Willingness to Pay for Drinking Water in Some Selected Dryland Areas of West Bengal: A Contingent Valuation Approach

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Abstract

The paper attempts to consider the valuation of drinking water using contingent valuation method in the dryland areas of West Bengal. The issue is important as in-house drinking water facilities are not available to the households in our study area and people are dependent on common-pool sources like tube-well, waterfall and watershed for drinking water in our specified dry land areas. Both 'dichotomous-choice type' closed ended and open ended cases are considered to examine the willingness to pay by the people to conserve and to get supply of drinking water in the dryland areas of the state. It has been estimated that the average willingness to pay by the poverty-stricken forest dwellers for the above-mentioned purpose is Rs.7.91 per month. Given that the stakeholders are poor, the amount of willingness to pay (though low) shows the willingness of the stakeholders to conserve water for drinking as they cannot survive without it.

Key Words: Dryland Area, Contingent Valuation, Willingness to Pay, Drinking Water.
JEL Classification: Q20, Q25 and Q51

1. Introduction

The world's drylands are fragile ecosystems due to harsh climatic conditions and growing human pressures. Yet, they constitute some of the world's largest land reserves and provide a wide range of goods and services which are fundamental to the livelihoods of millions of people. There is no single agreed definition of the term 'drylands'. Two of the most widely accepted definitions are those of FAO and the United Nations Convention to Combat Desertification (UNCCD, 2000).[1] According to the World Atlas of Desertification (UNEP, 1992)[2], drylands have a ratio of average annual precipitation (P) to potential evapo-transpiration (PET) of less than 0.65. In fact, according to the report of Food and Agricultural Organization (FAO) in 1993, drylands are categorized into hyper arid, arid, semi arid and dry sub humid zones not only on the basis of P/PET ratio but also on the basis of rainfall (in mm.).[3] On the basis of FAO statistics, the percentage share of arid and semi arid categories combined together are the highest among the total dryland areas of the world.

While about 40 percent of the world's total land area is considered to be drylands (according to the UNCCD classification system), the extent of drylands in various regions ranges from about 20 percent to 90 percent. India is one of the few countries, which conceived the problems of desert and desertification at the stage of their offing. In India, arid and semi arid zones are characterized by low to medium mean annual rainfall coupled with high coefficient of variability, large amplitude of fluctuations of temperature, strong wind regions and high potential evaporation. The average annual rainfall of these regions varies between 150 mm and 500 mm along with a coefficient of variation as high as 60% to 70%. The distribution of rainfall is also very erratic.[4]

In India out of the total geographical area, almost one-sixth area with 12% of the population belongs to drought prone areas. At present 74 districts, covering 13 states of the country have been identified as drought prone. Most of the drought-prone areas are found in arid, semi-arid, and sub-humid regions of the country, which experience less than average annual rainfall. Broadly, the drought-affected areas in India can be divided into two tracts. The first tract comprising the desert and the semi-arid regions covers an area of 0.6 million sq. km.[5] The second tract comprises the regions east of the Western Ghats up to a distance of about 300 km from coast.[6] Besides these two tracts of scarcity, there are many pockets of drought in India. Some of these are: Tirunelveli district, south of Vaigai River in Tamil Nadu, Coimbatore area in Kerala, Saurashtra and Kutch regions in Gujarat, Mirzapur plateau and Palamu regions respectively in Uttar Pradesh and Jharkhand, Purulia district of West Bengal, Kalahandi region of Orissa. [7]

On the basis of the document regarding "State Agriculture Plan for West Bengal" [8] Bankura, Birbhum and West Medinipur districts have been identified as the districts containing red laterite soils which are coarse in texture, highly drained with honeycomb type of ferruginous concentration at a depth of 15cm to 30cm. Soils are acidic in nature and poor nutrient status limit crop productivity. The district of Purulia which is mostly a plateau, like the three other districts mentioned above, soils are acidic in nature and crop productivity is poor due to high slopes. The State Plan of West Bengal has referred to the four districts together as "dryland areas of West Bengal" based on their nature of soil. Out of these dryland areas, Purulia is considered as arid zone and three other districts are considered as semi arid.[8] These areas also constitute a part of 'Chhotanagpur plateau'.[9] These four districts are faced with more or less similar problems. Purulia, being in the arid zone, has severe water crisis, other districts (especially Bankura and West Medinipur) also suffer from severe water crisis. This study wants to examine the possible ways by which people of drylands are valuing drinking water.[10]

