=1&

   Handout 3: http://www.utsandiego.com/news/2014/apr/06/ensenada-mexico-water-shortage-desalination/

   Students get together in groups of three (each having read a different handout) and respond to the following questions (15 min):

   - "What seems to be the problem?"
   - "What water-related issues are discussed?"
   - "What social issues emerge?"

   They write the concise form of their responses on a half sheet of letter-sized paper, one response per sheet. The responses for each team are posted on the wall, clustered according to the questions (i.e., three clusters).

3. Instructor reads through the responses, grouping those that sound most similar and summarizing the exercise in terms of general consensus among responses. (5 min)

4. Identification of information needed to understand the situation: Instructor asks "What more do we need to know to better understand the situation?" (10 min)
   a. Students are asked to separate in groups of 3 to 5, in order to explore this question
   b. In their groups, students brainstorm responses. Ideas are listed on a flipchart concisely with no more than eight words per idea
   c. Emphasis is made to list everything that is mentioned: 'all ideas are welcome'

5. Video of more information (10 min): They then watch a 5 minute video explaining the problem further. https://www.youtube.com/watch?v=3sFabQtq2yU. Alternatively they could be handed the article (Handout 4) that contains the text that goes with the YouTube video - the KPBS article by Jill Replogle (2012).

   Handout 4: http://www.kpbs.org/news/2012/mar/21/baja-wine-region-faces-high-taxes-low-water-supply/

   They are asked to check their lists and include any additional ideas that the video might have inspired. (5min)

6. Identification of components within a socio-ecological system (15 min)
   a. In plenary: Instructor asks groups to read out three ideas that they have listed. Each group is read out only those ideas not previously mentioned. Instructor points out how items that have been listed are highly disparate; that they range from highly biophysical properties of groundwater and others are to do with governance, social relations and politics. (5 min)
   b. In groups: Students return to their groups to group the items on their list into "***biophysical factors***" (those that have to do with the properties of the groundwater system - including aboveground properties such as forest cover), "***social factors***" (those that have to do with rules and regulations, stakeholder interactions, economics, governance, politics), and "***other factors***" (those that seem difficult to assign to any of the previous groups). On blue cards, they write one biophysical factor per card. On orange cards, they write one social factor per card, and on green cards, they list the "other factors". (10 min)

7. Causal relations and interactions between biophysical and social factors (40 min)
   a. Instructor gives a brief explanation of how these factors don't operate singularly and separately from each other. Numerous interactions occur within and between the biophysical and social systems. Some of these interactions are causal (i.e., the presence/activity of one causes a change in the status of another). In order to understand a system, getting a handle on causal relations, direction of cause-effect, size of effect, etc., helps identify the scale of the problem and its source. (5 min)
   b. In their groups, students attach two flipchart papers on which they arrange the cards they have prepared in step 4 according to their understanding (and agreement) of the causal relationship between factors. This is the first draft of a conceptual model of the socio-ecological system they will use to explore the rest of the case study (30 min)
   c. As they undertake the exercise, they are encouraged to add new cards if they agree that important factors are missing for overall understanding of the situation, and to eliminate cards that they no longer perceive as necessary.

   d. The conceptual model is stuck to the wall and a quick 'museum walk' of 8 minutes is conducted. The museum walk consists of the following: Students move around the class to look at the work of other groups. They spent 2 - 3 minutes per model. No particular order is needed. Each student should visit two models. (10 min)

8. Interdisciplinary nature of the problem (15 to 25 min)
   a. In plenary: As a wrap up to Module I an Instructor-led discussion is held whereby students are asked to identify the disciplines that are needed to identify the problem; whether they see the problem as strictly belonging to one discipline; whether they think that there is one (or two) disciplines that are best suited for understanding the essence of the problem. (5 - 10 min)
   b. It is recommended that the Instructor ends with a 10 - 15 min presentation on SE systems, the importance of interdisciplinary science, and an introduction to important concepts and theories in SES literature.

Tips

It is worthwhile to take a couple of minutes at the end of class to explain why they will be working in groups to explore the case (SES require an interdisciplinary approach, usually means teams get together, they will have different skill sets and their behavior can promote or impede group objectives). House rules for group work dynamics can be set. Instructor should point out examples of behaviors observed in the course of the class that were conducive (or not) to group work and provide tips for how to promote or avoid them (refer to supplementary materials "resources to manage classroom dynamics").

