Case Study

Willingness to Pay for Ecosystem Services among Stakeholder Groups in a South-Central U.S. Watershed with Regional Conflict

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Abstract: Ecosystem services valuation has become a popular approach to weighing trade-offs in environmental management, particularly where natural resources such as freshwater are limited. The authors assessed multiple stakeholders' social perception regarding a suite of ecosystem services in a south-central U.S. watershed that is water stressed and experiencing intense sociopolitical conflict. First, the ecosystem service beneficiaries were identified and characterized according to how they use and value ecosystem services. Second, the factors underlying social importance and economic support for maintaining these ecosystem services were analyzed. Finally, a willingness to pay approach was used to identify the economic value of services and explored potential biases in water management based on social and cultural attributes. Results (1) identified habitat for species and water quality as the most important and economically valuable ecosystem services, respectively, and (2) uncovered potential conflicts between water user groups based on whether or not they resided in the watershed. The authors suggest managers can use results (1) for dealing with water conflicts by examining stakeholder group attitudes toward specific services, and (2) to quantify the economic value of ecosystem services currently invisible in decision-making domains. **DOI: 10.1061/(ASCE)WR.1943-5452.0000671.** *© 2016 American Society of Civil Engineers.*

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Introduction

Healthy freshwater ecosystems provide important ecosystem services to society (Brauman et al. 2007; MEA 2005). Assessment of ecosystem services informs natural capital management because it allows value to be assigned to nature by translating ecosystem properties into services that benefit humans (Costanza et al. 1997). A common reason for applying an ecosystem service framework is elucidating trade-offs between different services that lead to conflicts between stakeholder groups (Harrison 2010). For example, maximizing the delivery of one service (e.g., energy or agriculture production) can result in a decline in other services (e.g., water quantity and quality), creating conflicts between different social groups that rely on these services and human well-being (Mouchet et al. 2014).

The valuation of ecosystem services can include a broad range of metrics (Castro et al. 2013) ranging from biophysical quantifications (e.g., Balvanera et al. 2005) to sociocultural (Sodhi et al. 2009) and economic valuations (e.g., Spash 2000). For economic valuations, methods based on preferences of socioeconomic information are useful to support environmental policy decisions (Martín-López et al. 2012). More specifically, the contingent valuation method (CVM) has been used widely to capture socioeconomic information that is relevant to ecosystem services (Castro et al. 2011, 2014; Martin-López et al. 2012). CVM establishes how much people are willing to pay for maintaining services (Castro et al. 2013; Venkatachalam 2004). This approach is known to have a number of limitations, especially when applied to environmental issues. There is a continuing debate regarding the suitability of CVM for environmental decision making because of possible biases arising from, for example, strategic responses (Carson et al. 2001). However, the method provides abundant information relevant to designing conservation policies (García-Llorente et al. 2011a, b), particularly when willingness to pay (WTP) results are viewed as attitudes rather than as indicators of economic preferences. Specifically, in the case of ecosystem services, some authors have argued that CVM should help detect and communicate changes in ecosystem services provision. In other words, it is argued that CVM should be useful in highlighting the connections between the economic valuation of ecosystem services and the biological systems underpinning them, thus increasing the so-called visibility of nature in valuation.

In this study, it was examined how social perceptions and willingness to pay for preserving ecosystem services varied among stakeholder groups [or ecosystem service beneficiaries (ESBs)]

