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Estimating Willingness to Pay (WTP) for Rural Water Supply Improvements for Pastureland Conservation in Mongolia

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Abstract

This paper estimated the benefits to pastureland conservation in Mongolia using the contingent valuation (CV) method. We measured herders’ willingness to pay (WTP) in order to improve the rural water supply thereby contributing to the expansion of usable pastureland areas. Mongolia experienced pastureland degradation because of the livestock density near the wells; the decrease in the number of wells encouraged herders to concentrate near the remaining wells. We inquired about their WTP per year for 1 additional hand-dug well compared with the current number of available wells. Our results indicated that the median WTP was 32.18 thousand tugrig (c. USD 26.70), and the mean WTP was 33.58 thousand tugrig (c. USD 27.86) in each household. Herders who recognized pastureland degradation, who were well-educated and received higher incomes, displayed positive and significant tendencies to accept a higher bid. We found that those who live farther away from the usable wells were more likely to accept a higher bid. This implies that water supply improvements on wells farther away from usable wells were promising, making it effective in the expansion of grazing area. We concluded that installing wells is a promising approach for conserving pastureland.

Keyword: pastureland conservation, willingness to pay, contingent valuation, well, Mongolia
1. Introduction

Livestock farming using pastureland had dominated Mongolian agriculture for centuries (Sheehy 1996). Herders moved seasonally in the pastureland to search for better edible grass and used wells to provide water for their livestock or for their household needs. Transhumance was the herders’ traditional culture and means of livelihood. However, available evidence indicated that overgrazing effected pastureland degradation in Mongolia (Ministry of Nature and Environment, Mongolia 1997), where 90% of the land was categorized as pastureland. Typically, the number of livestock was used as an indicator of overgrazing in Mongolia. For example, the livestock population increased from 25.5 million in 1991 to 33.6 million in 1999. Due to the severe dzud (severe winter season) in 2000–2002 the livestock number decreased; however, it steadily increased to 30.4 million in 2005 (NSO 2006).

The increase in the number of livestock in itself was not the only cause of overgrazing. In Mongolia, pastureland could support approximately 60 million sheep forage units (Sherry 1996; JICA 2003). The Mongolians used sheep forage units as a measure to calculate the feed requirement of one sheep per year; typically, camels, cattle, and goats used 5, 6, and 0.9 units, respectively (Sherry 1996). From 1995–2000, the number of livestock calculated by the sheep forage unit exceeded 60 million; however, it was below 60 million before 1994 and after 2001. For example, in 2005, 52.08 million forage units were the feed requirement of pastureland. In light of the recent increase in livestock and degradation of the pastureland, it can be concluded that overgrazing was not the only factor that affected Mongolian pastureland.

1.1. Mechanisms of Pastureland Degradation in Mongolia

Figure 1 shows the process of desertification in Mongolia. Since the collapse of the socialist regime in 1991, herders were granted the freedom to move with regard to their livestock farming; before 1991, the government regulated their movement. However, the decrease in the number of available wells severely affected the grazing pattern. For herders, the use of wells built in the pastureland was essential for their livestock farming and household activities. Before 1991, a collective maintained the existing wells and sunk new ones when necessary (Hanstad Duncan 2001). Since 1991, institutions that manage and maintain wells have gradually disappeared. Previously, there was no private or community-based ownership of wells, and if ever there ever was an abundance of wells, they remained in disrepair. This institutional change seriously affected the herders’ style of livestock faming.
The decreasing number of the available wells effected a reduction in the grazing area of the pastureland. From 1990 –2005, the share of unused and little used pastureland in Dondgovi province (a province in the southern region of Mongolia) increased from 33% to 40% due to a water source shortage (Pacific Consultants International and Mitsui Mineral Development Engineering 2006a, 2006b). According to the Pacific Consultants International and Mitsui Mineral Development Engineering (2006a), there existed four types of wells. “Production wells” were a type of tube well that could draw large amounts of water and required fuel (gasoline) to pump up water (depth: 40–200 m). “Shallow wells” were also a type of tube well and used livestock to pump up water (depth: 18–40 m). “Shaft wells” were livestock-driven wells, but its inner part was made of piled pieces of concrete (depth: 6–18 m). “Traditional wells” were hand-dug wells and used manpower to pump up water (depth: 2–9 m). Only 72 production wells out of 438 were used; 21 shallows out of 285; and 1,209 shaft wells out of 1,486. Both shallow wells and shaft wells required a pump that was suitable for use by livestock; which has not been developed until recently. Thus, the remaining shaft wells, particularly those that had shallow water levels, were used in the same manner as traditional wells. We were uncertain of the number of usable wells from among the total number of traditional wells (1507 wells). However, most of them were operational only for 20 years after their installation.
This implies that they would have to be rehabilitated for future use. However, most of them were operational only for 20 years after their installation. This implies that they would have to be rehabilitated for future use.

