ASSESSING THE OPTION VALUE OF THE OGALLALA AQUIFER IN TEXAS HIGH PLAINS: A CONTINGENT VALUATION APPROACH

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ASSESSING THE OPTION VALUE OF THE GROUNDWATER OF THE OGALLALA AQUIFER IN TEXAS HIGH PLAINS: A CONTINGENT VALUATION APPROACH

Abstract

The decline of the groundwater in the Ogallala Aquifer may create an uncertainty for water availability in the associated states in the future. Effective policy reforms are essential to determine efficient present and future use of water resources. Therefore, this study explores the option value for reducing current groundwater use to ensure the water availability in the Ogallala aquifer for future use. A double- bounded referendum format contingent valuation survey was carried out to investigate households' preferences and the mean willingness to pay (WTP) of households for conserving the groundwater is empirically examined using a censored regression model. The estimated mean WTP to conserve one million acre feet of water for future use is $17.66 and the total willingness to pay is $28.96 million. The results indicate education and prior knowledge about the aquifer are significant determinants that are positively related to WTP whereas age is a significant factor that is negatively related to WTP in conserving the groundwater in the Ogallala Aquifer. This study provides policy makers with valuable information for building effective and sustainable policies, and the value estimates provided by this study will help future studies of groundwater use on the Texas High Plains.

ASSESSING THE OPTION VALUE OF THE OGALLALA AQUIFER IN TEXAS HIGH PLAINS: A CONTINGENT VALUATION APPROACH

1. Introduction and the Problem Statement

The groundwater of the Ogallala Aquifer provides both extractive and in-situ services. Extractive services result in what is known as use value. For groundwater, extractive services include water for irrigation, households, commercial, and industrial sectors. In-situ services result in what is known as non-use value because they are not associated with direct use of the resource, such as the stability of water supply and high water quality (no treatment of groundwater is required for the Ogallala Aquifer). As one of the largest aquifers in the world, the Ogallala Aquifer covers 174000 square miles and it associates with eight states namely: South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas. The Aquifer is a vital component for the national economy and its " use for irrigation supports significant fractions of the nation's economy, 15% of the domestic corn and wheat as well as 25% of the cotton crop are raised on Ogallala water" (http://hrd.apec.org). More than 90% of the total pumped water from the aquifer is used for irrigation. It fulfills one fifth of all cropland in the USA, and this water represents 30% of the total groundwater usage for irrigated agriculture in the country. Cotton, corn, alfalfa, and soybeans are the major agricultural crops that are nourished by the aquifer (Guru and Horne, 2000).

Moreover, the aquifer provides an option value, which is the satisfaction that an individual derives from ensuring that a resource is available for the future. An option value further informs how much people are willing to pay to conserve a natural resource for future uses. The total economic value of groundwater is defined as the sum of value that is attached to use, non-use, and option values (White, Sharp & Kerr, 2001). Understanding the total economic value of a groundwater resource provides water resource managers, policy makers, and the community with a framework for integrating the different values that are attached to the resources (White, Sharp & Kerr, 2001). Efforts to improve water resource management require effective policy reforms with active involvement from the public. These effective policy reforms are essential to satisfy needs and desires of present and future generations and to determine efficient present and future use of water resources. Therefore, the option value concept provides a basis for water users to accurately reveal and understand the reasons for management decisions for future uses of the natural resources. This proposed study will explore the option value of groundwater in the Ogallala Aquifer in Texas by estimating the willingness to pay (WTP) for reducing current groundwater use to ensure the water availability in the aquifer for future use.