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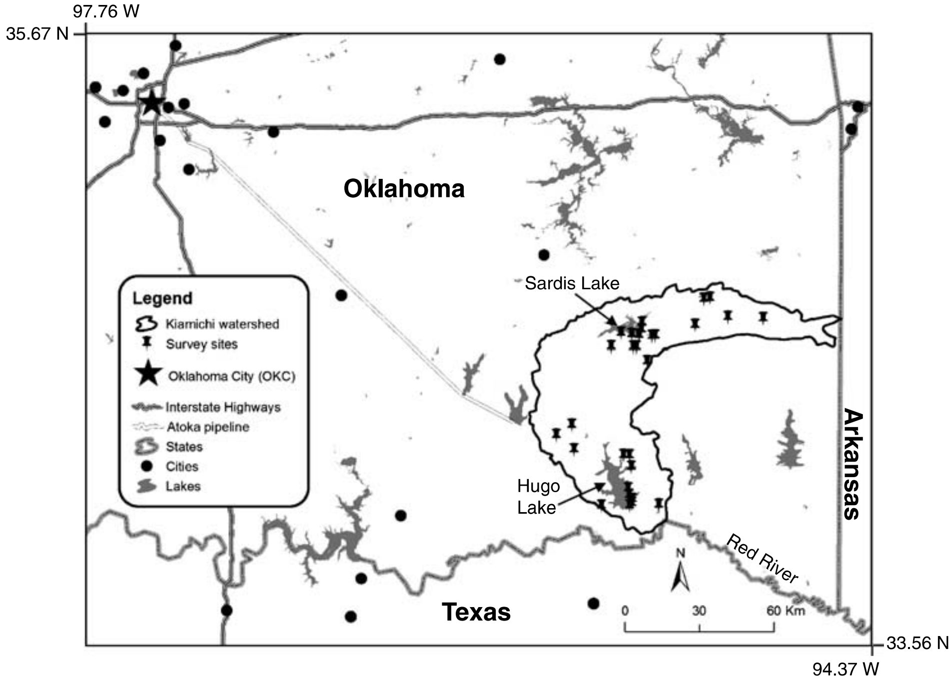

Fig. 1. Kiamichi River watershed study area; the Atoka Pipeline delivers water from southeast Oklahoma to Oklahoma City; the current extent of pipeline is shown; there are plans to extend it to the Kiamichi River (adapted from Castro et al. 2016)

in order to identify conflicts among stakeholders involved in a watershed with regional disputes. The case study is the Kiamichi River watershed in the south-central United States, which is the center of intense conflict over water use and governance (Gordon et al. 2010) and lies within a Native American jurisdictional area (the Choctaw Nation) (Castro et al. 2016). The authors specifically examined how the valuation of ecosystem services across its watershed and future service area (Oklahoma City via interbasin transfers) could be used to inform managers for future watershed management and planning. Throughout the analysis, the social perception of ecosystem services by different ESBs was also incorporated. Specifically, this study (1) identified and characterized categories of ESB types according to how they use, enjoy, and value watershed services; (2) analyzed the factors underlying economic support for maintaining watershed services; and (3) assessed the WTP estimation results, taking into account the influence of the type of ESB, identified the economic value of watershed services and explored potential biases in water management based on social and cultural attributes. Finally, this study discusses how it can be used by managers to inform maintenance of watershed ecosystem services.

Methods

Case Study: Kiamichi River and Water Conflict

This study was conducted in the Kiamichi River watershed in southeastern Oklahoma. The river is a major (fifth-order) tributary of the Red River (Fig. 1) with a drainage area of 4,650 km^2 and is 64% forest, 18% pasture, 11% grassland and shrubland, 3% urban, and 1% wetlands. Open water covers almost 3% of the watershed, with virtually all being Sardis and Hugo reservoirs (detailed subsequently). Urban land use only makes up a fraction of a percent of total land area (Castro et al. 2015).

The Kiamichi River and its discharge regime are influenced by two U.S. Army Corps of Engineers (USACE) dams: mainstem Hugo Dam [operational in 1974 with a maximum storage capacity of 118,368 m^2 (1,274,107 acre-ft)] and Sardis Dam [operational in 1983 with a maximum storage capacity of 68,360 m^2 (735,830 acre-ft)], which is a tributary impoundment that can provide almost all of the flow to downstream reaches during intense droughts (Fig. 1) (Vaughn et al. 2015). Together these reservoirs are the water supply for people in 29 Oklahoma counties. Water availability in these reservoirs is predicted to decrease over the next 25 years because of increased drought and increased water usage from an increasing human population (OWRB 2008). Current and planned interbasin water transfers will extract hundreds of thousands of cubic meters of freshwater per year out of southeastern Oklahoma, with 20,438 m^2/year (220,000 acre-ft/year) going to Oklahoma City alone by 2050 via the Atoka Pipeline (OWRB 2008). Water from these reservoirs is desired by multiple entities (North Texas Water District, Oklahoma City and other central Oklahoma cities, and southeast Oklahoma residents, which include the Chickasaw and Choctaw Nations) and is the subject of multiple, ongoing discussions and litigation over who gets to use and profit from this water (Castro et al. 2016). Operation of these reservoirs has negatively impacted aquatic life in recent decades (Vaughn and Taylor 1999). For example, in drought years water has been held in Sardis Lake rather than being released to flow downstream. This has occurred during hot summer months and has led to drying of the lower Kiamichi River, high water temperatures (>40°C), and massive freshwater mussel mortality (Atkinson et al. 2014; Vaughn et al. 2015).

