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Willingness-to-pay for restoration of water quality services across geo-political boundaries

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ABSTRACT

Establishing the value attached to ecosystem services provides instrumental information in the planning of conservation initiatives to ensure forest ecosystem sustainability. This study fills a gap in the literature regarding the value associated with ecosystem services for which their direct use can be challenged by distance and geo-political boundaries. We estimated US residents' willingness-to-pay (WTP) for the restoration of degraded temperate out-of-state and tropical out-of-the-country forested watersheds for improved water quality services under hypothetical payment for ecosystem services (PES) programs. Factors influencing WTP were estimated using a bivariate probit model and mean WTP values adjusted for self-reported certainty of responses. Transboundary economic value decay was reflected on lower households' annual WTP values for the restoration of the tropical out-of-the-country (US$ 124.15–238.30) than temperate out-of-state (US$ 131.70–256.79) forested watershed ecosystems. Bequest and existence were the non-use value motivations most strongly associated with WTP for temperate out-of-state and tropical international PES programs, respectively. Other salient explanatory variables included program cost to households, age, sex, income, household size, political party identification, attitudes towards PES, affiliation with environmental conservation group and direct experience with comparable natural resources. This study offers evidence of positive prospects for transboundary PES programs to restore geographically delimited ecosystem services driven by existence, option and bequest value motivations.

1. Introduction

Values placed on ecosystems and their services are not homogeneous. Ecosystem values can be systematically affected by direct, indirect, and prospective option uses as well as non-use motivations (Bishop, 1999; Pearce, 2001; Juutinen et al., 2014; ten Brink et al., 2011; Small et al., 2017). In some cases, passive and non-uses may comprise the largest values associated with habitat conservation services (Richardson and Loomis, 2009; Haefele et al., 2018). Value motivations, the motivations underlying values for ecosystems and their services, can be heterogeneous across socio-demographic conditions (e.g. income, age, sex), influenced by differing levels of awareness and familiarity of ecosystem functions, and affected by social desirability, among other factors (Ojea and Loureiro, 2007; Obeng and Aguilar, 2018; Haefele et al., 2018). The study of geographic or spatial effects adds another dimension to how economic values placed on ecosystems and their services are affected by physical proximity (Bateman et al., 2006; Hein et al., 2006; Concu, 2007; Kozak et al., 2011; Small et al., 2017; Tammi et al., 2017; Haefele et al., 2018).

Economic value decay of ecosystem services encapsulates the premise that values placed on ecosystem services erode with greater geographic distance and possibly across geo-political boundaries between beneficiaries, an ecosystem, and its services (Felardo and Lippitt, 2016; Ferraro et al., 2015; Loomis and Mueller, 2013; Zander et al., 2010). Economic value decay may be explained by lower levels of public awareness and knowledge of a particular ecosystem (Pate and Loomis, 1997). Beyond social constructs, bio-physical thresholds can limit benefits of localized services such as water purification offered within the boundaries of a watershed catchment area. Effects of geographic distance on values of ecosystem services have been reported by Pate and Loomis (1997), Kozak et al. (2011), Wouter Botzen and van Beukering (2018), among others, and some have derived functions between economic values and distance from particular ecosystem services as in the case of Kozak et al. (2011), Mueller et al. (2009), Mueller (2014a) and Haefele et al. (2018).

Economic value decay has been largely studied for domestic ecosystem services with only a few studies examining this effect across geo-political boundaries. For instance, Hanley et al. (2003), Bateman et al. (2005a), and Bateman et al. (2006) suggest that non-market (particularly non-use) values for ecosystem services can decline across country lines. Declining economic values for ecosystem services of national or international origin might be explained by limited direct and indirect uses associated with

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sheer geography but also national ownership and degree of cultural affiliation (Hanley et al., 2003; Bateman et al., 2005; Bateman et al., 2006). Moreover, Bateman et al. (2006) suggest that the boundary between use and non-use values is affected by site proximity and anticipated increases in resource quality, potentially turning non-users into expected resource users. However, little is known about economic value decay linked to option and non-use value motivations beyond biophysical thresholds and across geo-political boundaries. This study strives to make a contribution to a better understanding of economic value decay for ecosystem services across national and international geopolitical boundaries, and fills a void in the assessment of values derived from ecosystem services where distance can prevent in/direct benefits - but not option and non-use values.

We inferred values associated with an ecosystem service that largely yields direct benefits, but for which geo-political transboundary values might be explained by option and non-use motivations. Transboundary economic value effects and motivations for an ecosystem service yielding direct benefits were assessed with a sample of the US population using a contingent valuation approach with closed-ended willingness-to-pay (WTP) levels. We elicited WTP to restore domestic temperate out-of-state and tropical out-of-the-country degraded forested watersheds contingent on different cost levels for improved water quality through a payment for ecosystem services (PES) program. PES schemes designed to ameliorate market failures by internalizing values associated with non-market ecosystem services are increasingly used to reward landowners or communities for practices that conserve and restore forest ecosystem services. A PES contractual arrangement can be structured using monetary and other incentives financed by the users of ecosystem services (individuals or society as a whole), through general taxation, downstream water use fees, water tariffs, the carbon market, or grants (TEEB, 2010). Such PES schemes offer a framework for the establishment of PES across geopolitical boundaries.

Forested watershed ecosystems were chosen for two reasons. First, watersheds provide and sustain numerous ecosystem services including habitat for diverse aquatic and terrestrial species, offer flooding control and mitigation, among many others, but water quality is its most recognized and valuable service (Brooks and Eckman, 2000; Susswein et al., 2001; Calder and Aylward, 2006; Calder et al., 2007; Aguilar et al., 2018). Second, the benefits of water quality are largely derived from direct and indirect uses, nonetheless, economic values for this ecosystem service might still be derived from option and non-use motivations including bequest, existence and altruistic values. WTP for the restoration of water quality services across geo-political boundaries through a PES scheme was elicited based on a set of cost levels derived from focus group discussions, validated with the literature, and instrumentalized as increases in annual income taxes. Next, we offer a description of our conceptual framework, describe our methods to elicit values for the restoration of water quality services, present and discuss our results in the context of the extant literature, and offer a summary of our main findings.

2. Conceptual framework

The study was guided by (a) The Economics of Ecosystems and Biodiversity (TEEB, 2010) approach to the value of forest ecosystem services which emphasizes their contribution to human wellbeing and (b) the total economic value (TEV) of forest ecosystems which provides a framework that includes all societal values attached to their services (Pearce, 2001; ten Brink et al., 2011). Ecosystem services can be categorized into provisioning, regulating, supporting and cultural services (TEEB 2010). Both the TEV and TEEB approach to valuing these services consider direct, indirect, option and non-use values (Kettunen et al., 2009). Direct use values refer to benefits derived from both consumptive (e.g. timber production) and non-consumptive (e.g. bird watching) uses that directly enter an individual's production or utility functions (Brown et al., 2007; ten Brink et al., 2011). Indirect use values refer to benefits derived from ecosystem services that are an input into production of valuable goods or services yielding utility. For example, well-functioning watersheds provide water purification services, thus, reducing treatment costs of potable water (Pearce, 2001). Option values capture potential future uses and might be reflected on individuals' WTP for environmental goods to ensure their prospective availability (Kumar, 2012). Non-use values are derived from knowing that an ecosystem and their services exist, and/or could be bequeathed. For instance, an individual may value forests for their provision of wildlife habitat services (e.g., spotted owl nesting) but have no plan or intention to visit them (Pearce, 2001; Plottu and Plottu, 2007; Loomis and Mueller, 2013).

