Ecological Economics 138 (2017) 56–63

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

Environmental Valuation With Periodical Payments in High-inflation Economies. An Argentinean Case Study

Verónica Farreras [a,b,*], Pere Riera [c], Pablo F. Salvador [b]

[a] Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA-CONICET), 5500 Mendoza, Argentina
[b] Facultad de Ciencias Económicas, Universidad Nacional de Cuyo, M5502JMA Mendoza, Argentina
[c] Institut Ciència i Tecnologia Ambientals (ICTA), Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain

ARTICLE INFO

Article history:
Received 9 September 2016
Received in revised form 1 March 2017
Accepted 13 March 2017
Available online xxxx

Keywords:
Environmental valuation
Contingent choice
Periodical payments
Annuities
Inflation

ABSTRACT

Stated preference valuation surveys often ask respondents for periodical payments, sometimes for the remaining life of the individuals. Questionnaires do not usually specify whether those payments would vary according to inflation. This may be less important in low-inflation economies, but results could differ significantly in high-inflation countries. A contingent choice exercise was conducted to explore the severity of this effect in Argentina. The empirical application focused on an anthropogenic-pressure mitigation program for the basins of the Mendoza region. A comparison of willingness-to-pay results from a scenario where annual payments were to be increased according to inflation with another of fixed annuities, found inflation to be significantly influential on respondents' stated values. Furthermore, a test on the robustness of the estimated values found results to be consistent with prior expectations.

1. Introduction

Over the last decades, stated preference valuation methods have experienced a generalized growing interest, including an increasing number of applications in developing economies (Carson, 2011, and for some examples in Argentina, Agüero et al., 2005; Lacaze, 2009; Saidón, 2012; Farreras et al., 2016). They are used to estimate the value of a wide range of non-market goods in terms of maximum Willingness-To-Pay (WTP). Typically, a questionnaire describing the provision of the good in exchange for a payment is administered to a sample of the relevant population. The elicitation question can take different forms, depending on the specific method. Contingent choice is one of the extensively applied variants (Hensher et al., 2005). Typically, the elicitation question asks to select the preferred alternative out of a choice set, each alternative being defined by a given level of provision of one or several goods, and a payment amount.

Sometimes, the valuation exercise demands a certain periodical payment (annuity) over a given span of time, or for life (Hanemann et al., 1991; Kahneman and Knestsch, 1992; Willis and Garrod, 1998; Johnston et al., 1999). It is assumed that respondents would be more prompt to commit to the requested cost if the questionnaire expresses the annuities in nominal terms (e.g., *p* monetary units each time, regardless of inflation), compared to stating payments in real terms (e.g., *p* monetary units each time, to be adjusted according to inflation). In the former case, the estimated WTP result ought to be higher in a positive inflation environment. However, when annuities are used and the questionnaire does not indicate whether values are nominal or real, respondents are left with their own interpretation. In that case, individuals may reasonably take their own personal experience, or some other aspect, as a cue. Consequently, the researcher may not know the setting respondents had in mind when stating their valuation choices. In dealing with this uncertainty, some studies (e.g., Chilton et al., 2004; or Desaigues et al., 2011) treat annuity payments as real values, while others (for example, Unsworth and Bishop, 1994; Kinnell et al., 2002) interpret payments as nominal. However, most studies with annuities seem to obviate the inflation issue.

In order to explore this problem, a contingent choice valuation exercise was conducted to estimate the social welfare change due to the effects of possible anthropogenic-pressures over the next 10 years on the basins located in the western part of Argentina, this country facing relatively high inflation rates at the time of the study, in 2013, above 20% per year. A closer look at the macro-economic context of Argentina reveals that inflation has historically been a matter of concern for the population, also in recent times. In the mid-1970s, after different unsuccessful stabilization policies, the twelve-month inflation reached 347%. The 1980s was the worst decade in terms of price increases, reaching

* Corresponding author at: Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA-CONICET), Av. Ruiz Leal s/n Parque General San Martín, 5500 Mendoza, Argentina.
E-mail addresses: vfarreras@mendoza-conicet.gob.ar (V. Farreras), pablo.salvador@fce.uncu.edu.ar (P.F. Salvador).

http://dx.doi.org/10.1016/j.ecolecon.2017.03.028
0921-8009/

an unprecedented 4900% in 1989, followed by 1300% in 1990. In the early 2000s, after the sovereign default, inflation soared to 40% in 2002. It entered a rising path again in 2007, reaching 25.6% in 2012 and 28.7% in 2013, with an average annual inflation rate of 20% over the last 10 years.

The rest of the paper is organized as follows. Section 2 presents the materials and methods which includes the case study, the contingent choice method, the empirical application, and the hypotheses tests. Section 3 reports the main results and tests undertaken. Finally, Section 4 discusses the findings and draws the main conclusions.

2. Materials and Methods

2.1. Case Study

The valuation exercise deals with an environmental improvement in an area neighboring the agglomeration of Gran Mendoza, in western Argentina, on the eastern slopes of the Andes Precordillera (Fig. 1). Several watersheds run through this web of arid and semi-arid piedmont landscapes, providing several provisioning, regulatory, and cultural services. However, strong anthropogenic pressures on the basins west of Gran Mendoza threaten some of the services they provide to society. In recent decades, population growth and urban expansion have generated significant changes in the dynamics of the piedmont-city ecotone, which has contributed to the degradation of the services generated in the watersheds that integrate the alluvial area of Gran Mendoza (Vich et al., 2005; Salomón, 2009; Grunwaldt et al., 2010).

The vegetation of the region is composed of *larrea divaricata community* in 11.9%, *artemisia mendozana community* in 17.7%, *larrea cuneifolia community* in 9.6%, and *zuccagnia punctata community* in 60.8% (Martínez and Dalmasso, 1992; Martínez, 2010).

The progressive reduction of vegetation cover diminishes the infiltration of water into the soil and increases surface runoff (Vich et al., 1993). Furthermore, the natural drainage system to evacuate water excesses suffers alterations (Vich et al., 2007). All together leads to soil erosion, downstream sedimentation, and a further deterioration of the hydrological characteristics of the soil (Vich et al., 2004). The hydrological cycle alteration increases the threat of debris flow and flash floods in these alluvial fan environments, which places society at risk during brief spells of heavy rainfall (Vich et al., 1993; Vich and López Rodríguez, 2010). The reduction of plant cover and the increased risk of alluvial flow are two of the most pronounced effects of anthropogenic pressure on the Mendocinian piedmont.