Simultaneously, water scarcity creates a number of problems because the surrounding economy suffers due to the interrelation of the industrial sectors in the area (Johnson et al., 2011). Generally, as the population increases, the demand for water also increases; therefore available water likely decreases in the future. Even though federal, state, and local agencies such as groundwater districts and water districts implemented collaborative policies to limit total water consumption, water scarcity is still a growing concern for policy makers, interest groups, and for the public due to the increasing demand for water. Examining attributes and perceptions of water users on current strategies of water management would allow policy makers to realize that the undervaluation of water will lead to depletion of water in the future. Sustainable management decisions and effective policy reforms require reliable information about environmental and social values including economic values of the groundwater in the Ogallala Aquifer. Based on this concept, this study will first assess willingness to pay for reducing water scarcity by limiting water use. No research has estimated the willingness to pay value of ground water in the Ogallala aquifer. This empirical research will estimate the option value of the Ogallala Aquifer in the Texas High Plains. Therefore, this study will analyze the maximum willingness of consumers to pay for reducing ground water depletion for future uses. This quantitative approach will also allow policy makers to build effective and sustainable policies.

The overall objective of this study is to assess the total WTP to preserve Ogallala Aquifer's groundwater in order to draw implications for management of the Ogallala Aquifer and to make recommendations for further research. Specific objectives are to :

1) Identify the factors affecting WTP for preserving groundwater in the Ogallala Aquifer. Several factors, namely household income, age, number of children, and future residency can affect WTP, and assessing the significant factors will be helpful in managing water resources for the future.
2) Explore the option value of groundwater in the Ogallala Aquifer. By definition, option value refers to people's willingness to pay for preserving a natural resource for future uses. Groundwater of the Ogallala Aquifer is non-renewable; therefore, examining the option value for such a resource will be important for future policy analysis. Further, the value estimates provided by this study will help future empirical investigation in Texas High Plains.

2. Literature Review

This study uses the contingent valuation (CV) Method to elicit the benefits or people's willingness to pay for maintaining the groundwater in the Ogallala Aquifer in Texas.

The CV method is used to estimate the WTP of non-market goods, and it is a stated preference technique, which is a survey- based study to reveal people's preferences or values.

The total economic value of a resource or total willingness to pay consists of use value, option value, and nonuse value (Tietenberg and Lewis, 2009). Use value refers to the direct and indirect values associated with use of resources, and can be estimated by market revealed values. The option value is defined as how much people are willing to pay to conserve a resource for the future. The option value concept was first introduced by Weisbrod (1964), who argued that the option value can appear when a consumer is uncertain about the future demand of a particular good. To explain the option value concept, Weisbrod used a national park as the consumptive good. Weisbrod's option value concept was based on the demand uncertainty and to quote Weisbrod (pp472-473), " the demand would not be met because its giant trees had been cut down." He further stated that the extra willingness of a consumer to pay over the expected consumer surplus is the option value.

Several studies have focused on option price and option value including expected utility of consumer surplus; however, all previous analyses of option value focused on demand uncertainty (Bishop, 1982). Cicchetti and Freeman (1971) confirmed that the option value concept also exists if uncertainty of future supply of natural resources is present.

Despite numerous debates on the concept of option value, researchers have attempted to measure the option value, and at this point, more researchers have defined the option value as the difference between the option price (OP) and the expected value of consumer surplus(E(CS). The maximum amount that a consumer is willing to pay for an option to consume a resource in the future is the option price. Let option value (OV) of the individual be presented as

$OV = OP - E(CS)$

Where E(CS) is the expected value of the consumer surplus from consuming the resource in the future.

The existence value or non-use value refers to the WTP for existence or preservation of natural resources. Some individuals may derive satisfaction from knowing that a resource exists, and therefore, may be willing to pay for preservation. However, this existence value may not demand the generation of use values associated with a natural environment (Brookshire, Eubanks, and Randall, 1983). Because consumptive activities of existence value are both non-rival and non-exclusive, existence values are exhibited as a pure public good. Both option price and existence value are based on the concept of the probability of uncertainty in future availability.