Drinking water is one of the basic amenities needed to survive and it is known to all that people suffer severely from scarcity of drinking water in the drylands especially in the districts of Purulia, Bankura and some parts of West Medinipur. In the drylands of West Bengal, we have observed, during our survey, that people travel miles for getting drinking water and that too is not of the good quality. They collect drinking water from waterfalls or village tube wells and their quality is also not good. To have this drinking water, they need to spend several hours (in many areas more than 2 hours). Through this study we have tried to see how far people are willing to pay for getting good quality drinking water in their houses by applying Contingent Valuation Method (CVM).

The most obvious way to measure nonmarket values is through directly questioning individuals on their willingness-to-pay (WTP) for a good or service. Contingent Valuation Method (CVM) is a popular way of determining this WTP. It is a survey or questionnaire-based approach to the valuation of non-market goods and services. The values obtained for the good or service are said to be contingent upon the nature of the constructed (hypothetical or simulated) market and the good or service described in the survey scenario. The contingent valuation (CV) technique has great flexibility, allowing valuation of a wider variety of non-market goods and services than is possible with any of the indirect techniques. It is, in fact, the only method currently available for estimating nonuse values.

In CVM, usually *stratified random sampling* has been followed for selection of sample households from the general population. The sample households are then informed about hypothetical occurrence of any negative environmental externality (say in the form of an environmental disaster) and a policy action to abet or to restrict such a negative environmental externality has been suggested. They are then asked how much they would be willing to pay — for instance, in extra utility taxes, income taxes, or access fees — either to avoid such a negative environmental externality. The actual format may take the form of a direct question ("how much?") or it may be a bidding procedure (a ranking of alternatives) or a referendum (yes/no) votes. Economists generally prefer the referenda method of eliciting values since it is one most people are familiar with. The resulting data are then analyzed. The purpose of using CVM is very clear. Natural resources perform several economic functions on which price cannot be assigned. Even if there are announced property rights related to ownership of the resource, the rights cannot be properly assigned to the owners. Use of CVM helps to resolve these issues. In our study we want to value the supply of drinking water directly to the houses of the people in the study area, that is, in the dryland areas of West Bengal, through contingent valuation method (CVM) for further development of the people of drylands.

In this paper it is not possible to consider all the works that have used CVM in the context of natural resources. Only a small subset of the literature that is most important in the context of this study has been considered. Khurrana and Mahapatra (2008) have done their work on the crisis of water in the drought prone areas of Bundelkhand. Halder and Saha (2015) have identified the causes of water scarcity in Purulia of West Bengal. Koohafkan and Stewart (2008) have described about water and cereals of drylands. But none have tried to show how the people of drylands are valuing drinking water.

Many authors have used CVM technique for valuing various types of water. Several authors have applied this technique for valuing irrigation. (Ghatak and Singh, 1994, Storm, Heckelei and Heidecke, 2001). Again, this technique has been used for providing improved water supply as well. Nam and Son (2004) have compared CVM and choice modeling techniques for improved drinking water service in Ho Chi Minh City. Same has been done by Tussupova, Berndtsson, Bramryd and Beisenova (2015) for Kazakhstan.