Based on results from the above-referenced field studies, and on current knowledge of the plant cover in the Mendocinian piedmont (Martínez and Dalmasso, 1992; Martínez, 2010), threat of debris flows and flash floods (Vich et al., 2010; Moreiras, 2010; Fernández, 2010), and land use (López, 2010; Gudiño et al., 2010) in the watersheds that integrate the alluvial area of Gran Mendoza, we hypothesized a most likely base scenario over the next 10 years. This scenario is referred to as the Business-As-Usual (BAU) situation or “do nothing” scenario, according to two environmental variables, plant cover and alluvial flow risk. Under BAU, it was predicted that the plant cover percentage, currently averaging 45% of the Mendocinian piedmont, would drop to 20%, while the alluvial flow risk, currently affecting an average of 10 out of 100 houses of Gran Mendoza every year, would increase to 16 out of 100 houses.

The implementation of a program to mitigate the expected extent of the consequences of the anthropogenic pressures on the Mendocinian piedmont would modify the BAU situation. The suggested program includes small infrastructure works (like water traps, and dikes of gabions) and improvements of the natural vegetation (including seedling planting), as proposed in some watershed management studies (Vich and López Rodríguez, 2010). However, these management corrections would restrict the recreational access to the piedmont area during the application of the program. Depending on the extent of the management corrections, the consequences on the recreational restrictions would vary.

2.2. Contingent Choice Method

The label *contingent choice* refers to a survey-based valuation method that simulates a market choice situation (Louviere, 1988; Hanemann and Kanninen, 1999; Bennett and Blamey, 2001). A questionnaire details the good to be considered. The good description includes some of its characteristics, usually called attributes. Depending on the proposed action, the attributes of the good vary in their quantity or quality level. Different level combinations of the attributes, together with a proposed payment, conform different alternatives. Respondents face a choice from a set of alternatives (a choice set), consisting of BAU and two or

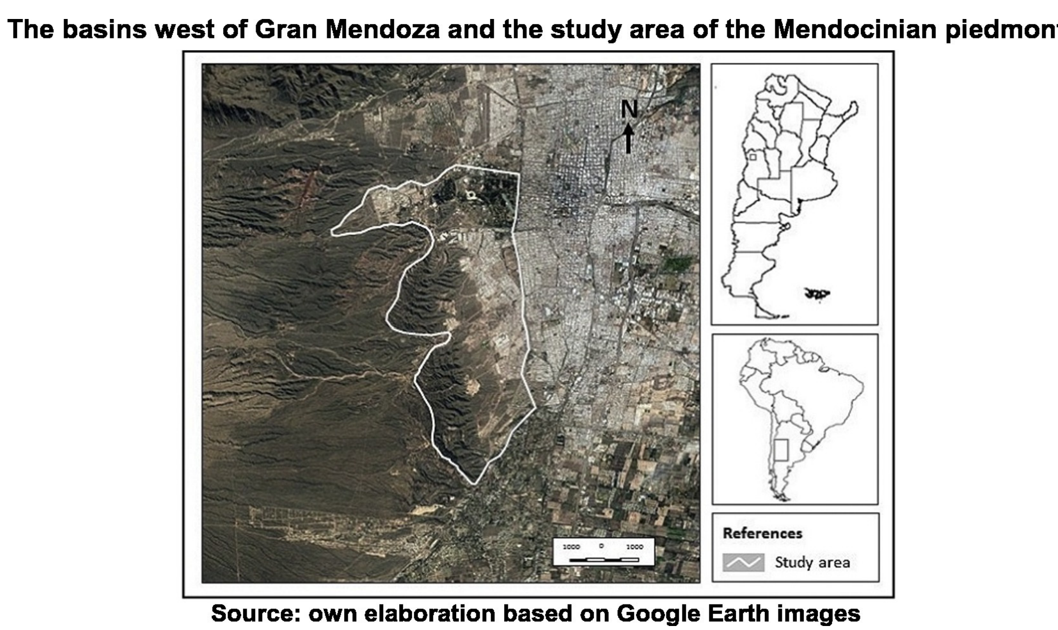

Fig. 1. The basins west of Gran Mendoza and the study area of the Mendocinian piedmont. (Source: own elaboration based on Google Earth images.)

more alternatives. Typically, they are asked to choose the most preferred option, although other variants are possible. A respondent can face several successive choice sets during the interview.

From an economic theory perspective, a contingent choice method is consistent with Random Utility Maximization (RUM) models (Thurstone, 1927; McFadden, 1973), therefore providing welfare measures consistent with consumer theory. Under the RUM framework, the utility U_{ij} derived from alternative j by individual i can be expressed as a function of a part observable by the researcher, V_{ij}, and a stochastic component ε_{ij} that is independent and identically distributed (iid) extreme value, and only known with certainty to the respondent, i.e. $U_{ij} = V_{ij} + \varepsilon_{ij}$. It can also be rewritten as.

$$U_{ij} = \beta_i' x_{ij} + \varepsilon_{ij}, \tag{1}$$

where x_{ij} is a vector of observed variables that relate to the alternative j and socio-economic characteristics (age, gender, education, income, etc.) of the respondent, i, and β_i' is a vector of coefficients of these variables for individual i representing that person's tastes (Manski, 1977).

The condition for individual i choosing a given alternative j over any alternative option k belonging to the set of alternatives A, can be expressed in probability terms, P, as

$$P_{ij} = P\ \left\{\beta_i' x_{ij} + \varepsilon_{ij} > \beta_i' x_{ik} + \varepsilon_{ik};\ \forall k \neq j \in\ A\right\}.$$

The choice probabilities can be estimated econometrically using different models. One of the most frequently used is the Mixed Logit model (ML). A widely applied and straightforward ML probability derivation is based on random coefficients (Train, 1998; McFadden and Train, 2000; Train, 2009). Utility is specified as in Eq. (1), where coefficients β_i vary over respondents in the population with density $f(\beta)$ representing the tastes of individual respondents (allowing for heterogeneous preferences). This density is a function of parameters θ that represents the mean and covariance of the β's in the population (Train, 2009; p. 137). This density is denoted as $f(\beta|\theta)$ and can be specified to be normal, log-normal, uniform, triangular, or any other distribution.