2.1. Option Value and Natural Resource Economics

Option value is known as the willingness to pay for conserving an option for future use, whereas the existence, non-use values, or passive use value, is the willingness to pay for preserving a resource for the future generations without any direct uses from that environmental good (Haab and McConnell, 2002). Both option and existence values have been important concepts in valuing non-market goods. Because market prices are not available for those goods, non-market valuation methods are the only options for deriving prices for those commodities. The availability of natural resources is uncertain; therefore, the probability of future supply would be a necessary factor in the option price and option value concept (Brookshire, Eubanks & Randall, 1983). Some researchers state that there are several possibilities to identify the preservation or conservation of a natural resource for future use, and the option value concept is one of the possibilities among them. The option value can further be defined as an insurance premium to maintain resources for future use (Walsh, Loomis & Gillman, 1984). Following the literature survey, for this study, the option price is defined as the maximum amount that users of the Ogallala Aquifer are willing to pay to preserve the groundwater for future use.

2.2. Contingent Valuation Method (CVM)

Willingness to pay for an environmental good or service can be elicited through a carefully designed survey by directly asking consumers relevant questions, thereby; indirectly investigating a market price for the commodity. This technique is known as the Contingent Valuation Method (CVM). The technique is also known as a stated preference technique because CVM involves asking direct questions about consumers' willingness to pay for a non-market good (Boardman et al, 2001).

Therefore, CVM is a non-market valuation technique that assigns a dollar value estimate of the economic value for an environmental good (Loomis, 2009). As mentioned earlier, CVM is a stated preference method since it directly asks the people's WTP for a particular service or good using a hypothetical scenario with a description of environmental services (Pearce and Turner, 1990). CVM has been the most widely used non-market valuation technique and a straightforward application of the CVM can be used to estimate the option value and the existence value. Mitchell and Carson (1989) stated that CVM can be applied to estimate passive use values since only the stated preference methods are eligible techniques to elicit their market values as passive use values do not carry any direct uses of natural or environmental goods. This further suggests that CVM is useful to explore the option value of a natural resource as the quality or quantity of the resource changes in the future.

Several researchers discussed the reliability and accuracy of CVM, and Arrow *et al* (1993) confirmed that a carefully designed and implemented CVM survey can assist in judicial and administrative decisions. In the Blue Ribbon Panel report for NOAA, Arrow et al (1993) strongly emphasized that the accuracy and reliability of the CVM value estimates increases while researchers follow the NOAA panel's guidelines. The panel concluded that the CVM can explore non-market benefits as long as the CV surveys follow the guidelines that were recommended by NOAA panel report.

Mitchel and Carson (1989) made a huge contribution for the development of CVM along with numerous empirical estimations to explain the applications of CVM for non-market valuations since the 1980s (Gunatilake, 2003). Outdoor recreation was the primary area that CVM surveys examined during the 1950s and 1960s (Hoyos and Mariel, 2010). Meanwhile CVM surveys were predominant in valuing public goods including recreation, forest and wildlife conservation, water and air quality, and waste management (Hoyos and Mariel, 2010). In the 1970s, CVM was applied to estimate the benefits of environmental goods (Mitchel and Carson, 1989). In 1980, the U.S. Department of Interior was required to apply CVM to value the loss of both recreation and existence values. In 1992, in the case of Grand Canyon recreation study, the Bureau of Reclamation assisted the use of CVM to value the recreation benefits of re-regulating the water releases from the Glen Canyon Dam. Further, the Federal Energy Regulatory Commission adapted to use the CVM for relicensing decisions in 1990s. The removal of a dam on the Elva River in Washington State was carried out by employing CVM. Total benefits for the whole society were estimated from salmon restoration. The potential recreational benefits increased as the salmon population increased.

More importantly, WTP for non-use values, especially, option value (Wiesbrod, 1964) and existence value (Krutilla, 1967) were a spotlight in developing the CVM for non-market valuation in environmental and resource economics. As this discussion reveals, CVM is a critical tool to measure welfare changes with environmental quality/quantity changes. The welfare measures associated with environmental improvement or water resource management provide useful implications for policy makers to identify and manage scarce resources for future generations.