Materials

☑ Handouts 1 to 4 (in supplementary materials)
☑ Physical geography of Guadalupe Valley
☑ Letter-sized sheets cut in half (preferably different colors per group)
☑ Flipchart paper: 4 sheets per work group
☑ Post it notes (size 1/4 of letter paper) - orange, green, blue
☑ Masking tape (1 roll per work group)
☑ Short Lecture: Introduction to SES and Interdisciplinary Science [refer to Zurlini et al 2013 and other references provided below to develop lecture presentation]

Assignments

1. Reading assignment 1 for next Module: Physical geography of Guadalupe Valley

2. Using only the hook and Reading assignment 1 students are asked to formulate a preliminary understanding of the problem by:
   a) Describing the problem or 'issue' as they understand it (a 1-pager)
   b) Formulating a list of potential solutions they would recommend to address "the issue" (a ½ page list of bullet points).

They are specifically asked not to research the issue further (on the web, for example) and only work with information that they have been given and whatever prior experiences they might have of a similar problem or situation.

Assessment

The purpose of the assignment is twofold:

a) To assess students' familiarity with SES and thus know whether the instructor may need to adjust the course accordingly (simplifying it or incorporating additional complexity)
b) To assess individual baseline abilities of students to address and understand SES before the course so as to track individual 'growth' over time (i.e. the 'before' conditions to be compared with an 'after' the course)

References:

Novak, J. D. 1990. *Concept maps and Vee diagrams: two metacognitive tools to facilitate meaningful learning.* Instructional Science 19:29-52

Ostrom, E. 2009. *A general framework for analyzing the sustainability of socio-ecological systems*. Science 325: 419 - 421

Reyers, B., Biggs, R., Cumming, G. S., Elmqvist, T., Hejnowicz, A. P., and Polasky, P. 2013. *Getting the measure of ecosystem services: a social–ecological approach*. Front Ecol Environ: doi: 10.1890/120144
Rogers, K. H., R. Luton, H. Biggs, R. Biggs, S. Blignaut, A. G. Choles, C. G. Palmer, and P. Tangwe. 2013. *Fostering complexity thinking in action research for change in social–ecological systems*. Ecology and Society 18(2): 31. http://dx.doi.org/10.5751/ES-05330-180231

Zurlini, G., I. Petrosillo, and M. Cataldi. 2013. *Socioecological Systems*. *In* Sven Erik Jørgensen and Brian D. Fath (Editor-in-Chief), Systems Ecology. Vol. [4] of Encyclopedia of Ecology, 5 vols. pp. [3264-3269] Oxford: Elsevier.

Module II: Basics of groundwater hydrology and the human-water interface

Estimated time needed:

2 hours

Overview

As the first step towards dissecting the problem, students learn about basic groundwater hydrology to ensure that they understand the physical system and its limitations, and to develop familiarity with groundwater terminologies and concepts. This is partially to emphasize the importance - in interdisciplinary work - to step out your comfort zone and learn some basics about the part of the systems that you are least familiar with. The presentation by the instructor also sets the stage for launching into geospatial distribution of GW and the importance of location in the landscape for GW access (Module III), but the lecture is primarily for introducing the human-interface with hydrology in terms of the role of wells and other water harvesting technologies, contamination, and aboveground human activities that contribute to groundwater quantity and quality. After the lecture, students work in groups to elaborate the physical system of their conceptual model given new information. Strong emphasis is made throughout this Module to use the correct hydrology terminology. The lecture and hands on exercise should facilitate reading and comprehension of hydrological information about the Valley.

Note: If research design is an important component of the course, in this module student can identify research questions for exploring how the system functions, the size and direction of interactions and causal relationships.