The individual knows the value of her own β_i and $\varepsilon_{ij}{}'$s for all j, and chooses the alternative that renders her the highest utility. The researcher observes the $x_{ij}{}'$s but not the β_i or the $\varepsilon_{ij}{}'$s. Therefore, the choice probabilities can be expressed in the form

$$P_{ij} = \int L_{ij}(\beta) f(\beta|\theta)\, d\beta, \tag{2}$$

where $L_{ij}(\beta)$ is the logit probability evaluated at coefficients β:

$$L_{ij}(\beta) = \frac{e^{\beta_i' x_{ij}}}{\sum_k e^{\beta_i' x_{ik}}}$$

The choice probability [Eq. (2)] is approximated through simulation. For any given value of θ, a value of β is drawn from $f(\beta|\theta)$, and then the logit formula $L_{ij}(\beta^r)$ is calculated with this draw. This process is repeated many times, and averages are obtained for the simulated probability (Hensher and Greene, 2001),

$$SP_i = SP(U_i > U_k) = \left(\frac{1}{R}\right) \sum_{r=1}^{R} L_{ij}\left(\beta^r\right),$$

where R is the number of replications (i.e., draws of β), β^r is the rth draw, and SP_i is the simulated probability that any particular individual prefers the alternative j in the choice set to any alternative k.

The simulated probabilities are inserted into the log-likelihood function to give a simulated log likelihood:

$SLL = \sum_{i=1}^{N} \sum_{j=1}^{K} d_{ik} \quad \ln\ SP_i$,where $d_{ik}\ =\ 1$ if individual i chooses j, and zero otherwise. The maximum simulated likelihood estimator is the value of θ that maximizes SLL. The properties of this estimator are discussed in Train (1999).

Once the parameter estimates have been obtained, the marginal WTP for each attribute in a linear additive model can be inferred using the ratio of coefficient as in

$$WTP = -\beta_n / \beta_m, \tag{3}$$

where β_n is the regression coefficient of the attribute to be valued, and β_m represents the coefficient of the monetary attribute or payment (Hensher et al., 2005). This value reflects the mean of the marginal WTP of the population, expressed in the units in which the payment is defined, as they entered the regression, e.g. Argentinean pesos per year, during ten years, at 2013 prices, for a unit increase of attribute n.

2.3. Empirical Application

2.3.1. Choice Sets

Alternatives were defined by three non-monetary attributes - plant cover, recreation, and alluvial flow risk -, and a monetary attribute in the form of an annuity to finance the program to mitigate the anthropogenic-pressure effects on the Mendocinian piedmont.

As shown in Table 1, each attribute was characterized by four levels. The levels for alluvial flow risk were described as the probability of 1 out of 100 houses to be harmed by an alluvial flow. Similarly, the levels for plant cover were expressed in percentage terms. The levels of both attributes were spread between the values expected in the BAU scenario, and the current ones. The levels for recreation were also expressed in percentages, and defined considering that the implementation of any mitigation program would restrict recreational access to the piedmont area; therefore, recreation levels for other than BAU scenarios were defined below 100%. The BAU levels for the physical attributes reflected the estimated situation in 10 years' time if no additional management were to be undertaken, while the rest of the levels corresponded to management corrections. Payment levels were determined after a pilot study in which respondents stated the maximum they were willing to pay for different scenarios, and then tested again; and reaffirmed by a focus group. The extra cost for doing nothing was zero (BAU option). The monetary levels were expressed in Argentinean pesos, to be

Table 1
Attributes and levels used in the contingent choice exercise.

Attribute	Description	Levels
Plant cover	The average percentage of piedmont plant cover in 10 years' time.	45% (current level) 40% 30% 20% (business-as-usual)
Recreation	The average percentage of piedmont area for leisure and recreation activities over the next 10 years.	100% (business-as-usual and current level) 60% 40% 20%
Alluvial flow risk	Alluvial medium flow risk for Gran Mendoza in 10 years' time.	10 out of 100 houses (current level) 12 out of 100 houses 14 out of 100 houses 16 out of 100 houses (business-as-usual)
Annual payment[a]	The required annual payment per person for a piedmont management program over the next 10 years.	125 Argentinean pesos 75 Argentinean pesos 50 Argentinean pesos 0 Argentinean pesos (business-as-usual and current level)

[a] Average exchange rate in autumn 2013: 1 US dollar equal to 5.2 Argentinean pesos.

paid by the individual each year, during the next 10 years. This variable was the object of a test related to inflation, as will be explained later.

There were 81 (3^4) possible combinations of attribute levels or different alternatives, excluding the BAU levels. Since this universe was large, an orthogonal fractional factorial design reduced the number of alternatives to 48 (Louviere, 1988). This design allows for the independent estimation of main effects and two-way attribute interactions. The alternatives were randomly grouped into 16 blocks of three alternatives plus BAU. Each block of four alternatives corresponds to a choice set. Two different sets of choices were presented to each individual. Respondents were asked to pick the alternative they preferred within the choice set. Given the sample size, each alternative was seen by an average of 25 respondents in the whole survey. Fig. 2 reproduces a typical choice set. In addition to focus groups, another pilot exercise confirmed the choice task adequacy. Likewise, the random combination of attribute levels posed no problems to participants.

2.3.2. Questionnaire

The first part of the questionnaire was devoted to the presentation of the attributes. It described the current average level of each non-monetary attribute in the Mendocinian piedmont and the most reliable prediction of the average levels of each attribute in 10 years' time. Next, the questionnaire presented the expected change in the plant cover and alluvial flow risk attributes under BAU. Regarding the recreation attribute, respondents were told that access to the piedmont for leisure and recreation would be restricted during the application of the management corrections. In order to further familiarize individuals with possible levels of change, and check for satiation within the levels segment, participants were then asked to indicate the preferred attribute level, regardless of the cost.