Sampling Strategy and Characterization of ESBs

In summer 2013, people that are considered beneficiaries of ecosystem services (ESBs) provided by the Kiamichi River watershed were sampled. Following Castro et al. (2011), visits were first performed to become familiar with the study area and to identify key stakeholder groups involved in the regional conflict. Then, during March and April 2013, a pretest was conducted with professionals at different academic institutions (including researchers in biology, hydrology, and botany from academic institutions and professionals related to water management and planning) to define and design questionnaire questions.

The final sampling strategy was based on individual, face-to-face surveys, during June and September 2013, representing the summer outdoor tourist season, and included people residing in the watershed, tourists, business visitors, and potential water users in Oklahoma City. Individuals were randomly selected from populated areas within the watershed (small towns and tourist locations, total population 146,000) and Oklahoma City (including public libraries and parks, restaurants, academic institutions, and shopping areas, total population 700,000) and covered a wide range of ESBs' backgrounds (Fig. 1). The authors had no contact with any of the interviewees in advance of the surveys. However, this study also included experts representing a stakeholder group with expertise in the biophysical and socioeconomic aspects of the Kiamichi watershed (e.g., biologists, climatologists, hydrologists, ecologists, sociologists, anthropologists, and watershed managers). The expert group was not randomly selected because of the necessity for a set of participants with high environmental knowledge and involvement in local watershed management. Overall, 505 valid surveys were collected. All respondents were first classified according to where they reside, and then, for those who were interviewed in the Kiamichi watershed, the purpose of their visit was used. Experts were classified separately. Then, all respondents were characterized using information related to the type of visit (e.g., if they visited the region previously), environmental attitude (e.g., if they are active in community affairs), economy (e.g., household income), and sociodemographics (e.g., age or gender).

The questionnaire contained 27 questions in five sections: (1) purpose of visit to the watershed, (2) preferences for watershed services, (3) contingent valuation exercise, (4) environmental attitudes and environmental knowledge, and (5) socioeconomic characteristics of their households. Finally, the survey included various case-based follow-up questions (see the questionnaire section in Appendix S1).

Ranking Ecosystem Services Preferences

This study included eight key ecosystem services in three classes (see ecosystem services panel in Appendix S2): provisioning services (freshwater provision), regulating services (water regulation, water quality, air quality, and habitat for species), and cultural services (recreation, cultural heritage, and local identity). These services were included in a panel with photographs and a brief description that was shown to respondents. Ecosystem services were selected based on the following criteria: representation of the different service categories (i.e., provisioning, regulating, and cultural services), inclusion of water-related services, and ecosystem services whose demand potentially involves sociopolitical conflicts.

The authors asked respondents if they felt the Kiamichi River provided benefits that contribute to human well-being (very much, much, not very much, and none), and asked them to provide examples of potential perceived benefits. Respondents were asked to select from the ecosystem services panel four services most important to them and to rank them from 1 (less important) to 4 (important to essential services). From this information, an ordinal measure of the importance of each service to each respondent was created (Winkler 2006). Then the differences in services perceptions across ESB groups were analyzed with a Kruskal-Wallis test.