Detailed description

1. Introduction to groundwater hydrology (*50 min*):
    a. Instructor gives a presentation on basic introduction to groundwater hydrology (*30 min*). The first half of the lecture is on general GW hydrology. The second half of the lecture applies concepts from the first half to the Guadalupe Valley case. This presentation is provided as supplementary material. Warn the students to take note; a quiz will be administered.
    b. A quick quiz is administered to emphasize groundwater basics (*10 min*)
    c. Answers are discussed in class to ensure that everyone knows what the correct answers should be (*10 min*)
2. Improving common understanding of the biophysical system (*15 min*):
    a. Using information that they now have from the lecture about the groundwater system of the Guadalupe Valley, they evaluate their preliminary draft of the biophysical system and rearrange cards to better reflect the situation in the Valley. This may require including additional factors (blue 'post it' notes) previously not mentioned or elimination of factors that are not relevant for the case. Instructor encourages students to use terminologies and concepts they have heard in the lecture
3. The human interface with hydrology (*30 min*)
    a. In their groups, students define each one of the arrows that flows from a green to blue factor and vice versa. They ask themselves: "What is this arrow?" "What does it represent?" Is it a flow of water? Is it a rule? Is it an activity? Is it uni-or multi-directional? A succinct summary of their discussion is included in Table 1 (drawn on a sheet of flipchart paper).
    b. On the same table they discuss and propose appropriate units that could be used to quantify or qualify the interaction (width of arrow represents size/importance of the flow or interaction)
    c. They use Handouts 1 to 4 from the previous module to identify human-hydrology interface specific for the Valley
    d. Students add another column to the table titled "existing data on interactions" and using the handout, they populate the column

Table 1: Human - hydrology interface for the Guadalupe Valley: What we know

Interaction between factor A to Factor B	*Definition/description of the interaction*	*Unit that could be used to quantify the interaction*	*Existing data on interactions*
Farmer to aquifer	Farmer pollutes aquifer (contamination)	Parts per million of contaminants	
Aquifer to Farmer	Farmer extracts water from aquifer	Cubic meters of water per second	

For complete table, see Supplementary Materials

4. The assignment is explained (*5 min*): Students are asked to explore the internet to inform the table further and specifically to obtain recent figures and/or data quantifying the flows between components of the system. Group decides how to divide the work among each group member and what information they are supposed to provide for the next class. A preliminary list of links is provided (see materials)

Tips

Allow group to self-organize, but check to see if that is really happening. The group should divide tasks equally among themselves. Make sure the assignment does not become the work of only a few students.

Materials

☑ The conceptual models from Module I
☑ Post it notes (size 1/4 of letter paper) - orange, green, blue
☑ Presentation on basic groundwater hydrology*
☑ Groundwater hydrology quiz*
☑ Handouts 1 to 4 from Module I
☑ List of links to find more information on groundwater use by agriculture, viticulture, residential

Assignments

1. Reading assignment 2 for next Module: *Guadalupe Valley water users and uses*
2. Reading assignment 2: *Sustainable groundwater pumping*
3. Supplemental reading assignment: Groundwater hydrology

Assessment

The quiz applied immediately after the lecture is an in-class assessment corresponding to this module. It responds to student learning objective 1: that students acquire basic understanding of groundwater hydrology [or the bio-physical component of the social-ecological system they will explore]. It is assigned immediately after the groundwater lecture for two reasons:

1) to assess how well individual students understand groundwater basics immediately after the lecture given that it is a key starting point for understanding the system, and

2) to assess how well the lecture conveys the right concepts to students (consistently 'wrong answers' may be due to poor conveyance of the material rather than student performance.

Discussing the answers in class will help clarify 'correct' responses and provides an opportunity to discuss more complex concepts in groundwater hydrology. The workgroup activities that follow allow students to immediately apply the new concepts, reinforcing them in actual practice, and increasing the likelihood that they will assimilate the new information.

References:

Campos-Gaytan, J. R., Kretzschmar, T., & Herrera-Oliva, C. S. (2014). Future groundwater extraction scenarios for an aquifer in a semiarid environment: case study of Guadalupe Valley Aquifer, Baja California, Northwest Mexico. *Environmental Monitoring and Assessment*, *186*(11), 7961–85.

