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Economic Assessment of Biodiversity Function of the Hamoon Wetland Ecosystem by Contingent Valuatiom

M. Dahmardeh[1*], J. Shahraki[2], A. Akbari[3]

1. Assistant Professor of Agricultural Economics, Payam Noor University (PNU), Iran
2. Associate Professor of Agricultural Economics, Faculty of Management and Economics, University of Sistan and Baluchestan, Iran
3. Professor of Agricultural Economics, Faculty of Management and Economics, University of Sistan and Baluchestan, Iran

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ABSTRACT

In the development process of the countries, the wetlands play a significant role in people's well-being by providing the goods and services that are used directly and indirectly. Some examples of these goods include recreational use (as non-consumable values), harvested meat (as direct consumable values), carbon uptake, oxygen generation, water conservation, and soil retention (as indirect consumable values). In addition to consumption values, wetlands have other values too; i.e. the money paid by people to protect the wetlands for future use, for next generations and for their being, no matter if they are used or not used. These non-consumable values are called protection values, too. The present work estimated the value of goods and services of Hamoon wetland ecosystem in the form of biodiversity function in order to economically evaluate the drought damages to Hamoon wetland in 2015. The data needed to estimate the value of these functions were collected by a questionnaire. The biodiversity protection value of Hamoon wetland as the protection value of its forest ecosystem was estimated by contingent valuation method using the data collected from 450 people living in the rural areas surrounding the wetland. The results show that the value of protection of the Hamoon wetland biodiversity is 333.75 billion IRR and the expected WTP to protect its wildlife is 35542.74 IRR per family per year.

1. Introduction

Wetlands are reserves of natural gifts. Their soil is saturated with surface waters and water tables during their evolution. Wetlands have had adequate time to be formed under normal environmental conditions and possess high biological potential. They house communities of plants and populations of specific animals that could adapt to these locations. Not only do the wetlands provide food and supply a part of water tables, but they also provide an environment for the diverse birds, fish and aquatic organisms whose livelihood depends on them to use as a suitable habitat for their survival and feeding.

With this long-held incorrect belief that natural resources are unending and they could be exploited forever, humans have growingly started to use new parts of these natural landscapes. Consequently, the natural resources, particularly the wetlands, have experienced a heavy pressure due to frequent unwise overexploitation. The sustained deterioration of wetlands is the common feature of all countries in the world. It is known that almost 50% of natural resources have been destroyed in the US. The destruction rate of wetlands is not better in Iran than in other parts of the world at all. Sadeghi (2008) reported that most wetlands located in the watershed of the Caspian Sea have been ruined by their use for agriculture, house construction, and garbage disposal.

In the World Bank's study on many countries including Iran in 2009, the damage cost of the destruction of wetland was estimated at US$350 million (2,800 billion IRR). The main threats to wetlands can be listed as below.

The first and foremost threat is drought and drying of the wetlands caused by the unpermitted use of the upstream water resources. Another threat rises from the huge developmental and infrastructure projects like the construction of roads, petro chemistry, airports, etc. while the constraints of the wetlands are overlooked.

On the other hand, the inflow of biological, chemical and physical pollutants emitted from farms and urban and rural centers and the sediments induced by soil erosion are seriously threatening the wetlands. Other threats include the change in wetlands land use to farming, unpermitted and excessive hunting and fishing, and overharvest of forage and other wetland crops in a higher rate than the wetlands' renewing potential.

Hamoon wetland has an area of over 4,000 km^2 and is divided into three distinct parts in dry seasons including Hamoon-e Puzak in the northeast, Hamoon-e Saberi in the northwest, and Hamoon-e Hirmand in the west and

*Corresponding author's email:
Majid_dahmardeh@yahoo.com

southwest of Sistan. Hamoon-e Hirmand and Hamoon-e Saberi are located in Afghanistan and water flows from Hamoon-e Puzak to them. These three parts join to each other in high-raining seasons. These changes depend on the water flow of the Hirmand River and as the level of water rises in the lake, water flows into the Shileh River in the south of the lake. This river flows for about 100 km to enter into Godzareh in Afghanistan. The Shileh Dam on this river controls the water outflow of the wetland (Environment Protection Organization, 2014).