3.Methodology

Survey Data

Data was collected during the summer of 2014 through an electronic survey from a random sample of the Texas population. The objective of this survey was to estimate the option value for conserving the water of the Ogallala Aquifer within the Texas High Plains for future uses, and therefore, a number of referendum questions was included in the survey questionnaire to elicit people's preferences following the NOAA panel guidelines. A total of 327 households responded, and table 01 presents the number and response rate for the different responses. For the survey, the randomly assigned bid amounts were offered, and ranged from $5 to $300.

Distribution of the WTP

This study was conducted by using four different bid designs for a double-bounded discrete choice model. Table 01 shows the distribution of the different outcomes for the three response categories.

Table 01. Distribution of Respondents on Different Dichotomous Choice Bids

Amount	%			
Initial Bid	Yes-Yes	Yes-No	No-Yes	No-No
$150	7.03 (23)	4.89 (16)	0.04 (15)	9.48 (31)
$5	13.46 (44)	2.45 (8)	0.009 (3)	7.34 (24)
$25	12.23 (40)	4.28 (14)	0.01 (4)	6.73 (22)
$75	7.03 (23)	4.59 (15)	0.05 (16)	7.95 (26)

Note: The numbers of respondents are indicated in the brackets

As expected from the economic theory, the number of individuals for the 'Yes-Yes' decreases as the bid amount increases. The same response rate for the 'Yes-Yes' can be found for bids of $75 and $150. The highest 'Yes-Yes' response rate was recorded for the lowest bid, $5. Also, most of the respondents voted 'No-No' when the initial bid was at a maximum level among the four bids. From the 327 respondents, 103 (31.5%) people had no WTP for any of those bid prices, while 35 (10.7%) respondents expressed that they are willing to pay some price; however, they rejected to accept both bids as the bid prices were higher than they expected.

Application

The double-bounded procedure was employed in the CV survey because double bounded models increase efficiency of the WTP estimates compared to the single bounded models. The double-bounded model was first introduced by Henenman (Heneman et al, 1991), and showed a number of factors, which can make more accurate WTP estimates. According to Henneman, yes-no pairs can also produce the clear bounds significantly and increased number of responses will eventually create more observations for the econometric model (Haab and McConnell, 2002).

Econometric Model

The total benefit of conserving the groundwater of the Ogallala Aquifer with the proposed policy scenario was analyzed using the double-bounded dichotomous choice method. The maximum likelihood estimates of the double-bounded model were estimated using SAS as the statistical tool. In this analysis, the dependent variables, the upper and lower bounds of the WTP were censored. A maximum and a minimum WTP were determined for each individual by observing the survey data, therefore, censoring the WTP data. Because the individuals' WTP is dispersed with an interval, the true values of the WTP are unobserved. Table 02 provides the lower and the upper bounds for the given bid levels around the maximum WTP in this study.

Table 02. Bid Ranges

	Lower and Upper bounds for the different responses			
Initial bid	Yes-Yes	Yes- No	No-Yes	No-No
150	[300,]	[150, 300]	[0,150]	[0, 0]
5	[5,]	[5,10]	[0,5]	[0 , 0]
25	[25,]	[25,50]	[0,25]	[0 , 0]
75	[75,]	[75,150]	[0,75]	[0 , 0]

Let the lower bid level be presented as B^L and the upper bid level be presented as B^U.