Other references are listed in Handouts 1 to 4

Module III: Understanding the interest groups and their stake in groundwater

Estimated time needed:
2 hours

Overview
In this Module, students are introduced to the numerous actors and groups that have a stake in the groundwater in Guadalupe Valley, the interactions between them and the power relations between them. By mapping the actors onto the Guadalupe Valley landscape, they are able to understand how location in the landscape has direct implications for groundwater access, groundwater quality received, and potential to jeopardize groundwater conditions. Using information gathered from different sources, they see how history, politics and geography are important for understanding how interest groups have ended up in their current locations. At the end of the module, students would have undertaken a stakeholder analysis, located actors on the landscape, and improved their understanding of the social component of the conceptual model they are developing.

Detailed description
1. Introduction to stakeholder analysis (*35 min*)
    a. A brief introduction to stakeholder analysis is given in the form of a presentation that covers who stakeholders are, their role in the use or management of the resource, and the interplay between them. A brief explanation is given to students of the steps they will undertake to conduct their own analyses of groundwater stakeholders in the Guadalupe Valley. (*20 min*)
    b. After the lecture, a brief instructor-led discussion is undertaken in which students list which stakeholders they have identified so far. Instructor lists these on a whiteboard. (*5 min*)
    c. Instructor asks what kind of information would be needed for each stakeholder group in order to improve our understanding of the groundwater situation in Guadalupe Valley. (*10 min*)

2. Undertaking a stakeholder analysis for the case (*80 min*)
    a. Nine primary stakeholders are already identified for the Valley and they have been alluded to in various ways from the reading materials and handout they have been receiving. Students have to piece the information together to come up with sufficient information to complete a stakeholder analysis table such as the one below (Table 2). (*20 min*)

Table 2: Stakeholder analysis for the Guadalupe Valley

Stakeholder	*Primary LU activity*	*Population*	*Area occupied (ha)*	*Amount of water used*	*How are they impacted by current GW conditions*	*How do they influence GW conditions*	*Do they participate in formal GW management*

    b. In groups, students use the table to update and improve the social system of their conceptual model (*30 min*)
    c. In plenary, an instructor-led discussion encourages students to describe what seems to be going on in the Valley. Leading questions can be: "So, what seems to be the problem in the valley? It is that there is not enough water? Is it that water is not equally distributed among stakeholder? Does it need to be equally distributed? Is the need for water equal across stakeholders? (*15 min*)
    d. At the end of the discussion, students should have come to a consensus on what the problem seems to be. A problem statement is developed on a flipchart and posted in the classroom for future reference. It is quite possible that no agreement is reached on a single problem statement in which case a discussion on why that might be may be necessary. (*15 min*)

Tips
It is important that students break down stakeholder groups into subgroups and refrain from lumping interest groups into broad categories such as "local communities" or "farmers". Instead, they should be encouraged to make the distinction between subsistence versus commercial farmers - for example - or large vs small landholders, men vs women, local vs regional leaders, etc.

Materials
☑ The conceptual models from Module II
☑ Post it notes (size 1/4 of letter paper) - orange, green, blue
☑ Presentation on introduction to stakeholder analysis *
☑ Handouts from previous modules

Assignments
1. IF students have not completed their table - they would be required to come to the next class with a completed stakeholder analysis.

2. Optional Reading assignment: Reed et al 2009 Typology of methods for stakeholder analysis, and Brugha et al 2000 Review of Stakeholder Analysis (see references)
3. Mandatory readings for next Module:
    a. Reading assignment: Groundwater institutions
    b. Reading assignment: IAD framework rules example

Assessment

The assessment for this module is in-class and done for the group, as a whole. It consists of the stakeholder analysis exercise. The instructor can take notes on the participation of individual students, and encourage groups to consider their dynamics and extent of inclusion of the inputs from all members.

The purpose of this assessment is to gauge whether students have developed understanding of and appreciation for stakeholder analysis in SES (Student learning objective #3). It is also associated with student learning objectives #5 (ability to simplify complexity) and #6 (understand a complex problem from interdisciplinary perspectives).

Stakeholder analyses are necessary to get an in-depth understanding of the social pull and push forces within a SES. Nevertheless, they can be difficult to conduct due to incomplete or insufficient information about interest groups and dispersal of information. Students are asked to evaluate the stakeholder analyses process that they undertook. This can be done as a plenary discussion in class, or as a group assignment between 2 to 3 students. The guiding questions can be:

1. How easy or difficult was it to do the analysis? And why?
2. Do they think they were able to capture and describe the most important actors? Which groups might be missing?
3. If you were a stakeholder in this system, would you approve of the outcomes of this analysis?
4. Did there seem to be more information about some stakeholders than others? Why would that be?
5. How could having more or less information about stakeholders affect the analysis process?

