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Households' Preferences and Willingness to Pay for Hydrological Services in Veracruz, Mexico

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HOUSEHOLDS' PREFERENCES AND WILLINGNESS TO PAY FOR HYDROLOGICAL SERVICES IN VERACRUZ, MEXICO

BY

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THESIS

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Abstract

Households' Preferences and Willingness to Pay for Hydrological Services in Veracruz, Mexico

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University of New Hampshire, May 2019

Payments for Ecosystem Services (PES) are transfer payments from governing bodies, households, firms, or non-governmental organizations to incentivize natural resource owners and managers to carry out environmental conservation efforts that promote the provision of ecosystem services. PES programs targeting reduction of deforestation have gained popularity due to the extensive ecosystem services of forests including carbon storage, wildlife habitat, biodiversity, and the provision of hydrological services (HS), the ecosystem services that provide benefits such as water quality improvement, water damage mitigation, and non-use value.

There is evidence in the literature that PES programs, while theoretically beneficial, face issues with long-term financial sustainability (Nava-Lopez et al., 2018). An increase in financing can be achieved through the introduction of a fee in the water bill of water users. However, these fees are often chosen arbitrarily[1] without any rigorous assessment of households' willingness-to-pay (WTP) for HS provided upstream (i.e., by forest landowners upstream from the cities) and little is known about the preferences of these households. This paper aims to estimate the value consumers have for HS through the use of a choice experiment (CE). The use of a CE allows us to elicit the preferences of the consumers of HS with respect to both the cost and the attributes of the PES program. We choose the state of Veracruz to conduct the CE because it is one of the

[1]For instance, the city of Coatepec charges 2 pesos (~10 cents) per month.

most intensely deforested states that also struggles with both water quality and water damage issues. (Nava-Lopez et al., 2018).

We developed and administered an in-person, tablet-based CE in October 2018 which used five attributes to describe the hypothetical Payments for Hydrological Services (PHS) program: *Water Quality, Water Regulation Services, Eligible Land, Program Administration,* and *Fee*. We obtained a sample of 777 observations, split between representative samples of Xalapa and Coatepec, the two cities of the state that have experience with hydrological PES programs. *Water Quality* and *Water Regulation Services* are the two attributes thought to be the main benefits that consumers would be interested in. *Eligible Land* has a policy implication because local governments are interested in increasing the eligibility to include shade-grown coffee. *Program Administration* will allow us to estimate whether consumer's support for such PES program depends on the type of institution managing it. *Fee* is a variable with options 5, 20, 40, and 80 MXN per month, the amount added to household's water bill to pay for the program.

In this thesis, we construct conditional logit and mixed logit models to analyze discrete choice data. The results show that for the four non-monetary attributes, the utility function parameters of the coefficients are positive, showing respondents propensity for an improved program. The sign of the Fee coefficient is negative, showing consumers demand for lower prices. Further, the coefficients of *Water Quality* and *Water Regulation Service* are higher than those for *Eligible Land* and *Program Administration*, showing that respondents care more about improved results than the organizational structure of program delivery. A key difference between Coatepec and Xalapa is the *Eligible Land* variable. It is significant for Coatepec while insignificantly different from zero in Xalapa. With Coatepec being more of an agricultural small-town and Xalapa being a larger city, it intuitively makes sense that Xalapa would not care about

the land enrolled in the program, and Coatepec would. Both cities do care about the *Program Administration* variable, with Coatepec having a coefficient twice the magnitude of the coefficient Xalapa.

Our research has shown that the downstream water users in an area serve as a viable option for substantially extending the financial base of a PHS program. Evaluating the total economic value of ecosystem services and revising the level payments to landowners are two of the key policy improvements that are recommended in the future in order to make PES programs in Mexico more effective and efficient (Lara-Pulido, 2018). Our results also highlight the need to take local perceptions as well as income inequality into consideration in the design and promotion of PHS programs.

Chapter I. Introduction

Motivation and Objectives

Land use change and deforestation are increasing due to urbanization and agricultural intensification. These changes have a negative impact on the ability of land to provide clean and reliable water supplies to downstream communities (Martínez et al., 2009). This negative impact is the result of a market failure, an inefficient provision of the services that the forest land provides. The market failure occurring is a negative externality, a cost incurred by the downstream communities that do not choose to experience it and is caused by the landowners not internalizing the full costs of their decisions. To combat this market failure, Payments for Hydrological Services (PHS) programs have been established to pay landowners to not deforest their land. However, these programs have issues with financial sustainability.

The purpose of this paper is to characterize household preferences for a PHS program as well and derive welfare measures for the program attributes, and for the program as a whole. We collected the survey data using an in-person, tablet-based choice experiment (CE) and asked participants to make choices among PHS programs that vary based on their impacts on water quality and regulation as well as program administration changes. Through the analysis of the choice's individuals make, we examine the tradeoffs between the outcomes of the program (i.e., improved water quality and water quantity regulation) and the administrative structure of the program (i.e., who administers the program and whether SGC lands are eligible) and price. We estimate a conditional logit model to estimate the probability of a program being chosen based

on the associated program attributes; and also account for individual heterogeneity through a mixed logit model.

Hydrological Services

The world's ecosystems provide numerous services that are vital to the health and well-being of humans (Costanza et al., 1997; de Groot et al., 2012; MEA, 2005). Hydrological services (HS) are terrestrial ecosystem services that affect freshwater resources, which have a direct impact on water quality and availability to humans. These can be put into five categories: (1) improvement of extractive water supply, (2) improvement of in-stream water supply, (3) water damage mitigation, (4) provision of water-related cultural services, and (5) maintenance of aquatic habitat. These services have an effect on the landscape in the quantity, quality, location, and timing of flow of water (Brauman et al., 2007). A recent review of hydrological service literature found that a significant portion of peer-reviewed journal articles link the effects of hydrological processes on the landscape, but do not effectively make the link between hydrological services and the people that are affected by them (i.e. downstream water users). However, making this link is critical to pursuing rigorous watershed management practices (Brauman, 2015).

Ecosystem Service Conservation

Hydrological services are affected by land use change. Increasing deforestation rates due to urbanization and agricultural intensification has negative effects on the ability of the land to capture and filter the water running through a landscape (Martínez et al., 2009). The undersupply of forest-generated hydrological services is due to a failure in the market for these services. This is a consequence of the fact that there is a discrepancy between the private value of forests from

the viewpoint of private landowners, and public good value of the forests. More specifically, private landowners do not internalize the full costs of deforestation and thus will underprovide hydrological services to the market. A wide-range of policies have been implemented. Most commonly governments develop protected areas or forest management units as a central planner approach to the issues. Also, reforestation projects, education initiatives, and other community integrated conservation projects have been attempted. However, governments typically fail to provide the optimal level of hydrological services and funding issues limit their ability to conserve adequate land. Political pressures decrease the effectiveness of these measures as well because important industries such as agriculture and timber profit from the deforestation and land use change that occurs. All of these measures have two issues: they are costly to the implementing agency and they do not address the underlying issue of market failure (Bishop, Pagiola, and Landel-Mills, 2002).

Market-based mechanisms, in an environmental conservation context, are measures taken to establish a market for the goods and services provided by the natural environment by providing incentives for conservation in an effective manner. Examples of market-based mechanisms include pollution charges which tax the environmental bad at the source, tradable permits which forces polluters to pay for their pollution, and payments for ecosystem services Zhang, 2013). These mechanisms attempt to correct market failures by either (1) increasing the benefits of conservation to forest landowners or (2) produce resources that can subsequently be used for conservation efforts. Market-based mechanisms have their own set of issues that may provide sub-optimal outcomes but offer increased effectiveness over command-and-control measures at a fraction of a cost (Bishop, Pagiola, and Landel-Mills, 2002).

Payments for Ecosystem Services (PES) are a market-based mechanism in which the suppliers of the services that ecosystems provide are paid by the consumers of these services. PES programs targeting reduction of deforestation have gained popularity due to the extensive ecosystem services of forests including carbon storage, wildlife habitat, biodiversity, and the provision of HS. These mechanisms are transfer payments from governing bodies, households, firms, or non-governmental organizations to incentivize natural resource owners and managers. The goal of PES is to carry out environmental conservation efforts that promote the provision of ecosystem services. These payments can address failures occur in the market for environmental goods that are typically undervalued and therefore undersupplied (Engel, Pagiola, and Wunder, 2008).

PES programs are a market-based mechanism that theoretically meets the following criteria: (1) a voluntary transaction where (2) a well-defined ecosystem service (3) is being bought by an ecosystem service consumer (4) from an ecosystem service supplier (5) if and only if the supplier secures ecosystem service provision (Wunder, 2005).

The first criterion, voluntary participation, is necessary to ensure that ES providers have land-use choices. Second, the ES being bought needs to be well-defined. This is especially important in the provision of HS because the results of the program (e.g. cleaner water, increased water availability) may not be readily measured. For example, this could result in a Payments for Hydrological Services (PHS) program being defined as paying for the conservation of land that is likely to improve the provision of HS, a measurable and enforceable transaction. Any PES should have resources going from ES buyers to ES suppliers, by definition. Finally, a PES scheme should be contingent on the service being provided continuously, meaning buyers should be able to pull out if they are not receiving the services they are paying for (Wunder, 2005).

Deforestation and PHS programs provide a clear context to study how PES programs may be an effective form of conservation because hydrological benefits are provided by upstream landowners, but the benefits go to the downstream water users (Bishop, Pagiola, and Landel-Mills, 2002). This creates a naturally occurring market-place for these services, while also presenting the challenge that decisions are made in an area geographically disconnected from where they have the largest effects.