The maximum WTP lies between these B^L and B^U values and therefore, a linear WTP function can be illustrated as

$WTP_j (Z_j, N_j) = \Upsilon x_j + \eta_j$, Where, x_j is a vector of explanatory variables, Υ is a vector of the coefficients of the explanatory variables and η_j is a vector of randomly distributed errors. Our objective is to estimate this WTP function, and can be estimated by the maximum likelihood function specifying a logistic distribution. The regression coefficients are highly sensitive to the large negative values with the normal distribution for the large samples. A logistic distribution provides more accurate parameter estimates as the logistic distribution influences the upper and lower bounds of the interval censored data (Accessed August, 11, 2014, from support.sas.com/documentation/onlinedoc/stat/lifereg.pdf). The LIFEREG procedure can be used for regression with censored data, and it estimates the parameter estimates using a log-likelihood function. The LIFEREG procedure is especially used for the survival analysis, when the dependent variable is bound, and therefore, this analysis was performed by employing the PROC LIFREG procedure in SAS.

4.Results and Discussion

Table 03 shows the mean values of the variables for the double -bounded WTP model.

Table 03. Descriptive Statistics of the Censored Regression model

Variable	Mean	Std Dev	Minimum	Maximum
Area	1.12	0.32	1.00	2.00
Age	4.18	0.98	2.00	5.00
Intend to reside	1.16	0.52	1.00	3.00
children	1.25	0.44	1.00	2.00
Education	3.72	0.49	0	1.00
HHincome	2.78	1.07	1.00	4.00
Familiar	1.59	0.49	1.00	2.00
Upper bound	433.60	465.67	0	1000
Lower bound	75.69	92.34	0	300

All of the explanatory variables used in this analysis were the qualitative variables. According to the data, most households were urban residents in this sample. The sample had a higher population with the age category of 46 – 60 years, with a mean age of 53.

A large number of households in the sample had children, and most households expected to live in the Texas High Plains. With respect to education, the most household had a college level education, and 36.2% of the households had completed college level education in this sample.

Table 04. Analysis of Maximum Likelihood Parameter Estimates

Parameter	Estimate	Standard Error	Pr > ChiSq
Intercept	5.3674	0.6406	<.0001*
Area	13.86	22.88	0.5447
age (18-30 yrs)	0.0245	0.3492	0.9441
age (31-45 yrs)	-0.0250	0.2756	0.9277
age (46-60 yrs)	-0.4008	0.2198	0.0682*
intend_toreside (yes)	0.4909	0.4143	0.2361
intend_toreside (no)	0.8709	0.7143	0.2227
children	0.1275	0.2099	0.5436
edu (high school)	-0.0854	0.3412	0.8022
edu (some college)	-0.4913	0.2572	0.0561*
edu (college)	-0.2161	0.2209	0.3280
familiar	0.3280	0.1770	0.0639*
hhincome (<30000)	-0.3842	0.2908	0.1864
hhincome(30000-60000)	0.0577	0.2263	0.7988
hhincome(>90000)	-0.0096	0.2365	0.9678

Note: significance levels are identified as : *P= 0.10

In this analysis, numerous factors were examined on the WTP for conserving ground water in the Ogallala Aquifer in the Texas High Plains. The selected variables were the area (a dummy variable taking the value of 1 if it is rural), household income (a qualitative variable including four categories), age (a qualitative variable including four categories), intend to reside in Texas (a qualitative variable with three possible answers, yes, no, and unsure), no. of children

(a dummy variable with a value of 1 for having children, and zero otherwise), and education, (a qualitative variable including four categories), prior knowledge about the Ogallala Aquifer (a dummy variable with a value of 1for having prior knowledge and zero otherwise).