TEV of forest ecosystems and their services is exposed to value decay as increasing geographic distances and geopolitical boundaries can challenge their capacity to contribute to beneficiaries' wellbeing. Direct and indirect benefits are inherently affected by geographic proximity (Pate and Loomis, 1997; Bateman et al., 2006). For instance, there are bio-physical limits to benefits such as water regulation and supply within watershed boundaries, and also economic limitations such as production and transaction costs that delineate regional timber product procurement areas (Likens, 2001; Aguilar, 2011). Geographic distance and accessibility can effectively constrain direct benefits such as recreational opportunities and turn them into option uses due to associated greater time and travel expenses. Graphically, this phenomenon is illustrated by a downward-sloping TEV curve (Fig. 1) as a function of proximity that might take a semi-logarithmic form (Kozak et al., 2011). Research by Bateman et al. (2006), Kozak et al. (2011), and Pate and Loomis (1997) offer evidence of the erosion of direct and indirect values as users' distance from a site increases within river or watershed boundaries, nearby counties, or within a state or country, respectively. However, such findings cannot be extrapolated to bio-physical or geopolitical thresholds that largely limit benefits to option and non-use values. We illustrate such truncation in direct and indirect values in Fig. 1 and how socio-political and geographical proximity thresholds can contribute to the decay of remaining option and non-use values. For simplicity, we present lower option and non-use values as a step function, however, they might plausibly follow a continuous form. The argument is not whether option and non-use values follow a decreasingly monotonic value decay function but that greater geographic distance and socio-political thresholds erode them. Wouter Botzen and van Beukering (2018) offer empirical evidence for an overall shift in values for nature protection between continental and Caribbean Netherlands.

2.1. Empirical model specification

We applied a closed-ended multiple-bounded contingent valuation approach (Alberini and Cooper, 2000; Loomis and Ekstrand, 1997) to elicit WTP to restore water quality ecosystem services across geo-political boundaries and their association with option and non-use value motivations. Following the TEV framework, an individual may derive utility based on the

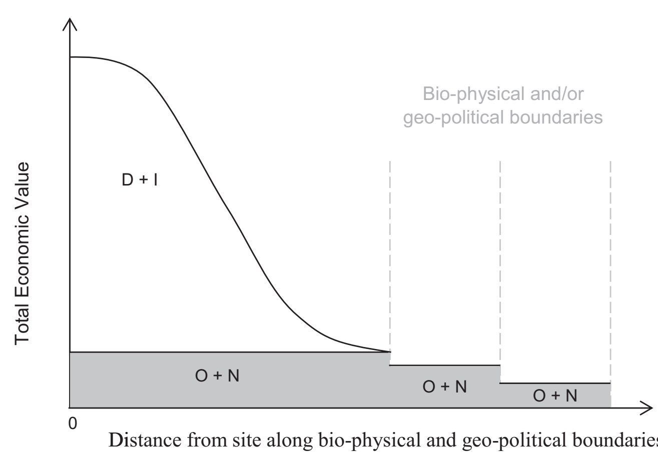

Fig. 1. Conceptualized effect of distance from resources on total economic value for ecosystem services distinguishing between direct (D), indirect (I) option (O), and non- (N) use values. Source: Authors own construct.

satisfaction from a PES program seeking to restore the degraded watershed for improved water quality services, although restoration may not directly contribute to that person's wellbeing. The latent utility (U) for the specific PES program can be systematically affected by cost of the PES program to household (C), an individuals' socio-demographic characteristics (D), Political affiliation (P), economic value motivations associated with the ecosystem services (EV), direct past experience with the resources (E), attitudes towards PES as a conservation mechanism (A), and environmental support (S). By considering WTP for the proposed PES program as a desired benefit yielding to the ith individual (U_i), an income compensation function can be denoted as the actual WTP function (Antony and Rao, 2012; Shang et al., 2012). As per Hanemann (1984, 1989) an individual is willing to pay only if the utility associated with program cost to the household and corresponding improved ecosystem conditions (q_1) is higher than the utility derived from the *status quo* (q_0) (the degraded state) at no additional expense. Generally, utility can be modelled as follows:

$$U_{i,w} = f(q, C\,D, P, EV, E, A, S\,) \tag{1}$$

where w = tropical out-of-the-country, temperate out-of-state

$$\Delta U_{i,w} = f(q_1, C\,D, P, EV, E, A, S) – f(q_0, C\,D, P, EV, E, A, S) \tag{2}$$

Dependent variables can be defined as an individual's WTP for the temperate out-of-state and tropical out-of-the-country PES watershed restoration programs. Of particular interest is whether there is a systematic effect of ecosystem values, in particular non-use and option value motivations, on WTP for transboundary forested watershed restoration initiatives. More specifically, explanatory variables to WTP included in the model (Eq. 1 and 2) are:

a. *Cost to household*: The cost to a household for agreeing to a proposed PES program with levels of 30, 60, 90, 120 and 150 (US$ household^{-1} year^{-1});
b. *Socio-demographic:* Descriptors included five categories of age which were combined to create a binary variable (*Age*: respondents above 45 years = 1; between 18 and 44 years = 0), sex (*Female*: female = 1; male = 0), income with five categories were similarly recoded as binary variable (*Household income*: annual household income greater than US$49,999 = 1; otherwise = 0), household size (*Household size*: household size greater than 2 = 1; otherwise = 0); *Political identification* (*Democrat*: identify as a Democrat = 1; otherwise = 0); (Garber-Yonts et al., 2004; Amponin et al., 2007; Calderon et al., 2012; Kreye and Adams, 2014; Mombo et al., 2014; Roesch-McNally and Rabotyagov, 2016).
c. *Economic value motivations*: Measured on a 5-point Likert scale (1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree) to statements reflecting *option, bequest* and *existence* value motivations (ten Brink et al., 2011; Kettunen et al., 2009). These attitudinal questions were presented prior to WTP questions to capture pre-existing attitudes and reduce issues with endogeneity. Values were transformed to a dichotomous form (1 = Agree or strongly agree, 0 = Otherwise) to capture the strength of respective motivations (Garber-Yonts et al., 2004; Kreye and Adams, 2014; Lindemann-Matthies et al., 2014).
d. *Direct past experience*: Reported past on-site visits to forested watersheds as our proxy variable (1 = has visited, 0 = has not). Visits distinguished between experiences in a US state other than the respondent's current residence (*Experience_ watersheds_US*) and in tropical countries (*Experience_tropical_countries*). This proxy helped distinguish effects of past direct use (e.g. recreation) of geographically-distant resources from option and non-use values (Shultz et al., 1998; Castro et al., 2016; Trujillo et al., 2016; Roberts et al., 2017; Haefele et al., 2018).
e. *Attitudes towards PES:* Measured as the average score to five attitudinal statements towards PES programs recorded on a 5-point Likert scale (1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree) (Moreno-Sanchez et al., 2012; Needham et al., 2012; Duncan, 2014; Kreye et al., 2014).
f. *Environmental support*: Affiliation with environmental conservation groups (*Support ENVgrp)* provides financial support or affiliated with an environmental conservation group = 1; otherwise = 0) was used to denote revealed support to environmental causes (Kramer and Mercer, 1997; Macias and Williams, 2014; Marbuah, 2016).