While theoretically beneficial, PES programs face a number of issues that must be solved to create long-term social and environmental gains. In the last 30 years, hundreds of PES programs have been implemented worldwide. Costa Rica was the first in the world to establish a nationwide PES program and continues to be the frontrunner in PES schemes of the developing world. The Costa Rican government developed a national program in 1997 that offered monetary payments to landowners to avoid deforestation on their land, paid for through a fossil-fuel tax. Costa Rica was successful in combating the deforestation trend of the 1990's, however, it is unclear whether the program had a causal impact on deforestation as it was enacted at the same time as other environmental and economic programs with similar goals. While the additionality[2] of the program is unclear, there is evidence that program enrollees have higher forest land cover rates and the program seems to have induced reforestation efforts by landowners (Pagiola, 2008). However, not every program achieves the same success. For example, a study of 40 PES watershed services programs in Latin America yielded that only 57.5% (23/40) were considered successful. Grima et al. (2017) defined program success as either meeting and/or exceeding its stated goals, or as adding value in terms of ecological, economic, or social wellbeing. They also assert that the following four criteria may increase the likelihood of a program being successful:

[2] Additionality is defined as "the measure of outcomes in relation to what would have occurred in the absence of intervention." (Sommerville, Jones,& Milner-Gulland, 2009)

(1) provide a crucial resource while simultaneously contributing to local livelihoods, (2) operate on a local or regional scale, (3) use in-kind contributions in addition to cash payments, and (4) involve private actors and reduce middle-men between buyers and sellers of the ES (Grima et al., 2017). PES can be implemented to conserve a number of ES. In this thesis, we focus on the conservation of land to provide hydrological services in the context of Veracruz, Mexico.

Ecosystem Service Valuation

As contributors to the welfare of humans, ecosystems represent a significant economic value (Costanza et al., 1997). In recent years, there has been significant resources devoted to the quantification of the value ES around the world. Costanza et al. (1997) find that the world's ES are valued at an average of $33 trillion/year, $4.7 trillion of which is forests which have an average value of $696/ha/year and are the primary providers of the total global climate regulation ecosystem services and a significant provider of the global water regulation ecosystem services.. Lara-Pudillo, Guevara-Sanginés, Martelo (2018) provide a more specific analysis by looking at the value of ecosystem services in Mexico and find that the value of the ES of forests in Mexico is $291/ha/year. Hydrological services of forests include water capture and filtration, flood control, timber, and recreational opportunities. Theoretically, a PHS program will help to maintain the provision of these ES and thus have significant economic value to the ES consumers.

Valuation of Hydrological Services in Central and South America

The majority of the economic research on the valuation of hydrological services uses the Contingent Valuation (CV) method. CV is a nonmarket, stated preference valuation method that

asks consumers their maximum willingness to pay (WTP) for a good or service. According to a meta-analysis of the ecosystem service valuation literature in Mexico, 43% of the studies were CV (Lara-Pudilo, Guevara-Sanginés, Martelo, 2018), while the rest were a mix of market price analyses, meta-analyses, travel-cost studies, and other methods were less represented including choice experiments which only represented 3% of studies. CV studies can help determine the feasibility of PES/PHS programs, estimate the welfare increase of hypothetical or existing programs, and provide an estimate of the price that consumers may be willing to pay for a program (Whittington and Pagiola, 2012). Numerous studies have estimated this WTP in Central and South America. Vasquez et al. (2009), in a study of Parral, Mexico, estimate that households are willing to pay between 1.8 and 7.55% of their household income, per month, to ensure safe and reliable drinking water. Another CV study uses a hypothetical new filtration system that would remove fluoride and arsenic from the groundwater in Guadalupe, Mexico, and find that consumer in the region would be willing to pay 56.55 Mexican pesos (MXN) (3.00 USD) for the removal of arsenic and 66.37 MXN (3.52 USD) for the removal of fluoride (Dávila, 2013). Other studies have found a WTP that ranges from MXN 32.63 (1.73 USD) /month to MXN 136.92 MXN (7.26 USD)/month depending on factors such as household income and survey type (Almendarez-Hernandez et al., 2013; Ojeda et al., 2008).

The literature is large enough that there have also been meta-analyses done on the contingent valuation method to value forest ecosystem services. Barrio and Louriero (2010) analyze the results of 35 CV studies that focus on consumers WTP for forest ecosystem services. They find that while consumers have positive WTP for these services, they are sensitive to the objectives of the proposed program. Other factors that affect WTP include socio-economic variables, question format, and type of forest. Another meta-analysis, Whittington and Pagiola

(2012) review 25 CV studies, most of which attempt to estimate the downstream water user demand for upstream watershed protection in Latin America. Their review asserts that while CV studies have potential to improve hypothetical and existing PES programs, many CV studies can be improved by attempting to reduce hypothetical bias and most lacked policy relevance.

Overview of Mexico's PHS Programs

A significant amount of deforestation occurred in Mexico between 1993 and 2000, where approximately 8.2 million ha of forests were converted to intensive land uses such as agricultural fields and pastures (Velásquez et al., 2002). In 2001, the environmental minister of Mexico gathered a team of politicians and academics to explore the possibility of starting a program to address Mexico's deforestation issues. They used Costa Rica as a model but decided that water user-fees would be a more salient option rather than a tax on fossil fuels. Water user-fees provide an easier link between the providers and the consumers of the HS. Specifically, landowners are providers of HS because the conservation of forested land helps to regulate and filter that water that reaches the downstream water users, the HS consumers (Carvalho-Santos, Honrado, & Hein, 2014). The program was finally established in 2003 with the Mexican Congress earmarking 2.5% of water fees to be used to fund the program, implemented by the National Forestry Commission (CONAFOR). After one year, in 2004, the budget was increased from $30 million to $100 million (Cameron, 2015).

Under the program, both private and communal farmers are eligible for payments of approximately $25-35 per-hectare-per-year (Cameron, 2015). Ejidos are a federally recognized property holding that are communally governed among several households. Ejidos made up more than half of the enrolled land in the initial cohort of the program while the rest was made

up of private landowners. Upon acceptance, landowners must not change the land cover of any enrolled parcels and are subject to satellite image analysis and ground visits for inspection purposes. If landowners are found to be in violation of the program agreements, payments stop (Muñoz-Piña et al., 2008; Engel, Pagiola, & Wunder, 2008).

In 2008, local programs known as "Matching" programs were established. These programs matched local funds with national funds in order to diversify the funding source of the program as well as begin the transition from national to local programs. Under this new mechanism, 50% of the funding would come from CONAFOR and the remaining 50% would need to come from local water fees, governments, or private entities. The transition to local programs was touted as an improvement by connecting the HS producers (landowners) with the HS consumers (water users) (Nava-López et al., 2018).

Veracruz, Mexico

The study area in this paper is comprised of the cities of Xalapa and Coatepec in Veracruz, a state in central Mexico along the Gulf of Mexico. As one of the most intensely deforested states that struggles with both water quality (Macauley, Harwell, & Alafita, 2007) and water damage issues (Ellis et al., 2012), Veracruz serves as a perfect area to study the preferences of residents for a program to help conserve the forests that provide their HS, including water quality and water regulation HS.. This, coupled with the fact that it was an initial area used to test both the National and local Matching programs, makes Veracruz an ideal model for making policy recommendations to improve current programs based on our results. Xalapa and Coatepec both fall in the Antigua River Watershed. Xalapa gets 40% of their water from the Pixquiac sub-watershed and the rest from the Huitzilapan. Coatepec gets their water entirely from the

Gavilanes sub-watershed. Known for their cloud forest cover, about 65% of their original forest cover has been converted to agricultural uses (Asbjornsen et al., 2017). The land change has hydrological consequences for both the quality and quantity of water that reaches the downstream water users of Xalapa and Coatepec.

In 2001, Coatepec historically established the first PES program in Mexico in response to a 1998 water shortage that was the worst in the city's history. A voluntary fee was paid by local residents in their water bill. This money was used to pay forest landowners in the watershed to not deforest their land, if they volunteered. Because it was the first of its kind, national lawmakers used the Coatepec program as a model for the national program. However, when the sitting mayor left Coatepec, mismanagement of funds and political issues led the program's premature ending (Cameron, 2015).

Xalapa established their first watershed protection program in 2005, paying $90 per hectare per year which is triple the national program amount. The municipal leaders sought to reduce deforestation and damaging farming practices in the Pixquiac watershed, the primary watershed that Xalapa's residents rely on for safe and reliable drinking water. This program was established by the non-governmental organization (NGO) Senderos y Encuentros para un Desarrollo Autónomo Sustentable (SENDAS) with the primary goal of developing a program that protects the resources of the watershed by bringing together the interests of both the downstream ES consumers (i.e. water users) and the upstream ES suppliers (i.e. farmers and landowners). They aimed to do this by providing benefits to the forest landowners in form of monetary payments and benefits to the citizens by improving the quantity regulation and quality of water provided (Cameron, 2015).

The water quality and damage issues that Veracruz has experienced has led to the establishment of PHS programs and environmental education campaign in the last 20 years. Thus, many residents have knowledge of PHS programs that attempt to deal with these issues. This makes Veracruz, and the difference between the preferences of Coatepec and Xalapa, an ideal study site for a hypothetical PHS program. These programs, particularly in Coatepec, have suffered from administrative pitfalls and financial mismanagement, highlighting the fact that future programs must be carefully planned in terms of administrative structure, land eligibility, and fees in order to produce an effective and sustainable future.