The ecosystem of Hamoon wetland is characterized by grand features in ecology, wildlife, and natural beauties. It has also played a significant role in different economic, social and ecological functions of the urban and rural areas in Sistan in different historical eras. However, it has unfortunately lost almost all its roles and functions due to consecutive droughts in Sistan so that its canebrakes and pastures and even its water has been depleted and all its advantages have been destroyed. Thus, it is imperative to pay increasing attention to this wetland and to find out the reasons for the deterioration of its potential capabilities so that solutions can be figured out to be used in planning and policy-making to restore its roles in local economic, social and ecological life.

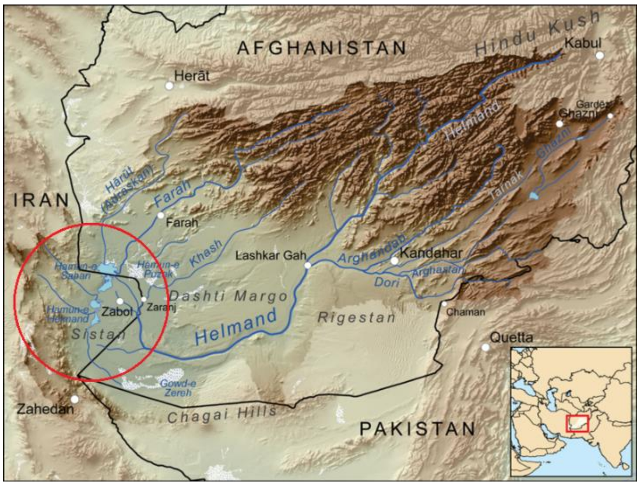

Figure 1. The location of Hamoon wetland in Iran and Afghanistan under high-water conditions (Source: Rasheki et al., A study on the permanent changes in the water level of Hamoon wetland in Iran, 2009)

2. Materials and Methods

The study used contingent valuation method (CVM) to estimate the value of biodiversity function of Hamoon wetland. CVM is used to find the value of the resources, utilities, environmental assets, and other goods for whose trade no markets are available. The method uses the interview or questionnaire to figure out how much money the interviewees/respondents are willing to pay to acquire a certain part of the non-marketable goods or services like environmental goods and services under the assumptions and conditions of a hypothetical market.

2.1. An overview of contingent valuation method

A model to estimate maximum willingness to pay (WTP)

Utility difference model is used to estimate the variations and Hicksian compensated surplus using the data collected by a binary choice questionnaire (Hanemann et al.,1984). In this model, individuals' response to binary questions (yes/no to bids) is derived from the maximum utility by the same individuals. An individual's indirect utility function (V) depends on his/her income, personal characteristics, and the quality of the environmental item that is valuated.

An individual will pay for an environmental item if the utility when he/she owns the item and pays for it is greater than the utility when he/she does not own it and thus, has not paid for it. In mathematical terms (Park et al., 1996):

$$V(1, INC - B; S) + \varepsilon_1 \geq V(0, INC; S) + \varepsilon_0 \qquad (1)$$

$$V(1, INC - B; S) + \varepsilon_1 - V(0, INC; S) - \varepsilon_0 \geq 0 \qquad (2)$$

$$V(1, INC - B; S) - V(0, INC; S) + (\varepsilon_1 - \varepsilon_0) \geq 0 \qquad (3)$$

$$dV + \eta \geq 0 \qquad (4)$$

Where 0 is when the person does not own the item and 1 is when he/she owns it, *B* is the amount of money that the individual takes from his income (*INC*) to procure the item, and *S* denotes personal characteristics. In this model, the random components that influence individuals' indirect utility function are expressed by ε_0 and ε_1. Hence, *dV* is a function of *INC*, *S*, and *B* (Park et al., 1996):

$$\mathrm{dV} = (\mathrm{INC}, \mathrm{B}, \mathrm{S}) \qquad (5)$$

When the utility difference (*dV*) is greater than 0, the respondent maximizes his/her own utility by agreeing to pay for the item. Consequently, we will have a 0 or 1 response for each individual. For example, the individuals are asked if they will pay *B* IRR to help the protection of Hamoon wetland. The answer will be affirmative or negative. As was mentioned, the factors underpinning this response (affirmative or negative) include *B*, *INC*, and *S*. Thus, we will have an econometric model whose dependent variable is 0 or 1. The models with a binary dependent variable are estimated by the Logit or Probit models.