This process forced herders to graze only in particular areas, thereby resulting in a high concentration of livestock in those areas. Further, livestock grazed extensively, causing the pastureland surrounding the wells to degrade and areas affected by desertification to expand. Fernandez-Gimenez and Allen-Diaz (2001) demonstrated that the pasture quality degraded near the wells where many herders grazed their livestock. As JICA (2003) mentioned, desertification was caused by the reduction of wells, followed by an increased concentration of livestock surrounding certain wells, consequently leading to the degradation of the surrounding pastureland. Herders did not use the desertified pastureland area, causing this vicious cycle to continue. Hanstad and Duncan (2001) presented one case about a town (soum) near Ulaanbaatar (the capital of Mongolia): when the herders concentrated around two wells, the pastureland near these wells degraded.

In that situation, the herders were advised to expand the usable area for livestock grazing by increasing the number of wells in order to stop the spiral of pastureland degradation. Usually, herders were able to utilize pastureland that contained usable wells, because water supply is an essential requirement of livestock farming. We recommended increasing the number of hand-dug wells (traditional wells) for livestock farming for the following reasons. First, although production wells were able to pump up a large amount of water, they required high maintenance and gasoline, thereby making them ineffective for livestock farming. Second, installing livestock-driven wells such as shallow wells or shaft wells was also impractical from the viewpoint of rehabilitation because no pumps existed that were suitable for use by livestock. In addition, these wells with shallow water tables were used in the same manner as the current hand-dug wells. Finally, all the herders that we recently surveyed used hand-dug wells for livestock farming, which implied that hand-dug wells were the most common among herders. ¹

With respect to well maintenance, defining the property or user rights of wells was considered as one of the options for pastureland conservation. Oniki and Xi (2004) proposed that the management of wells be entrusted to the public thereby clarifying the user rights of wells. The Ministry of Food and Agriculture of the Mongolian government promoted the effective use and privatization of wells and water sources (Ministry of Food and Agriculture 2006). In Dorvoljin town (soum) of Zavkhan province (aimag), herders paid a water usage fee on their livestock for agricultural cooperatives (JICA 2003), which implied that herders had experienced paying a water usage fee. Herders also could monitor the wells’ users because the wells were a point of resource, and herders could collect money from the well users. Increasing the number of wells for the purpose of expanding the usable pastureland area was expected to have a positive impact on herders’ livelihood and pastureland
conservation.

Land privatization was considered as an option to improve this situation. Land privatization could create incentives for herders to protect privatized land or to invest in the productivity of the pastureland. In the early 1990s, the Asian Development Bank (ADB) proposed privatizing the pastureland (ADB 2002). This, however, was not a realistic measure due to Mongolian livestock farming methods. Mongolian livestock farming had semi-nomadic transhumance, meaning that the herders relocate to the seasonal grazing areas, particularly in summer, and return to their settlements in the winter season. Furthermore, the herders opposed the privatization of pastureland because it indicated the possibility of diminishing their grazing area (Fernandez-Gimenez and Batbuyan 2004; ADB 2002). The pastureland was vast; this made it difficult to monitor the grazing pattern of the livestock belonging to outsiders even though the pastureland was privatized. In addition, because the edible grass could not annually be harvested in the same region, the herders had little incentive to protect the specific area of pastureland. Finally, privatization of pasturelands was prohibited by the Mongolian constitution; thus, herders now enjoy the constitutional right to move their animals freely (ADB 2002).

1.2. Challenges of Estimating Pastureland Benefits for Combating Desertification in Developing Countries

Combating desertification implies that the activities involved developing the land for sustainable use in drylands. The primary aim is to (1) prevent and reduce land degradation, (2) rehabilitate partly degraded land, and (3) practice reclamation of the desertified land (UN 1994). The approach mentioned above was also considered to be one of the activities for combating desertification in order to decrease the density of livestock in the pastureland. Further, many studies conducted in the pasturelands have attempted to estimate the benefits of pasturelands. For example, UNEP (1997) reported the environmental restoration activities in Senegal; attempts were made to mitigate the pressure of livestock by harvesting fodder crops. In this project, the fodder cultivation area was fenced and then observed as an indicator of benefit. Ma (2002) estimated the benefit of re-vegetation with scatterboard and fencing; the estimated benefit was derived from the agricultural products sales. Indeed, these activities are necessary for combating desertification to reduce the intensity of human activities or to rehabilitate the desertified land. However, these approaches could predominantly be applied to areas inhabited by many herders who follow sedentary livestock farming. In Mongolia where every herder needs vast areas for transhumance and desertification occurs in the pastureland, it was recommended that the values of the pastureland conservation be evaluated.