The difference between Xalapa and Coatepec lie in their cultural and economic characteristics, as well as their experience with hydrological issues and PHS programs. Also, the watersheds play an important role in the community support of the program. Coatepec's watershed is located within the municipality's jurisdiction, so the funds from a matching program would go to citizens of the city. This contrasts with Xalapa whose water comes from two separate watersheds, one of which extends into the neighboring state of Puebla, causing a disconnect between the funding source and where the funds end up. Coatepec also has a significant cultural difference of being unofficially designated as the "coffee capital of Veracruz." This implies an important cultural relationship that the citizens of Coatepec have with coffee farms. Households in both cities are equally familiar with the hydrological issues that deforestation has caused in the state as well as the programs that have been established in order to combat these issues. Another contrast of the cities is the percentage of their population that works in agriculture. According to the Intercensal (2015) data, 10.93% of Coatepec's population works in agriculture whereas only 1.39% of Xalapa's population does.

Attributes of a PHS Program

Institutions that establish PHS programs have considerations including payment amount, payment method, funding source, land eligibility, and many others. In the context of providing hydrological services to household water consumers, we consider the most important outcomes of the programs to be whether it improves consumer's water quality and reduces their flood and drought risk (i.e., improve their water regulation). Further, we hypothesize that consumers also care about institutional aspects of the program such as the type of implementing agency and the land that will be eligible for the program. There are results from the literature that support the claim that consumers value the results from these programs (Abdulkarim et al., 2017; Hensher, Shore, & Train, 2005), but little is known about how household consumers might value attributes related to program implementation.

The key outcomes of the programs are the improved water quality and improved water regulation services provided to downstream consumers. Historically, Mexico's PHS program focused on procuring a steady water supply in areas where water scarcity is worst (Muñoz-Piña et al., 2008) but does not take water quality consequences into consideration. Also, there is a lack of empirical evidence on where payments should be targeted within watersheds in order to maximize hydrological service provision (Alix-Garcia et al., 2012; Manson et al., 2013). The water contamination issues resulting from deforestation have led to a rise in gastrointestinal and other diseases associated with a lack of access to potable water in Mexico. This, in turn, has increased public health costs (Ishii & Sadowsky, 2008; Pattanayak & Wendland, 2007; and Schwarzenback et al., 2010).

The administration of the program is crucial to the long-term support and efficiency of any PES program. With respect to this, there has been some work done on the preferences of

participants (i.e. landowners and other ES suppliers) of the implementing agency of PES programs. A lack of trust in the agency which implements the program can reduce the level of participation in the program, especially when long-term contracts are at stake (Adhikari and Boag, 2013; Jones et al., 2017). However, if downstream consumers are considered to be an additional funding source, support for the administrative agency of the program cannot be understated. In fact, the institution of the program can even strengthen the consumers' awareness of ecosystem conservation in the presence of PES programs (Corbera, Soberanis, & Brown, 2009). Public perception and support are especially important for a program, especially in a context like Mexico where 90% of citizens believe the government is corrupt, according to the National Survey of Quality and Government Impact (ENCIG, 2017).

Targeting specific land, such as land with high deforestation risk, has been touted as a strategy to improve the effectiveness of PES programs (Börner et al., 2017; Wunder, 2015). One land use that can affect the provision of HS is shade-grown coffee. Intensive sun-grown coffee systems may increase the risk of groundwater contamination by chemicals (Cannavo et al., 2011) and have other negative hydrological consequences for surrounding watersheds (Zimmerman, Elsenbeer, & De Moreas, 2006). Combined with the significance of coffee to the culture and economy of Mexico, the addition of shade-grown coffee land to the eligible land of a PHS program can be an attribute of interest to respondents. On the other hand, because SGC can provide less HS than forests, households might not be supportive of expanding the land eligibility to this land use category.

Thesis Overview and Contribution

The contribution of this work is that it is one of the first to use a choice experiment to measure the value of hydrological services in Mexico while utilizing both program outcome and program administration variables. Using a hypothetical PHS program, we test the hypothesis that consumers have significant willingness to pay for the outcomes of these programs (i.e. improved water quality, fewer floods and droughts) by including these as attributes in our CE. We also include program organization and delivery attributes to test the hypothesis that consumers are willing to pay for improved program administration aspects such as incorporating an NGO or expanding the program to include shade-grown coffee lands. Shade-grown coffee systems have been shown to provide additional hydrological services, compared to intensive, sun-grown coffee (Zimmerman, Elsenbeer, & De Moreas, 2006). We consider the program administration variable to be key because not only have programs failed due to institutional failings, but there is evidence that significant distrust of the government exists in Mexico (Meschoulam et al., 2015) and improving these aspects of the program has significant consequences on program sustainability. A substantial body of work has also focused on the supply side of ES by examining which program designs maximize participation by the suppliers of ES (Jones et al., 2019; White & Hanley, 2016). For example, White and Hanley (2016) find that depending on information availability, it may be advantageous to pay for ecosystem service inputs rather than outputs, meaning paying for conservation efforts rather than ecosystem service improvement. This is because output-based contracts provide no guarantee that ecosystem service providers will be compensated for their efforts and are also more difficult to enforce for regulators. Jones et al. (2019) test the hypothesis that there are non-financial motivations for the participation in

PES programs and find that social and environmental motivations do affect the decision for households to participate in a PES program in Veracruz, Mexico.

There are several choice experiments that attempt to measure the value of safe and clean drinking water. Dauda, Yacob, and Radam (2015) measure consumers' marginal valuation for water quality level, total water supply, and tap water pressure. Similarly, Hensher et al. (2005) measures households' WTP for drinking water service using water service interruptions frequency, length, and timing, with fee, to see how households are willing to pay for their drinking water service attributes. These papers measure households' WTP for drinking water quality and quantity without referring to the hydrological services of forests, a key input in the provision of safe and reliable water supply in forest watersheds. The most similar paper to ours is Abdulkarim et al. (2017) who estimate households' preferences for a watershed services program in Malaysia. They use a choice experiment with the attributes: ecological functions, water quality, water quantity, and fee. Notably, these papers all neglect to consider program organization attributes which we consider to be our key contribution.

The paper is structured in the following way: Chapter II reviews the relevant literature with respect to the valuation of hydrological services. Chapter III describes the survey design process and the data collection. Chapter IV contains the theoretical discussion of discrete choice models. Chapter IV will present estimation results, and Chapter V will conclude.

Chapter II. Methodology and Data

Survey Development

We developed a choice experiment which used five attributes to describe a hypothetical Payments for Hydrological Services (PHS) program: *Water Quality, Water Regulation Services, Eligible Land, Program Administration,* and *Fee*. The final version of the survey can be found in Appendix A. We selected these attributes through consultation with researchers familiar with the PES programs in the state. The survey was tested in two focus group meetings in the cities of Xalapa and Coatepec, Veracruz, Mexico during July 2018. *Water Quality* and *Water Regulation Services* are dummy-coded variables where a 1 indicates an improvement in their current situation for option *j* and a value of 0 indicates otherwise. These two attributes are thought to be the main benefits that consumers would be interested in. *Eligible Land* is a dummy-coded variable that takes the value of 0 if only forest

land is eligible for the program and a value of 1 if shade-grown coffee lands will also be eligible. We included this variable because local governments are interested in increasing the PHS eligibility from forests only to include shade-grown coffee. *Program Administration* is a dummy-coded variable where a 0 indicates the Government will administer the program, and a 1 indicates the Government will work with an NGO to administer the program. Given a history of government mistrust, including this variable would allow us to estimate whether consumers' support for the PES program depends on the type of institution managing it. *Fee* is a variable with options 5, 20, 40, and 80 MXN per month, the amount added to household's water bill to pay for the program. Currently, there is a $1.00 MXN surcharge on residential water bills in

Coatepec and no surcharge in Xalapa (Nava-López et al., 2018), which may make these values seem arbitrarily large. However, the upper bound was determined by focus group meetings which was the maximum willingness-to-pay of participants for a program that offered the most attractive levels of each attribute. Table 1 describes the attribute levels.

Table 1: Attributes of PHS Programs

Product Attribute	Levels
Water Quality	Improved No Change
Water Regulation Service	Improved No Change
Program Administration	Government + NGO Government
Eligible Land	Forest + Shade-grown Coffee Forest
Price (MXN)	5, 20, 40, 80

Experimental Design

With four attributes of two levels each and one attribute of four levels, a full-factorial design would require respondents answering 64 questions each, which is not feasible. Instead, we use an Orthogonal Main Effects Design (OMED). This design implies that none of the main effects (i.e. attributes) are correlated with any of the other main effects in the study and therefore it is assumed that any interaction effects are negligible (citation). With 4×2^4 factors, we use a 2^7 OMED design that consists of 8 choice sets (Conniffe, Lorenzen, & Anderson, 1995). These were randomly divided into two blocks of four choice sets for each respondent and each respondent was randomly assigned one of the two blocks.

Data Collection

We hired The Center of Studies of Opinion and Analysis of the Universidad Veracruzana to administer an in-person, tablet-based choice experiment in October 2018. Participants in Xalapa and Coatepec were sampled in order to obtain representative socioeconomic traits among them. To do this, each municipality was divided into three zones based on their level of known characteristics such as education, health, housing, and household goods. A stratified sample size was then calculated based on the size of the three zones, classified from lowest to highest level of socioeconomic standing, and households were randomly sampled in order to complete this sample size. Screening questions were used to ensure that each respondent is over the age of 18 and is in charge of the water bill for their household. The latter question was used to ensure that we were reaching the target population of consumers that pay their household water bill. Then, each respondent was given information on the background of PHS programs Mexico, the hydrological services provided by forests, and the purpose of the survey.

Following the screening and introductory information, participants were asked questions regarding their environmental preferences and awareness of their water source such as "Do you volunteer or contribute to an environmental NGO?" and "Do you know the watershed of your city?" Respondents were then introduced to information about the attributes followed by four pairs of hypothetical PHS program options, one at a time, and asked to choose their preferred program, including an "opt-out" program which would cost nothing but also provide no additional benefits. A sample choice task used in the survey is shown in Figure 1.