2.2. Estimation of binary choice models

Assuming that the bid is *B* IRR, the respondent is asked if he/she is willing to pay *B* IRR for the protection of a natural resource (here, the ecosystem of Hamoon wetland). The possibility that the individual will give an affirmative and negative response to the question is calculated by (Hanemann et al., 1991):

$$\pi^n(B) = G(B;\theta) \qquad (6)$$

$$\pi^y(B) = 1 - G(B;\theta) \qquad (7)$$

Where *G(B;θ)* is the statistical distribution function with the vector of θ parameters. Eq. (6) and (7) indicate the possibility of affirmative and negative responses to the bid, respectively. Since utility maximization implies that:

$$Pr\{No\ to\ B\} \Leftrightarrow Pr\{B > \max WTP\} \quad (8)$$

$$Pr\{Yes\ to\ B\} \Leftrightarrow Pr\{B \leq Max\ WTP\} \quad (9)$$

The function *G(B;θ)* can be interpreted in this way that the affirmative or negative response to a bid is derived from a utility maximization process by respondent, in which case G(B;θ) will show the cumulative density function (cdf) of the maximum WTP (Hanemann et al.,1991). Bishap et al. (1979) considered the following logarithm-logistic function for G(B;θ):

$$\mathrm{G(B)} = [1 + \exp(-\mathrm{a} - \mathrm{b}(\ln \mathrm{B})]^{-1} \quad (10)$$

Where $\theta \equiv (a,b)$. Another form of a function for *G(B;θ)* is logistic cumulative density function (Hanemann and et al,1991).

$$\mathrm{G(B)} = [1 + \exp(-\mathrm{a} - \mathrm{bB})]^{-1} \quad (11)$$

Nonetheless, if *G (B;θ)* follows a normal distribution, the probit model will be used for its estimation. The selected model (either the logit or the probit) will make no difference in its estimation, and the maximum likelihood method is used in both models. Assuming that there are *N* respondents and the bid B_i^s is offered to the *i*th person, the likelihood logarithm function for the affirmative or negative response can be written as (Hanemann et al.,1991):

$$L^s(\theta) = \sum_{i=1}^{n}\{d_i^y ln\pi^y(B_i^s) + d_i^n ln\pi_i^s)\} = \sum_{i=1}^{N}\{d_i^y ln[1 - G(B_i^s;\theta)] + d_i^n lnG(B_i^s;\theta)\} \quad (12)$$

If the respondents agree with the bid, we have $d_i^y = 1$ and $d_i^n = 0$; otherwise, $d_i^y = 0$ and $d_i^n = 1$. The derivative of the likelihood function with respect to θ gives the values of the parameters:

$$\frac{\partial L^s(\hat{\theta}^s}{\partial \theta} = 0 \quad (13)$$

3. Estimation of the expected WTP

The previous section described how to estimate the bid function by binary choice models (the logit model). Here, we deal with methods to estimate the expected WTP.

The expected value of any random variable is calculated by (Boyle et al., 1988):

$$E(X) = \int^{+\infty} F(x)dx - \int_{-\infty}[1 - F(x)]dx \quad (14)$$

Where *F(X)* shows the possibility of accepting a bid and it is the cumulative distribution function of *X*, too (Hanemann, 1984) revealed that the expected value of any non-negative random variable, like WTP, can be written as

$$\mathrm{E(X)} = \int^{+\infty} \mathrm{F(x)dx} \quad (15)$$

Because the second term on the right side of Eq. (14), $\left(\int_{-\infty[1-F(x)]} dx\right)$, is equal to 0 for non-negative random variables (Mooney and et al, 1995). The following conditions should be met when the expected value is determined by Eq. (15):

$$\lim_{x\to 0} F(x) = 0, \quad \lim_{x\to\infty} F(x) = 1 \quad (16)$$

These conditions indicate that the area bounded by the curve of the cumulative distribution function is exactly equal to 1. When the cumulative distribution of *dV* (indirect utilities difference) that shows the possibility to accept a bid is defined as *F(dV)*, the definite integral of the cumulative distribution function is calculated to estimate the expected WTP in the methods of deriving binary choice (Bateman and et al, 2005).

