Proposal for a

Thesis in the Field of

Sustainability and Environmental Management

In Partial Fulfillment of the Requirements

For a Master of Liberal Arts (ALM) degree in extension studies

Harvard University

Extension School

February 15, 2016

Adam Keough

77 Ave. Norte Colonia Escalón

San Salvador, El Salvador

+503 2264 3405

+503 7910 3741

akeough1984@gmail.com

Proposed Start Date: August 2016

Anticipated Date of Graduation: May 2016

Thesis Director: TBD

Effects of Social-Ecological Systems Variables on Stakeholder´s Willingness-to-Pay for Ecosystems Services in Central American Watersheds

Summary

The proposed research seeks to better understand the different social and ecological variables that influence stakeholder´s willingness-to-pay (WTP) for ecosystem services for freshwater production in Central America. This research has two primary hypotheses: (1) despite living in financially poor areas, an individual´s WTP for both provisioning and regulating ecosystem services for freshwater production will be greater than the current pricing structures; and (2) the stated WTP will be highly dependent on the social variables that indicate the presence of strong local governance in a watershed. Failing infrastructure and environmental degradation are threatening access to water resources for millions of individuals in Central America. A major impediment to the sustainable access and distribution of water resources is that few communities pay enough in user fees to adequately maintain and protect water resources. Many experts believe that even in poor areas of Central America financial resources exist to pay for water services; however, local policies and tariffing structures do not reflect the true cost of sustainable water services.

All ecosystem services are part of highly complex networks of human and environmental interaction that dictate their usage and protection. The proposed research will improve resource managers´ understanding of the significant social and ecological variables that influence local resource users´ engagement in the conservation of both provisioning and regulating ecosystem services for freshwater production in their watersheds.

To demonstrate these relationships, survey data will be collected and analyzed from ten watersheds in Central America using the contingent valuation method (CVM) for valuation of ecosystem services. The WTP throughout the ten watersheds will be compared to a number of social and ecological variables that are present or absent in each watershed. The social and environmental data have already been collected by the Catholic Relief Services (CRS), an international non-profit organization; however they have not been organized in a manner that allows for comparative analysis across watersheds.

Correlations between resource users´ WTP and the social-ecological variables will be evaluated using a multiple linear regression model. This research will result in an improved understanding of which variables affect stakeholder´s stated value of ecosystem services. By knowing the factors that contribute to an increase in WTP from local stakeholders, resource managers could develop policy and tariffing schemes that help to fund conservation efforts of water resources. Furthermore, the overall analysis of valuation data from resource users in various watersheds throughout Central America would demonstrate that, even in developing areas, stakeholders are generally willing and able to contribute to the sustainable distribution of their water resources.

Introduction

Research Significance and Objectives

Failing infrastructure and environmental degradation is threatening access to water resources for millions of individuals in Central America. A major impediment to access and distribution of water resources is that few communities pay enough in user fees to adequately maintain and protect water resources (CRS, 2013). Even in poor areas it is believed that the financial resources exist to pay for water services; however, local policies and tariffing structures do not reflect the true cost of sustainable water services (CRS, 2013).

Understanding the common variables that influence effective watershed management is highly important to resource managers and policy makers in developing nations. All water resources exist in complicated human and ecological systems; time, energy, and financial resource must be invested by all stakeholders to effectively conserve shared natural resources.

The proposed research will improve understanding of the significant social and ecological variables that influence local resource users´ financial contributions to effective watershed management. Furthermore this research will show that certain factors, especially in the realm of local governance, are largely responsible for stakeholder´s willingness-to-pay (WTP) for ecosystem services. This research will be beneficial to resource managers in Latin America to demonstrate that even in developing areas resource users are willing to contribute to the sustainable distribution of their shared resources.

The research objectives are:

- To measure individual's WTP for ecosystem services, both provisioning and regulating, that contribute to sustainable water resources.
- To identify common social variables among effectively managed watersheds.
- To provide insights on potential payment schemes for policy makers in Central America.
- To identify the social and ecological variables that correlate with stakeholder's WTP for ecosystem services.