Figure 1: Example Choice Card

1. Please consider the following program adjustments and choose the option you most prefer.

	Option 1	Option 2	Option 3
Water Quality	No Change	Improved	I would not choose Option 1 or Option 2
Water Regulation Service	Improved	No Change	
Program Administration	Government	NGO	
Eligible Land	Shade-grown coffee	Forest	
Additional Fee	$40	$80	
I prefer:	○	○	○

Stated preference surveys are known to be subject to hypothetical bias. In an attempt to mitigate this bias to the best of our ability, we included an opt-out reminder, a budget reminder, and a cheap talk script, all of which have been shown to minimize hypothetical bias. Another important consideration to ensure incentive compatibility in the survey is the payment vehicle and how it is presented to the survey respondent. For example, open-ended questions are known to not be incentive compatible, and payments being considered as potentially mandatory improve incentive compatibility (Johnston et al., 2017).

Following the choice experiment, participants were asked if they ignored any attributes when answering the choice tasks. This is used to test for evidence of attribute non-attendance, a common problem in choice experiments that consumers do not consider certain attributes in their decision-making. This concern is typically minimized through proper survey design and utilizing focus group meetings but should be tested for validation of results. Subsequently, participants were asked about their level of trust of the government, and the combination of the government and an NGO, to administer a PHS program. This question was put after the choice experiment to

avoid biasing subjects on their choice task responses. The survey concluded with demographic questions.

Chapter III. Empirical Models

Discrete Choice Models

The theoretical framework of a CE was established by Lancaster, which recognized that consumers derive utility from the attributes of goods, rather than from only the goods themselves (Lancaster, 1966). This approach is especially useful when the good or service at hand is complex and requires multiple attributes to describe, such as a PES program. Econometrically, choice experiments require the use of discrete choice analysis (McFadden, 1974), which is rooted in the theory of the random utility model (RUM) (Thurstone, 1927); the idea that consumers maximize their utility perfectly, but it is based on factors which are both observed and unobserved in the data. Mathematically, we can describe the RUM model as an equation which is the sum of systematic and random components for individual i choosing choice j as:

$$U_{ij} = V(x_j, p_j, z_i) + \epsilon_{ij} \qquad \text{Equation 1}$$

In Equation 1, the deterministic (observed) components of consumer *i*'s utility from choice *j* is *V,* which is a function of x_j, a vector of choice attributes, p_j, the price of option j, and z_i, individual characteristics. The nondeterministic (unobserved) component is ϵ_{ij}. Assuming a conventional linear utility model, we can define V as:

$$V_{ij} = \beta x_j + \lambda p_j + \gamma z_i + \epsilon_{ij} \qquad \text{Equation 2}$$

Where λ is the marginal utility of income.

In the model, we make the usual random utility maximization assumption according to which consumer *i* chooses alternative *j* if he or she maximizes their utility relative to all other alternatives in the choice set C such as the following holds:

$$U_{ij} > U_{ih} \; \forall \; j \neq h \in C \qquad \text{Equation 3}$$

Conditional Logit

First, we define Y_{ij} as the dependent variable which takes on a value of 1 if the consumer chooses alternative j and a value of 0 if they do not, defined as follows:

$$Y_{ij} = \begin{cases} 1 \; if \; consumer \; i \; chooses \; alternative \; j \\ 0, otherwise \end{cases}$$

In the most basic conditional logit model, probability of consumer *i* choosing alternative *j* is:

$$P(Y_{ij} = 1) = P(U_{ij} > U_{ih} \; \forall \; j \neq h \in C) = \frac{e^{\beta x_{ij} + \lambda p_j}}{\sum_{j=1}^{N} e^{\beta x_{ij} + \lambda p_j}} \qquad \text{Equation 4}$$

The odds ratio of two alternatives, *j* and *k*, is, by definition in Equation 4, unaffected by some other alternative *m*. This property is known as the independence from irrelevant alternatives (IIA), and while it provides convenience in estimation, it places restrictions on consumer behavior which are not especially practical. Another shortfall of the conditional logit model is that it cannot represent preference heterogeneity. Specifically, the β's in Equation 2 are assumed to be fixed across the population. The mixed logit model is traditionally used to allow for preference heterogeneity by allowing the β's to vary across the population. The main approach to addressing the issue of IIA is the nested logit model (Ben-Akiva and Lerman, 1985; Louviere et al., 2000) which will not be discussed or implemented in this paper.

Mixed Logit

We can relax the assumption of fixed β's in the conditional logit model to allow for preference heterogeneity. This is known as the mixed logit or random parameters logit model (Train, 1998). This model assumes that the parameters of the model are randomly distributed in the population and preference heterogeneity is captured through the estimation of the mean and standard deviations of the parameters. This allows us to set the following equality:

$$\beta x_j = \bar{\beta} x_j + \tilde{\beta}_\iota x_j \qquad \text{Equation 5}$$

In Equation 5, $\bar{\beta}$ is the population mean coefficient and $\tilde{\beta}$ is the individual deviation from the mean. This leads to the following linear utility function of individual *i*:

$$V_{ij} = \bar{\beta} x_j + \tilde{\beta}_\iota x_j + \lambda p_j + \gamma z_i + \epsilon_{ij} \qquad \text{Equation 6}$$

In this case, x_j is still attribute characteristics, not including price, but now the parameters are assumed random. We keep price as a fixed coefficient because allowing it to vary may lead to a flat likelihood function that does not converge and it also affects the welfare measures so it is recommended to keep it fixed (Revelt & Train, 1998). Now, $\bar{\beta}$ is the population mean and $\tilde{\beta}$ is the individual deviation from the mean. The probability of person *i* choosing alternative *j* is still defined as in Eq. (4), except that now β varies across individuals.

It is standard to assume a normal distribution for the coefficients, which is what we will follow for our mixed logit estimation.

Welfare Measures

The strength of CEs is the ability to quantify the consumer tradeoffs between attributes of the good being valued. Specifically, we are able to estimate the amount that consumers would be willing to pay for each attribute of the hypothetical PHS program because we have estimated the

indirect utility function. Because we have estimated a linear utility function, the willingness to pay for each attribute is the ratio of the partial derivative of the utility function with respect to the attribute and the marginal utility of income, shown below:

$$WTP = \frac{\partial V_{ij} / \partial x_i}{\partial V_{ij} / \partial p_j} = -\frac{\beta_i}{\lambda} \quad \text{Equation 7}$$

In addition, we can estimate the compensating variation of consumers, the amount that they would be willing to pay to remain at the same utility that they were before the hypothetical change. To estimate this, we will use the following equation:

$$CV = \frac{1}{\lambda}[V^1 - V^0] \quad \text{Equation 8}$$

Where V^1 is the utility of the new state where each attribute takes on the changed level (1) and V^0 represents the utility of the base case.

Alternative Specific Constant

We also introduce a constant, specifically an Alternative Specific Constant (ASC) into the models. The ASC captures the average effect of unobserved factors on the choice and is a dummy variable coded for 0 for the status quo and 1 for the two hypothetical PHS programs. The value of the ASC is that a positive coefficient will tell us whether there is status quo bias, the result that respondents prefer the status quo option regardless of program attributes. The ASC can also be interacted with individual characteristics so that we can model heterogeneity at the individual level. We will interact the ASC with socioeconomic characteristics as well variables that measure environmental attitudes and familiarity with PHS programs

Chapter IV. Results

Descriptive Statistics

Descriptive statistics of the survey sample are shown in Tables 2 and 3, showing demographic characteristics and respondents' awareness of PHS Programs and other hydrological services variables, respectively. We collected these in order to verify that our sample is representative of Veracruz. They also serve the purpose of understanding how individual preferences for a PHS program vary based on their demographic characteristics, previous experience with PHS programs, and recreational tendencies. The individual characteristics of income, age, gender, education level, along with whether the respondent uses forest for recreation, will enter the model by interacting with the alternative specific constant to see if there are characteristics that affect whether or not a respondent is more likely to choose a program rather than the status quo options.

Table 2: Awareness of Hydrological Services

		Entire Sample	Xalapa	Coatepec
Are you aware of any programs providing Payments for Hydrological Services in Mexico?	Yes	3.35%	2.55%	4.16%
Do you know the watershed of your city?	Yes	10.57%	7.42%	13.77%
Does your water bill currently have an additional fee for Payments for Hydrological Services programs?	Yes	5.15%	2.05%	8.31%
Do you contribute to or volunteer for an environmental non-profit or NGO?	Yes	4.9%	4.9%	4.94%
Have you used forest land for recreation (hiking, camping, fishing, etc.) in the last 12 months?	Yes	52.97%	49.09%	56.81%

According to Table 2, respondents were not particularly aware of PHS Programs in Mexico. Also, the majority of our sample was not aware of the watershed of their city nor did they contribute to any environmental NGO's. These results are surprising given the prevalence of these issues and PHS program history in the region. However, it is consistent with our focus group experience. One purpose of asking these questions was to gauge their experience with the product, as respondents that are more familiar with the hypothetical product are less prone to hypothetical bias. We still believe that our results are consistent and the description of the program and its attributes at the beginning of the choice experiment was used to ensure all respondents have a baseline level of information. A significant portion of our respondents do use forests for recreational activities. This variable will be used in the choice analysis because individuals who recreate in forests should be more willing to pay for a program that attempts to conserve the land that provides recreational opportunities, in addition to providing hydrological services.