$$P(y_i = 1) = F_i(dv) \quad (17)$$

$$E(WTP) = \int F_i\,(\mathrm{dv})\mathrm{dB} \quad (18)$$

The integral (18) can be calculated in three intervals (Bateman and et al, 2005):

i. In the interval of all integers: (Johnson et al). (1989) argue that although the lowest money paid to acquire an item is 0 and the highest is B_{max}, there are individuals whose WTP is greater than B_{max} and individuals who show willingness to have their income increased by the reduction of item amount. Therefore, Integral (15) should be calculated in the interval $[-\infty,+\infty]$.

$$E(WTP) = \int_{-\infty}^{+\infty} F_i\,(dV)dB \quad (19)$$

ii. In the interval of non-negative broken numbers: Slur et al. (1986) suggest that the integral should be calculated in the interval of numbers that are observed ($0 \leq B_i \leq B_{\max}$).

$$E(WTP) = \int_0^{B_{max}} F_i\,(dV)dB \quad (20)$$

iii. In the interval of non-negative unbroken numbers: according to Hanman (1984), B_{max} cannot express the maximum WTP and the positive interval of the integral should be determined in $+\infty$. If the integral is calculated in the interval [0, B_{max}], then the following conditions will be met (Boyle and et al, 1988):

$$E(X) = \int^{B_{max}} max f_i(dV)dB < 1\ , F(B_{max}) < \lim_{B\to\infty} F(B) = 1 \quad (21)$$

Therefore, the properties of the cumulative distribution function mentioned in Eq. (16) are violated. Therefore, we have

$$\mathrm{E(X)} \neq \int^{\mathrm{B_{max}}} \mathrm{F_i(dV)dB} \quad (22)$$

These results show that Eq. (20) is unable to express the exact amount of average WTP. Also, (Hanemann, 1984), state that WTP estimated in the interval $[0,-\infty]$ cannot be a good estimation of WTP. Thus, the integral should be calculated in the interval $[0,+\infty]$.

$$E(WTP)=\int_0^{+\infty} F_i\,(dV)dB \quad (23)$$

The methods *i*, *ii*, and *iii* are also called mean total WTP, mean broken WTP and mean WTP, respectively (Duffield and et al, 2005). The mean WTP method is preferred because it considers WTP of all individuals of the community. However, (Hanemann, 1984) express that instead of calculating the integral in the interval $[0,+\infty]$, the median WTP should be estimated and applied since median WTP is less sensitive to the outliers. This value is estimated by $\exp(-a/b)$ and $(-a/b)$ in the logit models (10) and (11), respectively (Hanemann, 1984). Given these arguments, we will use median WTP.

4. Results and Discussion

4.1. Value estimation of biodiversity function of Hamoon wetland ecosystem

The value of the habitat function of Hamoon wetland ecosystem includes its wildlife protection value that was estimated by contingent valuation method (CVM). The willingness to pay (WTP) was, also, derived by the two-dimensional binary choice method. Next section reports the descriptive statistics of the variables, and the following sections deal with the results of the estimation of respondents' WTP for the protection of the Hamoon wetland ecosystem wildlife.

4.2. Descriptive statistics of variables

This section first describes the descriptive statistics of respondents' socioeconomic characteristics followed by the descriptive statistics of their attitudes and their WTP for the wildlife protection of the Hamoon wetland ecosystem.

4.3. Descriptive statistics of respondents' socioeconomic characteristics

Mean, standard deviation, minimum, and maximum of respondents' socioeconomic characteristics are tabulated in Table 5. The respondents were, on average, 31.2 years old with minimum and maximum of 15 and 65 years, respectively. Also, the mean, minimum and maximum family size was 6.5, 2 and 12, respectively.

Table 1. Descriptive statistics of explanatory variables (respondents' socioeconomic characteristics)

Variable	Variable type	Mean	SD	Minimum	Maximum
Age	Continuous	31.2	10.23	15	65
Gender*	Discrete	0.67	0.58	0	1
Educational level**	Ordinal	7.23	4.49	1	6
Family size	Continuous	5.8	1.89	2	12
Income	Ordinal	5.48	2.11	1	10
Membership in environmentalist organizations***	Discrete	0.056	0.31	0	1
Visit to Hamoon Wetland***	Discrete	0.27	0.56	0	1

* 1 = male, 2 = female; ** 6 = master's degree or higher, 5 = bachelor's degree, 4 = associate degree, 3 = diploma, 2 = under diploma, 1 = illiterate; *** 1 = yes, 0 = no (Source: Research findings)

Descriptive statistics of binary discrete variables are shown in Table 1, according to which 53% of the participants (265 people) were male and the rest were female. Also, 43% (215 people) had visited Hamoon wetland, but 57% (285 people) stated that they had not. Just 2% (10 people) were members of a private environmentalist organization.