Background

Ecosystems services are defined as the benefits to human populations derived from a natural resource (MEA, 2003). Critical ecosystem services on which humans depend are generally divided into 4 categories: provisioning (i.e. food production), regulating (i.e. water filtration), supporting (i.e. carbon sequestration), and cultural (i.e. sacred lands) (Kumar & Wood, 2010). In terms of freshwater, the provisioning service is the actual water we drink and the regulating services are the natural conditions of a watershed that produce and filter water for consumption; both are of great importance to human population around the world.

Ecosystem Services at Risk

Increased demands from growing populations coupled with rising contamination are endangering many of our world's ecosystem services. This affects human's ability to

access clean drinking water for domestic use, agricultural production, and sanitary conditions. Exacerbating this problem, the natural elements that provide regulating ecosystem services are being degraded at an alarming rate by anthropogenic causes. In developing nations water scarcity is often intensified by a lack of financial resources, technical training, and political efficacy that prevent millions of citizens from accessing reliable water services.

While water scarcity is a growing problem on a global scale, all water problems are local or regional in nature (Fishman, 2011). This in turn means that the solutions to water management must be local as well. There is not one global water crisis but thousands of local water crises, each with its own distinct problems, actors, and potential solutions (Fishman, 2011). To solve these local crises, time, energy, and financial resources must be invested by all stakeholders at the watershed and sub-watershed level.

Current Water Resource Management Approaches

Traditionally, issues such as potable water, irrigation, and wastewater have been addressed as separate and distinct needs that compete for importance. With ever-diminishing supplies and increasing demands this traditional approach is no longer viable to ensure the sustainable future of water resources. To break with this traditional attitude, resource managers are turning to an Integrated Water Resource Management (IWRM) approach that seeks to promote the efficient, equitable, and sustainable allocation of this valuable resource (Lenton & Muller, 2009).

IWRM as a conceptual framework outlines a holistic approach to watershed management that focuses not only on the direct water source being shared by users but

also the social, economic, and environmental factors that contribute to the sustainable use of a given water resource (Lenton & Muller, 2009). However, IWRM focuses on the outcomes of improved water management. Identification of the specific socio-political characteristics needed to accomplish successful IWRM is essential for resource managers to pinpoint areas of intervention. A promising method for addressing the multiple characteristics of water resource management is to adapt the Social-Ecological Systems (SES) Framework to water resource management.

The Social-Ecological Systems (SES) framework was created by noble prize winner, Elinor Ostrom, to provide an interdisciplinary approach to identifying specific variables that promote self-organization of users to maintain shared resources. The SES framework recognizes the relationships between four core systems: resource systems, resource units, governance systems, and users (Ostrom, 2009). Within each system are sub-variables that identify key characteristics which translate into positive governance of a shared resource pool. The purpose of assessing the multiple levels of interaction is to identify the relevant variables that promote positive resource management and those that are in need of improvement (Ostrom, 2009).

In both the IWRM framework and the SES framework there is an emphasis placed on investments in ecosystems services from all stakeholders. While water resources play such an important role in our everyday lives most users, whether domestic or industrial, pay very little for their water. Investments into water services in developing nations are especially underfunded (Figueres, Rockström, & Tortajada, 2012). The lack of investments from all stakeholders; governments, users, and organizations are leading to failing infrastructure and degradation of the environmental conditions that produce,

protect, and filter water resources. In Central America it is estimated that 70% of rural water infrastructure begins to fail within the first five years of construction (CRS, 2013). Investments are not only needed to improve infrastructure but also to restore those ecosystem services that ensure sustainable production of water resources (OECD, 2011). To address this important gap in resource management, the concept of payments for ecosystem services (PES) has emerged as a potential solution to protect diminishing resources.