After the presentation of the non-monetary attributes, the monetary trade-off was described. It was stated that the local government was considering to implement a program to mitigate the consequences of the anthropogenic pressures on the Mendocinian piedmont. The extent of the mitigation would depend on the amount of resources devoted to it, which in turn would depend on their answers to the questionnaire. If the average results indicated that people would be happy to pay something for the program, then payments would be compulsory and collected annually from citizens through a municipal tax.

The central part of the questionnaire focused on the choice tasks and a number of debriefing questions. It also contained the inflation experiment, where using the same nominal bid levels, two valuation scenarios were defined. In scenario A, payments were not keeping up with inflation - fixed installments -, with the annuities starting the year of the interviews. Since the choices made by respondents would already take this into consideration, the estimated WTP response would be in real (and discounted) Argentinean pesos. Scenario B, on the other hand, announced that annuities were to be adjusted for inflation, with results also reflecting real (and discounted) Argentinean pesos, making estimates from both scenarios directly comparable. Since the figures for the annuities were the same in both scenarios, respondents were expected to be less likely to pay under scenario B, therefore resulting in a lower WTP estimate. Each scenario presented two different choice sets to each respondent.

The third and final part of the questionnaire was designed to collect socioeconomic data such as age, education, or income.

The survey was undertaken in autumn 2013. A representative sample of residents of the Gran Mendoza area was interviewed face-to-face in respondents' homes. The total number of respondents was 213, aged between 24 and 80. According to the National Institute of Statistics and Censuses (INDEC, 2010), Gran Mendoza has a population of near one million people. The sample included residents in towns of over 10,000 people drawn randomly (after weighting towns according to their population size) and interviewed in blocks of 6. The selection of the individuals within a block followed a random-route procedure to find a household, and then age and gender quotas for a particular individual in the household. About 90% of the individuals approached agreed to be interviewed. All respondents completed the choice tasks, resulting in 852 valid observations (four choice sets per person). Socioeconomically, the sample and population composition were relatively similar (Table 2).

The questionnaire was administrated on paper and read out by the interviewer. Each questionnaire was accompanied by a series of color cards, depicting the attributes to be valued. The average time of the

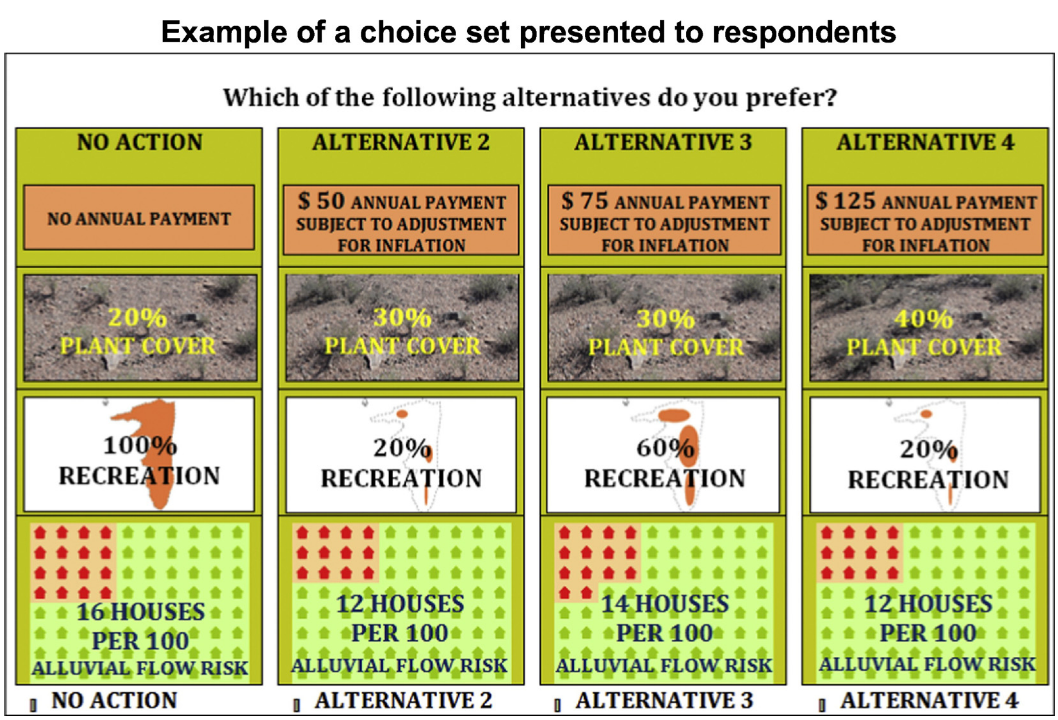

Fig. 2. Example of a choice set presented to respondents.

Table 2
Sample and population composition.

Gender and age groups	Region of Gran Mendoza[a] (%)	Sample (%)
Women	52.7	54.4
Age (years)		
24–35	16.5	16.4
36–49	14.7	15.0
50–65	13.9	15.0
66–75	5.5	5.6
76–80	2.0	2.3
Men	47.3	45.6
Age (years)		
24–35	16.3	16.0
36–49	13.5	13.6
50–65	12.0	11.7
66–75	4.2	3.3
76–80	1.3	0.9
Income[b]	Argentinean pesos 5,850[c]	Argentinean pesos 5,143

[a] INDEC (2010).
[b] Brackets were used in the survey, making the comparison less accurate between the average monthly income of the region and that of the sample.
[c] Average monthly income, according to the Ministry of Labour, Employment and Social Security in the first half of 2013.

interviews was 30 min and no signs of fatigue, or other obvious problems were detected.

2.4. Hypotheses Tests

The inflation-related test was organized in two stages. First, the exercise aimed at testing whether inflation was indeed considered by respondents, and next, the robustness of the estimated WTP values was checked.

2.4.1. Inflation Test

The null hypothesis (H_0) states that increasing installments by inflation has no effect on the valuation results, i.e., the WTP value estimates obtained from scenario A would be similar to those obtained from scenario B. The alternative hypothesis (H_1) implies that expressing annuities in nominal or real terms would influence people's WTP estimates, with higher mean values when payments do not increase with inflation. Therefore, a single-tailed test was used to formulate the null and alternative hypotheses,

$$\begin{aligned} H_0 &: WTP_rA - WTP_rB = 0 \\ H_1 &: WTP_rA - WTP_rB > 0, \end{aligned} \tag{4}$$

where WTP_r A is the willingness-to-pay estimated for attribute r, according to scenario A, and WTP_r B is the equivalent from scenario B.