Tables 2 and 3 summarize the descriptive statistics of the educational level and income. It can be seen that 37.45% (187 people) had bachelor's degree which had the highest frequency. The least frequency was related to illiteracy (1%). According to Table 3, the minimum and maximum frequencies of income level were related to the income category 9 (7.5-9 million IRR) forming 1.5% of the sample and the income category 7 (4.5-6 million IRR) forming 25.5% of the sample, respectively.

Table 2. Descriptive statistics of binary discrete variables

Variable	Gender		Visit to Hamoon Wetland		Membership in environmentalist organizations
Description	Male (= 1)	Female (= 0)	Yes (= 1)	No (= 0)	No (= 0)
Frequency	265	235	215	285	490
Frequency percentage	53	47	43	57	98

Source: Research findings

Table 3. Descriptive statistics of educational level

Educational level	Master's degree or higher	Bachelor's degree	Associate degree	Diploma	Under-diploma	Illiterate
Frequency	62	187	130	82	35	5
Frequency percentage	12.5	37.45	26	16.5	7	1

Source: Research findings

Table 4. Descriptive statistics of income

Group	Income level (000 IRR)	Frequency	Percentage
1	0-1200	24	4.5
2	1200-1650	62	12.5
3	1650-1950	72	14.5
4	1950-2400	68	13.5
5	2400-3000	56	11
6	3000-4500	67	13.5
7	4500-6000	127	25.5
8	6000-7500	10	2
9	7500-9000	7	1.5
10	>9000	70	1.5

Source: Research findings

4.4. Descriptive statistics of respondents' attitudes

Respondents' attitudes towards wildlife included the protection of wildlife for their own use in the present year and coming years, for the use of future generation and because of the fact that they should exist since they have the right to live, commitment and financial capability. The descriptive statistics of these opinions and attitudes are presented in Table 5.

Table 5. Descriptive statistics of respondents' attitudes

Statement	Completely agree	Agree	Neutral	Disagree	Completely disagree
My family should not pay for the protection of Hamoon wetland.	15.54	26.04	19.96	32.12	6.34
My family cannot afford to pay for the protection of Hamoon wetland.	9.65	19.29	24.87	30.8	15.39
In my family's opinion, wildlife is valuable just when it can be used in the current year or at least in future.	15.23	17.65	14.05	31.41	21.66
In my family's opinion, wildlife has the right to live, no matter if we can or cannot see it.	57.49	35.61	3.19	2.86	0.85
My family believes that wildlife should be protected for the next generations.0	45.39	25.81	7.79	11.23	9.78

Source: Research findings.

4.5. Continuous descriptive statistics of explanatory variables

As was mentioned in the section related to the estimation of the Hamoon wetland ecosystem protection value, Table 5 summarizes the mean, standard deviation, minimum and maximum of socioeconomic variables to be used in the calculation of the WTP.

4.6. Results of estimation of wildlife protection value of Hamoon wetland ecosystem

After the review of descriptive statistics of respondents' socioeconomic characteristics, their attitudes and their stated maximum WTP, we turn to the wildlife protection value. First, we look at the results of the logit model to examine the impact of individuals' socioeconomic characteristics on the probability of accepting the bid. Then, the variables pertaining to individuals' attitudes are included in the model and their impact is assessed on the probability of accepting the bid. Then, the individuals' expected WTP for the protection of wildlife is calculated.

