

# An Introduction to Socio-Environmental Systems: Harvesting Wild Aguaje Fruit in Peru



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*Note to instructors:* If you use this case, let us know how you used it and how it went. You can reach Chelsie Romulo at [Chelsie.Romulo@unco.edu](mailto:Chelsie.Romulo@unco.edu)

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## SUMMARY

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This case study introduces students to socio-environmental systems using the harvest of Aguaje (*Mauritia flexuosa*) fruit in Peru. Aguaje is a non-timber forest product with complex social and environmental impacts in a region with both heavy mineral development and conservation attention as well as historic disenfranchisement of several indigenous groups. Students go through the process of articulating an SES, defining a problem, and evaluating information from different sources (news articles, white papers, and peer-reviewed literature) to evaluate management strategies and make evidence-based recommendations. They also grapple with making decisions without full information and prioritizing and evaluating information. This is a Problem-Based Learning type of case study to help students practice skills related to environmental management. It is designed for a lower level environmental studies conservation course and best used early in the semester and can be used in conjunction with general introductory material of socio-environmental systems.

## STUDENT LEARNING OUTCOMES:

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After completing this case study, students will be able to:

1. Identify the social and environmental components of the system
2. Describe the direct and indirect relationships between social and environmental systems
3. Synthesize data to connect management strategies to social and environmental outcomes
4. Compare and contrast social and environmental tradeoffs between different management strategies
5. Develop evidence-based management recommendations

## Module Overview

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**Day 1: Introduction & Exploration Part 1**

**Day 2: Exploration Part 2**

**Day 3: Concept Mapping Part 1**

**Day 4: Concept Mapping Part 2**

**Day 5: Narrating the Concept Map**

**Day 6: Using the Concept Map**

### ACTIVITIES

1. Information Synthesis
2. Concept Map
3. Socio-Environmental Systems Map

## BACKGROUND



Over the past century harvest of *M. flexuosa* fruit has transitioned from subsistence levels to a large-scale commercial industry in the northern Peruvian Amazon. The market chain follows the same general pattern of most non-timber forest products, with four major stakeholder groups: (1) harvesters, (2) intermediaries, (3) vendors, and (4) consumers. Although some case studies have discussed individual communities (Manzi and Coomes 2009), there is little information on the trade values, value chains, and market of *M. flexuosa* fruit (Virgapongse et al. 2017), with the exception of one in-depth evaluation of intermediary sellers in the 1980s (Padoch 1988).

Currently, *M. flexuosa* fruits are harvested by rural communities and families throughout the Peruvian Amazon. Fruit are gathered and sold in sacks of about 50kg, containing about 1,000 fruits (Padoch 1988). In one example of the Roca Fuerte community along the Marañón river, 15% of household annual income came from the sale of *M. flexuosa* fruit, more than other forest

extraction and hunting activities combined (Manzi & Coomes 2009). *M. flexuosa* also provides several other economically and culturally important products and is described as the most socio-economically important palm in the Peruvian Amazon (Brokamp et al. 2011; Gilmore et al. 2013). The palm is so important to the Peruvian culture that the explorer Alexander von Humboldt named it "The Tree of Life" in the early 1800's (IIAP 2006).

Intermediary sellers aggregate *M. flexuosa* fruit by buying from many individual harvesters and then re-sell the sacks of fruit to vendors who either sell the fruit raw or process it into juice, ice pops, and ice cream. Vendors are ubiquitous throughout the city, selling products on street corners or from carts and consumption is reported to be a few fruits daily for many (Padoch 1988). In this early assessment of the market, women held powerful social and economic positions and represented the majority of intermediary sellers (Padoch 1988), but it is unclear whether this is still true.