Payment for Ecosystem Services

The concept of PES has become very popular among conservationist in recent years. PES is defined as a voluntary transaction where a well-defined environmental services, or a land-use likely to secure that service, is being bought by a buyer from a provider if and only if the environmental service provider secures provision (Wunder, 2005). In many instances this is implemented by the creation of a fund to pay private land owners not to develop lands that are considered to have valuable attributes for ensuring ecosystem services; most often done to ensure forest are left in their natural states.

In Central America the most well recognized PES arrangement has been developed in Costa Rica. The program created by the central government of Costa Rica established a fund using a fossil fuels tax along with the support of outside non-governmental organizations and voluntary contributions from the private sector. All participating land owners are paid an amount per hectare of forest that conducts a certified sustainable management plan. The goal of the program is to protect four environmental services: (1) carbon sequestration; (2) promote improved hydrological

services; (3) improve biodiversity; and (4) enhance scenic beauty for recreation and ecotourism (Malavasi & Kellenberg, 2002).

Even though the program in Costa Rica serves as a model for the potential of PES to restore natural forest in a degraded landscape, critics have stated two principle flaws in the approach. (1) The top-down nature of the program has limited the participation of many small-holder farmers and indigenous communities (Rosa, Barry, Kandel, & Dimas, 2004). (2) The emphasis placed on protecting natural forest does not take into consideration well managed agroforestry systems that have been proven to provide many of the same ecosystem services as natural forest systems while also creating much needed incomes for poor communities (Rosa et al., 2004).

In the case of Costa Rica, the price paid for ecosystem services to landowners is to compensate for foregone opportunity costs--the loss of potential profits through agriculture or logging. This does not reflect the total value of the ecosystem services. A more appropriate model would take into consideration not only the market values of the provisioning services but also the non-market values of the regulating services from a local perspective (Rosa et al., 2004)

Valuation of Ecosystem Services

In the context of Central America, most water services are interconnected with upstream agricultural areas. PES programs directly benefit farmers in these areas with financial incentive. However, based on the original definition of PES, it is necessary that the payments to land owners be continuous if the ecosystem service in question is to remain untouched by private land owners. To secure these continuous payments local

financing mechanisms are believed to be more effective than government or institutional ones (Van Hecken, Bastiaensen, & Vásquez, 2012). In this case it´s imperative that downstream communities be willing to make the necessary financial contributions to ensure the sustainability of this PES model.

To better understand downstream communities' willingness-to-pay (WTP) for PES programs, researchers have implemented contingent valuation methodology (CVM) for assessing the amount that resource users are willing to contribute to a proposed solution (Van Hecken et al., 2012). CVM is a survey based research method often used to determine individual´s WTP for a proposed change in the environmental quality (Raheem, 2015).

A CVM study in Matiguás, Nicaragua in 2009 found that downstream water users stated an increased WTP for improved water services; however, they were not willing to pay into a PES program that would benefit local farmers (Van Hecken et al., 2012). The researchers reasoned that this was due to an underlying mistrust among the farmers and downstream community members based on the past performance of farmers and their use of environmentally destructive agricultural practices. This research indicates a need for improved understanding of social-institutional context of an area in order to implement a PES program that effectively addresses the connections between all actors and their environment (Van Hecken et al., 2012).

Environmental economists believe that if resource managers and resource users have an understanding of the economic value of the local ecosystem services, improvements could be made in local policies and management decisions (Raheem et al., 2012). One distinct benefit of placing a monetary value on these services is to provide a

standard unit of measurement that stakeholders from all sectors are able to understand and assess (Raheem, 2015). However, approaching these payment models as collective funds for conservation efforts from the bottom up as opposed to top down, direct payments to land owners will hugely increase the potential success of conservation efforts in a given area (Rosa et al., 2004). This could be accomplished by adapting Ostrom´s social-ecological systems framework to evaluate the potential success of a proposed PES program (Bennett, 2015).