In case of drylands of West Bengal, as discussed earlier, the problem of drinking water deserves greater significance and attention than it usually does. So, proper ‘conservation cum use’ of water should be given importance both by the stakeholders and the policy makers. Being a poverty-stricken area, coupled with illiteracy, unemployment, deprivation and political unrest situation, removal of poverty along with provision of basic amenities in this region is a matter of national economic policy presently in India. Here arises the need for proper valuation as well as maintenance of this very scarce resource for the sake of development of this region. Given the fact that CVM is useful in capturing “non-use values” of environmental goods, and it has not been used before for the valuation of natural resource of drylands, we have used it for the development of availability of drinking water facilities in the dryland areas of West Bengal. Though ‘drinking water’ has use value, it is to be noted that the arrangement of ‘in house’ drinking water facility is almost nil in our study area and people have to depend on *‘common pools’* like tube wells, waterfalls and watersheds for drinking water in this region. As drinking water is not directly used through ‘in house drinking water facility’ in our study area, conservation of watershed and waterfalls helps to provide supply of fresh and safe drinking water directly to the households. So ‘conservation and use’ of drinking water in our study region implies overall conservation of water facility in the dryland area and it is not only considered as ‘use value’ but is also treated as a ‘non-use value’. Thus application of CVM is justified for drinking water.[11] The main motivation of this paper generates from the fact that to the best of our knowledge almost no work has used this technique for the valuation of drinking water in the dryland areas of West

Bengal. It is a well known fact that the people residing in drylands suffer heavily from the lack of availability of drinking water and more importantly, they do not have the facility of getting pipe-lined supply of drinking water in their houses. So, proper valuation of drinking water supply, especially in drylands, demands importance. This issue has been neglected in the literature. The present paper attempts to fill this lacuna in this regard.[12] One could focus on valuation of watersheds on a broader basis, which is a much broader concept, instead of focusing on a relatively narrower issue like valuation of drinking water. This is because in drylands in general watershed development has been the main source of solving the water crisis, including drinking water crisis. However, unlike drylands of the other areas, in the drylands of West Bengal 'watersheds issue' is not so important. Watersheds are not very much widespread in this area and even if they exist they are not in the best of conditions due to severe droughts in the districts so that people can have an idea about its benefits. The only exceptions regarding functioning of watershed in our study area is the region of Murguma of Purulia district.[13] Table – 2 of this paper also supports the fact that people of drylands of West Bengal are not very familiar to the concept of watershed for getting drinking water. So, we have focused on the valuation of drinking water by surveying the houses of various households in this region.

The remaining part of the present paper is organized in the following manner. Section 2 deals with the objectives and hypotheses of the study. In the next section, that is, Section 3 considers the data base, survey design and methodology of the study. The econometric specification and the results of the study are shown in section 4. Finally the concluding remarks are made in section 5.

2. Objectives and the Hypotheses of the Study

The major objectives of the present paper can be summarized as follows:

1. To consider the valuation of drinking water along with its facility in terms of estimation of willingness to pay for it by the people in the dryland areas of West Bengal.
2. To examine the determinants of willingness to pay(WTP) for conserving drinking water along with conservation of water facility in the dryland areas of West Bengal
3. To suggest appropriate policies for availability of drinking water along with overall conservation of water facility in the dryland areas of the state throughout the year.

To achieve these objectives the following hypotheses have been considered in the present study

1. The bids of the respondents regarding WTP in case of 'single-bounded dichotomous choice closed-ended referendum' a standard experimental bidding game (as followed in case of dichotomous choice random utility models) has been considered in terms of dice throwing.
2. Conservation and use of drinking water in our study region implies overall conservation of water facility in the dryland area not only as a 'use value' but also as a 'non-use value'.
3. Estimation of WTP can be considered both in terms of a logit model (with single-bound closed ended referendum for choosing the bids) and OLS method (with open ended referendum). So two WTPs for two different methods are to be estimated.
4. For closed ended referendum estimation of WTP depends mostly on socio-economic variables and also on various dummy variables
5. Comparison of the mean WTPs, obtained from the two different formats, throw light on the presence of anchoring bias in the context of response by the respondents.

3. Data Base, Survey Design and Methodology

In our study we want to focus on the problem of willingness to pay for availability of drinking water along with its conservation and try to connect it with the developmental perspectives of the study area. Our work is based on field survey and is confined to the districts of Pururlia, Bankura and West Medinipur. Here we have followed *stratified random sampling* technique. The *stratification has been done* to get those villages of each of the three districts which are severely affected from the lack of drinking water availability [14].This has been done on the basis of a pilot survey and after consulting with the local people and panchayat members.