Table 3: Demographic Characteristics of Sample

		Entire Sample	Xalapa	Coatepec
Income	< 2,500 MXN	31.31%	31.20%	31.43%
	2,500 – 5,000 MXN	26.55%	24.55%	28.57%
	5,000 – 7,500 MXN	16.11%	16.11%	16.10%
	7,500 – 10,000 MXN	8.89%	9.46%	8.31%
	10,000 – 15,000 MXN	4.90%	5.63%	4.16%
	> 15,000 MXN	5.80%	7.16%	4.42%
Mean Age		43.85	44.85	42.86
Sex	Male	46.07%	45.41%	46.75%
	Female	53.93%	54.59%	53.25%
Education Level	Without Elementary School	10.44%	8.44%	12.47%
	Elementary School	17.27%	15.09%	19.48%
	Junior High School	19.33%	18.93%	19.74%
	Senior High School	25.13%	26.09%	24.16%
	Technical School	5.54%	5.88%	5.19%
	University Degree	18.81%	20.97%	16.62%
	Graduate Degree	3.35%	4.35%	2.34%
Employment Status	Employed full-time	22.81%	23.53%	22.08%
	Employed part-time	13.92%	13.81%	14.03%
	Independent Contractor	24.61%	23.53%	25.71%
	Houseworker	20.23%	18.16%	22.34%
	Student	3.99%	8.95%	4.42%
	Retired	5.80%	5.63%	5.97%
	Unemployed	5.67%	5.88%	5.46%
Household Size	Adults (>18)	3.32	3.22	3.42
	Children (<18)	1.29	1.21	1.38
N		777	392	385

There were 777 respondents in our sample, 392 from Xalapa and 385 from Coatepec. As can be seen by Table 3, the demographic characteristics of the Xalapa and Coatepec samples are very similar. Differences include that the average of Xalapa has a slightly higher income, which may influence average welfare measures across the cities. Xalapa also has an older sample and has more respondents in the higher educated categories. Both of these variables may also contribute to differing WTP measures across the cities because age and education may play a role in how consumers view the program, past programs failing, and whether they would be willing to accept a fee in their water bill to have this program. Unfortunately, the exact demographic questions we asked to the sample are not available from current data sources. Using the Intercensal data from 2015, we attempt to compare our sample area to the demographic characteristics of the area. Compared to the Intercensal (2015) data, which can be found in Table 4, our sample has a substantially older mean age than the true population. Also, our sample seems to be less employed and has lower education level compared to the general population. The income level is difficult to compare across data sources because the bins are different. Our sample seems to have a lower income than the general population because our sample has a large portion belonging to the below 2,500 group whereas the census data has a much less in the 2,100. This is important because these variables enter into the model as an effect on whether the respondent prefers the status quo option and thus can have an effect on the interpretation of the results.

Table 4: True Demographic Characteristics of Sample Area

		Xalapa	Coatepec
Income[1]	< 2,100 MXN	7.60%	10.38%
	2,100 – 4,200 MXN	24.56%	29.98%
	> 4,200 MXN	57.67%	47.63%
	No answer	10.16%	12.01%
Mean Age		32.35	32.24
Sex	Male	47.11%	47.65%
	Female	52.89%	52.35%
Education Level	Without Elementary School	4.05%	7.04%
	Elementary School	19.24%	26.96%
	Junior High School	4.10%	4.73%
	Senior High School	16.63%	18.77%
	Higher Education[2]	55.68%	42.38%
Employment Status	Employed	49.82%	52.50%
	Unemployed	2.42%	1.95%%
	Not Economically Active[3]	47.75%	45.40%
Agricultural Workers		1.39%	10.93%
Population		480,841	92,127

Data obtained from the 2015 Intercensal report
[1] Bins calculated based on the national minimum salary which was 2,100 for 2015
[2] Higher education encompasses any education obtained after High School
[3] 'Not Economically Active' encompasses all persons aged 12 or older who are not working traditionally i.e. students, retired, etc.

Estimation Results

The estimation results of the conditional logit and mixed logit are presented in Tables 5 and 6, respectively. Each table has three models that differ by the sample: Xalapa, Coatepec, and pooled. Presented results show the estimated utility function parameters of the attributes, as well as the alternative specific constant and individual characteristics interacted with the ASC. Because each attribute is a dummy variable, the estimated parameter can be interpreted as how

that attribute affects the probability that a respondent chooses a program with that attribute having the value of X=1. Most attributes are significant and take on the expected sign. Because each attribute represents an improvement in the program, we see a positive sign for each attribute and a negative sign for the price variable. There are no significant differences between the conditional and mixed logit models, so the rest of the discussion will focus on the mixed logit results for simplicity and because mixed logit is an extension of conditional logit model by allowing for individual heterogeneity.

Table 5: Conditional Logit Utility Function Parameters of Choice Set Attributes

VARIABLE	**Full Sample**	**Xalapa**	**Coatepec**
Water Quality	0.68157***	0.65862***	0.70236***
	(0.04958)	(0.06997)	(0.07207)
Water Regulation Service	0.54797***	0.53593***	0.55388***
	(0.04729)	(0.06235)	(0.07172)
Program Administration	0.28453***	0.18620**	0.38573***
	(0.04974)	(0.07044)	(0.07211)
Eligible Land	0.11600*	-0.02864	0.26126***
	(0.04775)	(0.06373)	(0.07177)
Price	-0.01315***	-0.01536***	-0.01105***
	(0.00098)	(0.00142)	(0.00137)
Alternative Specific Constant	-1.20099***	-0.89728	-1.51031**
	(0.35113)	(0.49461)	(0.50293)
ASCxIncome	0.00844**	-0.00034	0.01483***
	(0.00270)	(0.00445)	(0.00358)
ASCxGender	-0.09634	0.14032	-0.32600
	(0.15270)	(0.21669)	(0.21959)
ASCxAge	0.02650***	0.02455***	0.02953***
	(0.00466)	(0.00641)	(0.00679)
ASCxEducation	-0.00560	-0.10450	0.09304
	(0.04953)	(0.07086)	(0.07129)
ASCxRecreation	-0.09775	-0.08417	-0.17244
	(0.15656)	(0.22110)	(0.21896)
N	9276	4656	4620
Pseudo R^2	0.134	0.135	0.153
Log-likelihood	-2940.721	-1474.329	-1433.528
LR Test Statistic for Data Pooling	65.728***		

Clustered standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Mixed Logit Utility Function Parameters of Choice Set Attributes

VARIABLE	**Full Sample**	**Xalapa**	**Coatepec**
Water Quality	0.83867***	0.74598***	0.85354***
	(0.06605)	(0.08685)	(0.09424)
Water Regulation Service	0.68696***	0.62543***	0.70824***
	(0.06170)	(0.07677)	(0.09506)
Program Administration	0.34188***	0.23409**	0.47111***
	(0.06040)	(0.07956)	(0.08980)
Eligible Land	0.15982**	0.01953	0.29755***
	(0.05714)	(0.07304)	(0.08821)
Price	-0.01671***	-0.01776***	-0.01505***
	(0.00121)	(0.00167)	(0.00172)
Alternative Specific Constant	-2.91079***	-3.77464***	-2.92269***
	(0.68936)	(1.05044)	(0.82623)
ASCxIncome	0.01879*	0.00867	-0.03895**
	(0.00769)	(0.00969)	(0.01342)
ASCxGender	-0.76573*	1.22853*	-1.51780**
	(0.38526)	(0.56388)	(0.53806)
ASCxAge	0.04389***	0.03539*	0.05201**
	(0.01149)	(0.01495)	(0.01598)
ASCxEducation	-0.02473	-0.18575	0.23085
	(0.10185)	(0.14421)	(0.16993)
ASCxRecreation	-0.28408	-1.50259**	-0.09423
	(0.35742)	(0.51219)	(0.43553)
N	9276	4656	4620
Log-likelihood	-2466.488	-1219.786	-1229.655
LR Test Statistic for Data Pooling	34.078***		

Clustered standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Likelihood ratio (LR) tests were performed for the conditional and mixed logit models to determine whether the data should be pooled or split. This serves as a test of whether Coatepec and Xalapa are significantly different in their estimated preferences for a PHS program. The conditional logit LR test statistic is 65.728 and the mixed logit LR test statistic is 34.078. Thus,

data pooling is rejected at .01 ($\chi^2_{11,.01}$= 24.72). This result suggests that the sample should be split, and results are dependent on the city which the respondent lives in. Therefore, we present all estimation and welfare analyses with Coatepec and Xalapa as separate results.