CRS Rating of Local Water Governance & Watershed Variables in Central America

Elinor Ostrom´s work on the SES framework has prompted many governmental and non-governmental institutions to improve their understanding of the social and ecological conditions of a resource pool to improve local development efforts. In Central America the Catholic Relief Service (CRS), an international non-profit organization, is incorporating the SES framework into its project indicators in an attempt to gauge the specific variables and sub-variables that relate to effective watershed management. To do this, the organization created an auto-evaluation tool that allows stakeholders in different watersheds to analyze, evaluate, and discuss the multiple factors that contribute to the sustainable use and conservation of shared water resources.

In ten different watersheds throughout Central America, CRS is collecting data on the ecological conditions of the principle water resources that are used by local stakeholders for domestic and agricultural purposes. Additionally, CRS is implementing what it calls the Governance Rating Tool to measure the performance of collective and inclusive political, social, economic and administrative systems that regulate the

protection, conservation, and management of water resources. The tool is made up of two main categories: governance systems and social capital /interactions.

These two categories seek to include issues related to the structures and rules necessary for governance as well as the relationships and interactions between stakeholders that enhance sustainable governance. There are six variables used to measure governance systems and four variables used to measure social capital/interactions; all variables are further broken down into a series of 24 questions that provide valuable insight into the social interactions of resource users and governance structures throughout the watershed. These variables are taken directly from Elinor Ostrom´s SES framework.

The application of this tool in Central America has only been applied over the past year (2015). However, its implementation in watersheds in Honduras, El Salvador, and Nicaragua provides a significant amount of data on the local stakeholders´ perceptions of their social-environmental conditions.

Research Questions, Hypotheses and Specific Aims

Research Question

As resource managers begin to focus on the different variables of the social-ecological systems (SES) framework to identify areas of interventions there is an opportunity to improve understanding on the factors that affect stakeholder´s willingness-to-pay (WTP) for ecosystem services. The proposed research intends to demonstrate that by using the data collected by the CRS Governance Tool as a proxy of SES variables a deeper analysis of stakeholder´s WTP can be conducted. The primary research question

that will be addressed in this study is: What are the significant social and ecological variables that distinguish areas that demonstrate high levels of WTP from areas that demonstrate low levels of WTP?

Hypotheses

The two principle hypotheses I expect to evaluate in this research are:

1. Despite living in financially poor areas, individual´s willingness-to-pay for freshwater production will be greater than current pricing structures.
2. A higher percentage of resource users will state a willingness-to-pay for both provisioning and regulating ecosystem services that ensure freshwater production when social variables suggest the presence of strong governance institutions.

Specific Aims

To test my hypotheses, five specific aims will be addressed. I intend to:

1. Define a sample population from each of the ten watersheds participating in the CRS Governance Tool workshops. This sample will reflect a cross section of the various stakeholders in regards to socioeconomic status, age, and gender. The sample population will also include participants of the governance workshop as well as those that did not participate.
2. Collect and organize existing SES data on each of the ten watersheds participating in CRS programing in a consolidated spreadsheet.

3. Create and conduct a survey that will collect information from sample population in each watershed in regards to stakeholder´s willingness-to-pay based on the Contingency Valuation Method.
4. Analyze survey data along with proxy SES variables collected using the CRS tool. Survey data will be digitized in Microsoft Excel for easy management. Correlation of the data points will be determined using "R". Translating data from Spanish to English will be completed as well.
5. Validate results in a watershed that has not participated in CRS programing. Using the Tunco River watershed in El Salvador the same survey will be presented after which the tool will be conducted with a focus group from the watershed to independently validate any inferences made through the analysis of original ten watersheds.

Methods

Research Plan

In order to examine stakeholder´s willingness-to-pay (WTP) in relation to the social and environmental variables within a given watershed two primary sources of data will be used. (1) Data that has been collected through the Catholic Relief Service's Blue Harvest Project on water resources and governance in watersheds. This project has collected data on ten social variables and four environmental variables over the course of two years in ten different watersheds in Nicaragua, Honduras, and El Salvador. (2) Original data on WTP will be collected using the contingent valuation method (CVM) in the same ten watersheds where the Blue Harvest Project is active.