Managing and monitoring *M. flexuosa* harvest is challenging for a few different reasons. Monitoring harvest and ecological impacts is difficult because *M. flexuosa* has a patchy distribution along rivers of the Amazon and these areas are difficult to access due to their swampy conditions. Both management and monitoring are inhibited by the lack of a single major organization or management plan coordinating the harvest, transportation, or sale of the fruit. Families or small communities are entering the forest from many different points and destructively harvesting female trees (Smith 2015). These harvesters are distributed throughout the Peruvian Amazon and because they are not affiliated with each other it is difficult for any single harvester to make ecosystem-wide management decisions or to extrapolate the impacts of their own individual actions. These communities also represent different socioeconomic and demographic classifications, with some being indigenous communities. These demographic classifications have legal and cultural implications that impact access to secure property

rights and use of natural resources. Management decisions may impact how benefits are distributed along the value chain and influence groups that play key roles in maintaining market functionality.

Several different organizations and institutions working within the Peruvian Amazon are developing conservation strategies for *M. flexuosa* and there is no indication that any coordination is occurring. Despite the fact that several groups are independently offering climbing workshops or implementing agroforestry or reforestation, these efforts and outcomes are patchy and limited. Only two projects observed and evaluated harvest method in the years after climbing workshops to determine whether climbing had been widely adopted or not (Manzi and Coomes 2009; Horn et al. 2012). One study reported that younger families who had a better understanding of forest ecology were more likely to have adopted climbing as their primary harvest method (Manzi and Coomes 2009). This aspect highlights the need for conservation practitioners and organizations to not only give communities the tools for sustainable alternatives, but also the need to address incentive and education gaps.

### **Background References**

Brokamp, G., N. Valderrama, M. Mittelbach, C. A. Grandez R., A. S. Barfod, and M. Weigand. 2011. Trade in Palm Products in North-Western South America. *Botanical Review* 77(4):571-606.

Delgado, C., Couturier, G., & Mejia, K. (2007). *Mauritia flexuosa* (Arecaceae: Calamoideae), an Amazonian palm with cultivation purposes in Peru. *Fruits*, 62(3), 157-169.

Endress, B. A., Horn, C. M., & Gilmore, M. P. (2013). *Mauritia flexuosa* palm swamps: composition, structure and implications for conservation and management. *Forest ecology and management*, 302, 346-353.

Horn, C. M., Paredes, V. H. V., Gilmore, M. P., & Endress, B. A. (2018). Spatio-temporal patterns of *Mauritia flexuosa* fruit extraction in the Peruvian Amazon: Implications for conservation and sustainability. *Applied geography*, 97, 98-108.

Instituto de Investigaciones de la Amazonia Peruana (IIAP). 2006. Aguaje: La maravillosa palmera de la Amazonia. Wurst Ediciones, Miraflores. 54pp.

Manzi, M., & Coomes, O. T. (2009). Managing Amazonian palms for community use: a case of aguaje palm (*Mauritia flexuosa*) in Peru. *Forest ecology and management*, 257(2), 510-517.

Padoch, C. (1988). Aguaje (*Mauritia flexuosa* Lf) in the economy of Iquitos, Peru. *Advances in Economic Botany*, 6, 214-224.

Smith, N. (2015). *Mauritia flexuosa*. In *Palms and People in the Amazon* (pp. 341-381). Springer, Cham.

Virapongse, A., Endress, B. A., Gilmore, M. P., Horn, C., & Romulo, C. (2017). Ecology, livelihoods, and management of the *Mauritia flexuosa* palm in South America. *Global Ecology and Conservation*, 10, 70-92.

## CASE STUDY TEACHING NOTES

This case study is designed for a 2-week module in a class that meets 3 times a week for 50 minutes each meeting, but could be modified to accommodate different weekly schedules (noted in these notes are places that could be good break points). Activities do not necessarily need to take up the entire class time so could be interspersed with lecture or other activities. All handouts and assignment pages are provided at the end of this document, after the class teaching notes. Time estimates for in-class work are provided in parentheses (XX min), but can be adjusted as needed based on class needs. Each day is designed to take up ~ 45 min to provide some buffer for a 50 min class period.