WTP for the two PES programs was estimated as a binary probability function using a bivariate probit model with two unobserved Y latent variables after the multiple-bounded ordinal responses were recoded into a dichotomous binary value (see data analysis section) to represent WTP following Loomis and Ekstrand (1997):

$$Y_1^* = X'_1\beta_1 + \varepsilon_1 \tag{3}$$

$$Y_2^* = X'_2\beta_2 + \varepsilon_2 \tag{4}$$

where X' and β are the information matrix of explanatory variables from eq. 1 and their respective coefficients, ε_1 and ε_2 are joint distributed errors with means zero, variance of one, and correlation ρ. A bivariate probit model specified observed outcomes where the dependent variable Y_1 denoted 'WTP for temperate out-of-state PES restoration program', and Y_2 'WTP for tropical out-of-the-country PES restoration program':

$$Y_{1\ (WTP\ temperate\ out-of-state)} = \begin{cases} 1\ if\ Y_1^*>0 \\ 0, otherwise \end{cases} \tag{5}$$

$$Y_{2\ (tropical\ out-of-the\ country)} = \begin{cases} 1\ if\ Y_2^*>0 \\ 0, otherwise \end{cases} \tag{6}$$

The generalized bivariate probit model can be written as:

$$P\left(Y_1 = y_i, Y_2 = y_j|X_1X_2\right) = \Phi\left(X'_1\beta_1, X'_2\beta_2, \rho\right) \tag{7}$$

where Φ is the standard cumulative normal probability distribution. The coefficients (β and ρ) can be estimated using maximum likelihood and marginal effects calculated from the magnitudinal differences in Φ of an associated change in explanatory variables at their means, holding other explanatory variables constant.

We tested for the possible endogeneity of attitudes towards PES with our response variable prior to bivariate model estimation. Intuitively, explanatory factors to attitudes might be similar to WTP covariates. Hence, we ran a single-equation probit model with interacted temperate/out-of-state and tropical/out-of-the-country effects where attitude towards PES was instrumentalized and tested for exogeneity. Wald-test statistic showed no statistically significant evidence against the assumption of exogeneity ($p > \text{Chi}^2 = 0.341$). Details of the instrumental variable regression are presented in Appendix 1 (Supplementary data).

We calculated the mean WTP as a measure of economic welfare for the improvement in water quality from both PES scheme using the grand constant formulae (Hanemann, 1989; Loomis and González-Cabán, 1998; Giraud et al., 1999; Giraud et al., 2001; Ojea and Loureiro, 2007):

$$Mean\ WTP = -\frac{\alpha + \sum X\beta}{\beta c} \tag{8}$$

where α is the estimated constant, $\Sigma X\beta$ is the sum of the products of the β coefficients multiplied by their respective means (excluding the cost variable), and βc is the coefficient estimated on the PES cost-to-household effect. The mean WTP for the respective value motivation (*bequest, existence and option*) was estimated using eq. 8 but considering only the estimated coefficient of each value motivation

3. Methods

3.1. Survey instrument

A four-section survey was developed following guidelines by Mitchell and Carson (1989), NOAA (1993), Carson (1999), Pascual et al. (2010), Dillman et al. (2014), and Johnston et al. (2017). The first section introduced ecosystem and ecosystem service concepts, and included questions regarding national and international visitation experiences to forested watersheds and TEV motivations. Questions were accompanied by descriptions and graphical images of different watershed ecosystem services. The second section introduced PES as a concept and gathered overall attitudes towards a PES program as a tool to promote conservation of forested watersheds. A PES program was defined as a market-based compensatory program which comprise of a voluntary and conditional transaction over well-defined ecosystem services or land uses likely to produce services between at least one supplier and one user. Attitudinal questions were preceded by a pictorial description of the concept of PES (Wunder, 2005). The third section included the contingent choice questions. The survey concluded by collecting participants' socio-demographic information.

To exempt in/direct uses and to offer realistic scenarios to our target population (Champ and Bishop, 2001), the description of a domestic out-of-state PES program involved the restoration of a degraded temperate forested watershed in any state within the US other than the respondent's own state of residence. The out-of-country PES program was specified as a conservation program that would restore a degraded tropical forested watershed located in Central America (Honduras) or West Africa (Ghana). These hypothetical PES programs were contextualized to US conditions to reflect on recent national and international restoration efforts. Domestically, recent inter-state litigation seeking compensation for damages of downstream water pollution across US states lines motivated our choice for this transboundary treatment (e.g. Memorandum of Agrreement by and between the Oklahoma Secreatry of Agriculture, the Arkansas Department of Environmental Quality, and the Arkansas Natural Resources Commission, 2018; Attorneys General of Maryland, Virginia, and the District of Columbia, 2020). Federal agencies such as the Environmental Protection Agency and the US Forest Service have been engaged in supporting forested watershed management across state lines (Doppelt et al., 2002). Internationally, there is a long history of US involvement in restoring watersheds largely confined to developing nations in tropical areas associated with support to low-income communities and post-conflict programs (e.g. Leonard, 2000; US Agency for International Development, 2006; US Agency for International Development, 2009; US Agency for International Development, 2019; US Government Accountability Office, 2011). Examples of hypothetical PES program scenarios used in the questionnaire are presented in Fig. 2.

Contingent valuation with closed-ended questions were framed as a stated WTP for PES initiatives to support the restoration of a hypothetical domestic temperate out-of-state and tropical out-of-the-country forested watersheds for improved water quality. Emphasis was solely placed on the restoration of water quality services as WTP estimates may be different from those focusing on a bundle of services and single service provisions (Hjerpe et al., 2015; Obeng et al., 2018). Visual aids and detailed descriptions of a single-service PES focused on water quality and depicted differences between bundled ecosystem services was employed for effective communication (Corso et al., 2001), to ameliorate possible embedding perceptions (Kahneman and Knestch, 1992), and to reduce response bias (Houtven et al., 2014). Furthermore, to meet fundamental considerations for incentive compatibility of WTP questions, we reviewed the literature and completed pre-testing and focus group discussions to ensure realistic scenarios with respect to cost levels and consequentiality.

WTP levels attached to the PES programs were set at US$30, US$60, US $90, US$120 and US$150 per household per year. These cost-to-household levels were derived after an exploratory open-ended questionnaire were