The original data will be collected using a survey of sample populations in each watershed. The final analysis will compare the original data against the multiple social and environmental variables collected through the Blue Harvest Project in an attempt to better understand the conditions that promote higher WTP by resource users.

Methods

To address the specific aims of the proposed research the following actions will be carried out:

Define a sample population. In each of the ten watersheds that are active in the CRS Blue Harvest Project a sample population will be defined in order to collect survey data on willingness-to-pay for ecosystem services. The sample will reflect a diverse cross-section of each watershed with equal representation from men, women, and young people between the ages of 18-24. The sample will also reflect different water users; i.e. farmers, domestic users, and business owners. Finally the survey will be conducted among persons participating in the Blue Harvest project and those who are not participating. The reason for this is that those who are participating in the project are responsible for the data gathered as the social variables. It is important to ascertain if the responses to the social variables are representative of the overall watershed. For each watershed 50 individuals will be surveyed for a total of 500 surveys.

Collect and organize existing SES data on each of the ten watersheds. Currently the Catholic Relief Service is monitoring a variety of social and environmental variable for the Blue Harvest Project in order to assess the projects influence in watershed management in intervention areas in Nicaragua, Honduras, and El Salvador. All watersheds are similar in size and demographic factors. The social variables being

monitored are based on key indicators that are known to relate to a community's ability to self-govern shared resource pools; as defined by Elinor Ostrom´s Social-Ecological Systems Framework.

The variables are monitored through the use of a spreadsheet assessment tool that is conducted with a focus group of each community. The focus group works directly with a facilitator for the Blue Harvest Project to conduct an auto-evaluation of the social variables found in their communities.

The environmental variables that will be organized along with the social variables are the key indicators of water resource health based on the Integrated Water Resource Management (IWRM) approach. All environmental variables are collected by field technicians from the Blue Harvest Project who have been trained in the appropriate methodologies for field data collection of each indicator. Table 1 defines each variable that are being monitored by the project:

Table 1. List of Variables.

Social Variables	1. Governing organization/authority participation (municipal and national governments/water governance groups or committees) in relation to water governance topics
	2. Civil Society participation in water resource management and governance (local water committees, NGOs, local community groups)
	3. Constitutional rules present (policies, laws, ordinances that are actively being implemented in regards to conservation and protection of water resources)
	4. Network structure present such as a platform in which principal stakeholders debate and agree upon planned interventions.
	5. Operational rules present- rules are set on how the network functions including transparency, accountability, and adaptability to change.
	6. Collective-choice rules - users have full autonomy at the collective-choice level to craft and enforce their own rules.
	7. Leadership- Users actively participate and are respected as local leaders.
	8. Norms for relationships- users share moral and ethical standards regarding how to behave in groups they form.
	9. Investment activities- Stakeholders at different levels contribute resources (human, in-kind or financial) to protection, conservation, and management of water resources.
	10. Lobbying Activities- Stakeholders participate and are engaged in improving policies/ordinances
Environmental Variables	11. Base flow of principle water resources. This is measured as liters per second and are monitored at the catchment of water systems that provide for the downstream populations.
	12. Water quality. This is measured based on biophysical and biochemical laboratory results of water sample taking from the catchment for water systems for downstream communities.
	13. Ground cover in the recharge area of the primary water resources. This is measured by monitoring sample plots for ground and aerial cover using point hit transects and densiometer readings.
	14. Land use in the recharge area of the primary water resource. This is measured as the observed land usages in the recharge area; i.e. agricultural practices, residential units, and commercial.

Table 1. Variable indicating levels of social and environmental systems as monitored be the Catholic Relief Service.

Create and conduct survey. The survey that will be conducted among the 500 participants across ten watersheds will gather data on individual´s willingness-to-pay for ecosystem services of freshwater production. The survey will be created using the Contingency Valuation Method (CVM). CVM is the most commonly used model to collect data on the non-market valuation of ecosystem services (Ninan, 2014). The survey will gather data on willingness-to-pay for both provisional ecosystem services of freshwater as well as regulating ecosystem services for freshwater production.