Previous CVM studies around the world show that factors such as household income, urban residence, and education are positively related for the individuals' WTP. As the examples, the studies by Wilson et *al* (2012) and Bateman et *al* (2002) investigated that the household income, urban residence, and education are positively related to the individual's WTP. It is expected that people who have a higher household income, a better education, or who are urban residents would better realize the importance of the groundwater protection for their future generations. The results of the censored regression model in table 04 show that the WTP of rural people is lower than the urban residence. Also, the results show that the lower education categories are negatively related with the WTP; therefore, our results are consistent with the previous findings. The parameter estimates of the household income show that WTP decreases as income decreases, however, it is not a significant variable but it is close to the significant level. The results found that there is a lower willingness-to-pay for groundwater conservation from the respondents with high school level education in comparison to the respondents with college and advanced degree. This reveals that there will be a lesser awareness and attention for the environmental protection from the people, who have lower education. They may not realize the scarcity of natural resources, and they may not better understand whether or not the unlimited human demand will finally lead to resource depletion in the future. The results show that the education variable (some college level) is significant at 1% level in this analysis, and it highlights that education can influence the policy makers in managing ground water resources in the Ogallala Aquifer. Moreover, the area is positively related to the WTP, and it explains that the urban households have a higher WTP than the rural households in the selected population; however, the area variable is also not significant in our analysis. This indicates that the WTP for ground water conservation program is independent from the rural or urban status.

The intent to reside variable has a positive relationship with the WTP. This reveals that the households who will expect to live in Texas have a higher WTP, and people who are unsure about the future residence also have a higher WTP for resource conservation than the average level. However, those variables are not the significant determinants for the WTP. This might be due to the fact that the sample did not have enough data to produce accurate results.

According to the previous studies, the age variable is negatively related to the WTP (Wilson et al, 2012; Lehtonen et al, 2003), and our findings also show that age has a negative relationship with WTP. This may reveal that younger generation would be highly concerned about groundwater conservation for their future uses, and their children's future uses as well. It is very obvious from our analysis that the WTP of the age category 3 and 4 are negatively related with WTP comparison to the respondents of age category 2 (18-30 yrs). Regarding the significance of the age variables, the age category 4 is significant at 1% level; therefore, it can be concluded that the age variable is a powerful determinant for the policy implications since the age variable has a capacity to decide the issues on natural resource protection. The negative relationship between age and the WTP suggest that the older people are more likely retired, and their fixed lower income may not allow voting for resource conservation programs for the future.

Results suggest that there is a higher willingness to pay for the groundwater conservation from the households who have children. However, the variable is not a significant determinant at 1% level. The lack of the significance of the children variable points out that the households with children may not influence policy implications for the future water resource management in Texas High Plains.

This study found that the mean willingness-to-pay of a household for preserving the ground water of Ogallala Aquifer for future uses is $17.66. The total willingness-to-pay (TWTP) was calculated by multiplying the mean WTP of the sample by the total households in the study area (4.6mills).

5.Conclusion and Discussion

The Ogallala Aquifer mainly provides water for irrigated agriculture and for the industrial sectors in particular states. This study explored the option value of the groundwater of the Ogallala Aquifer for Texas Residents. Table 01 shows that the respondents are not willing to accept a large initial bid because the response rate for the 'No-No' response increased from 6.73% to 7.95% when the bid was raised from $25 to $75, and finally increased to 9.48% at the bid level of $150. Table 01 reports that the 'Yes-No' response rate was increased as the bid increased and that 16.2% of the households in the total sample rejected the second bid.

Our referendum question in the survey questionnaire was 'Would you support a one-time increase in your household taxes, in the amount of $(5, 25, 75, or 150), in order to postpone the use of 1 million acre-feet of water in the Ogallala Aquifer for future agricultural, industrial, or municipal use?'. Our study found that 31.5% of the sample answered negatively to this question because they responded No-No to both questions. However, 40% of the households were very positive in answering for the referendum questions because they voted for the Yes-Yes response.

The study estimated the mean willingness-to-pay of a household for preserving the ground water of Ogallala Aquifer in Texas for future uses is $17.66. This shows that a household is willing to pay taxes by $17.66. The study area consisted of a 1.64mills of households; thereby the total WTP of this policy will be $28.96million to postpone the use of 1 million acre-feet of water in the Ogallala Aquifer. Therefore, WTP for one acre inch will be $2.41. Prior to this survey procedure, the use value for maintaining the ground water of one acre-inch of the Ogallala Aquifer was estimated as $2.87. Our findings imply that the option value of the ground water of the Ogallala Aquifer is very close to the theoretically estimated use value. Therefore, our mean WTP estimates show that Texas households are willing to pay to conserve the Aquifer because the option value of the ground water of the Aquifer is almost equal to the use value. This further shows that the Texas households are able to realize the importance of the ground water of the Ogallala Aquifer for future uses. Further, this analysis provides useful insight for policy implications in order to develop ground water management strategies as Texas residents vote for implementing such a ground water conservation program.