References:

Burgha, R., and Varvasovszky, Z. 2000. *Stakeholder analysis: a review*. Oxford University Press. Health Policy and Planning 15: 239 - 246

Grimble, R., and Wellard, K. 1997. *Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences and opportunities*. Agricultural Systems 55 (2): 173–193

Jepsen, A. L., and Eskerod, P. 2009. *Stakeholder analysis in projects: Challenges in using current guidelines in the real world.* International Journal of Project Management 27 (4): 335–343

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C. H., Stringer, L. C. 2009. *Who's in and why? A typology of stakeholder analysis methods for natural resource management*. Journal of Environmental Management 90 (2009) 1933–1949

Schmeer (date unknown) stakeholder analysis guidelines

WWF 2005 Cross-cutting tool for stakeholder analysis

Module IV: Governance of socio-ecological systems

Estimated time needed:
2 hours

Overview
In this Module, students get an overview of the political and legal framework of groundwater control and management in Mexico and the formal and informal rules guiding use and access to groundwater in the Guadalupe Valley. They use this to deepen their understanding of the social system, primarily, by evaluating how existing governance may contribute to the problem or impede potential resolutions, or present opportunities for viable solutions. A lecture on governance starts broad - discussing Ostrom's rules, types of rules, but then narrows down to the specific rules and regulations (formal & informal) that govern groundwater use in Guadalupe Valley. Using the lecture material and their outputs from previous Modules the students identify how the laws are expressed in the social and biophysical fabric of the system in terms of actual activities or processes that impact access and use of groundwater by stakeholders.

Detailed description
1. Introduction to natural resource governance in general and groundwater governance in Mexico and Guadalupe Valley
    a. Instructor gives a lecture on the basic NR governance, pulling mostly from Ostrom's work and others. Examples of how these rules play out in the field are provided. (*30 min*)
    b. As a plenary, students identify on their conceptual models where rules are at play and form typologies of those rules based on the lecture material (formal/informal, etc). They place a star at every place where rules are explicitly or implicitly implied. (*20 min*)
    c. The discussion shifts to focus on the effect that rules may be having on the biophysical and social components of the Guadalupe Valley system. Using prompt question such as: How do the rules & regulations affect different stakeholders? Which rules favor which stakeholder group? How do the rules generate or resolve conflict? (*20 min*)
2. Instructor explains about a recent change in Mexico's rules on groundwater governance that restricts groundwater use and promotes local management. In plenary, using one of the

conceptual models, the classroom identifies how the rule may alter existing interactions. (*30 min*)

3. Discussion is then shifted to focus on whether students think that this recent change is 'bad' or 'good' and how so. This discussion can be managed as a debate where students take on the role of the different stakeholders. (*20 min*)

Tips

Materials

- ☑ The conceptual models from Module I
- ☑ Post it notes (size 1/4 of letter paper) - orange, green, blue
- ☑ Lecture Presentation on governance (can be based on References below)
- ☑ Handout 5: Mexico Groundwater Governance

Assignments

No assignments are suggested for this Module

Assessment

The debate at the end of class allows instructor to assess how well students have understood the rules. It also provides an opportunity to clarify misunderstandings of rules.

References:

Arts & Buizer 2009 discursive-institutional analysis of global forest governance

Andersson, K., 2006. Understanding decentralized forest governance: an application of the institutional analysis and development framework. Sustainability: Science Practice and Policy, 2(1), pp.25–35.

Ostrom, E., 2010. Institutional Analysis and Development Framework and the Commons, The Cornell Law Review, 95, pp.807–816.

Module V: Finding viable solutions for socio-ecological problems

Estimated time needed:

2 hours

Overview

By the end of Module IV students should have a very good understanding of the complex nature of the problem, but should also have begun to identify potential solutions. In this final Module, students are required to identify (on their conceptual model) strategic entry points for potential interventions that could improve current conditions. They justify their strategies to each other, arguing for why they believe it is the best possible resolution. In doing so, they begin to realize that there may not be a 'perfect' solution, that a set of different interventions at different levels might be needed, or that there is still large information gaps that prevent complete identification of potential solutions. They revisit the list of solutions they had proposed as an assignment on the first day of introducing the case and reflect on the similarities and disparities that might exist between their current proposals for solutions and earlier proposals.