In order to estimate the value of pastureland, it was imperative to estimate the herders’ benefit,
because in Mongolia, it is the herders who are the beneficiaries. The pastureland could be beneficial where a water source was available, which implies that valuation of wells in the pastureland was required. Although these values could not be tradable in a market system, contingent valuation (CV) method was a possible method to elicit the value of pastureland with water source for herders, the beneficiaries, with the ultimate aim of conserving pastureland. CV was a method of obtaining information about preferences or willingness to pay (WTP) through asking direct questions (Habb and McConnell 2002). There had been a limited numbers of studies that evaluated the value of pasturelands. For example Lienhoop and MacMillan (2007) used the CV method to estimate the environmental costs and benefits of hydro-scheme developments in pasturelands in Iceland. Shoji et al. (1999) evaluated the benefit of conserving semi-natural landscapes in Japan. However, our studies took on the challenge of evaluating the benefits of conserving pasturelands in developing countries affected by desertification. In this respect, our research had the added advantage of providing a new benefit assessment for combating desertification.

The overall objective of this paper was to estimate the benefits of pastureland conservation through improving rural water supply in order to expand usable pastureland area. The remainder of this paper is organized as follows: section 2 describes the methodology (survey site, survey design) and our benefit assessment scenario. Section 3 presents the results of our survey, with a discussion of our model’s validity and reliability. Finally, section 4 provides conclusions.

2. Methodology

2.1. Survey Site

We selected Saintsagaan town in Dondgovi province of Mongolia as our study site. This province is situated in central Mongolia, and is considered to have been affected by desertification. As per the main indicators listed in table 1, Dondgovi and Saintsagaan have 49.6 thousand and 13.9 thousand residents, respectively. The population density in Dondgovi province is 0.49/km² (NSO 2006). Further, both Dondgovi and Saintsagaan witnessed an increased ratio of the share of unused land to that of low used pastureland; in Dondgovi, this ratio increased from 33% in 1990 to 40% in 2005, and in Saintsagaan, it increased from 13% in 1990 to 23% in 2005. Saintsagaan comprised 9 villages (bag), among which 5 were urban and 4 were rural. Around 90% of the herders live in rural places (Saintsagaan office 2006). We conducted a pilot survey in 2 rural villages (Dalai and Uizen) in June 2006. After that, we selected the remaining 2 villages (Naran and Tersh) for the main survey that was conducted in October 2006.
Table 1. Main Indicators in the Survey Area

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Dondgovi Province</th>
<th>Saintsagaan Town</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (thousand people, 2005)</td>
<td>49.6 a</td>
<td>13.9 b</td>
</tr>
<tr>
<td>Herder Population</td>
<td>16.9 a</td>
<td>3.8 b</td>
</tr>
<tr>
<td>Households (thousand people, 2005)</td>
<td>12.6 a</td>
<td>2.6 b</td>
</tr>
<tr>
<td>Herder Households</td>
<td>7.9 a</td>
<td>1.0 b</td>
</tr>
<tr>
<td>Total Livestocks (thousand head, 2005)</td>
<td>1829.1 a</td>
<td>188.6 b</td>
</tr>
<tr>
<td>Goat</td>
<td>825.4 a</td>
<td>87.8 b</td>
</tr>
<tr>
<td>Sheep</td>
<td>819.7 a</td>
<td>83.4 b</td>
</tr>
<tr>
<td>Horse</td>
<td>119.5 a</td>
<td>12.7 b</td>
</tr>
<tr>
<td>Cattle</td>
<td>43.8 a</td>
<td>3.8 b</td>
</tr>
<tr>
<td>Camel</td>
<td>20.7 a</td>
<td>1.0 b</td>
</tr>
<tr>
<td>Number of Livestocks per household (head, 2005)</td>
<td>232.2 a</td>
<td>192.8 b</td>
</tr>
</tbody>
</table>

(Share of Unused and Low Used Pastureland to Whole Province (Town) Area)

<table>
<thead>
<tr>
<th>Year</th>
<th>Dondgovi Province</th>
<th>Saintsagaan Town</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>33% c</td>
<td>13% c</td>
</tr>
<tr>
<td>2005</td>
<td>40% c</td>
<td>23% c</td>
</tr>
</tbody>
</table>

(Source)  
a: NSO (2006)  

2.2. Survey Design

We distributed 147 questionnaires in the survey site. In rural Saintsagaan, every citizen was categorized as a herder. We visited herder households, which were selected randomly, and with the guidance of village personnel (village governor, doctor, etc.). In the cover letter of the questionnaire, we also mentioned that this survey was conducted purely for academic purposes and that the responses would be kept confidential.