2.4.2. Validation

An additional test was conducted to check whether the difference between WTP_r A and WTP_r B disappears when the estimated WTP values from scenario B are adjusted for inflation. Formally,

$$\begin{aligned} H_0 &: WTP_rA - WTP_rC = 0 \\ H_1 &: WTP_rA - WTP_rC \neq 0, \end{aligned} \tag{5}$$

where A stands for individuals' choices from scenario A; and C stands for individuals' choices from scenario B adjusted for inflation. The non-rejection of H_0 would suggest that the inflation expectations that respondents had in mind when answering the questionnaire did not differ from the average inflation rate over the previous 10 years.

2.5. Data Treatment

The regression analysis and the rest of the data processing were undertaken using version 4.0 of NLOGIT statistical package (Econometric Software, Plainview, New York).

3. Results

WTP estimates were obtained by regression analysis. An ML model was used to detect the relationships between the levels of the attributes and the probability of respondents choosing a particular alternative. The application of the ML model requires certain assumptions about the distribution of preferences. Initially, we assumed that preferences relating to the three non-monetary attribute – plant cover, recreation, and alluvial flow risk – were heterogeneous and followed a triangular distribution,[1] while preferences for the monetary attribute were assumed to be homogeneous. However, only the standard deviation for the alluvial flow risk distribution was statically significant, which seems to reflect a heterogeneous preference composition of the surveyed population for this attribute. On the contrary, the standard deviations for the plant cover and recreation distributions were not statically significant, which seems to indicate that preferences for these attributes are more homogeneous among respondents. These first findings were used in the ML model specifications shown in Table 3. The three non-monetary and monetary variables entered the regression expressed in the units of the respective attributes as they were described in Table 1.

As reflected in Table 3, the signs of the coefficients of the random and non-random parameters for both scenarios (columns 1 and 2) are consistent with prior expectations, and all variables are statistically significant at 99% confidence level, except recreation. The negative coefficient of alluvial flow risk and annual payment attributes suggests that, on average, higher values of these attributes decrease the welfare of a Mendocinian citizen, with alternatives of higher risk and annual payments being less likely to be selected. Conversely, the positive coefficient of plant cover indicates that higher values of this attribute increase population's welfare.

Since the socio-economic variables of the respondent do not vary over alternatives, they can only enter the model if they are specified in ways that create differences in utility over alternatives. The standard procedure is to normalize one of the coefficients to zero (Train, 2009, p. 21). With 4 alternatives per choice set, 3 alternative-specific coefficients of income variables entered the model, where one of the coefficients was normalized to zero (i.e., the BAU situation was left out). The income data were collected in the survey using eleven categories: no direct income; <1001 Argentinean pesos; 1001–1500; 1501–2500; 2501–4000; 4001–5500; 5501–7000; 7001–9000; 9001–12,000; 12,001–14,000, and >14,001 Argentinean pesos. Thus, income entered the regression as categorical variables reflecting the monthly earnings of the respondent, with 2, 3, and 4 being alternative-specific. The positive sign of the coefficients of the income variables reflects that the probability of choosing an alternative other than the BAU option increases as income increases from one category to another, being more prompt to pay for the anthropogenic-pressure mitigation programs. This suggests that, on average, wealthier respondents obtain greater utility from the application of the proposed environmental policy.

To further examine the source of the preference heterogeneity of the alluvial flow risk attribute, the random parameter was interacted with socio-economic variables in the utility function. Only the age variable – a continuous variable denoting the age in years of the respondent– was found to be statistically significant at 95% confidence level

[1] The assumption of a triangular distribution was due to lower risk levels and higher recreation and plant cover levels being the most selected (i.e., the ones with a higher probability of occurrence) when participants were asked to indicate the preferred attribute level, regardless of the cost.

Table 3
Results of the mixed logit regression analysis.

Variable	Scenario A coefficient (standard error) [Column 1]	Scenario B coefficient (standard error) [Column 2]
Random parameters in utility functions		
Alluvial flow risk	−0.408**	−0.432**
	(0.131)	(0.116)
Non-random parameters in utility functions		
Plant cover	0.069**	0.072**
	(0.010)	(0.011)
Recreation	0.007	0.005
	(0.004)	(0.004)
Annual payment	−0.008**	−0.018**
	(0.003)	(0.004)
Income 2	0.191**	0.157**
	(0.067)	(0.057)
Income 3	0.197**	0.191**
	(0.070)	(0.060)
Income 4	0.248**	0.152*
	(0.078)	(0.074)
Derived standard deviations of parameter distributions		
Alluvial flow risk	(0.812)**	0.6166*
	(0.293)	(0.31)
Heterogeneity in mean		
Age	0.004*	0.0046*
	(0.002)	(0.0023)
Log-likelihood function	−469.90	−454.05
Akaike Information Criterion	2.39	2.31
Bayesian Information Criterion	2.48	2.40
Pseudo-R^2	0.15	0.18
Observation	400	400

Estimates were obtained using 1000 random draws to simulate the sample likelihood.
N.B. 6% of respondents chose the BAU situation (annual payment of 0 pesos) quoting reasons other than lack of value for the program, which could be considered as protests. After removing those observations, the quantitative analysis was performed on a subset of 200 respondents.
* Significant at 5% level.
** Significant at 1% level.

(Table 3). This result suggests that differences in the marginal utilities held for alluvial flow risk attribute may be partly explained by the different perception of respondents of different ages. More specifically, the positive sign of the age coefficient suggests that, on average, young people were markedly alluvium averse, whereas older people showed less concern.

The WTP estimates were inferred from Eq. (3). Table 4 shows the estimated mean WTP values for a marginal change in each attribute, with a 95% confidence interval, expressed in fixed annuities (column 1) and in adjusted pesos of 2013 (column 2). Thus, on average, a citizen would be willing to pay at most 47.71 pesos annually, from 2013 to 2022, to get a one percentage point reduction in the alluvial flow risk and 8 pesos for a marginal increase in the level of plant cover (24.13 and 4.02 respectively, if the amount was to be adjusted annually for inflation). The confidence intervals for the marginal value of each attribute were calculated using the Krinsky and Robb (1986) bootstrapping procedure with 2000 draws.