4.7. Factors determining the acceptance of bid for the protection of wildlife

The major question in estimating the wildlife value is about the bid the respondents would pay. The question was asked in a two-dimensional binary choice form. As was noted about the bids for the protection of the Hamoon wetland ecosystem, the bids for the protection of wildlife were determined by a pretest. The median derived from the pretest (80,000 IRR) was set as the first bid. In the case of its acceptance, it would be doubled to have 160,000 IRR as the second bid. In the case of its rejection, it would be halved to set 40,000 IRR as the second bid. As well, the logit model was applied to estimate the econometric models of the wildlife protection values. Similar to the protection values of the whole ecosystem of Hamoon wetland, the models were estimated in linear or logarithm forms. Table 7 reports the results of the estimations.

Table 7. Factors influencing the possibility to accept the bid for the protection of wildlife

Variable	Linear model		Logarithmic model	
	Coefficient	t-statistic	Coefficient	t-statistic
Bid	-0.0008872	-3.23	-0.065	-2.56
Age	0.14	1.3	0.14	1.23
Educational level	0.10	1.05	0.10	1.04
Income	0.05	1.23	0.05	1.22
Visit to Hamoon Wetland	1.16	0.033	1.16	0.032
Education × north region	0.1	1.57	0.1	1.56
Education × west region	0.11	0.87	0.11	0.8
Education × east region	0.15	1.89	0.13	1.87
Education × Tehran	0.14	2.26	0.14	2.25
y-intercept	-1.06	-1.5	2.39	1.25
Prediction precision percentage	89.50		87.47	
Likelihood statistic	-613.87		-612.69	
Sig. of likelihood statistic	0.000		0.000	
Pseudo R^2	57.85		56.78	
Adjusted court R^2	78.6		76.34	

Source: Research findings

Table 8. Effect of respondents' attitudes on the possibility of accepting the bid for the protection of wildlife

Variable	Linear model		Logarithmic model	
	Coefficient	t-statistic	Coefficient	t-statistic
Bid	-0.00095	-4.18	-0.069	-4.06
Age	0.14	1.46	0.14	1.43
Educational level	0.11	1.75	0.10	1.74
Income	0.04	0.89	0.04	0.88
Visit to Hamoon Wetland	1.23	0.035	1.23	0.034
Commitment	1.39	0.029	1.39	0.028
Financial capability	1.37	0.025	01.37	0.023
Environmental	0.45	0.011	0.45	0.01
Development	-3.31	0.016	-3.31	0.015
Education × north region	0.1	1.59	0.1	1.59
Education × west region	0.13	0.91	0.13	0.90
Education × east region	0.17	2.21	0.17	2.20
Education × Tehran	0.16	3.06	0.16	3.05
y-intercept	-1.37	-2.53	3.63	1.25
Prediction precision percentage	91.39		91.36	
Likelihood statistic	-599.34		-600.21	
Sig. of likelihood statistic	0.000		0.000	
Pseudo R^2	600.66		60.05	
Adjusted court R^2	81.82		80.13	

Source: Research findings

4.8. Impact of respondents' attitude on wildlife value

The participants' attitudes towards the protection value of the wildlife were collected in four categories of entertainment, being, selection and inheritance values whose results are summarized in Table 5. The examination of these attitudes yielded a mixed index that was included in econometric models. These estimations and all relevant socioeconomic variables are presented in Table 8.

The likelihood test was applied to select a group of models with and without the participants' attitudes. The statistic value of this test is 29.06 for linear models and 24.96 with two degrees of freedom for logarithmic models. As was noted, this test complies with χ^2 statistic. The value of χ^2 with two degrees of freedom at the 5% confidence level is 4.87. Therefore, the fact that the value of likelihood test statistic is greater than χ^2 value rejects the null hypothesis that the coefficient of the variables pertaining to individuals' attitudes (commitment and financial capability) was zero. In other words, individuals' attitudes should be included in econometric models.

$$LR_{linear}=-2\times(-613.87+599.34)=29.06$$

$$LR_{Logarithmic}=-2\times(-612.69+600.21)=24.96$$

Now that we know the models including participants' attitudes are preferred to models excluding them, we turn to the comparison of linear and logarithmic models to select one of them for the subsequent analyses and interpretations. To this end, the expected WTP is calculated by both models and one of them is picked in accordance with the statistical significance of the estimated WTP.