Willingness to Pay for Watershed Services Preservation

In the third section of the survey, the following question was included to understand an individual's WTP for maintaining ecosystem services delivery in the region:

> Due to recent droughts, water flows in the Kiamichi River have been negatively affected over the past few years, and this affects the benefits that humans obtain from the river. If an environmental association that is to preserve the river through different conservation programs asked you, (1) would you be willing to pay through an annual donation to protect the Kiamichi River watershed to continue providing these benefits to the society? and (2) If yes, what is the maximum amount per household per year). Your financial contribution would be in the form of an annual donation to a trust fund that would be managed by the environmental organization to maintain these nature·s benefits.

If the response was affirmative, that is, if the respondent indicated a maximum WTP for watershed services in a question with open format, the authors then ascertained the level of financial support that the respondents would be willing to provide (Spash 2000). If the response was negative, it was asked why the respondents would not want to provide financial support to distinguish protest responses from the real zero values. Individuals who are not willing to pay anything for watershed services are frequently encountered in CVM studies with open-ended question formats (Boyle and Bergstrom 1999) and are encountered even more frequently in the case of natural resources management (Mitchell and Carson 1989). The monetary contribution was in the form of an economic donation to a trust fund, which has been found to be a popular means of payment (Castro et al. 2011; García-Llorente et al. 2011a, b). Finally, respondents were asked to evaluate the eight target services by proportionally distributing the total amount of money they were willing to pay for watershed services they considered to be important (Bateman and Turner 1993).

This study applied the Heckman (1979) model to the WTP analyses. The Heckman model uses two different equations: the first explains the respondent's decision to pay or not to pay through a probit regression, and the second explains the positive value of the WTP through ordinary least squares (Sigelman and Zeng 1999). The model maintains the assumption of dependence between the two decisions by analyzing the covariance between the error terms. Furthermore, the Heckman model assumes that a distribution for the second-stage variable (the amount of WTP) exists but is not observed when the dependent variable is beyond a given threshold (e.g., when WTP < 0) (García-Llorente et al. 2011a). Following Sigelman and Zeng (1999), the Heckman model is a response to sample selection bias, which arises when data are available only for cases in which a variable reflecting pay exceeds zero. For more details about the Heckman model, see García-Llorente et al. (2008) and Castro et al. (2011). The variables used in the Heckman model are presented in Table 1. Finally, the Kruskal-Wallis test was used to identify differences in the mean scores for willingness to pay by ecosystem services beneficiaries groups.

Results

ESBs and Preferences for Ecosystem Services

The total population sample was classified into five ESB groups (Appendix S3): (1) watershed residents (44%, respondents residing

Table 1. Summary of Variables Explored and Used in Economic Valuation Analyses

Groups	Variables	Description	Heckit model stage: Probit	Heckit model stage: OLS
	Watershed residents	Typified as residents within the watershed (0: none; 1: yes)	*E*	*E*
	Business visitors	Typified as a visitors working (0: none; 1: yes)	*E*	*E*
	Tourists	Typified as a visitors doing tourism (0: no; 1: yes)	*E*	*E*
Ecosystem service	Oklahoma City residents	Typified as residents living in Oklahoma City (0: none; 1: yes)	—	*X*
beneficiaries	Experts	Typified as scientists with expertise in the region (0: none; 1: yes)	*E*	*E*
Related to the visit	Visited before	Is this your first visit? (0: no; 1: yes)	*X*	—
Environmental knowledge and	Government influence	Are government's actions affecting the health of the river? (0: no; 1: yes)	*X*	*X*
attitude	Community affairs	Are you politically or socially active in community? (0: no; 1: yes)	*X*	—
	Income	(ln) Annual household income (semicontinuous variable which reflected the middle point of the range taken in questionnaires)	—	X
	Education level	College degree (0: no; 1: yes)	*X*	*X*
Sociodemographic	Age (ln)	(ln) Age	*X*	*X*
characteristics	Native American	Do you identify yourself with a particular tribe? (0: no; 1: yes)	*X*	*X*

Note: *E* describes variables initially explored in the economic valuation and X the variables finally included in the economic analysis; probit (first stage of Heckman model) explains the probability of participation in the hypothetical market; OLS (second stage of Heckman model) phase identifies which variables are statistically significant; income is a semicontinuous variable that reflects the midpoint income from the questionnaire responses ($20,000; $40,000; $60,000; $80,000).