The censored regression results of the double-bounded dichotomous choice model show that household income positively influences the WTP. There is a lower willingness-to-pay for groundwater conservation from the respondents with lower income in comparison to the households with higher income. The household income is not a significant factor to determine WTP for conserving the groundwater resources. The people are more likely to be concerned about resource protection as their education level increases. The education variable is a significant variable in this analysis, and higher educational levels lead to an increase in individuals' income, and higher incomes encourage people to vote for resource conservation and management. Because the age category 4 was significant at 1% level, the age would be a powerful determinant for managing natural resources. It can be concluded that age variable has a capacity to decide the issues on natural resource protection, and policy makers should consider increasing the taxes based on age, which would be a similar procedure to the health insurance premiums based on the age category.

This study empirically estimated the mean WTP for conserving the groundwater of the Ogallala Aquifer for future generations by using the double-bounded dichotomous choice bids. The double-bounded CVM procedure provides more information than the conventional method by adding follow-up questions, and therefore it elicits individuals’ maximum WTP, which finally improves the efficiency of the WTP estimates in terms of the statistical information provided by the CV survey.

References:

Alberini, A., and R. Kahn. 2006. Handbook on Contingent Valuation. Massachusetts: Edward Elgar Publishing, Inc.

Ahearn, M.A., K.J. Boyle, and D.R. Hellerestein. Designing a Contingent Valuation Study to Estimate the Benefits of the Conservation Reserve Program on Grassland Bird Populations. In: Alberini, A, R. Kahn, editors. Handbook on Contingent Valuation. Massachusetts: Edward Elgar Publishing, Inc.2006, 204-231.

Valuing Nature Network. (2012). *An Interdisciplinary Network for Valuing Biodiversity, Ecosystem Services and Natural Resource Use*. available at http://www.valuing-nature.net. accessed 30 June, 2014.

Arrow, K., R. Solow, P. Portney, E. Leraner, R. Radner , and H. Shuman. 1993. *Report of the NOAA panel on contingent valuation.* Federal Register: 4602-4614.

Asia-Pacific Economic Cooperation. *The Ogallala Aquifer and Its Role as a Threatened American Resource.* Available at http://hrd.apec.org. accessed April 04, 2014.

Boardman,A., D.Greenberg,A.Vining, and D.Weimer. 2001. New Jersey: Prentice Hall, Inc., Upper Saddle River.

Bishop, C. 1982. "Option Value: An Exposition and Extension." *Land Economics* 58:1-15.

Brookshire, D., L. Eubanks , and A. Randall. 1983. "Estimating Option Prices and Existence Values for Wildlife Resource." *Land Economics* 59:1-15.

Cicchetti, C and M. Freeman. 1971. "Option Demand and Consumer Surplus: Further Comments." *The Quarterly Journal of Economics* 85:528-539.

Davis, R.K. 1963. "The value of Outdoor Recreation: An Economic Study of the Maine Woods." Ph.D. dissertation in Economics, Harvard University.

Freeman, A.M. 2003. The Measurement of Environmental and Resource Values. 2nd.ed. Resources for the Future, Washington, DC.

Guru, M., and J.Horne. 2000. "The Ogallala Aquifer". an online resource available at: www.uhu.es/pablo.hidalgo/ogallala_aquifer.pdf. accessed 07 February, 2012.

Gunatilake, H.M. 2003. Environmental Valuation: Theory and Applications. University of

Peradeniya, Sri Lanka: Post Graduate Institute of Agriculture.