We visited all the herder households in the respective villages. Other herders were migrating to other locations for the purpose of grazing or wintering. We gathered 139 questionnaires for estimation after eliminating those that respondents could not understand sufficiently to answer properly, had no answer, or were protest bids. We inquired about their WTP per year for 1 additional hand-dug well\(^1\) compared to the current number. We also devised a scenario in which the herders formed groups consisting of 5 herder families (including the respondent’s family) to contribute to rehabilitation or the construction fee, which was a realistic situation in Mongolia.\(^2\) The description of the hypothetical scenario was as follows:

Suppose that you rehabilitate the old hand-dug wells that are currently not being used, or
construct new hand-dug wells. In order to accomplish this, you organize a herder group consisting of 5 herder families (including your family), and you jointly rehabilitate or construct hand-dug wells. You will be able to draw the water from that well during any season of the year. As a result of your cooperation, you would be able to use 1 additional hand-dug from the current situation. You should contribute to the rehabilitation or construction fee. Your collected money will be used for the rehabilitation or construction of hand-dug wells only.

The results of these actions include the following:

a) Expanding your grazing area that was unused due to the lack of water sources.

b) Increasing your income by increasing livestock.

c) Saving pastureland by decreasing the density of livestock.

If the annual fee was ______ tugrig per household, would you be willing to pay this amount? In the case that you are willing to pay, you would lose some of your income that you could spend for other things using the same amount.

We applied the double-bounded dichotomous choice questionnaire format. The first bid amount offered was 5,000, 10,000, or 30,000 tugrig per household. The second bid was 3,000 for rejection or 10,000 for acceptance if the first bid was 5,000. The second bid was 5,000 for rejection or 30,000 for acceptance if the first bid was 10,000, 10,000 for rejection or 50,000 for acceptance if the first bid was 30,000 respectively.

All of the information which was considered to be affected by WTP acceptance is listed in table 2. We inquired about the opinions on the status of pastureland on a scale from very well maintained (score 1) to severely degraded (score 5); all of the responses ranged from fairly maintained (score 3), slightly degraded (score 4), to severely degraded (score 5). Additionally, we asked about the herding (herding areas, number of wells being used, satisfaction with the number of hand-dug wells), and socio-economic background (age, number of family members, children, elder persons, education, and household income). We did not use number of livestock (number of goats or sheep) because this was highly correlated with income (correlation coefficient: 0.81). We also excluded the sex of the respondent because there were no clear distinctions between the roles of males and females; both worked for livestock farming and carried water for household needs in Mongolia.

We also used the distance from their households to the nearest usable wells from their household, which clearly revealed the state of a household’s current water supply. If we found that those who lived farther away from usable wells displayed an acceptance for a higher bid, we could assume that they supported the expansion of grazing areas. Herders living far away from usable wells could install wells closer to their houses, which implied that the usable areas of the pastureland could be
expanded. Each household was identified by longitude and latitude using GPS (etrex Vista, Garmin Ltd). The location of usable wells was obtained from Pacific Consultants International and Mitsui Mineral Development Engineering (2006b). Distance to the city was also calculated from the distance of households to the Saintsagaan town office.

Table 2. Independent Variables Used in Regression Model (Except Bid Amount)

<table>
<thead>
<tr>
<th>Definition of Independent Variable</th>
<th>Variable Name</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opinion for the status of pastureland comparing to 5 years before</td>
<td>CND_PSTR</td>
<td>4.80</td>
<td>0.43</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>(1: very well maintained up to 5: severely)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Areas of moving (1: within town, 2: within province, 3: outside of</td>
<td>MOVE_AREA</td>
<td>1.61</td>
<td>0.76</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>province)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of wells using per year</td>
<td>WELL_USE</td>
<td>4.86</td>
<td>4.08</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Satisfaction for the current number of hand-dug wells (1: Yes, 2: No)</td>
<td>WELL_STSFY</td>
<td>1.76</td>
<td>0.43</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Age (1: under 20, 2: 20-29, up to 6: 60 or above)</td>
<td>AGE</td>
<td>3.83</td>
<td>1.41</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Number of family members</td>
<td>NUM_FML</td>
<td>4.42</td>
<td>2.11</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Number of children (under 8 and schooling age)</td>
<td>NUM_CLD</td>
<td>0.59</td>
<td>0.85</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Number of elder persons (over 65 years old)</td>
<td>NUM_ELD</td>
<td>0.47</td>
<td>0.71</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Education (1: never, 2: primary school up to 6: graduate school</td>
<td>EDUC</td>
<td>2.73</td>
<td>0.88</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>(where one would obtain a Masters, etc.))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to the city (km)</td>
<td>DIS_CITY</td>
<td>22.97</td>
<td>12.68</td>
<td>3.6</td>
<td>49.9</td>
</tr>
<tr>
<td>Distance to the nearest working well (km)</td>
<td>DIS_WELL</td>
<td>1.77</td>
<td>1.00</td>
<td>0.2</td>
<td>5.9</td>
</tr>
<tr>
<td>Income (household income in thousand tugrig per year)</td>
<td>INC</td>
<td>1596.74</td>
<td>1067.11</td>
<td>300</td>
<td>8500</td>
</tr>
</tbody>
</table>