To test Hypothesis (4), the nonparametric statistic proposed by Poe et al. (1997) was used. It is obtained by calculating the difference between the simulated distribution of WTP_r A and the simulated distribution of WTP_r B following the Krinsky and Robb procedure. The *P*-value for a one-tailed test is then estimated from the ratio of negative differences.

The last column of Table 4 concerns the H_0 test from Eq. (4). The equality between the estimated WTP_r A and WTP_r B is rejected at the 5% significance level for both alluvial flow risk attribute and plant cover attribute (0.014 < 0.05 and 0.007 < 0.05 respectively), with scenario A WTP values being higher than those estimated from scenario B, as anticipated.

To test Hypothesis (5), the 2000 simulated values of WTP_r B by the Krinsky and Robb procedure were adjusted for the inflation experienced in the past 10 years. The inflation rate was around 20% annually, on average, according to official figures from the Argentina's Congress. Table 5 shows the estimated mean WTP values for a marginal change, WTP_r A and WTP_r C, with a 95% confidence interval. The confidence intervals were calculated based on 2000 random draws (Krinsky and Robb, 1986).

Following the nonparametric statistic proposed by Poe et al. (1997), the difference between the two simulated distributions of interest (WTP_r A and WTP_r C) was calculated. The last column of Table 5 tests H_0 from Eq. (5) – the equivalence between WTP_r A and WTP_r C. The null hypothesis cannot be rejected at the 30% significance level for both alluvial flow risk and plant cover attributes (0.305 > 0.30 and 0.666 > 0.30 respectively), implying that WTP_r A and WTP_r C are of similar size. Therefore, it cannot be rejected that the inflation expectations respondents had in mind were close to the actual average annual inflation rate over the previous 10 years.

4. Discussion and Conclusions

The inflation tests suggest that the nominal or real definition of the annuities is a factor that ought to be clearly defined in non-market valuation questionnaires, in inflationary economies. The empirical application has illustrated the importance of inflation in a valuation case study. Inflation seems to be taken into account by respondents. Although not specifically dealing with inflation, the results are in line with Fischhof and Furby (1988), Kahneman and Knestsch (1992), Stevens et al. (1997), Johnston et al. (1999), and Kovacs and Larson (2007), among others, who have reported sensitivity in estimated WTP values for changes in payment designs, inflation being one that is often neglected.

The sign and statistical significance of the results obtained are consistent with economic theory and expectations. For instance, the estimated WTP increases with income, a result often observed in valuation studies (see for example Arrow et al., 1993). The goodness of fit of the two regressions is based on the McFadden's pseudo-R2 (McFadden, 1973). The explanatory power of the regressions is adequate according to the conditional standards (Hensher and Johnson, 1981). The model fit

Table 4
Estimated marginal value in terms of the monetary variable.

	Marginal WTP_r A [Column 1]	Marginal WTP_r B [Column 2]	Significance level (H_0: WTP_r A - WTP_r B = 0) [Column 3]
Alluvial flow risk	−47.71 (−173.94, −13.91)[a]	−24.13 (−44.51, −11.33)[a]	0.014
Plant cover	8.07 (4.09, 26.58)[a]	4.02 (2.55, 6.86)[a]	0.007

[a] 95% confidence interval, calculated based on 2000 random draws following Krinsky and Robb (1986).

Table 5
Estimated marginal value in terms of the monetary variable.

	Marginal WTP_r A [Column 1]	Marginal WTP_r C [Column 2]	Significance level (H_0: WTP_r A - WTP_r C = 0) [Column 3]
Alluvial flow risk	−47.71 (−173.94, −13.91)[a]	−55.47 (−98.04, −26.65)[a]	0.305
Plant cover	8.07 (4.09, 26.58)[a]	9.15 (5.77, 14.53)[a]	0.666

[a] 95% confidence interval, calculated based on 2000 random draws following Krinsky and Robb (1986).

comparison between scenario A and scenario B is based on the Akaike's Information Criterion and the Bayesian Information Criterion. As reflected in Table 3, scenario B shows a slightly superior fit compared to scenario A, given that the former reports lower values for both criteria.

The additional test reported in Table 5 provided consistent results with prior expectations, derived mainly from economic theory and empirical regularities observed in the literature. This test suggested that the difference between WTP_r A and WTP_r B disappears when scenario B estimated values are adjusted for previous inflation rates. The result suggests that inflation expectations were close to the average annual inflation achieved in the previous 10 years. This is consistent with the conclusions from other studies, pointing that individuals use information derived from their personal experience as consumers to form their inflation expectations, (Cavallo et al., 2014; Bruine de Bruin et al., 2011; Malmendier and Nagel, 2016; Madeira and Zafar, 2014). In that line, surveyed individuals would seem to have been well informed about the inflationary context.

In summary, this study shows that inflation was taken into account by respondents when making decisions. Nevertheless, this fact has attracted little attention in valuation studies. Valuation studies typically involve periodical payments, for several years, or for life (Hanemann et al., 1991; Kahneman and Knestsch, 1992; Willis and Garrod, 1998; Johnston et al., 1999). However, most studies seem to obviate whether installments incorporate inflation. Chilton et al. (2004) or Desaigues et al. (2011), deal with the problem a posteriori, interpreting the payments for the increase of life quality (QUALYs) as real ones. We are not aware of any valuation study explicitly including the information a priori, in the questionnaire, or testing the inflation effects on WTP estimates, and other economies, with lower inflation rates, could yield different results.

When periodical payments are used in stated preference methods and there is no indication on whether values are nominal or real, respondents might reasonably take their own personal experience as a cue to interpret the type of payment for the good. Consequently, if not clarified in advanced, the researcher may not know the setting respondents had in mind when stating their valuation. This uncertainty could become troublesome when the results of the valuation study are to be used in relation to policy design instruments, like cost-benefit analysis, equivalency analysis, or optimal taxation. In a high-inflation context, this consideration becomes more critical.

Acknowledgments

We are grateful to the Secretaría de Ciencia, Técnica y Posgrado, Universidad Nacional de Cuyo (06/G636), for financial support. We are also grateful to five anonymous referees for their valuable comments, and to Emilce Vaccarino for her help in drafting the map.