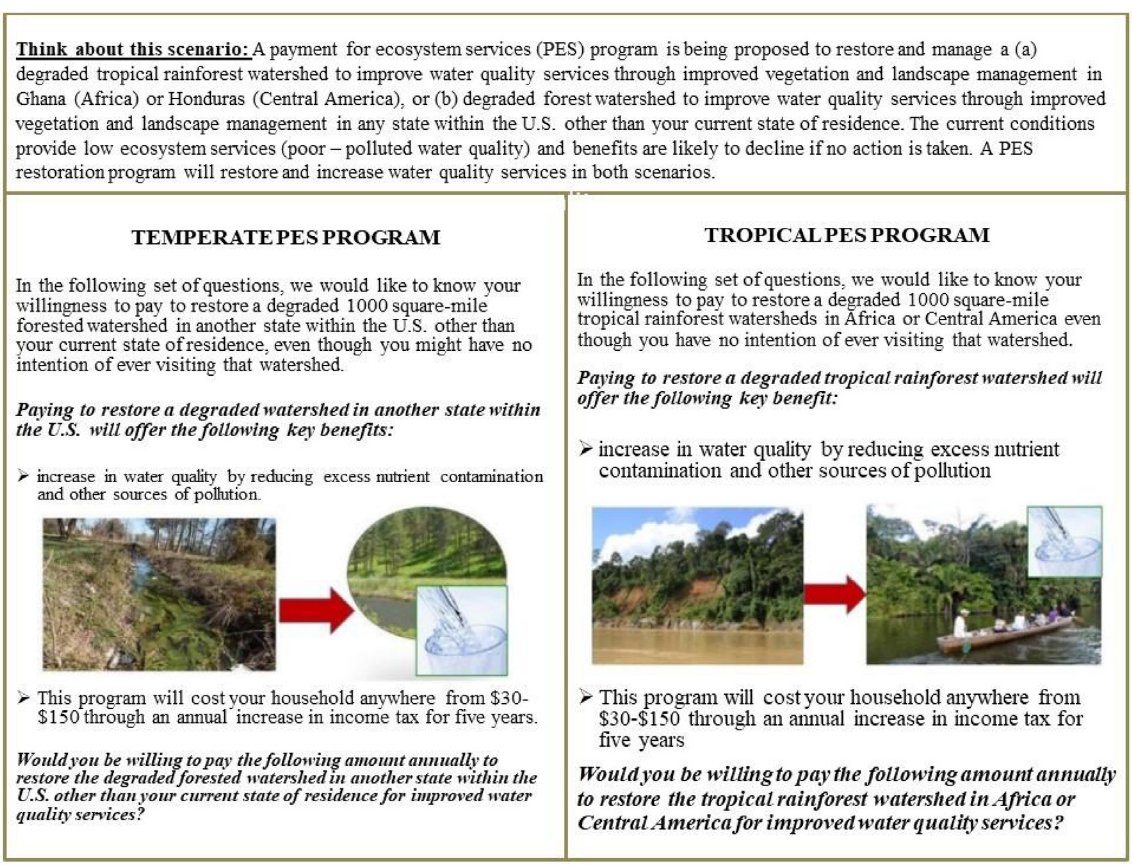

Fig. 2. Descriptive information of the hypothetical PES programs used in the web-based survey. Source: Obeng (2017).

administered to a section of our sample population which requested each respondent to state the amount, they would be willing to pay in each PES scenario. Subsequently, two focus group discussions were organized with 9 individuals in each session to discuss and validate the range of cost levels obtained from the exploratory interviews as well as the suitability of the scenario descriptions and payment vehicle to be used. The selected cost range obtained was further cross-referenced with past studies eliciting WTP for forest ecosystem services and improved water quality (e.g. de Zoysa, 1995; Houtven et al., 2014; Hjerpe et al., 2015; Roesch-McNally and Rabotyagov, 2016).

A multiple-bounded payment approach was used to elicit WTP (Welsh and Bishop, 1993; Loomis and Ekstrand, 1997; Welsh and Poe, 1998; Alberini and Cooper, 2000). The multiple-bounded approach used an ordinal scale to allow respondents to convey their degree of certainty in WTP responses (1 = Definitely not pay this amount, 2 = Probably not pay this amount, 3 = Probably pay this amount, 4 = Very likely pay this amount, 5 = Definitely pay this amount) in response to restoration initiatives at incremental cost levels. This approach meant to not force participants to answer "yes" or "no" without absolute certainty which could bias initial responses (Ready and Whitehead, 1995; Loomis and Ekstrand, 1997). All respondents answered questions on both the temperate out-of-state and tropical out-of-the-country treatment. Each participant was asked to respond to 10 total scenarios equally split between the two PES programs (i.e., five cost levels in sequential order for each program). During this process the different PES household cost levels were not previewed, and respondents were given the option to adjust previous answers at will. The 5-point ordinal responses were recoded into dichotomous values to represent WTP. A value '1' was assigned when respondents chose either "Definitely willing to pay this amount" or "Very likely pay this amount" and '0' when the choice was "Probably pay this amount, "Probably not pay this amount" or "Definitely not pay this amount". This approach is consistent with that of Loomis and Ekstrand (1997) as well as the voting literature (Polasky et al., 1996; Magelby, 1989) which usually treats undecided answers as negative responses.

The payment vehicle of an annual income tax increase was chosen after the focus group discussions and careful pre-testing in order to minimize response strategic bias by being credible, binding, and familiar to the sampled population (Shultz et al., 1998; Johnston et al., 2017; Wouter Botzen and van Beukering, 2018). Given the national scope of our survey, income tax was the only instrument that would have had uniform consequences across the US. Moreover, it was coherent to have a form of financial resource transfer through the federal goverment as US federal agencies such as the US Environmental Protection Agency and Agency for International Development have previously engaged in domestic and international watershed restoration efforts. We also included a protest question regarding paying additional income tax to improve conservation initiatives (Morrison et al., 2000). It allowed us to assess the potential of payment vehicle bias and ascertain how respondents appraise income tax as a payment tool. To reduce bias due to consequentiality issues, we further included a 'cheap talk' script (Fig. 2) to remind respondents about the financial implications of their WTP choices (Cummings and Taylor, 1999; Blumenschein et al., 2008; Ninan, 2014; Vásquez-Lavín et al., 2016). Furthermore, the WTP elicitation questions was followed by a 5-point Likert-certainty scale to capture participants' confidence in responses in order to address potential certainty bias (Champ and Bishop, 2001; Mueller, 2014b; Vásquez-Lavín et al., 2016).

3.2. Data collection

Data collection followed recommended guidelines for web-based surveys (Dillman et al., 2014). The survey was administered online to 1200 randomly sampled US residents, 18 years of age or older and recruited through the market intelligence company Survey Sampling International (SSI). SSI maintains a pool of over 7 million resident online panelists in the US recruited by employing a multi-sourced approach through partnerships with established membership programs and media outlets. SSI sample quality measures include digital fingerprinting to prevent duplication, spot-checking via third-party verification to prove identity, benchmarking against known external data points and consistency on a number of personality and psychographic measures. Each participant was allowed to complete one survey only and data collection was terminated once the targeted number of complete surveys was attained. Our sample conforms to similar studies making inferences about the US population using online panelists (e.g. Aguilar and Cai, 2010; Jensen et al., 2010; Meldrum, 2015; Presnall et al., 2015). Sample representativeness was explored by comparing socio-demographic information with the most recently available US Census data (United States Census Bureau, 2015; Ryan and Bauman, 2016). All data collection protocols were approved for compliance with Human Subject research.

3.3. Data analysis

Descriptive statistics including test-statistics for significant differences in proportions and means were performed on attitudes towards PES and value motivations associated with respondents' willingness to pay for forested watershed ecosystem protection. With regard to factors influencing WTP, two different model specifications were estimated. The first model controlled for the effects of PES cost, geographic location of the PES program, socio-demographic characteristics, economic value motivations, experience with resource, attitude towards PES as a conservation mechanism and support for environmental conservation initiatives on WTP for the improved forested watershed ecosystem services. The second model controlled for the likely extent of WTP uncertainty in the first model (Champ and Bishop, 2001; Hausman, 2012; Mueller, 2014a). Following Blumenschein et al. (2008) and Mueller (2014b), the dichotomous WTP responses were recoded based on answers to self-reported certainty questions (1 = Not at all certain to pay; 2 = Slightly certain to pay; 3 = Somewhat certain to pay; 4 = Absolutely certain to pay) that followed the stated payment preferences. A strict threshold point of '4' on the numerical certainty scale was followed to recode positive binary responses of '1' to '0' if certainty was rated as less than '4' (Shaikh et al., 2007). The recoding followed an asymmetric certainty approach that allows all original negative '0' responses to remain unaltered and without losing data (Akter et al., 2008; Vásquez-Lavín et al., 2016). Differences between the uncertainty-adjusted and unadjusted models were subsequently gauged.