For selecting the villages after the pilot survey we had in mind about the categorization of drylands of West Bengal so that the selected areas (villages) can be categorized as *'plain (non-hilly) dryland' areas and 'hilly dryland'* areas. This categorization along with crisis in availability of drinking water has been discussed with the local people and the panchayat members and the selection of villages has been made. Once the stratification has been done we have conducted our survey through random sampling. We have selected random sample from each of the selected villages per district. The total households that are selected randomly in the sample are 1/3rd of the total household population per village as usually done in case of selection of random sample. We have conducted our survey in the above-mentioned three different districts, covering 200 households from each of the three districts, so that the total sample size is 600.

In Bankura, we have done the survey in two villages -Susunia and Sewlibona. In Purulia, we have conducted our survey in Murguma and Baghmundi and in Chharra. In West Medinipur, our survey has covered two villages, namely, Salboni and Bishnupur. Out of 600 households, 300 have been taken from hilly dryland areas and 300 have been taken from non-hilly dryland areas.
Thus Susunia and Sewlibona of Bankura and Baghmundi and Murguma of Purulia fall under *'hilly dryland'* areas and the remaining villages are in '*non-hilly dryland*' areas (although all these areas suffer from the problem of drinking water). So, we have tried to capture the nature of drinking water problem and perception of the people of both hilly dryland as well as non-hilly dryland areas, within the drylands of West Bengal. This categorization is shown in the following table.

Table: 1- Division of Households for Sample Survey

District	Village	No. of Households used for sample survey
Bankura	Susunia	170
	Sewlibona	30
Purulia	Murguma	75
	Baghmundi	25
	Chharra	100
West Medinipur	Salboni	125
	Bishnupur	75

Source: Primary Data (Year: 2016)

The survey has been conducted between January and March, 2016. We have collected household data on various socio-economic aspects covering their income status, age, sex, years of education, etc. Among the various questions in the questionnaire about drinking water one important question is that whether the households have their own water resources in their houses or they fetch it from elsewhere. The answer that we have received is shocking in the sense that almost all the households that we have surveyed have replied that they do not have access to drinking water facility in their houses and all of them spend more than an hour per day to fetch drinking water from the nearby resource like waterfall; dam (watershed), tube wells or a type of pond, popularly known as '*chuha*'. The source of getting water and the time needed to get it are also included in our questionnaire. We have also asked about the amount of drinking water needed by households per day and most importantly the amount of money the household is willing to pay for getting safe drinking water in their houses and also to conserve drinking water. All these information have helped us to use CVM for knowing the maximum willingness to pay (WTP) of the households for getting supply of safe drinking water along with its conservation.

For the purpose of valuation, we have used both closed-ended (also known as dichotomous choice) and open-ended formats. From the first format, we have obtained the mean WTP of the respondents, within the "random utility modeling" (RUM) framework. Here the econometric analysis has been done by applying the logit model. The close-ended format helps in bringing out the true preference of the respondents. In case of the latter format, we have used OLS regression technique to know about the variables that influence the maximum WTP. The main advantage of an open-ended question format is that a direct measure of WTP is obtained.

Additionally, the questionnaire also contains supplementary questions to guide respondents to the contingent valuation section and to derive additional explanatory variables required for the regression analysis. The selections of variables which potentially influence WTP are based on previous studies, economic theory and knowledge about the situation in the region. While framing questionnaire and conducting survey, we have followed the guidelines of the NOAA panel.