in the watershed); (2) business visitors (5.5%, respondents in the watershed on business and not residing in the watershed); (3) tourists (10%, respondents visiting the watershed for vacation or recreation); (4) Oklahoma City metropolitan area residents (29%); and (5) experts (10.5%, professionals with expertise in biophysical, social, or economic aspects of watershed science). Ninety-six percent of all respondents thought that the Kiamichi River is providing at least some level of benefits that contribute to human well-being, and 80% of respondents considered that it contributes substantial benefits. Respondents identified habitat for species, followed by freshwater provision, water quality, and recreation as the most important ecosystem services. In contrast, local identity and cultural heritage were rarely perceived as important.

ESBs differed in how they perceived the importance of specific ecosystem services [Fig. 2(a)]. Oklahoma City residents and experts ranked freshwater provision as the most important service, while business visitors ranked this service as one of the least important [Fig. 2(a)]. Habitat for species was the most important service for business visitors, as well as for watershed residents. Watershed residents ranked recreation relatively high, while Oklahoma City residents, experts, and business visitors ranked this service relatively low [Fig. 2(a)].

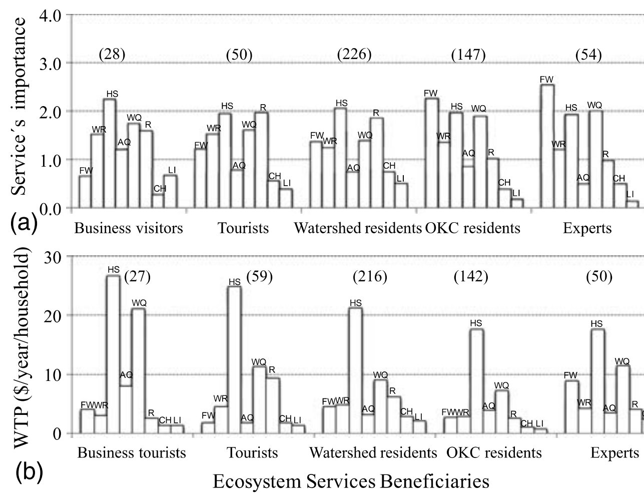

Fig. 2. (a) Social importance of ecosystem services; (b) WTP for ecosystem services preservation by ESB groups; sample size for each ESB group is in parentheses (a total 505 and 484 for the social importance and WTP, respectively); service·s importance is expressed as the sum of scores (i.e., 4 maximum, 1 minimum) by the total of respondents; WTP is expressed as the average amount in dollars per household and year for preserving each ecosystem service; AQ = air quality; CH = cultural heritage; FW = freshwater provision; HS = habitat for species; LI = local identity; R = recreation; WR = water regulation; WQ = water quality

Factors behind Willingness to Preserve Ecosystem Services

Using probit regression, the authors found five significant variables that explained the probability of participation in the hypothetical market (Stage Probit of the Heckman model; Table 2). These variables were *visited before* (if they visited the area before they were interviewed), *education level* (if they have a college degree), *government influence* (if they consider government·s actions are affecting the health of the Kiamichi river), *community affairs* (if they are socially or politically active in the community), and *Native American* (identification with any tribe). All five of these variables were positively related to the probability of participating in the economic valuation exercise (Table 2).

In the second stage of the Heckman model, the authors identified four statistically significant positive variables: *income* (annual household income), *Native American* and *government influence*, and *education level* (college degree earned) [Stage ordinary least squares (OLS) of the Heckman model; Table 2]. One statistically significant negative variable was identified: *OKC residents* (residents in Oklahoma City). Native American respondents were more likely to donate more money for maintaining ecosystem services. Respondents with a higher level of education were more likely to donate money for maintaining services. Intuitively, individuals who had a higher income were more amenable to providing financial support to maintain ecosystem services. In addition, people who rated government influence high were more likely to favor a higher level of financial support for ecosystem services. Conversely, people living in Oklahoma City (OKC residents) were less willing to

Table 2. Heckman Model Results Showing the Factors Influencing Willingness to Pay for Preserving Watershed Services