4. Results

Our final sample included 1002 respondents after screening for completeness. Comparison with demographics of the US population (Table 1) shows that respondents' sex, household size, urban and rural residency, and annual household income closely resembled the census data (United States Census Bureau, 2015; Ryan and Bauman, 2016). Adjusting the US census age data to exclude those under 18 years of age shows that 52.6% of the country's population was above 44 years old which closely matched the respective share in our sample (52.1%). We found our sample was skewed towards greater representation of individuals with an advanced education. Approximately 30% of our respondents had attained graduate level education which is higher than the 12% reported in national statistics (Ryan and Bauman, 2016). Appendix 2 (Supplementary data) tabulates demographic information.

4.1. Descriptive statistics

Table 2 presents the distribution, mean and standard deviations of self-reported attitudes towards PES as a forest protection and restoration tool. Attitudinal responses suggest a degree of support for PES initiatives with lower desirability beyond national boundaries. Over half of respondents (64.1%) agreed or strongly agreed to the statement "*Paying landowners to manage and protect forest for ecosystem services under PES is desirable*". Nearly half of respondents (49.3%) agreed or strongly agreed with the statement "*it is my right to have a well preserved forest and I should not have to pay extra for it through mechanisms such as PES*". Some 44.4% of respondents

Table 1
Summary of sample demographic characteristics of respondents from our study data compared with US census data.

Socio-demographic variables[b]	Sample $n = 1002$ (%)	US Census [a]$n = 150,147$ (%)
Residence		
Urban and urban clusters	81.44	80.70
Rural	18.56	19.30
Education attainment		Education attainment of the population 18 years and over
Some high school to high school, or general education development test	33.13	29.57
Some college or post high school training	17.56	28.38
College degree	18.76	19.20
Graduate degree or graduate professional degree	30.04	12.00
Other forms of education	0.50	n.a.
Age		Population age distribution, 2012 (size = 234,719)[a]
18 to 24 years	11.08	
25 to 34 years	18.26	
35 to 44 years	18.56	
(Cumulative distribution: 18 to 44 years)	*(47.90)*	*(47.41)*
45 to 54 years	19.86	
55 to 64 years	15.57	
(Cumulative distribution: 45 to 64 years)	*(35.43)*	*(34.90)*
≥65 years	16.67	*17.68* (≥65)
Sex		
Male	47.90	49.10
Female	52.10	19.30
Support/affiliation with environmental conservation group		
Yes	17.07	n.a.
No	82.93	n.a.
Political affiliation	(%)	
Democrat	42.22	n.a.
Republican	21.96	n.a
Other	35.82	n.a
Annual household income		Total annual household income in 2014
<$30,000	32.14	28.63
$30,000–$49,999	19.96	18.12
$50,000–$99,999	24.35	32.64
$100,000–$119,999	10.98	6.66
>$120,000	12.57	18.01
Household size (number of persons)		All households by size (124,586)
One	20.96	27.99
Two	33.93	33.62
Three	19.16	15.50
Four	16.27	13.21
> Four	9.68	9.69

Country population data sourced from the U.S. Census Bureau, Current Population Survey (2015) Annual Social and Economic Supplement; Ryan and Bauman (2016). n.a. = Not available.

[a] Census data (Age distribution for 2012; 234,719 is the total sample size without the population below 18 years) was adjusted by excluding age category 'below 18'.

[b] See appendix for cross-tabulation of different characteristics.

expressed skepticism in PES outcomes by agreeing or strongly agreeing with the statement "*Incentives to landowners may not guarantee continuous commitment to good management practices, therefore, PES is not desirable*". Over a third (39.2%) of respondents strongly disagreed or disagreed with the statement regarding financial commitment to restore and manage degraded tropical forested watersheds outside the US. A similar program at a local or national level seemed more acceptable (29.2% of respondents disagreed or strongly disagreed). Some 43.2% and 33.5% of respondents agreed or strongly agreed to the statements "*My household should pay landowners to restore and manage degraded forested watersheds near my residence*" and "*My household should pay landowners to restore and manage degraded forested watersheds in any state within the US*", respectively.

Responses to statements of value motivations for WTP for forested watershed ecosystem protection are presented in Table 3. Nearly 59% indicated bequest values as a motivation for WTP (*I am willing to pay to protect forested watersheds in the US and around the world for the benefits of future generations*). Over half of respondents (56.2%) agreed or strongly agreed with the statement "*I am willing to pay to protect forested watersheds for my personal current and future use*" inferring direct and option uses as motivations for their WTP. Existence values captured similar support with 51.4% of respondents at least agreeing to the statement "*I am willing to pay to protect forested watersheds in the US and around the world to exist, whether I benefit from them or not*". The mean of the 5-point Likert scale for bequest values was greater than existence and direct/option values ($p < 0.001$). Regarding experiential direct use, 22.5% of respondents had visited tropical forested watersheds compared to 44.3% within the US.

4.2. Factors influencing willingness-to-pay to restore water quality services of degraded forested watersheds

Results of the bivariate probit regressions are presented in Table 4. Descriptive details on WTP for the PES program at different cost levels distinguishing by location are presented in Appendix 3 (Supplementary data). Results of the re-coding based on certainty in WTP responses improved model fitness as denoted by lower AIC and BIC estimates in model 2. Approximately 66.0% of respondents reported to be very to absolutely certain of their responses, 30.3% somewhat certain, 10.5% slightly certain and 8.5% were not at all certain. The overall fitness of the binary models show they are statistically strongly significant (Wald test, $p < 0.001$). The likelihood ratio test rejects the null hypothesis of zero correlation between the simultaneous equations ($p < 0.001$) validating the use of the bivariate probit specification. Results consistently show that PES cost per household per year, and age (i.e. respondents older than 45) had a negative and significant effect ($p < 0.001$) on WTP for both the out-of-state temperate national and out-of-the-country tropical PES programs. The sex of respondent being a female had an inverse and significant effect in the out-of-state national PES program but was statistically insignificant in the out-of-the-country PES program in both models. Household income was similarly insignificant in the national out-of-state program but significantly predicted WTP for the out-of-the-country program. To the contrary, political affiliation (*Democrat*), experience with watershed resources in similar locations (other state and other countries), positive attitudes towards PES and support for environmental groups had consistently statistically positive effects. Although political affiliation significantly predicted respondents' willingness to pay for the national and international PES programs it was insignificant in predicting the out-of-state national program when stricter payment certainty threshold was applied. Experience with watershed resources in similar locations within the US had a positive and statistically significant effect on WTP for both the out-of-state and out-of-the-country PES programs. Attitude towards PES as a conservation mechanism and current support to an environmental NGO both had a significant impact in predicting WTP for both the out-of-state and out-of-the-country PES programs.