Table 7: Standard Deviations of Random Parameters

VARIABLE	**Full Sample**	**Xalapa**	**Coatepec**
Water Quality	0.21203	-0.34061	0.74186***
	(0.20030)	(0.39642)	(0.19237)
Water Regulation Service	0.18377	-0.17724	-0.15713
	(0.17345)	(0.25482)	(0.39420)
Program Administration	-0.73786***	0.49711	-0.39269
	(0.11828)	(0.31755)	(0.32982)
Eligible Land	0.57668***	0.11249	0.79942***
	(0.11350)	(0.32202)	(0.16950)
ASC	1.00977***	-1.46393***	0.76683*
	(0.27447)	(0.35473)	(0.39085)
ASCxIncome	-0.00439	-0.00341	-0.17085***
	(0.00679)	(0.00833)	(0.02772)
ASCxGender	2.12010***	-1.61817***	2.40406***
	(0.43318)	(0.47293)	(0.57498)
ASCxAge	0.07694***	0.06777***	0.05682***
	(0.00715)	(0.00870)	(0.00814)
ASCxEducation	0.20320**	0.18178*	0.38333***
	(0.07601)	(0.08288)	(0.09696)
ASCxRecreation	1.01970**	-2.78277***	2.02117***
	(0.36705)	(0.48438)	(0.48291)

Clustered standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Trust of PHS Administration

	Xalapa		Coatepec	
	Government	**Government + NGO**	**Government**	**Government + NGO**
I do not trust this entity to administer the program	43.73%	20.72%	42.34%	18.44%
I trust this entity a little to administer the program	31.97%	34.78%	33.51%	34.55%
I trust this entity a moderate amount to administer this program	20.46%	37.08%	20.00%	37.66%
I trust this entity a lot to administer this program	3.32%	7.16%	3.64%	8.05%

Both cities have positive, significant estimated coefficients for the improved *Water Quality* and *Water Regulation Service* variables, which is expected as the consumers would be more willing to choose a program that provides these key outcomes to them. What is a more interesting finding is the significance and magnitude of the *Program Administration* variable, also positive and statistically significant. This variable is consistent across all models and sub-samples. The difference lies in the magnitude; the *Program Administration* variable for Coatepec is twice as large as that for Xalapa. This follows our expectation that the consumers have some distrust of the government and have a higher probability of choosing a theoretical PHS program which has NGO's working with the government to administer the program. In addition to this, Table 7 shows the results of the survey question which asked respondents to rank their trust in the entity administering a PHS program. These results support the fact that consumers have a higher level of trust with the addition of an NGO to the administration of the program, but overall have a low level of trust for anyone to administer this program. Coatepec has a slightly

higher level of trust, overall. This may help drive the result that they have a higher mean willingness to pay for the program.

The preferences of Coatepec and Xalapa diverge at the *Eligible Land* variable. This variable measures the incremental value that consumers place on adding shade-grown coffee to the eligible land of the PHS program versus limiting the eligibility to forests. This variable is statistically significant and positive for Coatepec, while not statistically significant for Xalapa. This can be explained by the fact that Coatepec is one of the oldest coffee-producing regions in Mexico and it is tied to their culture and identity, so the residents would have a greater interest in having shade-grown coffee being eligible for the PHS payments (Hausermann, 2014). This can be contrasted with Xalapa, a large city where the residents may be more disconnected from the coffee culture of the area.

The *Alternative Specific Constant (ASC)* variable is negative and significant at the 1% level in all mixed logit models and significant at the 5% level in all conditional logit models except in Xalapa. This variable suggests that consumers widely prefer a program, regardless of the attributes, over their status quo situation. Individual characteristics cannot enter the model independent from the *ASC* because they have no within-individual variation and the conditional logit model requires this, so the model is a function of the characteristics of the choice rather than the individual. When *ASC* is interacted with individual characteristics, *Age* has a positive and significant coefficient in most models which suggests that older respondents are more likely to choose the status quo option. The best interpretation of the income[3], variable is that in Coatepec, higher income households are more likely to choose a program, regardless of

[3] We also tested the hypothesis that being a low-income household would have a significant interaction with ASC.

attributes, whereas higher income households' in Xalapa are more likely to choose the status quo option.

We also include estimated standard deviations of the random parameters in the mixed logit model in Table 7. Many of the program variables do not have significant standard deviations while the Alternative Specific Constant interaction variables do. The significance of the ASC interaction terms of Gender, Age, and Recreation implies that these variables are randomly distributed in the sample. The insignificance of the program attribute variables implies that the parameters may be fixed, and that the conditional logit model is a sufficient estimation, or that the normal distribution is not the correct assumption. In future analyses, we may consider making these program variables fixed and re-estimating the model.

The welfare estimates of each attribute, separated by city, are reported in Table 8. As defined in Equation 7, these estimates are derived from the estimated utility function parameters of the model. The mean welfare measures for each program are easily interpreted as the value of an incremental change because each attribute is represented as a dummy variable in the model and thus the estimate is the value that the mean respondent is willing to pay for the X=1 value for that attribute, with respect to their status quo of X=0 of the given variable. The mean welfare estimates are similar between the conditional and mixed logit models. Between cities, Xalapa has slightly lower WTP measures than Coatepec among all attributes. The most significant difference between the cities, again, is the estimated welfare measure of the *Eligible Land* attribute, with Xalapa residents being willing to pay less than 2 MXN for that attribute, while Coatepec residents are willing to pay up to 23 MXN. The *Program Administration* variable has significant WTP. Each model shows that the mean welfare measure for the *Program*

Administration variable is 30-70% of the welfare measure for the *Water Regulation Service* variable, which is considered the key outcome of the program.

Table 9: Estimated Welfare Measures for Each Program Attribute

	Conditional Logit		**Mixed Logit**	
VARIABLE	**Xalapa**	**Coatepec**	**Xalapa**	**Coatepec**
Water Quality	42.89	63.55	41.99	56.72
Water Regulation Service	34.90	50.12	35.21	47.06
Program Administration	12.13	34.90	13.18	31.30
Eligible Land	[1.87]	23.64	[1.1]	19.77
N	4656	4620	4656	4620

Values reported in 2018 MXN. 1 USD ≈ 19 MXN.
Welfare measures of coefficients insignificant at the .1 level are designated with square brackets.

The overall value of the program, which is defined by Compensating Variation (CV) in Equation 8, is reported, split by city, in Table 9. This measure is consistent across the conditional and mixed logit models, with Coatepec having a higher overall WTP than Xalapa. Compared to their household income, residents are willing to pay between 2-5% of their monthly income for the program. These values are in line with the findings of Vasquez et al. (2009) and other studies with respect to the percentage of income that households are willing to pay for clean and reliable water.

Table 10: Estimated Value of the Program

	Conditional Logit		Mixed Logit	
VARIABLE	**Xalapa**	**Coatepec**	**Xalapa**	**Coatepec**
Overall Value	88.05	172.21	91.48	154.85
Overall Value as a % of Income	2.35%	4.59%	2.44%	4.13%

Values reported in 2018 MXN. 1 USD ≈ 19 MXN.

Chapter V. Discussion

Discussion of Results

We designed an in-person choice experiment that was implemented in Xalapa and Coatepec, Veracruz, Mexico. Using this data, we used choice models to estimate households' preferences and welfare measures for a hypothetical payment for hydrological services program. This method allows us to evaluate the tradeoffs between the attributes that consumers experience when choosing a program that maximizes their utility. Determining the consumer preferences and value for hydrological services serves as an important step in establishing PHS programs that are sustainable in the long run.

We find that, in the pooled sample, households' have positive and statistically significant coefficients of improved water quality, improved water regulation services, adding an NGO to the program administration, and the addition of shade-grown coffee to the eligible land of the program. When we separate the results into Xalapa and Coatepec, the coefficient for the *Eligible Land* variable changes to be significant for Coatepec but not Xalapa. In addition, the magnitude for the *Program Administration* for Coatepec is twice as large as Xalapa. Because Coatepec has

a history of program mismanagement, this finding aligns with that history. We also find that the Alternative Specific Constant is negative and significant, which suggests that respondents have a preference for a PHS program, rather than their status quo situation, regardless of the values of the attributes of the program. We also include individual characteristics in the model, interacted with the ASC, with age being the only feature that has a statistically significant effect on the choices of consumers.

The results also indicate that consumers have a significantly higher willingness to pay than the current program fee. In Coatepec, the current fee is 2 MXN per month in the water bill, but the results indicate that the households mean WTP for a program with all of the desirable attributes range from 88 – 172 MXN which is 2.35 – 4.59% of the median household income of the sample. The combination of an NGO with a government agency, as opposed to just a government agency administering the program, is an attribute of the program that households are willing to pay for across all models and subsamples. This attribute had a mean WTP of 12-34 MXN, which is a significant portion of their total WTP and close to what they are willing to pay for improved water quality and water regulation services. This result is also closely tied to the idea what Mexican citizens have distrust in their government (Meschoulam et al., 2015). As seen in Table 7, respondents have a lower level of trust in the government to implement this program than they do in an NGO in combination with the government.

Using a split sample approach, we see the differences between the Xalapa and Coatepec which are in close geographic proximity. The most key result of this is that Coatepec has a sizable mean WTP for the addition of shade-grown coffee to the eligible land of the program, while Xalapa does not have any WTP for such program eligibility modification. Coatepec is one of the oldest coffee-producing regions in the state of Veracruz and has a long history of its land

being used for coffee production (Hausermann, 2014). The significant WTP for the *Eligible Land* variable in Coatepec suggests that coffee farming is a cultural ecosystem service for the residents of Coatepec, a non-use value that consumers have due to their cultural identity being associated with this ecosystem. Also, due to the fact that Coatepec has a lower median household income than Xalapa, this is not merely an income effect.

There are a few limitations with our study that should be addressed. First, the use of an Orthogonal Main Effects Design comes with the strong assumption that there are no interactions between attributes. In reality, it could be that consumers perceive a correlation between outcome variables and process-based variables, which Grolleau and Caswell (2006) argue would create a substitution or complementarity effect of the interactions of these attributes. Analyzing whether this is the case with respect to PHS program preferences would only be possible with the use of interaction terms in the model. The conditional logit model design also limits us to individual characteristics entering the model only as interactions with the ASC because they do not vary by individual. Another option is to interact individual characteristics with attributes. However, this can lead to estimation difficulties and collinearity issues, so we do not attempt this. Finally, stated preference studies are known to deal with hypothetical bias and difficulties in describing complex ecological interactions. We attempted to mitigate these as much as possible with recommendations and guidance of Johnston et al., (2017) by allowing the respondents to choose a clearly outlined status quo option, describing the specific payment vehicle that allows for incentive compatibility (mandatory fee installed in water bill), and by using focus group meetings to test the validity of the survey. One potential change, in future choice experiments, would be to have implemented a more robust pretesting phase in order to obtain design priors.