### *Key to provided materials*

Linked Materials (provided in the “During Class” sections)

In-class Handouts to be printed before class (End of this document)

Assignments to be printed or provided in online (End of this document)

### **Day 1 - Introduction & Exploration**

#### *Purpose:*

The introduction day is geared toward letting the students engage with some basic information about *Mauritia flexuosa* and to get them interested in the topic. This first day is also designed to start them with a small amount of information and starting to work on defining and describing the problem statement. For homework they are ambiguously tasked with “researching for more information” to start Day 2 with a discussion of research methods and critique of information resources. This is also the day to start with a basic understanding of the system to which we will add complexity throughout the module.

#### *Before Class Preparation:*

1. Review the Introduction materials and assignments.  
Decide whether to use the [SpeedTalk Video](#) or one of the Introduction Articles provided as supplemental materials. The video is a SpeedTalk from the 2017 International Conference for Conservation Biology and lasts ~ 5 min, giving a few minutes to discuss and answer questions.  
<https://vimeo.com/245420509>
2. Print out copies of [Handout 1](#), [Handout 2](#), and [Assignment 1](#) for each student. [Assignment 1](#) could be printed on the back of [Handout 1](#). I recommend leaving the back of [Handout 2](#) blank in case students need extra space to write.

#### *During Class:*

NOTE: Steps 2 and 3 can be combined into an interrupted discussion where students are provided each question individually and discussed in a think-pair-share approach.

1. (10 min – Lecture) Introduce the case study species using [SpeedTalk Video](#) or one of the Introduction Articles provided as supplemental materials.  
<https://vimeo.com/245420509>
2. (15 min – Individual Work) Provide [Handout 1](#) prompt and allow students time to read and respond to the questions. This handout contains a short paragraph about the destructive harvest of aguaje and the following questions; (1) What terms or concepts do you not yet understand?, (2)

What do you think is the problem and what is causing the problem?, (3) Who are the groups involved in the problem?, (4) Who or what are the people and things impacted by this problem?, (5) What other information do you want to know and how will that information help you understand this system?

3. (15 min – Group Work/Discussion) Have the students get into pairs and to review their list of new concepts and terms and see if their partners know what they mean. Then see if this new knowledge impacts their responses to the other questions. End discussion time by having the class synthesize their list of information needs using [Handout 2](#).
4. (5 min – Homework Explanation) Before the end of class, review [Assignment 1: Case Study Exploration Homework](#) by explaining that the next class will focus on synthesizing information, but first they need to spend some time gathering information. Students should use their list of information gaps from the class activity to guide their research, but come prepared to class ready to share with at least 2 pieces of information.

*Assignments:*

1. [Case Study Exploration Homework](#) (Note: Can print on back of Handout 1)

## **Day 2 – Exploration Part 2**

*Purpose:*

The second day is designed to provide a basis for learning how to search and synthesize information from an inquiry-based focus. Starting with a critique of search findings, students will review strategies for searching and then be provided with instruction on how to use library resources, reference management software, and

*Before Class Preparation:*

1. Prepare for synthesizing entry ticket information. This can be done on the whiteboard, as a think-pair-share activity, or using tools like Poll Everywhere: <https://www.polleverywhere.com/>
2. Review [Lecture Powerpoint 2: Searching for Information](#) or create your own lecture notes tailored to your university resources. My university will have librarians come to class and go over all this material with the students at computers as an in-class workshop.

*During Class:*

1. (5 min - Individual work) Start class with the following Entry Ticket:  
Using the research you conducted as homework, write down 2 new things that you learned during your search.
2. (10 min – Group Discussion) Review Entry Ticket: Using the white board or a resource like Poll Everywhere, synthesize the information students provided. This could also be done as a Think-Pair-Share activity.