The number of respondents that have been interviewed in the six villages, taken together from three dryland districts, namely, Bankura, Purulia and West Medinipur, is 600 and the response rate is as high as 100% which is really a very high figure. High percentage of response rate in our study can be considered as unconventional but it is a good outcome in a developing country. We attribute this high response rate to the *"face-to-face in-person interviews"* that we have conducted following the suggestions of the NOAA (1993) panel. Such a process of interview helps the respondents in several ways in the understanding of the purpose of the survey clearly. Actually this is an application of experimental game which has been explained in various works of dichotomous choice through bidding game in terms of a dice throwing in the literature. For application of bidding game in terms of dice throwing one can refer to the works of Arrow, K.; Solow, Portney, Leamer, Radner, R. & Schuman (1993), Hanemann (1984), Haraou, Markandya, Bellu.& Cistulli, (1998), Hoyos & Mariel(2010), Banerjee (2001) Saha(2015) etc.[15] The method can be explained explicitly on the basis of dice throwing. *Since we have followed single bounded dichotomous choice CVM, it is quite natural that a specific representative respondent is offered only one bid, if he/she accepted it then it would be taken as his/her willingness to pay and in case of not acceptance of the offered bid by the responded, the representative respondent is considered as 'protest bidder'*[15]. For the above kind of analysis it is important to determine the bid first and then to determine how these bids are to be shown to the respondents. We can consider six bids, namely, Rs. 2, Rs.5, Rs.8, Rs. 10, Rs. 15 and Rs.25. These bid amounts are expressed in terms of payment per month to have and to conserve drinking water. The bidding (though appears arbitrary) has been done after discussing with the local people through pilot surveys of course after going through the economic condition of the households. This procedure gives us an idea of the maximum and minimum amounts that we should put forward to the respondents as bid amounts (as usually done in case of Dichotomous choice models of CVM). Study of the socio-economic profile of the region is essential for these types of exercises, but keeping in mind the limitation of size of the paper for a journal it has not been explained in detail here.

The next step is to determine the strategy behind the survey. During our survey, we have assigned these ***six bids*** in terms of ***three groups***. ***Rs. 2 and Rs.5*** have been assigned for '***low bid group'***. ***Rs.8 and Rs. 10*** have been assigned for the ***'medium bid group'*** and the last two bids, i.e. ***Rs. 15 and Rs.25,*** have been assigned for the ***'high bid group'***. This strategy has been followed arbitrarily in order to get valid responses out of 600 respondents. The question now arises that how to categorize the sample in terms of bid groups. For categorizing the selected sample households on the basis of ***bid group*** and *also to bring randomness in selection* of sample household under ***each bid group***, we have 'first' thrown a dice. It can be done through any other method, say lottery method, to bring randomness in selection. However, throwing of dice or throwing of coin usually are the conventional ways of having randomness in selection. We have followed here the throwing of dice method. If the outcome is ***1 or 6***, then the household has fallen under '***low bid group'***, if the outcome of the dice-throw is ***2 or 5***, then the household has fallen under ***'medium bid group'*** and lastly if the outcome is 3 or 4 then the household has fallen in the ***'high bid group'***. *The procedure that has been followed is thus purely a random one and this procedure is followed in many works as mentioned above on dichotomous choice CVM model*.

After the selection of the household in any one of the three bid groups just mentioned above, we have offered the household only one particular bid. *It is to be noted that we have assigned for each bid group two bids.* This has already been mentioned earlier. So the question arises which one of the two bids that has been assigned for a bid group is to be assigned to a particular household belonging to that bid group. To bring randomness in this regard we have thrown dice for the 'second' time. This time, if the outcomes of the dice-throwing are odd numbers, that is 1, 3 and 5 then the household has been offered 'lower of the two bids' of a certain bid group but if the outcomes of the dice-throw are the even numbers, that is, 2,4,6, then the respondent has been offered the 'higher of the two bids' of a certain bid group. Thus for the ‘low bid group’ if the outcomes are any one of the three possible odd numbers -1, 3, 5, then the respondent has been categorized to accept the bid of Rs. 2 (lower of the two bids), if the outcomes are ‘even numbers’, that is, 2, 4 or 6, then the respondent has been offered the bid of Rs. 5 (higher of the two bids). In this case the respondent has been asked whether he or she willing to accept the bid of Rs. 2 and is willing to pay an equivalent amount (i.e. whether the respondent is willing to pay an amount of Rs.2 per month for conserving and having drinking water). If the answer was ‘YES’, then we consider the WTP for conserving and having drinking water as Rs.2 per month. If the answer is NO we consider the respondent as a *protest bidder*. This is also true for the bidding amount Rs.5.