4.9. The expected WTP

The expected WTP in linear and logarithmic models was calculated by Eq. (24) and (25), respectively, in which β_{bid} represents the coefficient of bid in linear model and $\beta_{log(bid)}$ represents the coefficient of bid in logarithmic model. Since the dummy variables pertaining to the four regions were included in the models and WTP should be estimated for the four regions separately, it is imperative to firstly calculate GC_{linear} and $GC_{logarithmic}$ for the four regions.

$$GC_{linear,N} = \alpha + \beta_{age} \times M_{age} + \beta_{edu} \times M_{edu} + \beta_{inc} \times M_{inc} + \beta_{visit} \times M_{visit} + \beta_{res} \times M_{res} + \beta_{aff} \times M_{aff} + \beta_{Nedu} \times M_{edu} \quad (24)$$

$$GC_{linear,T} = \alpha + \beta_{age} \times M_{age} + \beta_{edu} \times M_{edu} + \beta_{inc} \times M_{inc} + \beta_{visit} \times M_{visit} + \beta_{res} \times M_{res} + \beta_{aff} \times M_{aff} + \beta_{Tedu} \times M_{edu} \quad (25)$$

$$GC_{linear,E} = \alpha + \beta_{age} \times M_{age} + \beta_{edu} \times M_{edu} + \beta_{inc} \times M_{inc} + \beta_{visit} \times M_{visit} + \beta_{res} \times M_{res} + \beta_{aff} \times M_{aff} + \beta_{Eedu} \times M_{edu} \quad (26)$$

$$GC_{linear,W} = \alpha + \beta_{age} \times M_{age} + \beta_{edu} \times M_{edu} + \beta_{inc} \times M_{inc} + \beta_{visit} \times M_{visit} + \beta_{res} \times M_{res} + \beta_{aff} \times M_{aff} + \beta_{Wedu} \times M_{edu} \quad (27)$$

Where β_{visit}, β_{edu}, β_{inc}, β_{age}, β_{aff} and β_{res} denote the coefficients of visit to Hamoon wetland, educational level, income, age, index of financial capability, and index of commitment, respectively, M_{visit}, M_{edu}, M_{inc}, M_{age}, M_{aff} and M_{res} represent their averages, respectively, and α is the y-intercept. Also, β_{Nedu}, β_{Tedu}, β_{Eedu} and β_{Wedu} denote the coefficient of the interaction of education in the north, Tehran, the east and the west regions, respectively. $GC_{linear,N}$, $GC_{linear,T}$, $GC_{linear,E}$ and $GC_{linear,W}$ represent the expected WTP in the north, Tehran, the east and the west regions, respectively. $GC_{logarithmic}$ can be calculated for the four regions by these equations. The only difference is the fact that the values are used for the coefficient estimated from the logarithmic model. After the estimation of GC_{linear} and $GC_{logarithmic}$ by Eq. (26) and (27), the expected WT can be estimated for different regions for linear and logarithmic models. The results are summarized in Table 9.

Table 9. Estimation of expected WTP to protect the wildlife

Model	Region	GC	WTP	Standard error	χ^2	Sig.
Linear model	Tehran region	0.36	45637.32	95438.13	3.92	0.00
	North region	0.39	48690.61	11784.65	3.92	0.00
	East region	0.28	37407.12	10407.90	3.92	0.00
	West region	0.067	10435.94	8329.34	3.92	0.00
Logarithmic model	Tehran region	3.85	43170.49	83865.54	0.45	0.48
	North region	3.88	44138.68	90453.10	0.44	0.47
	East region	3.62	35476.87	83075.38	0.46	0.44
	West region	3.58	30583.14	53768.59	0.43	0.47

Source: Research findings

The results of one of this function forms should be selected to be used in final analyses and the calculations of the protection value of the Hamoon wetland ecosystem. As is evident in Table 9, the expected values derived from the linear model were significant and those derived from the logarithmic model were not statistically significant. Thus, the linear model is preferred to the logarithmic model.

According to Table 8, the families in the north region were more willing to pay for the protection of the Hamoon wetland wildlife than the other regions. The families in the west region exhibited the lowest WTP.

The comparison of the models shows that the linear model in which respondents' attitudes were included was more appropriate. Now, we address the question how influential each explanatory variable can be on bid acceptance. It can be concluded from the estimations that age, education, visit to Hamoon wetland, bid, people's commitment, and their financial capability influence the wildlife protection value of the Hamoon wetland ecosystem significantly.