Haab,T., and K. McConnell. 2002. Valuing Environmental and Natural Resources. Massachusetts: Edward Elgar Publishing, Inc.

Hanemann, W.M. 1994. "Valuing Environment Through Contingent Valuation." *Journal of Economic Perspectives 08*:19-43.

Hanemann, W.M. 1984. "Welfare Evaluations in Contingent Valuation Information with Discrete Responses." *American Journal of Agricultural Economics 66*:332-341.

Hoyos, D., and P. Mariel. 2010. "Contingent Valuation: Past Present and Future." *Prague*

Economic Papers 4:329-343.

Johnson, J., P. Johnson, B. Guerrero, J. Wenheimer, S. Amosson, L. Almas, B. Golden, and E. Wheeler. 2011. "Groundwater Policy Research: Collaboration with Groundwater Conservation Districts in Texas." *Journal of Agricultural and Applied Economics* 43*:* 345-356.

Kotchen, M. J., and S.D.Reiling. 2000. "Environmental Attitudes, Motivations, and Contingent Valuation of Nonuse Values: A Case Study involving Endangered Species." *Ecological Economics 32*:93-107.

Krutilla, J.V. 1967. "Conservation Reconsidered." *American Economic Review 57*:777-786.

Loomis, J.B. 2009. Use of Non-Market Valuation Studies in Water Resources Management Assessments. Available at http://www.rivernetwork.org/resource-library/use-non-market-valuation-studies. accessed 08 March, 2014.

Loomis, J.B. 1997. Use of **Non-market Valuation Studies** in Water Resource Management Assessments. available at https://www.cbd.int/financial/values/usa-valuenonmarket.pdf. accessed 16 March, 2012.

Loomis, J.B. 2005. "Economic Values without Prices: The Importance of Non-market Values and Valuation for Informing Public Policy Debates." *Choices 20*:179-182.

Long,M.F.1967. "Collective-Consumption Services of Individual-Consumption Goods: Comment." Quarterly *Journal of Economics* 81:351-352.

Lindsay, C.M. 1969. "Option Demand and Consumer Surplus." *Quarterly Journal of Economics* 83:344-346.

McFadden, D. 1974. "Conditional Logit Analysis of Qualitative Choice Behavior", In Zarembka, P, editor., Frontiers in Econometrics, New York: Academic Press, 105-142.

Mitchell, R.C., and R.T. Carson. 1989. Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future, Washington DC.

Pearce, D., and K.Turner. 1990. *Economics of Natural Resources and the Environment*. Maryland: John Hopkins University Press.

Schmalensee, R. 1972. "Option Demand and Consumer's Surplus" Valuing Price Changes under Uncertainty." *American Economic Review 62*:813-824.

Tietenberg, T., and L. Lewis .2009. *Environmental Economics & Policy*. 6th. ed. Massachusetts: Pearson Education ,Inc.

U.S. Environmental Protection Agency. 1983. Guidelines for performing Regulatory Impact Analyses. Washington, DC: Office of Policy Analysis.

United States Geological Survey. 2009. *High Plains Aquifer Water Quality Currently Acceptable but Human Activities Could Limit Future Use.* available at http://www.usgs.gov/newsroom/article. accessed 05 May, 2014.

Walsh,R.G., J.Loomis, and R.Gillman. 1984. Valuing Option, Existence, and Bequest Demand for Wilderness." *Land Economics 60*:14-29.

Weisbrod, A. 1964. "Collective-Consumption Services of Individual-Consumption Goods." Quarterly *Journal of Economics* 78:471-477.

White, P., B. Sharp, and G. Kerr. 2001. Economic Valuation of the Waimea Plains Ground Water Systems. *Journal of Hydrology* 40:59-76.

Whitehead, J.C. 1999. "A practitioners Primer on the contingent Valuation Method." available at http://courses.wcupa.edu/tandrews/cvprimer.pdf. accessed 16 June, 2014.