This would allow for a greater degree of statistical efficiency in the estimation and fewer necessary observations to estimate the model which can save time and resources.

Our study is one of the first to use a choice experiment to measure the value of hydrological services in Mexico while utilizing both program outcome and program administration variables. While the program outcomes, expectedly, have significant WTP, the program administration variables have an impact on the public support and policy implications of future PHS programs.

Policy Implications

Our research has shown that the downstream water users in an area serve as a viable option for substantially extending the financial base of a PHS program. Evaluating the total economic value of ecosystem services and revising the level payments to landowners are two of the key policy improvements that are recommended in the future in order to make PES programs in Mexico more effective and efficient (Lara-Pulido, 2018). By incorporating non-use value and estimating the total economic value of hydrological services, our results are key to the incorporation of rigorous studies in the design and revision of PHS programs in Mexico.

Our results also highlight the need to take local perceptions as well as income inequality into consideration in the design and promotion of PHS programs. Local values are important in quantifying the full benefits of programs and can be used to justify higher payments than can be used to expand both the level of payments and the lands that are eligible to enroll in the program. For example, in Coatepec, using the enrollment of shade-grown coffee should be considered to not only increase willingness to pay but also to expand the program to provide greater hydrological services in the watershed. The consideration of income inequality is important in

policy implementation, especially in Mexico. Mexico has an estimated Gini index of 48.2 which ranks them the 24th most unequal country in the world, worse than many less developed African and Central/South American countries (Central Intelligence Agency, 2017). The severe income inequality in Mexico combined with the fact that our estimates are mean WTP may complicate the implementation of the study results. Low-income households may not be able to pay for this program if a uniform fee was implemented.

Future Work

One potential avenue of future research is to extend the choice experiment to analyze dynamic preferences in response to a treatment effect. Because CE's are a static value of preferences, little is known about whether, how or why preferences change over time. Combining a choice experiment with a social science method such as a role-play simulation (RPS) could be useful to see how preferences change when consumers are exposed to opposing viewpoints of stakeholders in the policy-making process. Discrete choice analysis and social science techniques could combine to develop a behavioral nudge (Thaler & Sunstein, 2009) that is experiential in nature (e.g., empathy) and too complex to be adequately expressed in a survey statement. Such complex nudges might have the effect of influencing behavior and promoting change with respect to PES programs in Veracruz and across the world to better conserve our natural resources.

Another aspect of this work that can be improved in the future is the welfare calculations. Recent developments in choice modeling have attempted to resolve the problem that, with estimated parameters being random variables, the distribution of the ratio to calculate WTP is not clear (Armstrong et al., 2001). This issue becomes worse parameters are assumed random as in

the mixed logit model (Sillano & D Ortúzar, 2005). Using simulation maximum-likelihood and Bayesian estimation procedures can yield more accurate estimates.

Finally, one aspect of the mixed logit model that was not utilized in this analysis is the use of individual characteristics as a function of the program variables. For example, allowing the program variables to be a function of income would allow for our estimates to better handle the issue of income inequality in our sample. This would make WTP estimates more amenable to policy implementation.

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Appendix A. Survey Instrument

Payments for Hydrological Services in Veracruz, Mexico

Hello, we are researchers in a joint project between the University of New Hampshire in the U.S.A., and Instituto de Ecología in Veracruz, Mexico, we thank you for taking the time to complete this survey.

Forest cover is associated with the capture and storage of rainwater and therefore fewer problems with floods and droughts. Forests also act as natural filters of rain runoff and associated contaminants and can help reduce soil erosion, helping to ensure water quality and reducing the associated treatment cost to water users. Despite the importance of these services provided by forest cover, forested land is being replaced by other land uses which do not provide these services. Since both water supply and quality are important to the well-being of water users in towns and cities, local governments have worked with the National Forest Commission (CONAFOR) to establish programs making Payments for Hydrological Services (PHS) that provide landowners with forest land an economic incentive to conserve their forest and ensure hydrological services for downstream users. These agreements have important consequences for water quantity and quality. Your responses to this survey can help improve PHS programs in the future.

The purpose of this survey is to understand which aspects of the PHS programs are important to the citizens of (insert city here). Your responses will be important to the accuracy of our research project as well as improving the effectiveness of (Insert city here). PHS program. We will share the results of our research with the local and national institutions administering PHS programs and they might use your responses to improve the design of these programs in the future, including a fee that acts as a PHS. Participation in this survey is voluntary and you may choose to skip any questions which you do not feel comfortable answering. Individual responses will not be made available. Only summary statistics will be reported in publications or presentations produced from this project and will be shared for informing public policy.

All responses will be kept <u>strictly</u> confidential.

If you have any issues while completing this survey, please ask the surveyor who provided you the survey. If you have questions about your rights as a research subject, you can contact Melissa McGee in UNH Research Integrity Services at 603-862-2005 or melissa.mcgee@unh.edu to discuss them. If you have any concerns about the research project, please do not hesitate to contact:

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[Screening Questions]

1. Do you live in (insert city here), Veracruz, Mexico?
   - Yes
   - No

If you answered NO to the question above, please stop now.

2. Do you pay the water bill for your household?
   - Yes
   - No

If you answered NO to the question above, please stop now.

SECTION A - Hydrological Services Information

1. Are you aware of any programs providing Payments for Hydrological Services in Mexico?
   - Yes
   - No

If Yes, which one(s)?

_____

2. Do you know the watershed for the city of (Insert city here)?
   - Gavilanes
   - Pixquiac
   - Huitzilapan
   - I don't know

3. Does your water bill currently have an additional fee for Payments for Hydrological Services programs?
   - Yes
   - No

If Yes, how much is this additional fee?

_____

4. Do you contribute to or volunteer for an environmental non-profit or NGO?
   - Yes
   - No

5. Have you used forest land for recreation (hiking. bird watching, etc.) in the last 12 months?
   - Yes
   - No

If Yes, please select below which recreation activities you have used water for in the last 12 months:
   - Hiking
   - Bird Watching
   - Other (please specify): _____

SECTION B - Hydrological Services Decisions

The PHS program for conserving forested land could have beneficial effects on the quality and quantity of water available to you, but this program is not free. If approved, additional costs for improving the program will be paid for through fees charged to local water users, one fee per household. We would like to know how you feel about the program.

There are no right or wrong answers. We want your honest opinion about this program. Please treat your choice as if you would actually have to pay for the program you chose. Also, please keep your budget in mind and tell us which option you would choose. Thank you and if you have any questions, please ask your surveyor.

For the following **choice set** questions, you will be asked to consider the following attributes:

1. **Water Quality Change** – Due to the natural filtration of the forests, an improved PHS program can improve the water quality in your community. **Improved** indicates an improvement in the water quality, while **No Change** indicates your current water quality.
2. **Water Regulation Service** – Forests help to provide more reliable water during dry seasons and less water during flood seasons. A program could be specially designed to target this service of the forest, so water regulation services are **Improved,** and you experience fewer droughts and floods, or **No Change** so you receive no change from your current flood and drought issues.
3. **Program Administration** – A program could either be run by a local **Government Agency**, or by a local government agency with a **Non-governmental organization** (NGO).
4. **Eligible Land** – The land that is eligible for PHS programs include may include typical **Forest** land (current plan) or to include **Forest and Shade-grown coffee** farms that could also help regulate water quality and quantity.
5. **Additional Fee** – This is the additional fee that would be added to your regular monthly water bill. The options of the fee will be **$10, $20, $40, or $80 per month.**

For the following, Option 3 refers to your current situation. Choosing this option means you would experience no change from your current water situation and water bill, meaning no improved hydrological services, no changes in program administration or eligible land, and no additional fees. If neither of the options below appeal to you, please select Option 3.

1. Please consider the following program adjustments and choose the option you most prefer.

	Option 1	Option 2	Option 3
Water Quality	No Change	Improved	I would not choose Option 1 or Option 2
Water Regulation Service	Improved	No Change	
Program Administration	Government	NGO	
Eligible Land	Shade-grown coffee	Forest	
Additional Fee	$40	$80	
I prefer:	◯	◯	◯

If you answered Option 3, please select why you chose this answer (choose all that apply)

- o Options 1 and 2 are too expensive
- o I do not understand the program's objective
- o I do not care about hydrological services or watershed quality
- o I do not support any tax-funded programs
- o Other (please specify below):

_____

2. Please consider the following program adjustments and choose the option you most prefer.

	Option 1	Option 2	Option 3
Water Quality Change	No Change	Improved	I would not choose Option 1 or Option 2
Water Regulation Service	No Change	Improved	
Program Administration	Government	NGO	
Eligible Land	Forest	Shade-grown coffee	
Additional Fee	$5	$20	
I prefer:	◯	◯	◯

If you answered Option 3, please select why you chose this answer (choose all that apply)

- o Options 1 and 2 are too expensive
- o I do not understand the program's objective
- o I do not care about hydrological services or watershed quality
- o I do not support any tax-funded programs
- o I do not care about forests
- o Other (please specify below):

_____

3. Please consider the following program adjustments and choose the option you most prefer.

	Option 1	Option 2	Option 3
Water Quality Change	Improved	No Change	I would not choose Option 1 or Option 2
Water Regulation Service	Improved	No Change	
Program Administration	NGO	Government	
Eligible Land	Shade-grown coffee	Forest	
Additional Fee	$5	$20	
I prefer:	◯	◯	◯

If you answered Option 3, please select why you chose this answer (choose all that apply)

- o Options 1 and 2 are too expensive
- o I do not understand the program's objective
- o I do not care about hydrological services or watershed quality
- o I do not support any tax-funded programs
- o I do not care about forests
- o Other (please specify below):

_____

4. Please consider the following program adjustments and choose the option you most prefer.

	Option 1	Option 2	Option 3
Water Quality Change	Improved	No Change	I would not choose Option 1 or Option 2
Water Regulation Service	No Change	Improved	
Program Administration	NGO	Government	
Eligible Land	Forest	Shade-grown coffee	
Additional Fee	$40	$80	
I prefer:	◯	◯	◯

If you answered Option 3, please select why you chose this answer (choose all that apply)

- o Options 1 and 2 are too expensive
- o I do not understand the program's objective
- o I do not care about hydrological services or watershed quality
- o I do not support any tax-funded programs

- I do not care about forests
- Other (please specify below):

_____

When you answered the previous questions, did you **ignore** one or more of the attributes of each program?