Variables	Probit coefficient	OLS coefficient
Visited before	0.494[a] (0.001) (2.062)	—
Government influence	0.290[b] (0.050) (−0.341)	0.565[b] (0.050)
Family belongs to study area	−0.173 (0.171)	−0.384 (0.106)
Community affairs	0.235[b] (0.125)	—
Education level	0.332[a] (0.018)	0.491[c] (0.064)
Age (ln)?	−0.316 (0.045)	−0.401 (0.170)
Native American	0.260[c] (0.104)	0.527[b] (0.065)
Oklahoma City residents	—	−0.662[a] (0.001)
Income (ln)	—	0.250[c] (0.091)
Inverse of Mill's ratio	—	2.688 (0.001)
Log likelihood	−297.28	−713.92
Log likelihood restricted	−313.73	−1,103.69
R^2	—	0.79
R^2 adjusted	—	0.79
Chi-square	32.90	—
Correct predictions (%)	64.8	—

Note: Probit regression results are presented for the first stage of the model regarding whether respondents were willing to pay (binary answer); then in a second state the OLS regression estimate WTP (standard errors are shown in parentheses); dependent variable in probit regression was 0 when WTP = 0 and 1 when WTP > 0; dependent variable in OLS was ln (WTP); $n = 335$.
[a]Statistical significance where $p = 0.05$ levels.
[b]Statistical significance where $p = 0.1$ levels.
[c]Statistical significance where $p = 0.01$ levels.

contribute to the maintenance of ecosystem services. It was also observed that people with family members living in the region were also less willing to contribute with financial support for watershed services (Table 2).

Willingness to Pay for Preserving Watershed Services

All ESBs were willing to pay a total of $270.81 annually per household to maintain the ecosystem services provided by the watershed (Table 3). Regulating services received the highest economic value: $20.34 for habitat for species annually and $9.59 for water regulation. Provisioning services received $4.17 for freshwater provision. Cultural services received the least per service: $4.99 for recreation, $2.03 cultural heritage, and $1.52 for local identity (Table 3). Beneficiary groups differed in their WTP for different watershed services [Fig. 2(b)], especially for provisioning and cultural services, such as freshwater provision, cultural heritage, and local identity, respectively. Business visitors and tourists were more likely to pay for maintaining watershed services ($67.95 and $56.58 annually, respectively) and preferred to pay more for habitat for species and water quality [Fig. 2(b)]. Watershed residents were willing to pay $53.82 annually and considered habitat for species, water quality, and recreation to have the highest economic value. Oklahoma City residents were the least likely to pay with $38.54 annually, and experts ($53.97 annually) considered freshwater provision as the most economically important watershed service (Table 3). Significant differences among ESB views were found regarding ecosystem services for freshwater provision, water quality, cultural heritage, recreation, local identity, and air quality (Table 3).

Discussion

Maintaining sustainable water supplies is a global challenge, especially with increasing population demands and climate change (Baron et al. 2002; Guo et al. 2000). Because economic priorities often dictate water management strategies, it is useful to assess the economic value of watershed services. Stated preference methods such as contingent valuation have been used widely to capture socioeconomic information that is relevant to ecosystem services by establishing how much people are willing to accept as compensation for the loss of benefits provided by nature (de Groot et al. 2012; Martín-López et al. 2007). This study, applied in a watershed experiencing intense water conflict, (1) identifies habitat for species and water-related services (freshwater provision and recreation) as the most important for the maintenance of human well-being; (2) addresses the economic value of watershed services by exploring the WTP for their preservation, with habitat for species and water quality as the most valued services; and (3) identifies potential conflicts of interest among water users by comparing their social preferences and WTP metrics for preserving watershed ecosystem services.