Detailed description

1. Brief instructor-led talk on the need to present some kind of resolution. That the Government of Mexico has hired the class as consultants to propose viable solutions. The terms of reference require the students to identify at least three strategic points of entry and describe briefly what the strategies would entail. (*15 min*)
2. Identification of entry points:
    a. Instructor gives brief explanation of what a 'point of entry is' and how to identify it on the conceptual model (instructions provided) (10 *min*)
    b. Students move into their groups and discuss three strategic points of entry they believe they should focus on. For each strategy, they write a brief statement (<20 words) justifying their decision and explaining what the strategy would achieve. (*30 min*)
3. Prioritization of strategies:
    a. In plenary, each group presents their three entry points. The instructor lists them on table on the whiteboard. Similar entry points are grouped. (*15 min*)
    b. Instructor-led process asks students to vote which three strategies should be presented to the Mexican Government. Discussion revolves around justifications for the entry points voted for, and students are asked to defend their stance, using the conceptual models and information generated in the course to make their point. (2*0 min*)
4. Wrapping up the case study
    a. Instructor hands out Module 1 assignment back to students. A pre-prepared list of all the solutions that they had proposed in that assignment is presented. (*5 min*)
    b. Discussion revolves around differences and similarities between early proposals and new proposals. What was obvious from the first instance about the nature of the problem and hence similarities in potential solutions? Which solutions would have never been possible to identify without a more comprehensive understanding of the system? Which solutions remain largely uni-disciplinary and why? Was it necessary to go through this process to identify strategic entry points? (*20 min*)

5. Final assignment is assigned. Students are referred to recommended readings Bogardi et al (2012), Freemand (2000), Pahl-Wostl (2008) and Sharma et al (2005).

Tips

Materials

☑ The conceptual models from Module IV

- ☑ Post it notes (size 1/4 of letter paper) - bright yellow, pink
- ☑ Instructions for how to identify strategic points of entry in a conceptual model

Assignments

Language for a verbal assignment to follow the class discussion:

"*We've spent this case study exploring the many facets, interdependencies of and perspectives on this problem, and you've diagramed this in your conceptual maps. Drawing upon the knowledge gained through the conceptual mapping, identify the key obstacles/challenges to improving groundwater management in the Guadalupe Valley. Next, come up with potential solutions that address these challenges and would improve groundwater management. Your solutions should reflect an understanding of both the social and biophysical systems involved*."

Assessment

The assignment is a summative assessment that gives students an opportunity to demonstrate their overall understanding of all five modules of the case study. Their answers will largely draw on the preceding discussion in this module, although the best essays will be those are able to justify the particular solution they selected (student learning objective #7).

References

Bogardi, J. J., Dudgeon, D., Lawford, R., Flinkerbusch, E., Meyn, A., Pahl-Wostl, C., Vielhauer, K., Vörösmarty, C. 2012. *Water security for a planet under pressure: interconnected challenges of a changing world call for sustainable* Water *solutions*. Current Opinion in Environmental Sustainability 4 (1): 35 - 33

Freeman, D. M. 2000. *Wicked water problems: sociology and local water organizations in addressing water resources policy*. American Resources Association 36, (3): 483–491

Pahl-Wostl, C. 2008. *Requirements for Adaptive Water Management* In: *Adaptive and Integrated Water Management* (*Eds*: Pahl-Wostl, Kabat, and Möltgen). Springer Berlin Heidelberg, pp 1-22

Sharma, B. R., Villhorth, K. G., Sharma, K. D. (eds) 2005. *Groundwater research and management: Integrating science into management decisions.* Proceedings of IWMI- ITP- NIH International Workshop on "Creating Synergy between Groundwater Research and Management in South and Southeast Asia" 8-9 February 2005, Roorkee, India

Teaching the Case with Advanced Students

For advanced students, a term-long assignment could be given in which students are asked to undertake a truncated version of the process they are going through in class to develop a thorough understanding a natural resource problem of their interest. At the end of each Module, they are asked to take themselves through the same process for their individual case as homework. At the end of the Case or semester, they submit a more comprehensive term paper that describes the problem, explores its social and biophysical intricacies, and proposes a set of solutions.