We used household income based on the respondents’ statements. Usually, herders earned money by selling livestock products (meat, wool, cashmere, etc.), and they did not consider the value of livestock products that they consumed in their households. Real income would be higher than the stated 1,596.74 thousand tugrig (c. USD 1,331.87) per year (annual mean). However, there were no reliable sources indicating the domestic consumption of livestock products in Mongolia; previous CV studies used the stated income in developing countries (e.g., Fujita et al. 2005). In addition, Oniki and Xi (2004) showed that the mean household income of the herders in Khenti province (northern part of Dondgovi province) was 922 thousand in Batnorov town, 1,531 thousand in Norovlin town, and 1,607 thousand in Kherlen town. This suggests that the income level we used is reliable for estimation.
2.3. Estimation Method

We applied the indirect utility function approach proposed by Hanemann et al. (1991), which is considered as being the most appropriate for double-bound dichotomous choice CV method estimation. We describe this estimation method using Terawaki’s (2002) explanation as follows.

The first bid was set at $B^u_i$. The second bid was $B^u_i$ if the respondent accepted the first bid, and $B^d_i$ if the respondent rejects it. The likelihood was set at $\pi^{yy}(B^u_i, B^u_i)$ if the respondent answered “Yes” for both the offered bids. Similarly, the likelihood was $\pi^{yn}(B^u_i, B^u_i)$ if the respondent accepted the first bid, but rejected for the second bid. Further, the likelihood was $\pi^{yn}(B^u_i, B^d_i)$ if the respondent rejected the first bid, but accepted for the second bid. The likelihood was $\pi^{nn}(B^u_i, B^d_i)$ if the respondent rejected for the both bid. Each likelihood was derived as follows:

\[
\begin{align*}
\pi^{yy}(B^u_i, B^u_i) &= \Pr \{ B^u_i \leq WTP_i \} = 1 - F(B^u_i; \theta) \quad (1) \\
\pi^{yn}(B^u_i, B^u_i) &= \Pr \{ B^u_i \leq WTP_i \leq B^u_i \} = F(B^u_i; \theta) - F(B^u_i; \theta) \\
\pi^{yn}(B^u_i, B^d_i) &= \Pr \{ B^d_i \leq WTP_i \leq B^u_i \} = F(B^d_i; \theta) - F(B^u_i; \theta) \\
\pi^{nn}(B^u_i, B^d_i) &= \Pr \{ WTP_i \leq B^d_i \} = F(B^d_i; \theta) 
\end{align*}
\]

$WTP_i$ implies the real WTP of respondent $i$, and $x_i$ was the vector of respondent $i$. $F(\cdot)$ was the distribution function of the WTP, and $\theta$ was the parameter vector. We set $F(B)$ as follows.

\[
F(B) = F(-\alpha - x_i \beta - \beta_{\text{bid}} \ln B) 
\]  

(5)

where $\alpha$ was a constant, $\beta$ was a parameter vector of $x_i$, and $\beta_{\text{bid}}$ was a parameter of $\ln B$.

WTP follows a log-normal distribution if $F(\cdot)$ was assumed to have normal distribution, and follows a log-logistic distribution if $F(\cdot)$ was assumed to have logistic distribution. The reason why we used two different models was that we wanted to assess the robustness of the estimation result. We refer to them the log-normal model and the log-logistic model, respectively. The log-likelihood function takes the following form using equations (1) through (4):

\[
\ln L(\theta) = \sum_{i=1}^{N} \left[ d^{yy}_i \ln \pi^{yy}(B^u_i, B^u_i) + d^{yn}_i \ln \pi^{yn}(B^u_i, B^u_i) + d^{yn}_i \ln \pi^{yn}(B^u_i, B^d_i) + d^{nn}_i \ln \pi^{nn}(B^u_i, B^d_i) \right] 
\]