The CVM survey will be comprised of multiple hypothetical situations that propose scenarios that would require an increase in payments for water services to maintain or improve their current water resources. The CVM survey conducted in Nicaragua (Van Hecken et al., 2012) will be used as a guide for the proposed research. *Analyze survey data along with proxy social and environmental variables.* Using the spreadsheet of social and environmental variables, a multiple regression analysis will be conducted using the statistical software "R". The analysis will compare willingness-to-pay against combinations of social and environmental variables to detect which factors are significant in predicting the amount people are willing to pay.

Furthermore, the data provided by the Catholic Relief Service will be used to objectively rank each watershed as having a high or low level of water resource management. The varying levels of resource management will be compared to the willingness-to-pay among users to provide correlations with management and WTP. *Validation of results.* For further verification of the results, another survey will be conducted in a watershed were the CRS Blue Harvest program is not active. Before

conducting the survey, predictions will be made regarding the social and environmental conditions of the watershed based on the results for the previous analysis.

After conducting the CVM survey an evaluation of the watershed will be conducted using the same model as the CRS Blue Harvest project to assess the social and environmental variables in the area. If reasonable predictions of the current social conditions of the watershed can be made using the data collected on willingness-to-pay this could help to establish a link for policy makers on the needed conditions for instituting improved tariffing structures within a watershed.

Research Limitations and Expected Results

Potential limitations of this research are that participants may overestimate their willingness-to-pay due to the hypothetical nature of the survey questions (Blomquist, Blumenschein, & Johannesson, 2009). Furthermore, working with a total of 11 watersheds across three countries may prove to be very time consuming in regards to travel and coordination with local groups of research participants.

I expect the results regarding resource users´ willingness-to-pay for ecosystem services will be beneficial to policy makers and resource managers in designing tariffing models for water services and resource conservation.

Glossary

- Catholic Relief Services (CRS) – A non-profit aid agency working in developing nations around the world.

- Contingency Valuation Method (CVM) - a survey based method that determines individual´s values for a proposed change in the environmental quality (Raheem, 2015).

- Ecosystem Services - defined as the benefits to human populations derived from a natural resource (MEA, 2003).

- Integrated Water Resource Management (IWRM) – management approach that seeks to promote the efficient, equitable, and sustainable allocation of this valuable water resources (Lenton & Muller, 2009).

- Payment for Environmental Services (PES) - a voluntary transaction where a well-defined ecosystem service (or a land-use likely to secure that service) is being 'bought' by buyer from a provider if and only if the provider secures ecosystem service provision (Wunder, 2013).
- Social and Environmental Systems (SES) Framework - an interdisciplinary approach to identifying specific variables that promote self-organization of users to maintain shared resources (Ostrom, 2009).

References

Bennett, D. (2015). Integrating multiple perspectives on payments for ecosystem services through a social–ecological systems framework. *Ecological Economics*, *Volume 116*, Pages 172–181.

Blomquist, G., Blumenschein, K., & Johannesson, M. (2009). Eliciting Willingness to Pay without Bias using Follow-up Certainty Statements: Comparisons between Probably/Definitely and a 10-point Certainty Scale. *Environmental Resource Economics*, (43), 473–502.

CRS. (2013, March). Water Services that Last in Central America: Recommendations for financial viability , equitable distribution, and water source protection. Catholic Relief Services. Retrieved from http://www.blue-harvest.info/assets/pdfjs/web/viewer.html?file=/system/balloom/asset/documents/attachments/000/000/084/original/crs-achieving-water-services-that-last-in-central-america-march-2013.pdf?1398710357

Figueres, C., Rockström, J., & Tortajada, C. (2012). *Rethinking Water Management: Innovative Approaches to Contemporary Issues*. Earth Scan. Retrieved from https://books.google.com/books?id=-nu6fmzA0DgC&dq=editions:ISBN1849772401

Fishman, C. (2011). *The Big Thirst: The Secret Life and Turbulent Future of Water*. Free Press. Retrieved from http://www.thebigthirst.com/

Kumar, P., & Wood, M. (2010). *Valuation of Regulating Services of Ecosystems: Methodology and Application*. Routledge Explorations in Environmental Economics.