The authors found that 96% of all respondents believe the Kiamichi River watershed provides them with environmental benefits. Habitat for species and water quality were considered the most important and economically valued, respectively. Cultural watershed services, such as cultural heritage and local identity, were judged the least important by all EBSs. These results are consistent with previous research that emphasizes the importance

Table 3. Mean Scores for WTP for Ecosystem Services in Dollars Annually per Household by ESBs with Standard Deviations and Kruskal-Wallis Test

Ecosystem services	Business tourists	Standard deviation	Visitors tourists	Standard deviation	Watershed residents	Standard deviation	Experts	Standard deviation	Oklahoma City residents	Standard deviation	Kruskal-Wallis	Average WTP for ecosystem services
Freshwater provision	4.07	10.40	1.72	5.58	4.46	2.71	8.96	6.45	2.70	3.46	10.94[a]	4.17
Water regulation	2.94	6.75	4.44	3.75	4.85	3.12	4.20	6.26	2.78	5.54	6.17	4.01
Habitat for species	26.78	13.04	24.94	8.25	21.24	4.94	17.53	9.82	17.66	4.63	4.76	20.34
Air quality	7.97	12.59	1.72	2.57	3.19	2.04	3.39	2.49	3.82	1.63	7.84[b]	3.49
Water quality	21.05	17.88	11.33	14.86	9.06	4.15	11.45	24.80	7.27	4.86	11.96[a]	9.59
Recreation	2.46	6.75	9.41	3.75	6.25	3.12	4.10	6.26	2.51	5.54	18.16[c]	4.99
Cultural heritage	1.33	2.29	1.72	6.23	2.78	5.17	2.42	8.90	1.02	2.01	14.95[c]	2.03
Local identity	1.33	3.07	1.29	1.31	2.00	3.49	1.93	3.08	0.78	1.59	11.56[a]	1.52
Total WTP for ecosystem services	67.95	—	56.58	—	53.82	—	53.97	—	38.54	—	—	270.81

[a]Significance = 0.01.
[b]Significance = 0.05.
[c]Significance = 0.001.

of conserving water resources for activities that support local economies such as drinking water, farming, boating, and fishing (Castro et al. 2016; García-Llorente et al. 2011b). However, despite the broad consensus about the importance of preserving ecosystem services, there were significant differences among ESBs regarding the importance of and WTP for different ecosystem services (Fig. 2). Water quality, recreation, cultural heritage, and local identity displayed the greatest differences among ESBs. These differences are likely related to disputes over water use and conservation in the region among different groups including the State of Oklahoma, the Choctaw and Chickasaw Nations, and watershed residents (Castro et al. 2016) (Appendix S4).

Greater WTP for maintaining habitat for species and water quality could be associated with social perceptions regarding the driving forces behind businesses that sustain the local economy such as hunting, fishing, and tourism. The importance placed on water quality supports the role of this service in maintaining overall human well-being (Guo et al. 2000). These results also support the findings of Ward et al. (2000) and Welsh et al. (2013) in which respondents living in rural areas experiencing water conflicts had a greater awareness of water issues than other respondents. In contrast, local identity and cultural heritage were rarely perceived as important by all ESBs. One reason underlying this may be that Native Americans in the region receive state and federal support to protect cultural resources, but is also likely that people in general place less economic value on culture and identity.

Willingness to pay was significantly greater for visitors, both for those on business and tourists ($67.95 and $53.82 annually per household, respectively), followed by watershed residents ($143.49; Table 3). There are three likely explanations (in some combination) for this result: these ESBs (1) are more informed about water-related environmental issues, (2) appreciate the importance of a healthy environment around them, and (3) are willing to invest more for places they visit often. Moreover, it is interesting that Oklahoma City residents were the least willing to pay for watershed services ($38.54 annually), particularly for freshwater provision ($2.70 annually), which is planned to be part of their future water supply (OWRB 2008). This demonstrates than urban Oklahoma City dwellers are likely unaware of the source of their water (Hennessy-Fiske 2011).

The authors found that environmental attitudes influenced WTP for preserving watershed services (Table 2). People that were socially or politically active in the community (i.e., community affairs) and more concerned about the role of government in river health (i.e., government influence) were more likely to be willing to pay for preserving services provided by the Kiamichi River watershed. Education level was also positively related to WTP for watershed services, indicating a likely correlation between environmental awareness and commitment to environmental protection (García-Llorente et al. 2008; Lindemann-Matthies 2005; Martín-López et al. 2007). This hypothesis is further supported by the fact that the experts group (with the highest level of education by group) were willing to pay relatively more for ecosystem services even though they ranked near the bottom in terms of amount of services provided by the watershed. Native Americans, who make up 28% of watershed residents (Appendix S3), were also more willing to pay for preserving watershed services, which may be related to a greater appreciation of the connection between environment and well-being. Because the Choctaw and Chickasaw Nations own and profit from the natural resources in the Kiamichi watershed, thus have the most to gain from ecosystem services, they should be the most willing to invest in their preservation.