- Yes
- No

If Yes, which attributes did you **ignore**?

_____ Water Quality Change
_____ Water Regulation Service
_____ Program Administration
_____ Targeted Land
_____ Fee

SECTION C
Respondent Background Information

1. How long have you lived in (insert city here), Mexico?

_____ years

2. What is your postal code?

_____

3. How many children (under 18) are there in your household?

_____ people

4. Including you, how many adults (over 18) are there in your household?

_____ people

5. What is your age?

_____ years

6. What is your marital status?
   - Single
   - Married/Living with a partner
   - Divorced/Separated/Widowed

7. What is your gender?
   - Male
   - Female

8. What level of education have you finished?
   - Elementary School
   - Middle School
   - High School
   - University degree
   - Graduate degree (MA, MS, Ph. D, JD, MD, etc.)

9. Please circle the response that best describes your employment status:
   - Employed full-time
   - Employed part-time
   - Unemployed seeking work
   - Student
   - Retired
   - Not seeking a job
   - Other: _____

10. Which of the following statements do you think is more accurate?

a. I do not trust a municipal government agency to administer a Payment for Hydrological Services program.

b. I have a little trust in a municipal government agency to administer a Payment for Hydrologic al Services program.

c. I have moderate trust in a municipal government agency to administer a Payment for Hydrological Services program.

d. I have a lot of trust in a municipal government agency to administer a Payment for Hydrological Services program.

e. Don't know/No answer

11. Which of the following statements do you think is more accurate?

a. I do not trust a combination of a non-governmental organization and municipal government agency to administer a Payment for Hydrological Services program.

b. I have a little trust in a combination of a non-governmental organization and municipal government agency to administer a Payment for Hydrological Services program.

c. I have moderate trust a combination of a non-governmental organization and municipal government agency to administer a Payment for Hydrological Services program.

d. I have a lot of trust in a combination of a non-governmental organization and municipal government agency to administer a Payment for Hydrological Services program.

e. Don't know/No answer

12. Does your family own your home or rent?

- Own
- Rent

13. Other than your home, does you or your family own land?

- Yes
- No

14. Please circle the response that best describes your current **monthly** household income:

- Less than 2,500 MXN
- Between 2,500 and 5,000 MXN
- Between 5,000 and 7,500 MXN
- Between 7,500 and 10,000 MXN
- Between 10,000 and 15,000 MXN
- More than 15,000 MXN

Thank you for taking the time to complete this survey!
Your opinion will help to reduce deforestation and improve the PHS program in Veracruz!

Appendix B. Focus Group Consent Form

CONSENT FORM FOR PARTICIPATION IN A RESEARCH STUDY

RESEARCHER AND TITLE OF STUDY

My name is Shadi Atallah and I am a professor at the University of New Hampshire and the title of this study is "Households' preferences and willingness to pay for hydrological services in Veracruz." This study is funded by the University of New Hampshire and the National Science Foundation of the USA.

WHAT IS THE PURPOSE OF THIS FORM?

This consent form describes the research study and helps you to decide if you want to participate. It provides important information about what you will be asked to do in the study, about the risks and benefits of participating in the study, and about your rights as a research participant. You should:

- Read the information in this document carefully.
- Ask the research personnel any questions, particularly if you do not understand something.
- Not agree to participate until all your questions have been answered, or until you are sure that you want to.
- Understand that your participation in this study involves you giving feedback on a survey that will last about three hours.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this research is to understand households' preferences for a payment program that can keep or improves the consistent supply of water and its quality. We plan to conduct surveys in Coatepec and Xalapa to collect information on households' perceived benefits of improved water quantity and quality. Focus group and survey participants will be given the opportunity to express their concern regarding these issues. It is hoped that the information collected from the survey respondents will be valuable to the water companies, municipalities, and and policy makers in improving the consistent supply of hydrological services in Veracruz.

We anticipate 8-10 people to participate in the focus groups. Participants must be at least 18 years old to participate in the study.

WHAT DOES YOUR PARTICIPATION IN THIS STUDY INVOLVE?

Your participation in the focus groups is important to make sure that the survey we have prepared is written in a way that reflects the reality of and language used by households. We would also like to learn your opinions on forest conservation and hydrological ecosystems services. Specifically, we will ask you to:

(1) read the survey individually; (2) discuss in small groups with the other landowners on your table the parts (e.g., multiple-choice answers or different words to be used) that you think should

be changed; (3) participate in a session led by a moderator to come to a consensus among all the small groups.

The exercise is expected to take three hours including a break.

WHAT ARE THE POSSIBLE RISKS OF PARTICIPATING IN THIS STUDY?
Participation in this study is expected to present minimal risks to you such as those associated with sitting on a chair.

WHAT ARE THE POSSIBLE BENEFITS OF PARTICIPATING IN THIS STUDY?
This project will provide information on households' potential support for a payment program for forest landowners in Veracruz. If implemented, such program can conserve forests and therefore increase the quality of water and its quantity during drought periods.
Focus group participants will be given the opportunity to express their opinions and concerns regarding these issues of forest conservation and water supply and quality. It is hoped that the information collected from the respondents will be valuable to the policy makers in designing payments for hydrological services that help insure water supply and quality in Veracruz.

WILL YOU RECEIVE ANY COMPENSATION FOR PARTICIPATING IN THIS STUDY?
There is no monetary compensation for participating in this study.

DO YOU HAVE TO TAKE PART IN THIS STUDY?
Taking part in this study is completely voluntary. You may choose not to take part at all. If you agree to participate, you may refuse to answer any question. If you decide not to participate, you will not be penalized or lose any benefits for which you would otherwise qualify.

CAN YOU WITHDRAW FROM THIS STUDY?
If you agree to participate in this study and you then change your mind, you may stop participating at any time. Any data collected as part of your participation will remain part of the study records. If you decide to stop participating at any time, you will not be penalized or lose any benefits for which you would otherwise qualify.

HOW WILL THE CONFIDENTIALITY OF YOUR RECORDS BE PROTECTED?
I plan to maintain the confidentiality of all data and records associated with your participation in this research.

There are, however, rare instances when I may be required to share personally-identifiable information with the following:

- Officials at the University of New Hampshire,
- The sponsor(s), or
- Regulatory and oversight government agencies.

While I plan to maintain confidentiality of your responses, other focus group participants may repeat responses outside the focus group setting.

To help protect the confidentiality of your information, data will be stored on a secure platform

called UNH Box; UNH project investigators Dr. Shadi S. Atallah, Dr. Ju-Chin Huang, Dr. Catherine Ashcraft and Graduate Students Ian McGinnis and Andres Urcuqui will have access to the data; De-identified data might be shared with other researchers on the project; audio-recording will be transcribed and then destroyed. I will report the data in aggregate and using pseudonyms. The results may be used in reports and presentations and will be used to adjust the survey.

WHOM TO CONTACT IF YOU HAVE QUESTIONS ABOUT THIS STUDY

If you have any questions pertaining to the research, you can contact Dr. Shadi S. Atallah (+1-603-862-3233; shadi.atallah@unh.edu) to discuss them.

If you have questions about your rights as a research subject you can contact Melissa McGee in UNH Research Integrity Services, 603-862-2005 or melissa.mcgee@unh.edu to discuss them.

I have enclosed two copies of this letter. Please sign one indicating your choice and return in the enclosed envelope. The other copy is for your records.

Yes, I, _____consent/agree to participate in this research project.

No, I, _____do not consent/agree to participate in this research project.

_____ _____

Signature Date

Appendix C. IRB Approval Letter

University *of* New Hampshire

Research Integrity Services, Service Building
51 College Road, Durham, NH 03824-3585
Fax: 603-862-3564

27-Aug-2018

McGinnis, Ian
NREN, James Hall
56 College Rd
Durham, NH 03824

IRB #: 6983
Study: Households' Willingness to Pay for Hydrological Services in Veracruz, Mexico
Approval Expiration Date: 27-Jun-2019
Modification Approval Date: 23-Aug-2018
Modification: Per memo Request 8/8/18

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved your modification to this study, as indicated above. Further changes in your study must be submitted to the IRB for review and approval prior to implementation.

Approval for this protocol expires on the date indicated above. At the end of the approval period you will be asked to submit a report with regard to the involvement of human subjects in this study. If your study is still active, you may request an extension of IRB approval.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the document, *Responsibilities of Directors of Research Studies Involving Human Subjects.* This document is available at http://unh.edu/research/irb-application-resources or from me.

Note: IRB approval is separate from UNH Purchasing approval of any proposed methods of paying study participants. Before making any payments to study participants, researchers should consult with their BSC or UNH Purchasing to ensure they are complying with institutional requirements. If such institutional requirements are not consistent with the confidentiality or anonymity assurances in the IRB-approved protocol and consent documents, the researcher may need to request a modification from the IRB.

If you have questions or concerns about your study or this approval, please feel free to contact Melissa McGee at 603-862-2005 or melissa.mcgee@unh.edu. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Director

cc: File
,
Atallah, Shady