There were no statistically significant effects of household income and size on WTP for the national out-of-state program but significantly predicted WTP for the out-of-the country program. However, while income had inverse effect, family size had positively predicted WTP for the international program. To the contrary, both variables (income and family size) were insignificant when a stricter payment certainty threshold was applied. Option, bequest and existence value motivations were all positive and statistically significant in predicting WTP for the out-of-state national PES, but only option and existence motivations exhibited associations significantly different from '0' with the restoration of out-of-the-country forested watershed. A similar trend is evident when WTP was controlled for by certainty in responses, except option values was no longer significant in predicting willingness to pay for the out-of-the-country PES program.

At the average, marginal effects showed that a US$1.00 increase in the cost of the program was associated with a 0.1% decrease in the predicted probability of being willing to pay for the out-of-state program. Respondents

Table 2
Attitudes towards PES as a forest protection and restoration mechanism.

Statements	Level of agreement (% respondents)					Mean	Std. dev.
	1	2	3	4	5		
Paying landowners to manage and protect forest for ecosystem services under PES is desirable[a***]	2.30	4.79	28.84	43.01	21.06	3.76	0.92
Incentives to landowners may not guarantee continuous commitment to good management practices, therefore, PES is not desirable[***]	3.49	12.38	39.72	29.24	15.17	3.40	1.00
It is my right to have well preserved forests and I should not have to pay extra for it through programs such as PES[***]	2.89	12.08	35.73	31.04	18.26	3.49	1.02
Most people who are important to me (for example family members, friends) would expect me to participate in a PES program and pay to protect forest for ecosystem services[a***]	7.68	15.87	40.82	23.35	12.28	3.17	1.08
My household should pay landowners to restore and manage degraded forested watersheds near my residence or within my state[a***]	12.28	11.38	33.13	31.54	11.68	3.19	1.16
My household should pay landowners to restore and manage degraded forested watersheds in any state within the U.S.[a]	12.77	16.47	37.23	25.25	8.28	2.99	1.12
My household should pay landowners to restore and manage degraded tropical forested watersheds outside the U.S.[a***]	18.16	21.06	34.23	18.26	8.28	2.78	1.18

1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree.
[a] Attitudinal statements used to construct the proxy variable "*PES Attitudes*" based on α reliability test of responses (α value of 0.85).
[***] p-value <0.001 of mean being different from '3' (Neither agree nor disagree).

Table 3
Option and non-use value motivations associated with WTP for forested watershed ecosystem protection.

Statements	Value typology	Distribution (%) of responses					Mean	Std. Dev.
		1	2	3	4	5		
I am willing to pay to protect forested watersheds for my personal current and future use[***]	*Option*	7.09	5.89	30.84	41.02	15.17	3.51	1.05
I am willing to pay to protect forested watersheds in the U.S. and around the world for the benefits of future generations[***]	*Bequest*	7.39	5.09	28.84	40.12	18.56	3.57	1.08
I am willing to pay to protect forested watersheds in the U.S. and around the world to exist, whether I benefit from them or not[***]	*Existence*	7.98	9.18	31.44	36.33	15.07	3.41	1.09

1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree.
[***] p-value <0.001 of mean different from '3' (Neither agree nor disagree).

above 45 years of age showed a 3.2% lower probability to be willing to pay than younger participants. On average, females were 1.7% less likely to be willing to pay for the out-of-state program than males. Respondents who reported identification with the Democratic Party have 1.2% higher probability to be willing to pay for the national out-of-state PES program than those who reported other or no affiliation.

Marginal effects on WTP for the out-of-state national program show that respondents who agreed or strongly agreed to statements reflecting option and existence values respectively had a 2.7% and 2.7% higher WTP probability. Among the three motivation variables, bequest values had the strongest predictive impact. On average, respondents who agreed or strongly agreed to the statement reflecting bequest values had a 4.7% higher probability to be willing to pay for the out-of-state national PES program. Respondents with past visit experience of watersheds in another state had 1.7% higher WTP probability for the out-of-state PES program than those who had none. Respondents who financiallly support a conservation group had 1.7% higher WTP probability for the out-of-state PES program. Overall, attitude towards PES as a conservation mechanism had the strongest significant effect on WTP for the out-of-state PES program. On average, respondents with favourable attitude towards PES had a 6% higher probability to be willing to pay for the domestic out-of-state national PES program than otherwise.

Regarding marginal effects on WTP for the out-of-the-country PES programs, respondents older than 45 had a 4% lower WTP probability for the out-of-the-country program than otherwise. On average, respondents with an annual income of approximately fifty-thousand dollars or more had a 1.6% lower WTP probability than those with lower income. The significantly positive marginal effects of *household size* suggest that respondents with households of more than 2 persons had a 1.5% higher likelihood to be willing to pay for the out-of-the-country PES program than otherwise. Similarly, the significantly positive marginal effects of the variable *Democrat* suggest that on average, respondents who reported identification with the Democratic Party had 1.4% higher WTP probability ($p < 0.05$) for the international PES program than those who reported other or no affiliation. *Existence* and *option* were the only value motivation variable that had a statistically significant impact on WTP for the out-of-the-country international PES program. Those who agreed or strongly agreed to statements reflecting existence and option values have a 2.2% and 1.5% higher WTP probability ($p < 0.05$ and $p < 0.1$) for the out-of-the-country international PES program than otherwise.

Experience with geographically distant forested watersheds located in another state in the US and support for environmental organization were statistically significant in predicting WTP for the international PES program at $p < 0.1$ and $p < 0.05$ levels, respectively. Those who have such experience have a 1.3% higher probability to be willing to pay for the out-of-the-country PES program than otherwise. On average, respondents who provide financial support to environmental organization have 2% higher probability to be willing to pay. Similar to the out-of-state national PES program, the strongest predictor of WTP for the out-of-the-country PES program was attitude towards PES as a conservation mechanism. On average, respondents with favourable attitude towards PES have 5.7% or 5.4% higher probability ($p < 0.001$) to be willing to pay for the out-of-the-country program depending on whether respondents WTP certainty threshold is applied. Overall, comparison between expanded Models 1 & 2 shows very limited noticeable differences in marginal effects except in the variable existence with a marginal effect of 0.027 in model 1 relative to 0.043 in the certainty-controlled model (Model 2).

Table 5 shows computed mean economic values (mean WTP) and confidence intervals from the bivariate regression model. The computed amounts also reflect on the relative value of each economic motivation to restore water quality services in both locations. Overall, average economic values per household per year for the restoration of a 1000-mile^2 out-of-state national and out-of-the-country forested watersheds through a PES program were estimated at US$ 131.70 and US$ 124.15 respectively. The computed economic values for the certainty-adjusted data were US$ 256.79 and US$ 238.30 per household per year for the restoration of an out-of-state national and out-of-the-country restoration PES programs, respectively. Effectively, respondents more certain in their choices (about

Table 4
Parameter estimates from bivariate probit model of WTP for improved water quality services of geographically-distant out-of-state temperate and out-of-the-country tropical forested watersheds ($n = 10{,}020$).