References

Agüero, A., Carral, M., Sauad, J., Yazlle, L., 2005. Aplicación del método de valoración contingente en la evaluación del sistema de gestión de residuos sólidos domiciliarios en la ciudad de Salta, Argentina. Revista Iberoamericana de Economía Ecológica 2, 37–44.

Arrow, K., Solow, R., Portney, P., Leamer, E., Radner, R., Schuman, H., 1993. Report of the NOAA panel on contingent valuation. Federal Register, January 15, 58 (10). U.S. Government Printing Office, Washington, D.C., USA, pp. 4602–4614.

Bennett, J., Blamey, R., 2001. The Choice Modelling Approach to Environmental Valuation. Edward Elgar Publishing, Cheltenham, UK, p. 269.

Bruine de Bruin, W., van der Klaauw, W., Topa, G., 2011. Expectations of inflation: the biasing effect of thoughts about specific prices. J. Econ. Psychol. 32 (5), 834–845.

Carson, R., 2011. Contingent Valuation: A Comprehensive Bibliography and History. Edward Elgar Publishing, Cheltenham, UK, p. 464.

Cavallo, A., Crucas, G., Perez-Truglia, R., 2014. Influencing Household Inflation Expectations (VoxEU.org, 10 Nov).

Chilton, S., Covey, J., Jones-Lee, M., Loomes, G., Metcalf, H., 2004. Valuation of Health Benefits Associated With Reductions in Air Pollution. Final Report. Department for Environment Food and Rural Affairs (DEFRA), London, UK.

Desaigues, B., Ami, D., Bartczak, A., Braun-Kohlová, M., Chilton, S., Czajkowski, M., Farreras, V., Hunt, A., Hutchison, M., Jeanrenaud, C., Kaderjak, P., Máca, V., Markiewicz, O., Markowska, A., Metcalf, H., Navrud, S., Nielsen, J.S., Ortiz, R., Pellegrini, S., Rabl, A., Riera, P., Scasny, M., Stoeckel, M., Szántó, R., Urban, J., 2011. Economic valuation of air pollution mortality: a 9-country contingent valuation survey of value of a life year (VOLY). Ecol. Indic. 11 (3):902–910. http://dx.doi.org/10.1016/j.ecolind.2010.12.006.

Farreras, V., Salvador, P., Vaccarino, E., 2016. La incorporación de las preferencias sociales en el análisis espacial: una aplicación a los espacios naturales del piedemonte mendocino. PRO 19, 46–76.

Fernández, P., 2010. Hidrología del piedemonte del oeste del Gran Mendoza. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico en el Centro Oeste Árido de Argentina. Diagnóstico y Estrategia Para su Mitigación y Control En el Gran San Juan y Gran Mendoza. Chapter 7. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Fischhof, B., Furby, L., 1988. Measuring values: a conceptual framework for interpreting transactions with special reference to contingent valuation of visibility. J. Risk Uncertain. 1 (2):147–184. http://dx.doi.org/10.1007/BF00056166.

Grunwaldt, E., Hernandez, J., Vich, A., 2010. La actividad pecuaria e influencia de la población urbana en las cuencas aledañas a la ciudad de Mendoza. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico en el centro oeste árido de Argentina. Diagnóstico y estrategia para su mitigación y control en el Gran San Juan y Gran Mendoza. Chapter 10. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Gudiño, M., López, M., Valpreda, C., D'Inca, V., Villegas, B., Berón, N., Muñoz, L., Bizzotto, F., 2010. Amenazas naturales y antrópicas en zona oeste del Gran Mendoza. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico en el Centro Oeste Árido de Argentina. Diagnóstico y Estrategia Para su Mitigación y Control en el Gran San Juan y Gran Mendoza. Chapter 12. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Hanemann, M., Loomis, J., Kanninen, B., 1991. Statistical efficiency of double-bounded dichotomous choice contingent valuation. Am. J. Agric. Econ. 73 (4), 1255–1263.

Hanemann, W., Kanninen, B., 1999. The statistical analysis of discrete-response CV data. In: Bateman, I.J., Willis, K.G. (Eds.), Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EC, and Developing Countries. Chapter 11. Oxford University Press, Oxford, UK http://dx.doi.org/10.1093/0199248915.003.0011.

Hensher, D., Greene, W., 2001. The Mixed Logit Model: The State of Practice and Warnings for the Unwary. Institute of Transport Studies. University of Sydney. Faculty of Economics and Business Available from. http://people.stern.nyu.edu/wgreene/MixedLogitSOP.pdf.

Hensher, D., Johnson, L., 1981. Applied Discrete Choice Modelling. Halsted Press, Division of John Willey and Sons, Inc., New York, USA, p. 468.

Hensher, D., Rose, J., Greene, W., 2005. Applied Choice Analysis: A Primer. Cambridge UniversityPress, Cambridge, UK, p. 742.

INDEC, 2010. Censo Nacional de Población, Hogares y Vivienda en Argentina. Available from. http://www.censo2010.indec.gov.ar/.

Johnston, R., Swallow, S., Weaver, R., 1999. Estimating willingness to pay and resource trade offs with different payment mechanisms: an evaluation of a funding guarantee for watershed management. J. Environ. Econ. Manag. 38 (7):97–120. http://dx.doi.org/10.1006/jeem.1999.1077.

Kahneman, D., Knestsch, J., 1992. Valuing public goods: the purchase of moral satisfaction. J. Environ. Econ. Manag. 22 (1):57–70. http://dx.doi.org/10.1016/0095-0696(92)90019-S.

Kinnell, J., Lazo, J., Epp, D., Fisher, A., Shortle, J., 2002. Perception and value for preventing ecosystem change: Pennsylvania duck hunters and the prairie pothole region. Land Econ. 78:228–244. http://dx.doi.org/10.2307/3147270.

Kovacs, K., Larson, D., 2007. Identifying individual discount rates and valuing public open space with stated preferences models. Land Econ. 84 (2), 209–224.

Krinsky, I., Robb, L., 1986. On approximating the statistical properties of elasticities. Rev. Econ. Stat. 68 (4):715–719. http://dx.doi.org/10.2307/1924536.

Lacaze, V., 2009. Consumos alimentarios sustentables en Argentina: una estimación de la disposición a pagar por alimentos orgánicos frescos y procesados por consumidores de la ciudad de Buenos Aires. Agroalimentaria 15 (29), 87–100.