(6)
where the binary-valued indicator variables $d_{iy}$, $d_{in}$, $d_{ny}$, and $d_{nn}$ indicate the respondents’ answers (yes, yes), (yes, no), (no, yes), and (no, no), respectively; each indicator is represented as 1 while the others are represented as 0. The ML estimator $\hat{\theta}$ was the solution of $\frac{\partial \ln L(\theta)}{\partial \theta} = 0$. Using the estimated parameters and the mean independent variables substituted in equation (5) and deducting 1 from that equation, we obtain the survival function of WTP $S(X)$. The median WTP was estimated with $S(WTP) = 0.5$, and the mean WTP was estimated with the following equation, which was truncated as the maximum offered bid.

$$E(WTP) = \int_0^{WTP_{max}} \frac{S(WTP)}{1 - S(WTP_{max})} dWTP$$

However, the mean WTP was not an appropriate value because the variance of mean WTP is usually large (Terawaki 2002) and sensitive to a higher offered bid. With the exception of the statistical efficiency, this scenario assumes that 5 herders jointly construct wells and mutual agreement is necessary. In this case, the median WTP is more appropriate because this scenario assumes the “decision by majority” social welfare function. Thus, we mainly use the median WTP for discussion and the mean WTP for reference. We used the econometric software NLOGIT 3.0 (Econometric Software, Inc.) for estimation.

3. Results and Discussion

Table 3 presents the respondents’ answers for the offered bid (139 samples). Table 4 presents the full model, which uses every independent variable for estimation. Based on the full model, we reduced each of the insignificant independent variables. Table 5 exhibits the final results, which lists the minimum value of Akaike’s Information Criteria (AIC) for each combination of independent variables. Also, Table 6 lists the estimated WTP by using independent variables in table 5. The significance of independent variables was mostly same in both the log-logistic and log-normal models, which implies that our estimation demonstrates the robustness for the model specification. Even though the results of both models in table 5 were fairly similar, we provide further discussions of using log-logistic model because the value of AIC in the log-logistic model was smaller.

Our results showed that the median WTP was 32.18 thousand tugrig (c. USD 26.70), and the mean WTP was 33.58 thousand tugrig (c. USD 27.86), using log-logistic model. The 95% confidence interval of the median WTP was 25.69–40.30 thousand tugrig (c. USD 21.32–33.44); the 90% confidence interval was 26.64–38.87 thousand tugrig (c. USD 22.10–32.25). Our results also
revealed that the income (logarithmic scale) showed positive tendencies to accepting a higher bid at the 1% significance level. Opinions on the status of pastureland, education, and distance to the nearest usable well exhibited a positive influence at the 5% level. In contrast, we found that the bid amount had a negative influence on the acceptance ratio at the 1% level. The mean income of households was 1596.74 thousand tugrig (c.USD1,331.87) per year; thus, the median and mean WTP were 2.02% and 2.10 % of income, respectively.

Table 3. Response for the Offered Bid

<table>
<thead>
<tr>
<th>First Bid</th>
<th>Second Bid</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,000</td>
<td></td>
<td>44</td>
<td>10,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>3,000</td>
</tr>
<tr>
<td>10,000</td>
<td></td>
<td>42</td>
<td>30,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>5,000</td>
</tr>
<tr>
<td>30,000</td>
<td></td>
<td>28</td>
<td>50,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
<td>10,000</td>
</tr>
</tbody>
</table>

(Note) Sample size is 139.

Table 4. Estimation Results (Full Model)

<table>
<thead>
<tr>
<th>Independent Variable (Variable Code)</th>
<th>Log–Logistic Model</th>
<th>Log–Normal Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.48</td>
<td>1.25</td>
</tr>
<tr>
<td>CND_PSTR</td>
<td>0.91</td>
<td>0.47</td>
</tr>
<tr>
<td>MOVEAREA</td>
<td>-0.38</td>
<td>-0.21</td>
</tr>
<tr>
<td>WELL</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>WELL_STSFY</td>
<td>-0.30</td>
<td>-0.03</td>
</tr>
<tr>
<td>AGE</td>
<td>-0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>NUM_FML</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td>NUM_CLD</td>
<td>-0.07</td>
<td>-0.04</td>
</tr>
<tr>
<td>NUM_ELD</td>
<td>-0.22</td>
<td>-0.13</td>
</tr>
<tr>
<td>EDUC</td>
<td>0.37</td>
<td>0.20</td>
</tr>
<tr>
<td>DIS_CITY</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>DIS_WELL</td>
<td>0.45</td>
<td>0.26</td>
</tr>
<tr>
<td>INC</td>
<td>0.76</td>
<td>0.43</td>
</tr>
<tr>
<td>BID</td>
<td>-1.79</td>
<td>-1.00</td>
</tr>
</tbody>
</table>