Finally, the total economic value estimated for all watershed services by all ESB groups, $270.81 annually per household and an average of $6.57 per ecosystem service, is consistent with other WTP exercises performed in U.S. watersheds. Loomis et al. (2000) estimated for the Platte River a total of $252 annually per household for five ecosystem services (dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation). Similarly, Mueller et al. (2013) estimated the value for improved watershed services and found a WTP of $183.50 per household. However, an important aspect to consider from this study is how people perceive the specific ecosystem processes that support the benefits that nature provides to society (Peterson et al. 2009). With this in mind, the authors suggest the social and economic value of watershed services identified here must be combined with biophysical quantifications in order to incorporate all of the dimensions responsible for maintaining the integrity of social-ecological systems (Castro et al. 2014). Yet, as stated by Mueller (2014), the socioeconomic valuation performed here is a useful tool for identifying human motivations and conflicts of interest among stakeholder groups involved in a watershed with regional conflict.

The Heckman model was an effective approach for identifying variables that describe the conflict over water use among users in the Kiamichi watershed and its future service area in Oklahoma City. As shown by previous studies (Castro et al. 2011; García-Llorente et al. 2016; Higuera et al. 2012; Nicolau and Más 2005), nine variables were differently used along the two stages of Heckman model in order to explore the decision to pay or not for services and the positive value of the WTP. Heckman results clarified important aspects about the stakeholder·s disputes over water use. People residing in Oklahoma City (future service area for planned interbasin water transfers) are willing to pay less for preserving water-related services than Native Americans (Table 2), which represent 28% of the watershed residents. This demonstrates that Oklahoma City residents likely do not know the source of their water, a fact that will dramatically affect both the economic development of the Kiamichi watershed (e.g., benefits from fishing and hunting) and the conservation of federal endangered species (e.g., freshwater mussels) (Atkinson et al. 2014). On the other hand, from a total 130 respondents who were not willing to pay, 62% corresponded to true zero bids and 35% were protest bids. The number of protest bids can be explained by the intensity of the conflict over water use and governance occurring in the watershed (Appendix S4). In fact, the number of protest bids is consistent with the Heckman·s results, where the government influence variable (describing the government as responsible or somehow influencing over the water conflict) is key to understanding whether an ESB is willing to participate in the survey process and how much they are willing to pay for services.

Finally, results also support the widely accepted view that the knowledge and needs of all stakeholders involved in water-related conflicts must be considered in watershed management and planning. Results can be used by managers and planners (1) as decision support criteria for new watershed management strategies, (2) for dealing with water conflicts by examining attitudes of different stakeholders toward watershed services (e.g., Oklahoma City residents versus watershed residents), and (3) to make apparent the economic value of watershed services such as habitat for species ($34.08 annually per household) that currently are invisible in decision-making domains due to the lack of environmental policies that consider nonconsumptive use of water.

Conclusions

Watershed management faces the challenge of ensuring not only the needs for development, but also ecosystem health, which has a direct connection to human well-being through ecosystem services (Perrings et al. 2011). The results exploring preferences and attitudes surrounding WTP for preserving watershed ecosystem services demonstrate the importance of both the social and economic value of nature·s benefits into watershed management (Mueller et al. 2013; Quintas-Soriano et al. 2014). In addition, many environmental management initiatives have been designed without a watershed-scale socioeconomic assessment of desired ecosystem services. This approach evaluates issues that arise in applying nonmarket valuation methods to ecosystem services and should assist policy makers in natural resource management, particularly multidimensional watershed management (Castro et al. 2013).

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Supplemental Data

Appendixes S1–S4 are available online in the ASCE Library (www.ascelibrary.org).

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