López, Rodríguez M., 2010. Tipologías urbanas presentes en el piedemonte. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico en el Centro Oeste Árido de Argentina. Diagnóstico y Estrategia Para su Mitigación y Control en el Gran San Juan y Gran Mendoza. Chapter 13. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Louviere, J., 1988. Analyzing individual decision making: metric conjoint analysis. Quantitative Applications in the Social Sciences. University Series N° 67, Sage, Newbury Park, CA.

Madeira, C., Zafar, B., 2014. Heterogeneous inflation expectations, learning, and market outcomes. J. Money, Credit, Bank. 47 (5), 791–1029.

Malmendier, U., Nagel, S., 2016. Learning from inflation experiences. Q. J. Econ. 131 (1), 53–87.

Manski, C., 1977. The structure of random utility models. Theor. Decis. 8 (3):229–254. http://dx.doi.org/10.1007/BF00133443.

Martínez, Carretero E., 2010. La vegetación del piedemonte de la precordillera de Mendoza y San Juan. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico En el Centro Oeste Árido de Argentina. Diagnóstico y Estrategia Para su Mitigación y Control en el Gran San Juan y Gran Mendoza. Chapter 6. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Martínez, Carretero E., Dalmasso, A., 1992. Litter yield in shrubs of larrea in the Andean piedmont of Mendoza, Argentina. Vegetatio 101 (1), 21–33.

McFadden, D., 1973. Conditional logit analysis of qualitative choice behavior. In: Zarembka, P. (Ed.), Frontiers in Econometrics: 105–142. Academic Press, New York, New York, USA.

McFadden, D., Train, K., 2000. Mixed MNL models of discrete response. J. Appl. Econ. 15 (5):447–470. http://dx.doi.org/10.1002/1099-1255(200009/10)15:5<447::AID-JAE570>3.0.CO;2-1.

Moreiras, S., 2010. Riesgos geológicos del piedemonte Mendocino. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico En el Centro Oeste Árido de Argentina. Diagnóstico y Estrategia Para su Mitigación y Control en el Gran San Juan y Gran Mendoza. Chapter 4. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Poe, G., Welsh, M., Champ, P., 1997. Measuring the difference in mean willingness to pay when dichotomous choice contingent valuation responses are not independent. Land Econ. 73 (2):255–267. http://dx.doi.org/10.2307/3147286.

Saidón, M., 2012. Valoración ambiental del reciclado de residuos: El caso de Quilmes, Argentina. Economia 34, 33–53.

Salomón, M., 2009. Externalidades Ambientales Sobre la Gestión y Administración del Recurso Hídrico. Estudio De Caso Cuenca Río Mendoza. XXII Congreso Nacional del Agua. Resúmenes de Trabajos. pp. 174–255 (Chubut, Argentina).

Stevens, J., De Coteau, N., Willis, C., 1997. Sensitivity of contingent valuation to alternative payment schedules. Land Econ. 73 (1):140–148. http://dx.doi.org/10.2307/3147083.

Thurstone, L., 1927. A law of comparative judgment. Psychol. Rev. 34 (4):273–286. http://dx.doi.org/10.1037/h0070288.

Train, K., 1998. Recreation demand models with taste variation. Land Econ. 74 (2), 230–239.

Train, K., 1999. Mixed logit models for recreation demand. In: Herriges, J., Kling, C. (Eds.), Valuing Recreation and the Environment. Edward Elgar, Northampton, MA.

Train, K., 2009. Discrete Choice Methods with Simulation. second ed. Cambridge Books Online. Cambridge University Press, Cambridge, UK http://dx.doi.org/10.1017/CBO9780511753930.

Unsworth, R., Bishop, R., 1994. Assessing natural resource damages using environmental annuities. Ecol. Econ. 11 (1):35–41. http://dx.doi.org/10.1016/0921-8009(94)90048-5.

Vich, A., Cobos, D., Villegas, L., 2004. La Erosión Hídrica En el Piedemonte Árido de Mendoza. VI Jornadas de Investigación en Geografía. Organizada por la Facultad de Humanidades y Ciencias. Universidad Nacional del Litoral (UNL), Santa Fe (26 y 27 de Agosto, Argentina).

Vich, A., López Rodríguez, M., 2010. Estrategias de mitigación y control de amenazas naturales en áreas de piedemonte. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico En el Centro Oeste Árido de Argentina. Diagnóstico y Estrategia Para su Mitigación y Control En el Gran San Juan y Gran Mendoza. Chapter 19. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Vich, A., Ojeda, R., Cobos, D., Grünwaldt, E., 2007. Environmental degradation and flooding hazards. Proposal for its mitigation and control in central western Argentina. In: Scarpatti, O.E., Jones, J.A. (Eds.), Environmental Change and Rational Water Use. Orientación Gráfica Editora, Buenos Aires, Argentina, pp. 114–124.

Vich, A., Ojeda, R., Cobos, D., Pedrani, A., 2005. Ecological Management of the Andean Piedmont. Congreso AIG, Buenos Aires–USA.

Vich, A., Pedrani, A., Ojeda, R., Grunwaldtand, E., Cobos, D., 1993. Programa de Investigación y Desarrollo: Manejo Ecológico del Piedemonte. Ministerio de Medio Ambiente Urbanismo y Vivienda. Unidad de Manejo Ecológico de Cuencas – CRICYT, Mendoza, 154. Mendoza, Argentina.

Vich, A., Vaccarino, E., Bizzotto, F., 2010. La erosión hídrica en el piedemonte mendocino. In: Vich, A.I., Gudiño, M.E. (Eds.), Amenazas Naturales de Origen Hídrico en el Centro Oeste Árido de Argentina. Diagnóstico y Estrategia Para su Mitigación y Control en el Gran San Juan y Gran Mendoza. Chapter 8. Fundación Universidad Nacional de San Juan, San Juan, Argentina, p. 434.

Willis, K., Garrod, G., 1998. Biodiversity values for alternative management regimes in remote UK coniferous forests: an iterative bidding polychotomous choice approach. Environmentalist 18 (3):157–166. http://dx.doi.org/10.1023/A:1006698016933.