We follow the same procedure for other ‘bid groups’. For example, when the dice has been thrown in the front of the respondent for the *first time* if the outcomes are 2 or 5 then the particular respondent is categorized as a part of *medium bid group*. In the next step again, just described above, the dice has been again thrown for the *second time* and if the outcomes are any of the three possible ‘odd numbers’, then the respondent has been offered to accept Rs. 8, otherwise Rs. 10, in case the outcomes are any of the three possible ‘even numbers’ of the dice. Here also we find that if the answer is YES for any of the two bids as mentioned above then we can determine the bidding amount. If the answer is NO for each of the above-mentioned two bids then we again consider the respondents as *protest bidders*. The same procedure is true for the *‘high-bid’* group.

These procedures have been followed for bringing randomness both in terms selection of a particular household in a certain bid group and offering a certain bid to that household. There is some ‘anchoring bias’ in the system but this *‘anchoring bias’* has been taken care of at the end of section 4 of this paper. In this way a particular bid has been shown to a particular respondent from different events when the events are mutually exclusive, equally likely and independent. So, for a particular respondent, we have thrown a dice twice, firstly, for randomly selecting the bid-group for each and every respondent and, secondly, for randomly selecting the amount of bid that has been offered to the respondent.[16] This is the standard procedure that is followed in case of *closed-ended referendum under single-bound dichotomous choice* CVM.

For the open-ended segment of our study we have directly asked the respondents about their maximum willingness to pay (Max WTP). From our survey we have found that 232 respondents are in the group of protest bidders and the rest, that is, 368 are willing to pay for the prescribed programme. Before moving over to the

CV technique we focus on a few of the socio-economic indicators of the study-region.

Before passing on to the methodology we just want to mention a few words about the sources of getting drinking water and also to consider the families with and without 'in-house' drinking water facility in our study area. The reason is to focus on the importance of drinking water in the study area which one should consider before conducting a survey for valuation of drinking water in the region. Tables 2 and 3 cover such classifications as mentioned above.

Table: 2- Division of respondents according to sources of drinking water (Figures indicate the number of households)

District	Total no. of families surveyed	No. of respondents getting water from tube wells	No. of respondents getting water from waterfalls	No. of respondents getting water from watersheds
Bankura	200	69	131	0
Purulia	200	178	0	22
West Medinipur	200	200	0	0
Total	600	447	131	22

Source: Primary Data (Year: 2016)

Table 2 shows that, on the basis of our sample, most of the households are dependent on tube- wells for having drinking water in the districts of Purulia and West Medinipur. However, in the district of Bankura the households are dependent mainly dependent on waterfalls for having drinking water. If we combine the three districts of our study we find that the major source of drinking water of the households is tube-wells. Except in some parts of the district of Purulia watershed has no role in providing drinking water.

Table: 3- Drinking Water availability in the houses of the respondents

(Figures indicate the number of households)

District	Total no. of families surveyed	Families "with in-house drinking water" facility	Families "without in-house drinking water" facility
Bankura	200	0	200
Purulia	200	0	200
West Medinipur	200	0	200
Total	600	0	600

Source: Primary Data (Year: 2016)

Table 3 shows that in our sample in all the concerned districts the households do not have in-house drinking water facility.

From the point of view of methodological part of the paper we followed a random utility model (RUM).This methodological aspect is widely used in the context of the literature on CVM and hence we are mentioning it in brief in the context of the present paper.[17]

This model closely replicates the choices individuals face in a market situation. The respondent is presented with a specific monetary value (e.g. Rs. X) for a policy change and he/she is asked to make a judgment of accepting or rejecting the offer. The size of X is randomly varied across the sample of a study.
The DC elicitation method provides us only limited amount of information about the WTP value of the respondents, namely, “YES” or “NO” answer to a particular bid and nothing more.
If Bid Amount (X) > WTP, then the response is “NO”. If Bid Amount (X) ≤ WTP, then the response is “YES”