Log likelihood function: -135.15 -136.07
AIC: 298.29 300.13
Table 5. Estimation Results (Final Model)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Log–Logistic Model</th>
<th>Log–Normal Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std.Err.</td>
</tr>
<tr>
<td>Constant</td>
<td>1.64</td>
<td>4.84</td>
</tr>
<tr>
<td>CND_PSTR</td>
<td>0.85</td>
<td>0.43</td>
</tr>
<tr>
<td>EDUC</td>
<td>0.39</td>
<td>0.19</td>
</tr>
<tr>
<td>DIS_WELL</td>
<td>0.41</td>
<td>0.20</td>
</tr>
<tr>
<td>INC</td>
<td>0.75</td>
<td>0.29</td>
</tr>
<tr>
<td>BID</td>
<td>-1.75</td>
<td>0.20</td>
</tr>
<tr>
<td>Log likelihood function</td>
<td>-136.81</td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>285.62</td>
<td></td>
</tr>
</tbody>
</table>

(Note) One, two, three asterisks indicate statistical significance at 10%, 5% and 1% level, respectively.

Table 6. Estimated WTP from the Final Model

<table>
<thead>
<tr>
<th></th>
<th>Log–Logistic Model</th>
<th>Log–Normal Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median WTP (thousand tugrig)</td>
<td>32.18</td>
<td>32.04</td>
</tr>
<tr>
<td>Mean WTP (thousand tugrig)</td>
<td>33.58</td>
<td>33.49</td>
</tr>
<tr>
<td>Median WTP (95% confidence interval, thousand tugrig)</td>
<td>25.69-40.30</td>
<td>25.05-40.97</td>
</tr>
<tr>
<td>Median WTP (90% confidence interval, thousand tugrig)</td>
<td>26.64-38.87</td>
<td>26.06-39.38</td>
</tr>
</tbody>
</table>

We found that those who lived farther away from the usable wells were more likely to accept a higher bid at the 5% significance level. This implied that water supply improvements farther away from the usable wells were promising, making it effective in the expansion of grazing area. If this independent variable showed no significant influence for acceptance or for rejection, we should consider another scenario such as rehabilitating wells closer to each household.

The results also indicated that education was a positive factor for accepting the higher bid; education was also important for encouraging pastureland conservation. This result also maintained that more herders who considered pastureland to be degraded had a positive and significant tendency for a higher WTP at the 5% significance level. Although most of the respondents (113 out of 138) answered “severely degraded” in the questionnaire, and no herders responded “very well maintained or well maintained,” if herders gave serious thought to pastureland degradation, they would have more possibilities to invest in the rehabilitation of wells. Encouraging the consciousness of pastureland conservation and environmental education was an important factor in realizing the wells’ development and pastureland conservation.

The estimated median WTP accounting for the income was revealed to be 2.02%. Wells were used as the source of drinking water not only for humans but also livestock, which made the
estimated value appear to be low. However, we concluded that the estimated values were reliable for the following reasons. First, the WTP for improving natural water sources (wells, springs, streams, or river) was low. For example, Johnson and Baltodano (2004) showed that the income ratio of the WTP to improve natural water sources was 0.61%. Our survey also asked respondents about their WTP to increase the number of natural water resources. As Whittington and Swarna (1994) indicated, many previous researches showed the WTP for potable water supply was 0.5%–10%, and that we could expect higher WTP if the tap water or waterworks was integrated or water quality was improved. For example, Oca et al. (2003) showed that in Mexico, the WTP for avoiding health risks by maintaining the current water service level was 2.85%; the WTP for avoiding health risks by improving the service conditions was 5.27%. Although, in the rural areas of Mongolia, tap water installation or water quality improvement of wells cannot be expected. Second, herders typically used 4.86 wells (mean, see table 3) according to the respondents’ answers; they might have underestimated the utility of an additional well. We observed an insignificant relationship between the numbers of wells used or the satisfaction of the current number of wells and the acceptance ratio; further research and discussions are required on this point.

With respect to contingent behavior questions, we were often unable to observe “true” changes in the activity levels under identical conditions that existed when the questions were asked (Freeman 1993). However, there were some possible ways to ensure the validity of the estimated results. We used the “construct validity” to test whether the CV responses were related to the variables that act as predictors of WTP, as suggested by economic theory. (Freeman 1993). The positive/negative significance levels for accepting the higher offered bid was consistent with the perception of the herders’ situation of Mongolia. As income demonstrated positive significance and offered bid, negative significance, we could argue that these results passed the validity test.

To ensure the significance level and the influence of the independent variables on the bid, we used two estimation models as alternatives. We found that there was no large difference in the models’ specifications; these factors could also pass the validity test. Further, it could be concluded that this survey was successful: the non-response rate was low (1 respondent), as was that for protest zero bids (4 respondents) Protest zero bids occurred when the respondents rejected some aspect of the constructed hypothetical scenario by reporting a zero value, even though they placed a positive value on the resource (Freeman 1993). We found 2 respondents reported, “I do see the importance of this project, but all the costs should be covered by the government.” One respondent stated, “I do see the importance, but rich people should pay the fee and I do not want to pay it.” Finally, one other respondent said, “My family is always moving; we have no chance to use hand-dug wells.”