3. (10 min – Group or Class Discussion) Review [Assignment 1: Case Study Exploration Homework](#). This does not have to be graded, but if it is then I recommend grading via completion and checking off at the beginning of class.
  - a. What was the student experience searching for information? What strategies did they use? What worked and what didn't work?
4. (20 min – Lecture / Library Demonstration)
  - a. I recommend having students download a free reference management software and use it to organize their search findings:  
Zotero: <https://www.zotero.org/>  
Mendeley: [https://www.mendeley.com/?interaction\\_required=true](https://www.mendeley.com/?interaction_required=true)
  - b. Review Library databases and search engines (Google Scholar)
  - c. Review Boolean phrasing and keywords searching
  - d. Allow students a few minutes to try different phrasings and search engines

*Assignments:*

1. Read the following systematic review: Virapongse, A., Endress, B.A., Gilmore, M.P., Horn, C. and Romulo, C., 2017. Ecology, livelihoods, and management of the *Mauritia flexuosa* palm in South America. *Global Ecology and Conservation* 10:70-92.
2. Go back to [Handout 2](#) and use the information from the article to help fill out needs information and new gaps/needs that become apparent as students learn more. Students might want a new sheet of paper, and I recommend providing the handout as a pdf on the online learning management system.

### **Day 3 – Concept Mapping Part 1: Starting**

*Purpose:* The purpose of the third day of the case study is to introduce students to concept mapping. Students should have all read the systematic review by Virapongse et al. (2017), which contains a lot of information about aguaje as well as discussion of gaps in the literature.

*Before Class Preparation:*

1. Read the following systematic review: Virapongse, A., Endress, B.A., Gilmore, M.P., Horn, C. and Romulo, C., 2017. Ecology, livelihoods, and management of the *Mauritia flexuosa* palm in South America. *Global Ecology and Conservation* 10:70-92.
2. Review the SESYNC Hangout on “[Concept Mapping: A Technique for Teaching about Systems and Complex Problems](#)” for best practices about teaching concept mapping:  
<https://www.sesync.org/for-you/educator/case-studies/case-study-teaching-resources>
3. Prepare lecture or [video](#) to introduce concept mapping. The handout I use also has a blurb about results chains.
4. Get post-it notes and markers for students to use in class to being concept mapping. If your classroom is equipped with sufficient whiteboard, those can also be used for the activity.

*During Class:*

1. (20 min) Lecture or video to introduce concept mapping. The handout I use also has a blurb about results chains. [SESYNC has a video series](#) that could be useful for this (16.5min video)  
<https://www.youtube.com/watch?v=MMAAdOrW6I48&t=312s>
2. (25 min) In pairs or small groups, have students use [Handout 3](#) to start the concept maps.

*Assignments:*

- (1) Finish the concept map activity from [Handout 3](#)
- (2) Request an account password for Mental Modeler: <http://www.mentalmodeler.org/#download>

## **Day 4 – Concept Mapping Part 2: Iteration**

*Purpose:*

This section uses the free Mental Modeler software (Link below), which requires either that the classroom have computers or students to bring their own. At my university we have computer labs that can be requested for classroom sessions if your classroom does not already have computers.

Link: <http://www.mentalmodeler.org/>

*Before Class Preparation:*

1. Review the [Mental Modeler video](#) and double check that the link works  
[https://www.youtube.com/watch?time\\_continue=17&v=UbKzyDctkrY](https://www.youtube.com/watch?time_continue=17&v=UbKzyDctkrY)
2. Request classroom with computers if needed or remind students to bring their computers to class.

*During Class:*

3. (15 min) [Start with the introduction video about Mental Modeler](#). NOTE: The video can also be assigned as homework before class, and works really well for a flipped classroom format.  
[https://www.youtube.com/watch?time\\_continue=17&v=UbKzyDctkrY](https://www.youtube.com/watch?time_continue=17&v=UbKzyDctkrY)
4. (30 min) Students work on inputting their model from previous class and [Handout 3](#) into Mental Modeler.

*Assignments:*

1. Work on concept maps and bring map to next class session.

## **Day 5 – Narrating the Concept Map**

*Learning goals:*

The purpose of this classroom activity is for students to create a narrative using their concept map. This narrative will inform their eventual strategies and options.