The negative sign of the bid reflects the fact that the probability to accept a bid decreases as the bid is increased. The positive sign of the variables education, visit to Hamoon wetland, commitment, and financial capability indicates that the probability to accept the bid increases with individual's education, financial capability, and commitment. Also, people who have visited the wetland have higher WTP than those who have not. However, the marginal effect of these variables should be calculated to quantify these effects.

According to Model 3 in Table 8, the final impacts of the variables 'visit to Hamoon wetland' and 'age' were 3.19 and 1.15, respectively. It implies that the probability of accepting a bid by an individual who has already visited Hamoon wetland is 3.19% higher than that of an individual who has never visited it. Also, the marginal effect of an individual's age is 1.15%. Table 10 presents the marginal effects of these variables. This value shows that the probability of bid acceptance is increased by 1.15% for each year that an individual with the mean age of the sample becomes older.

Table 10. Marginal effects of the variable 'visit to Hamoon wetland' and 'age'

Model	Visit to Wetland	Age
Linear including respondents' attitudes	3.19	1.15

Source: Research findings

To calculate the marginal effect of income, first the probability of bid acceptance was estimated for each income category since this variable is included in the model as an ordinal variable. The difference in the probability of bid acceptance by each income category as compared to other categories reflects the marginal effect.

Table 11. The calculations of marginal effect of the income

Income category	Probability of acceptance	Marginal effect
1	15.54	0.92
2	16.46	0.93
3	17.39	0.94
4	18.33	0.95
5	19.28	0.96
6	20.24	0.97
7	21.21	0.98
8	22.19	0.99
9	23.18	1
10	24.18	

Source: Research findings

Like income, bid is ordinal too and its marginal effect was estimated with the same procedure that was described for income. As is evident in Table 11, the possibility to accept the bid of 80,000 IRR is 0.99% lower than the possibility to accept the bid of 40,000 IRR.

Table 12. Calculations of the marginal effect of the bid

Model	Bid	40,000	80,000	160,000
Linear including individuals' attitudes	Probability of acceptance	8.65	7.66	6.67
	Marginal effect	-0.99	-0.99	

Source: Research findings

The individual's commitment was included in the model as an ordinal variable. Given its positive sign and its marginal effect presented in Table 12, people who feel more commitment to the conservation of the wildlife have higher WTP for its protection. For example, the possibility of bid acceptance by individuals whose commitment index is five is 4.61% higher than that by those whose commitment index is four.

Table 13. Marginal effect of commitment

Commitment	Probability of acceptance (%)	Marginal effect (%)
1	17.63	4.03
2	21.66	4.27
3	25.93	4.35
4	30.28	4.61
5	34.89	

Source: Research findings

One another component of people's attitudes is their financial capability. The positive sign and the percentage possibility of bid acceptance for this variable reveal that people with higher financial capability are more willing to pay for the protection of the Hamoon wetland ecosystem. Results of the marginal effect of respondents' financial capability index are summarized in Table 14.

Table 14. Marginal effect of the individual's financial capability

Financial capability	Probability of acceptance (%)	Marginal effect
1	17.58	3.94
2	21.52	4.39
3	25.91	4.87
4	30.78	4.95
5	35.73	

Source: Research findings

4.10. Wildlife protection value of the Hamoon wetland ecosystem

The expected WTP to protect the wildlife of Hamoon wetland in different regions was estimated in the previous sections. Therefore, the protection value could be separately calculated for the regions and their sum was considered as the total protection value of the wildlife or the value of habitant function of Hamoon wetland. The wildlife protection value of a certain region is calculated as the product of the number of local families and the expected WTP in that region. The weighted mean of WTP in four regions reflects the expected WTP for the whole sample. The results of these calculations are presented in Table 15.

Table 15. Results of estimations of wildlife protection value of Hamoon wetland

Region	Number of families	WTP (IRR)	Total value (billion IRR)
Tehran region	3847234	45637.32	175.57
North region	1538607	48690.61	74.91
East region	2087913	37407.12	78.10
West region	496291	10435.94	5.17
Total		35542.74*	333.75

* Weighted mean of WTP
Source: Research findings

As can be observed in Table 14, the habitant function value of Hamoon wetland is 333.75 billion IRR and the expected WTP to protect its wildlife is 35542.74 IRR per family per year.

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