Response variable	Explanatory variables	Unadjusted			Certainty-adjusted		
		Coefficient (β)	Standard error	Marginal effects	Coefficient (β)	Standard error	Marginal effects
Out-of-state temperate forested watershed	Cost to household	−0.008***	0.001	−0.001	−0.006***	0.001	−0.001
	Age (>45)	−0.206***	0.048	−0.032	−0.213***	0.064	−0.026
	Female	−0.106**	0.045	−0.017	−0.096*	0.056	−0.012
	Household income (≥$50 K/year)	0.035	0.043	0.007	−0.012	0.056	−0.001
	Household size (>2 persons)	−0.007	0.046	−0.002	−0.064	0.059	−0.009
	Democrat affiliation	0.082*	0.043	0.012	0.048	0.055	0.006
	Option	0.167**	0.062	0.027	0.167*	0.089	0.021
	Bequest	0.288***	0.070	0.047	0.221**	0.099	0.028
	Existence	0.175**	0.067	0.027	0.338***	0.090	0.043
	Experience: Temperate-US	0.109**	0.049	0.017	0.146**	0.063	0.018
	Experience: Tropical-other countries	0.046	0.052	0.007	0.118*	0.063	0.015
	Attitudes PES	0.382***	0.036	0.060	0.502***	0.049	0.063
	Support *E*-NGO	0.107**	0.052	0.017	0.161**	0.062	0.020
	Constant	−2.183***	0.124		−3.110***	0.173	−0.001
Out-of-the-country tropical forested watershed	Cost to household	−0.007***	0.001	−0.001	−0.005***	0.001	−0.001
	Age (>45)	−0.312***	0.060	−0.040	−0.321***	0.075	−0.033
	Female	−0.079	0.053	−0.010	−0.060	0.063	−0.006
	Household income (≥$50 K/year)	−0.117**	0.053	−0.016	−0.097	0.063	−0.010
	Household size (>2 persons)	0.114**	0.056	0.015	0.057	0.068	0.006
	Democrat affiliation	0.152**	0.050	0.019	0.138**	0.060	0.014
	Option	0.123*	0.074	0.015	0.139	0.101	0.014
	Bequest	0.090	0.084	0.010	0.156	0.112	0.016
	Existence	0.174**	0.075	0.022	0.231**	0.097	0.023
	Experience: Temperate-US	0.104*	0.058	0.013	0.131*	0.071	0.013
	Experience: Tropical-other countries	0.032	0.061	0.004	0.061	0.071	0.006
	Attitudes PES	0.453***	0.042	0.057	0.582***	0.054	0.060
	Support E-NGO	0.156**	0.060	0.020	0.202***	0.070	0.021
	Constant	−2.527***	0.151		−3.486***	0.196	−0.001
ρ correlation of error terms		−0.917	0.017		−0.952	0.018	
Fisher's z transformed ρ correlation		−1.571***	0.108		−1.847***	0.190	
Log pseudo-likelihood		−5257.4931			−4174.6454		
Wald Chi^2 (26) =		1496.76			1092.06		
Prob > Chi^2 =		0.001			0.001		
Wald test of ρ =		0.001			0.001		
Chi^2(1) =		216.77			94.7254		
BIC		10,782.14			8617.693		
AIC		10,572.99			8408.535		

Type-I errors: * $p < 0.1$; ** $p < 0.05$; ***; $p < 0.001$.

Table 5
Estimated perceived economic option and non-use values (mean WTP and 95% confidence intervals) for improved water quality services resulting from restored geographically-distant out-of-state national and out-of-the-country forested watersheds.

WTP (US$/household/year)	Model used for estimation	Overall	Option	Bequest	Existence
Out-of-state national temperate forested watershed	Unadjusted	131.70*** [97.57, 165.84]	20.17** [5.31, 35.02]	34.85*** [17.88, 51.83]	21.12** [5.00, 37.22]
	Certainty-adjusted	256.79***[177.15, 336.43]	28.94** [−1.41, 59.28]	38.37** [4.19, 72.54]	58.51*** [26.11, 90.90]
Out-of-the-country tropical forested watershed	Unadjusted	124.15*** [77.99, 170.31]	16.85* [−3.02,36.73]	12.22* [−10.39, 34.84]	23.74** [3.22, 44.24]
	Certainty-adjusted	238.30*** [151.47, 325.14]	26.74* [−11.29, 64.77]	29.99* [−12.68, 72.65]	44.45** [6.55, 82.35]

Statistical significance: * p-value <0.1; ** p-value <0.05; ***; p-value <0.001; 95% confidence intervals [_, _] computed using the Delta method.

two-thirds of our sample) exhibited greater WTP. Economic values associated with different motivations ranged from US$ 12.22 to US$ 58.51 per household per year depending on whether certainty in stated WTP responses were censored. For the out-of-state national restoration program, *Bequest* motivations revealed the highest estimated mean economic values followed by *Existence* and *Option* values. However, when the strict certainty threshold was applied to WTP, existence values elucidated the highest mean value (US$ 58.51) followed by *Bequest* (US$ 38.37) then *Option* value motivations (US$ 28.94). A similar trend was noted when the strict certainty threshold was applied in the out-of-the-country PES program with *Existence* value motivation revealing the highest mean economic values per household per year followed by *Bequest* and *Option* values.

5. Discussion

Our findings point to heterogeneous preferences for selected PES restoration programs. Attitude towards PES as a forest conservation initiative had the strongest effect on WTP in both programs and is consistent with findings reported by Duncan (2014), Moreno-Sanchez et al. (2012), and Needham et al. (2012). Additionally, positive attitude towards paying for conservation, affiliation with environmental conservation or related clubs showed a positive and significant effect on WTP. This trend of a positive association of environmental attitudes and WTP is consistent with Amponin et al. (2007) who found a positive correlation between the support for environmental groups and WTP for watershed protection in the Philippines and also with arguments by Stern et al. (1995) and Johansson-Stenman (1998) that perceptions, beliefs and environmental attitudes have relatively stronger predictive impact on WTP than socio-demographics. Other implications from our study, relevant to WTP elicititation but not in direct response to our study questions are discussed in Appendix 4 (Supplementary data).

We found evidence of economic transboundary value decay for ecosystem services. We posit that the difference in elicited mean WTP between out-of-state national and out-of-the country water quality restoration programs was partly driven by a lower probability of future uses (option values), or plausibly less interest in supporting residents of other states or countries as direct and indirect benefits of water quality services were negligible in the two scenarios. For example, Haefele et al. (2018) found U.S. households would be willing to pay US$30.00 annually to protect habitat of a transborder migratory species (Mexican free-tailed bat) in the US but US$24.00 annually to protect its habitat in Mexico. Nevertheless, values obtained for the out-of-state domestic program -particularly when the stricter certainty threshold on WTP were employed - are in range with past studies that estimated perceived economic values of benefits of improved watersheds among US residents. For example, Roesch-McNally and Rabotyagov (2016) obtained lower and upper bound values of US$114.83–206 household^{-1} year^{-1} in voluntary payments for improved forest ecosystem services in Oregon. A median WTP of US$ 114.72 household^{-1} year^{-1} for protection of watersheds in Flagstaff, Arizona was obtained by Mueller (2014a), who also applied a stricter threshold point on a numerical certainty scale in their estimation. In our case, lower estimates for bequest and option values of US$12.22 and US$16.85 household^{-1} year^{-1}, respectively, for the international PES program likely point to how distance challenges future option use and bequest benefits. Similar observation is noted even in the estimation from the stricter certainty-adjusted model.