In terms of the reliability of this survey, we attempted to measure their WTP while taking the herders’ situation into consideration. One of the reasons that many economists and survey
researchers had been skeptical about the ability to conduct CV surveys in developing countries was the presumed difficulty of understanding and interpreting respondents’ answers to abstract (or hypothetical) questions (Whittington 1998). We did not force the herders to respond quickly because they needed adequate time to respond to the proposed bid after due consideration. As Whittington et al. (1992) mentioned, respondents who were given time to evaluate the proposed bid significantly less than those who did not have adequate time. This survey utilized a face-to-face approach by visiting each household. As Arrow et al. (1993) recommended, eliciting the values face-to-face is usually preferable and more reliable than mail surveys; our survey method enabled respondents to answer their WTP smoothly. In addition, the enumerator bias affected inconsistent results in developing countries if the enumerators were poorly trained and could not deliver the CV scenario smoothly (Whittington 2002). Our survey had only one enumerator who was employed as a lecturer in Faculty of Economics at the Mongolian State University of Agriculture; we also had a driver and guide. Thus, enumerator bias did not affect our survey.

4. Conclusion

We concluded that installing wells for conserving pastureland could be a promising approach for combating desertification. We found that those who lived farther away from the usable wells were more likely to accept a higher bid. This implied that water supply improvements farther away from usable wells were a promising effective strategy in the expansion of grazing area. We also discussed the validity and reliability of our results. Our estimations could be explained well with relevant independent variables, including income and offered bid; this testifies the validity of our estimation. We attribute the reliability of our results to the survey design.

In addition, we could conclude that this approach was applicable in an arid environment witnessing desertification. Arid environment regions usually have pasturelands with a low capacity to feed livestock. In order to support herders’ livelihood by conserving the pastureland, it was necessary to decrease the density of livestock by improving the rural water supply. Compared with the projects that focus on pastureland rehabilitation or forestation, this approach expects the improvements of herders’ livelihood by supporting the development of their basic infrastructure.

However, this research experienced some limitations in applying the policy to combat desertification. One limitation was the scope test. The scope test requires CV estimates of WTP to be responsive to the amount, or scope, of the environmental amenity being offered (Smith and Osborne 1996). Our results do not involve scope sensitivity; thus, our findings could become more reliable if we found a positive relationship between the WTP estimate and the number of wells offered. In this case, the survey should consider what the respondents felt about the wells. Mongolian herders were
afraid that if many wells were constructed near their houses, the pastureland quality would be degraded because many herders would come to their pastureland. This issue requires further analysis to arrive at a better solution.

There are some notable points in the practically application of our results for real projects that aim to increase the number of wells. The objective of increasing wells was to expand the grazing areas and decrease the density of livestock; this enhances the incentive for herders to graze in unused pastureland. Thus, it is very important to decide the location of newly installed wells in order to expand usable areas. The location of wells is one of the most important factors in livestock farming; in reality, however, market access or other issues would affect the decision of a location. Cooperation and discussion among local governments and herders, and data on wells are required for selecting an optimal location. Further researches are required to apply these results in Mongolia and also to generalize them to developing countries with arid environments.

Acknowledgements

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Note

1 For herders, hand-dug wells include the traditional wells and shaft wells that were used in a similar manner as traditional wells.
2 In Mongolia, Khot ail, a farmers’ cooperative was organized for cooperative herding. It included a group of households camping together and sharing labor, comprising the smallest local community (Hanstad and Duncan 2001). Installing a well for only one household was not a practical solution because wells require manpower to build. One Khot ail was usually comprised 2–10 households (Kamimura 2004).
3 The labor to rehabilitate or construct hand-dug wells is slightly different because only rehabilitating a part of the wells was difficult due to well structure (Pacific Consultants International and Mitsui Mineral Development Engineering 2006a). In terms of the cost, the expense would be the same in Mongolia.
4 We used the following exchange rate USD 1 = 1205.27 tugrig. This exchange rate was the
annual average exchange rate in 2005 (NSO 2006).

Reference


Ministry of Food and Agriculture of Mongolia. Objectives of food and agriculture sectors in 2005,


Saintsagaan Office Statistics of Saintsagaan Town (Received information from town databases on (October, 2006).


UNDP (United Nations Development Programme) Sustainable Grassland Management Project MON/02/301, Semi-Annual Progress Report (July-December), (February 2006).


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