We now consider the Random Utility Version of the model. An individual respondent will respond with “YES” if his/her utility from the drinking water conservation measure is larger than or equal to her utility compared to status quo position; and NO, otherwise.
$(U_1 - U_0) \geq 0$, the individual will accept to pay the bid X (1)
$(U_1 - U_0) < 0$, the individual will reject to pay the bid X (2)
The utility U of the individual is not directly observable (hence the differences are also not directly observable). However, its determinants are observable. Under the two different scenarios, one with the acceptance and other with the rejection of the bid, the following specification of the utility function can be put forward:[20]
$U_1(1, y - X;\ S) = V(1, y - X;\ S) + e_1$ (3)
$U_0(0, y;\ S) = V(0, y;\ S) + e_0$ (4)
Where, $V(.)$ is the utility function without random element and $U(.)$ is the utility function with random element. It is to be noted that in equations (3) and (4) we find Y = total income; 1= acceptance of the bid; 0 = rejection of the bid; S = other socio-economic features; e = random error component due to the limited knowledge of the utility model of the individual by the analyst.

From equations (3) and (4) we can write
$\Delta U = \Delta V - e$
(5)

where $(U_1 - U_0) = \Delta U$, $(e_0 - e_1) = e$ and $[V(1, y - X; S) - V(0, y; S)] = \Delta V$, Given equation (5), the inequalities (1) and (2) can be written as,

$\Delta V \geq e \rightarrow$ Acceptance of X (6)

$\Delta V < e \rightarrow$ Rejection of X (7)

There are two types of models for estimating the mean WTP value from the DC bids – the probit and the logit model. Here we have considered a logit model (logistic distribution of the error term) for our purpose.[21] The probability that the individual agrees to accept the bid is therefore:

$P(accept\ X) = P\ (Y = 1) = P(e \leq \Delta V) = F(\Delta V)$

where Y is the observed dichotomous variable, acceptance = 1, refusal = 0.

Assuming that the random variable e follows a logistic probability distribution we can write:

$$P(accept\ X) = F(\Delta V) = 1 / [1 + exp(-\Delta V)]$$

When the individual accepts to pay the proposed bid X, its means that the maximum Willingness to Pay (WTP) is greater than the proposed bid X. The probability of acceptance, given a bid X, is the probability of individual $WTP \geq X$. Therefore we can write:

$$P(accept\ X) = P(WTP > X) = 1 / [1 + exp(-\Delta V)]$$

This means that the probability the WTP is less than or equal to X is:

$$P(WTP \leq X) = G(X) = 1 - 1 / [1 + exp(-\Delta V)]$$

Where, G(X) is the probability distribution of the WTP.

The mean of the WTP distribution is commonly assumed to be indicators of the individual WTP.

The mean of the maximum WTP can be calculated using the formula that relates the mean of a random variable to its probability distribution:

$$E(WTP) = \int_0^{\infty}\{1 - G(X)\}dX$$

We also need to specify the theoretical model into a functional form from which the unknown parameters can be estimated. Now we move to econometric analysis of CV results.

4. Econometric Specification and Results of the Study

We now want to consider the econometric specification of the DC model for a closed-ended referendum. The purpose is to derive the mean WTP for the drinking water in the dryland areas. To estimate the WTP we have used a logit model and we have derived the values for the DC bids used for the respondents.

The logit model[22] used for the study can be specified in the following manner:

Dependent Variable: $\ln \frac{P_i}{1-P_i}$. Given, Pi as the probability of WTP amount greater than or equal to an assigned bid and $\ln \frac{P_i}{1-P_i}$ is the log odds ratio.[23] The independent variables used in this model are described in terms of table 4.

Table: 4-Description of independent variables of the model

dc bid	Bids vector of Rs. 2, Rs.5, Rs. 8, Rs.10, Rs.15 and Rs.25
Income	Total monthly income from all sources
family size	Household Size
Age	Age of the respondent
edu yrs	Total years of education of the respondent
Sex	Dummy Variable. 0 for Males and 1 for Females.
Caste	Dummy Variable. 0 for General Caste, 1 for OBC, 2 for SC and 3 for ST
dom animals	Dummy variable. 0 for having no animal and 1 for having any.

We have used several socio-economic aspects as independent variables by using dummy. It has been done because in a poverty-stricken, backward area it is expected that these aspects can play an important role in the response of the respondents. The estimated result of the logit model is shown in terms of table 5.