If teaching the case to Spanish-speakers, students could generate a lot of the information that comes pre-prepared in this description. For example, students could search the web and come up with a list of stakeholders (Module III) and sufficient information about them to complete Table 1. Similarly, for Module IV (governance) students could explore Mexico's National Commission for Water (*Comisión Nacional del Agua* - CONAGUA) website (http://www.conagua.gob.mx/) to find much of the information on the legal framework governing groundwater use and access in Guadalupe Valley, opinions on the implications of recent changes to the rules, and so on.

SUPPLEMENTARY MATERIAL (Supplementary_Material.pdf)
This is material that is necessary to complete each Module. Answer keys will not be made available online - requests can be made to acquire them from SESYNC or the authors.

Lecture materials to prepare lecture presentations:
Module 1:

1. Module 1_The case study Hook
2. Module 1_Lecture prep-Reyers et al article]
3. Module1_Lecture prep Ostrom article

Module 2:

1. Module 2_ Lecture introduction to groundwater hydrology
2. Module 2_Lecture material future groundwater scenarios. A collection of slides with basic groundwater hydrology information and hydrological maps of the Guadalupe Valley.

Module 3:

1. Module 3_Lecture prep_Schmeer et al –stakeholder analysis guidelines
2. Module 3_Lecture prep_WWF 2005 tool for stakeholder analysis

Module 4:

1. [Module 4_IAD framework rules example; Groundwater Institutions; Mexico's water resource governance] Reading assignments can also be used as a basis for lecture materials.
2. Module 4_Artz & Buizer 2009 article

ANSWER KEYS – (Answer Keys.doc)
1. Module 2_Groundwater Quiz Answer Key
2. Module 3_List of key human-groundwater interface interactions that students are expected to explore and find information for.
3. Module 4_Full list of main stakeholder groups (9) with information about them and a list of additional stakeholders that students might mention during the plenary/discussion session for Module 3)

HANDOUTS – (Handouts.doc)
Module 1

1. Module 1_Handout Case Study_*The Hook*] – can be presented as a presentation in plenary instead of as a handout.
2. Module 1_Handout 1 Cervin 2013 Palate Mexican Wine
3. Module 1_Handout 2 Dibble 2014_San Diego_Ensenada confronts water shortage
4. Module 1_Handout 3 Mancilla 2011_San Diego Reader_on Guadalupe Valley
5. Module 1_Handout 4 Repogle 2012_Baja wine region faces high taxes

Module 2

1. Module 2_ Handout 6 Groundwater Quiz

Module 3

1. Module 3_Handout 7 Links for communal and indigenous factsheet
2. Module 3_Handout 8 Links for residential factsheet
3. Module 3_Handout 9 Links on agriculture and viticulture factsheet
4. Module 3_Handout 10 Links on CONAGUA factsheet
5. Module 3_Handout 11 Links on COTAS factsheet
6. Module 3_Handout 12 Links on urban users of Ensenada factsheet

Module 4

- No handouts

Module 5:

- No handouts

Resources for managing classroom dynamics

- *Improving interpersonal dynamics in workgroups*: This page contains links to a collection of more than 40 videos, created through the POGIL / HACH Northern Colorado Consortium. The videos were designed as instructional tools to help students better understand the importance of effective interpersonal skills in group work. The brief vignettes show both positive and negative examples of interactions between students, providing a starting point for class discussion on student roles and appropriate behavior in group situations. https://pogil.org/resources/implementation/interpersonal-effectiveness-videos

- *Higher education teaching strategies*: Faculty Focus: http://www.facultyfocus.com/

EVALUATING THE CASE STUDY

For students:

- Was there balance between social and ecological?
- Was there enough complexity? Too much?
- Was the case successful at bringing out the complexity?
- Do they feel sufficiently equipped to address SES complexity?

For instructors teaching the case:

- Is there adequate background information to establish a foundation on which to teach the course?
- Were the activities sufficient to meet the stated learning objectives?
- Was there balance between social and ecological components of the system?

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