*Before Class Preparation:*

1. Print out or provide copies of [Assignment 2: Concept Map and Narrative](#)

*During Class:*

2. (10 min) Review [Assignment 2: Concept Map and Narrative](#) and discuss narrating the concept map. Point out that students have already worked on objective statements/research questions that should guide their narrative and they have resources



3. (25 min) *Peer Review*: Pair up students for a peer review of each others concept maps. Once the students are in pairs, give each person in the pair 5 minutes to explain their concept map and 5 minutes for feedback from their partner (10 minutes of focused time on each concept map)
4. (10 min) *Exit Ticket*: Have students outline their narrative based on the peer review feedback and show the outline before leaving class

*Assignments:*

1. **Assignment 2: Concept Map and Narrative** (Write up narrative and polish the concept map based on discussion)  
NOTE: might want to make this due at a later date than the next class period to give students time to finish it up.
2. Potential Supplemental Reading for Day 6: Margoluis, R., Stem, C., Swaminathan, V., Brown, M., Johnson, A., Placci, G., ... & Tilders, I. (2013). Results chains: a tool for conservation action design, management, and evaluation. *Ecology and Society*, 18(3).  
<https://www.ecologyandsociety.org/vol18/iss3/art22/>

## **Day 6 – Using the SES Map Part 2 / Wrap Up**

*Learning goals:*

The purpose of this class session is to have students work through a results chain to develop a recommendation for this system.

*Before Class Preparation:*

1. Print out or provide copies of **Assignment 3: Results Chains and Recommendations**
2. Review Results Chain reading (can use as a supplemental reading for students to prepare for this day) to prepare lecture
  - a. Margoluis, R., Stem, C., Swaminathan, V., Brown, M., Johnson, A., Placci, G., ... & Tilders, I. (2013). Results chains: a tool for conservation action design, management, and evaluation. *Ecology and Society*, 18(3).  
<https://www.ecologyandsociety.org/vol18/iss3/art22/>
  - b. OECD. 2017. Strengthening the results chain: Synthesis of case studies of results-based management by providers. <https://www.oecd.org/dac/peer-reviews/results-strengthening-results-chain-discussion-paper.pdf>
  - c. Optional Video 1: <https://www.youtube.com/watch?v=dpb4AGT684U>
  - d. Optional Video 2: <https://www.youtube.com/watch?v=nPMLpEHhHTU>
  - e. Optional Video 3: [https://www.youtube.com/watch?v=6zRre\\_gB6A4](https://www.youtube.com/watch?v=6zRre_gB6A4)

*During Class:*

1. (10 min) Review the concept of a “theory of change” and developing a results chain. This can be done as a lecture, or via use of one of the videos provided above.
2. (15 min) Have students work on their own to start their results chains on paper or whiteboards.
3. (10 min) After starting their own results chains, give the students time to share their results chains and recommendations with pairs to get feedback. What assumptions have they made? Do they have background information to back up these assumptions?

*Assignments:*

1. Final paper containing background, concept map, map narrative, and recommendations

## **Resources**

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Story Map (can be incorporated into courses/programs that use GIS)

<https://www.arcgis.com/apps/MapJournal/index.html?appid=bc3f239de22e464daf5c8916de9394dd>

Blog Post / Articles

<https://news.mongabay.com/2019/06/study-reveals-a-fragile-web-of-knowledge-linking-plants-to-people/>

<https://www.caminoverde.org/blog/aguaje>

[https://www.vice.com/en\\_us/article/d753aj/can-fruit-from-the-amazon-save-the-world](https://www.vice.com/en_us/article/d753aj/can-fruit-from-the-amazon-save-the-world)

<https://phys.org/news/2019-05-cultural-significance-carbon-storing-peatlands-rural.html>

<https://www.ecosystemmarketplace.com/articles/ecoola-blending-business-sense-and-environmental-sensibility-in-the-peruvian-amazon/>

Team Work

<https://info.catme.org/>