Lenton, R., & Muller, M. (2009). *Integrated Water Resource Management In Practice: Better Water Management for Development*. Global Water Partnership. Retrieved from https://books.google.com/books?hl=en&lr=&id=VmOsBwAAQBAJ&oi=fnd&pg=PR3&dq=Integrated+Water+Resource+Management+In+Practice:+Better+Water+Management+for+Development&ots=-SHdiwycsB&sig=t3ta2s9Oh0XfH5-Uhx5eZCaRnW0#v=onepage&q=Integrated%20Water%20Resource%20Management%20In%20Practice%3A%20Better%20Water%20Management%20for%20Development&f=false

Malavasi, E., & Kellenberg, J. (2002). Program of Payments for Ecological Services in Costa Rica. Fondo Nacional de Financiamiento Forestal. Retrieved from http://www2.gsu.edu/~wwwcec/special/lr_ortiz_kellenberg_ext.pdf

MEA. (2003). Ecosystems and Human Well-Being: Synthesis. Millennium Ecosystem Assessment. Retrieved from http://www.millenniumassessment.org/documents/document.356.aspx.pdf

Ninan, K. (2014). *Valuing Ecosystem Services: Methodolical Issues and Case Studies*. Edward Elgar Publishing Limited.

OECD. (2011). Meeting the Challenge of Financing Water and Sanitation. OECD Studies on Water, OECD Publishing. Retrieved from http://www.oecd-ilibrary.org/environment/meeting-the-challenge-of-financing-water-and-sanitation_9789264120525-en

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social Ecological Systems. *Science*, *325*, 419–422.

Raheem, N. (2015, October). *Ecosystem Services and Valuation*. Harvard Extension School. Retrieved from file:///C:/Users/Adam.Keough/Downloads/Lecture%20Week%208_Ecosystem%20Services%20and%20Valuation_Raheem_10.21.15%20%283%29.pdf

Raheem, N., Colt, S., Fleishman, E., Talberth, J., Swedeen, P., Boyle, K. J., … Boumans, R. M. (2012, January 11). Application of non-market valuation to California's coastal policy decisions. Marine Policy. Retrieved from file:///C:/Users/Adam.Keough/Downloads/Raheem_Application%20of%20non-market%20valuation%20to%20CA%20coastal%20policy%20decisions_2012.pdf

Rosa, H., Barry, D., Kandel, S., & Dimas, L. (2004). Compensation for Environmental Services and Rural Communities: Lessons from the Americas. Political Economy Research Institute. Retrieved from http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1078&context=peri_workingpapers

Van Hecken, G., Bastiaensen, J., & Vásquez, W. (2012). The viability of local payments for watershed services: Empirical evidence from Matiguás, Nicaragua. *Ecological Economics*, *74*, 169–176.

Wunder, S. (2005). Payments for environmental services: Some nuts and bolts. Center for International Forestry Research. Retrieved from http://www.cifor.org/publications/pdf_files/OccPapers/OP-42.pdf

Wunder, S. (2013, April 29). When payments for environmental services will work for conservation. Conservation Letters. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/conl.12034/epdf

Timeline

- *March-May 2016 Identifying Thesis Director*
- *June 2016 Receive approval of survey from IRB*
- *July 2016 Starting Thesis Research*
- *July 2016 Registering for the Thesis Course (requires approved thesis director, this officially starts your thesis clock, also when you pay) – when you want to do this you will*
- *August-October 2016 Conduct Contingency Valuation Survey throughout research area*
- *November 2016 Data Analysis of CV survey and social and environmental variables*
- *January 2017 Validation process with Tunco River Watershed*
- *June 1 2017 Final draft date*
- *July 15 Submission online of Final PDF*