Econometrically, non-use bequest and existence value motivations showed stronger statistical significant and positive effect on WTP for the out-of-state national program. Furthermore, bequest had the highest estimated mean economic values relative to option and existence value motivations. However, when a stricter threshold certainty was applied, respondents were willing to pay more for a distant national forest watershed to exist (existence values) than a motivation for future use (option values) and bequeathing intentions (bequest values). Our results likely suggest that even without localized benefits, individuals might be willing to pay to support restoration of distant degraded ecosystems (e.g., Wouter Botzen and van Beukering, 2018) for its existence and for future generations particularly, within their national boundaries. This is congruent with findings by Kreye and Adams (2014) who reported high ratings for bequest values relative to option and existence motivations for water protection in the US. Given that heirs among US residents are plausibly more likely to benefit from watershed services within the country, it is reasonable to expect that bequeathing and existence reasons yielded higher mean economic values for the PES restoration programs within the US.

The strongest value motivation behind WTP for the international PES program was from existence values. Dallimer et al. (2015) in their assesssment of public preferences for ecosystem services in home countries and across international borders for example, found that people in Estonia, Denmark and Poland were generally willing to pay for ecosystem services but even more for locally delivered ones. They suggest that ecosystem services with use and indirect use (e.g. habitat conservation, landscape preservation) might gather a “patriotic” premium, thus, international services carry lower values. In our case, the lower likelihood of bequeathing foreign ecosystems and their services to one's heirs might offer an explanation for transboundary economic value decay in restoration efforts. An out-of-the-country, tropical ecosystem that is not within a bio-physical or geo-political proximity – as in the case of most in our target population - but command essential environmental benefits and might be desirable to continue to exist in the future due to altruistic reasons and perhaps option values. The marginal effect of existence motivations on WTP might reflect on altruistic reasons that might be reinforced on family intergenerational motives to preserve wellbeing (Gatti, 2005) - which we found in the significant effect associated with household size being greater than two.

Overall, we found evidence of a relationship between non-use values and WTP for PES programs even in the absence of in/direct benefits. Individuals may have a desire for the preservation of an environmental resources in this case, forested watersheds for it to exist, on altruistic grounds and also to benefit heirs and future generations, particularly within their home country. It is also worth noting that past experience with a comparable resource significantly predicted higher WTP for both programs. We posit that direct experiences might contribute and generate greater economic value for the improved conditions of the degraded forested watershed ecosystem particularly those in the US based on existence value motivation. For instance, Trujillo et al. (2016) reported higher mean economic values for coral reef conservation efforts in the Colombian Caribbean among past scuba divers who have had direct experience. Such values might not be limited to past experience but extended to intended future use as implied by Kramer and Mercer (1997) who found a positive correlation between intentions to visit tropical rainforests and WTP among US residents. This is also confirmed by the findings in this study as option values had strong statistically significant effect on WTP for the out-of-state national PES program, and marginally significant impact on the out-of-the-country PES program.

5.1. Study limitations

We point to various limitations in our study. First, most sociodemographic characteristics in our sample were comparable with the US census data but individuals with advanced education seemed to be overrepresented as is disclosed in the Results section. Thus, we are precluded from making incontrovertible statements extending findings from our sample to the US population. Second, the use of annual increase in income tax is not exempt from potential response bias. The payment instrument was selected based on criteria for being realistic, credible, binding, and familiar, and chosen after careful pre-testing (Johnston et al., 2017). However, our estimates cannot be deemed free of potential response bias possibly rooted in social desirability, avoidable consequences, and free ridership motivations, among others (Leggett et al., 2003; Johnston et al., 2017). Negative bias (Johnson and Scicchitano, 2000) against the income tax instrument might be rooted in a general lack of trust in government institutions among a large segment of the US population; and it was a strong motivation to include a protest and certainty questions (e.g. Cook and Gronke, 2005; Zeleny and Thee-Brenan, 2011). While our survey pre-tests pointed to the minimization of payment vehicle bias our results cannot be considered fully free of its potential effects. Third, the restoration program profiles were explicit about water quality as the one service that the PES would be supporting. Nonetheless, when engaging in ecological restoration other services can be supported which could expose our scenarios to possible perceived embededness. Furthermore, differences in possible domestic and international program implementation costs were not explicitly controlled for because we were mainly interested in the value that participants place on water quality across geopolitical boundaries. This is a limitation as mean WTP values may not be financially sufficient to support watershed restoration (Cummings and Taylor, 1999). Lastly, as previously noted, our profiles are faced with the empirical inability to discern tropical/temperate regional from geopolitical boundaries. This remains an area where further research is warranted as other ecological services in addition to water quality can be different between tropical and temperate regions. Thus, it will be valuable to better understand sole regional effects. We offer our findings within these caveats.

6. Conclusions

We assessed whether US households would be willing to pay to restore water quality ecosystem services in degraded forested watersheds of another state or country. We elicited WTP using a contingent choice for PES programs that would restore improved water quality services of geographically-distant degraded forested watersheds challenging in/direct uses but potentially holding option and non-use values. Results show that favourable attitudes towards PES as a forest conservation mechanism, past experience, economic value motivations, support for environmental conservation groups, political party identification, and age were salient explanatory factors behind WTP for either program. Positive attitudes towards PES were the strongest predictor. Other socio-demographic information such as household income and size, and sex showed heterogeneous effects between hypothetical PES programs. Economic value motivations exhibited stronger marginal effects on WTP than socio-demographic information.

As hypothesized, we found lower mean economic values for restoring water quality services within out-of-the-country international PES program as compared with the out-of-state national PES programs partly explained by option and non-use value motivations. Option, bequest and existence values had a significantly positive marginal effect on WTP for restoration of an out-of-state national forested watershed. Existence, and option (only statistically significant in the original model without a strict certainty threshold), values had positive and significant marginal effects on WTP for the out-of-the country forested watershed PES program. Corresponding marginal effects of bequest motivation were not statistically significant. These trends might reflect on the greater likelihood of prospective personal and/or heirs'use of domestic watersheds. In the case of international PES restoration programs, motives to preserve the existence of these ecosystems, regardless of use, might point to more altruistic root causes and perhaps future option motivations. Direct past experience as captured by visiting a watershed, might counter economic value decay. Lower overall mean economic values for water quality services from restoration of distant ecosystems suggest economic value decay extends beyond bio-physical and geo-political boundaries. Elicited certainty-adjusted mean economic value to restore water quality services of an international forested tropical watershed was US$238.30 household^{-1} year^{-1} (non certainty-adjusted = US $124.15 household^{-1} year^{-1}) compared with US$256.79 household^{-1} year^{-1} (non certainty-adjusted = US$131.70 household^{-1} year^{-1}) for a domestic out-of-state program, or about 8% lower value.

This study has important implications informing policies on future PES conservation initiatives in a US context. It recognizes that WTP for domestic ecosystem restoration initiatives is supported by option and non-use (bequest and existence) economic value motivations even when distance prevents in/direct benefits. In the case of international initiatives, these are grounded on existence value motivations. WTP for restoration using a PES program is strongly contingent on the public's general attitudes towards such initiatives. This is early evidence of positive prospects for transboundary PES programs to restore locally-delimited ecosystem services. People may exhibit altruistic behaviors in their WTP for conservation of ecosystem services they may never enjoy driven by existence and bequest motivations.

Declaration of Competing Interest

In reference to our submitted article titled "*Willingness to pay for water quality restoration from degraded forested watersheds across geo-political boundaries*", we the authors write to confirm that we have no conflict of interest in the submission of this manuscript for publication in Current Research in Environmental Sustainability.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.crsust.2021.100037.

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