Table: 5- Results of Estimated Logit Model

Variable	**Coefficient**	**Marginal Effects(dY/dX)**
dc bid/ close-ended bid	-0.0892767*** (-7.73)	-0.020077*** (-3.097)
Income	0.0018388*** (8.94)	0.000879*** (8.342)
family size	-0.6055039*** (-6.21)	-0.106427*** (-5.855)
Age	0.0012448 (0.09)	0.000028 (0.007)
edu yrs	0.1018711** (2.01)	0.098659** (1.973)
Sex	-0.1898442 (-0.69)	-0.075946 (-0.544)
Caste	-0.3233304*** (-2.78)	-0.667856*** (-2.439)

dom animals	0.788741*** (2.65)	0.213222*** (2.328)
Constant	-2.471031*** (-2.59)	
Log-likelihood	-209.87803	The terms in the parentheses for both coefficient and marginal effects are the t-values
LR chi-square	318.29	
Prob > chi-quare	0.000	
Pseudo R^2	0.4313	
Total no. of observations	600	
*** denotes significant at 1 % levels ** denotes significance at 5 % levels * denotes significance at 10% level		

Source: Author's Calculations

From table 5 we find that the variables age and sex are insignificant but others are significant. Among the significant variables, dichotomous choice bid has a negative sign before it which implies that the probability of willingness to pay falls with a unit increase in the bid. The negative sign of caste signifies the fact that people of general caste are more willing to contribute and as we move from general caste community to OBC, SC and ST respectively, this willingness to contribute decreases. This is also quite expected because, generally, people of so-called lower castes (SC, ST) are very poor. Income has a positive impact on WTP because it is expected that with an increase in income, people of drylands would want to pay more for conserving drinking water for their survival as it is scare in our study area. On the other hand, people with lower income suffer from the lack of drinking water and given their affordability, they are willing to pay less for getting the facilities and also for conserving drinking water. Family size, having a negative co-efficient, signifies the fact that larger families have more members to fetch the water from the nearby resource and so their probability to pay falls with a unit increase in the bid. Expectedly, education bears a positive coefficient which implies that educated people value the availability of drinking water in their houses. Domestic animal is used as a dummy of economic asset. The coefficient having a positive sign indicates the fact that in the presence of domestic animal, people are in a better economic condition than others. We can say that our estimated model gives a good fit, as the value of pseudo-R^2 is 0.4313. We have performed the test for presence of multicollinearity among the explanatory variables of the estimated logit model. The variance inflation factor (VIF) [24] and the tolerance[25] for the model have been estimated and the reported results (Mean

VIF 3.71) show that the model does not suffer from severe multicollinearity problem (as shown in the appendix).[26]

We next proceed to find the mean willingness to pay of the close-ended referendum under dichotomous choice model. This is given in the following table. (Table-6).

Table: 6- Estimation of Mean WTP (DC model under Closed-ended Referendum)

Measure	WTP	LB	UB
Mean	10.42	6.11	15.72
Achieved Significance Level for testing H_0: $WTP <= 0$ vs. H_1: WTP>0 LB: Lower bound; UB: Upper bound			

Source: Estimated by author

The mean WTP of our model is 10.42 Rs. per month, with lower bound of Rs. 6.11 and upper bound of Rs. 15.72 per month. Though the mean WTP, in general, appears to take a low value, but, given the backwardness of our study area and also given the fact that most of the stakeholders considered for our study lie below the poverty line, the mean WTP figure of Rs. 9.86 per month for getting drinking water facilities at home is quite reasonable. The marginal effects model for the above logit equation have also been estimated which shows the rate of change in the probability of willingness to pay due to change in the value of an independent variable X_j (j=1, 2… n). This is shown in the last column of table 5. From table 5 we find that as income changes by one unit, holding other factors constant, the probability of WTP also rises; same explanation applies in case of variables like years of education and domestic animals. The opposite explanation applies to the variables family size, sex and caste. For these variables, one unit of change in the independent variables causes the probability for WTP to conserve and use drinking water falls.

After going through the closed-ended referendum, we have focused on the open-ended referendum. Here, we have directly asked people how much they want to pay to get drinking water in their houses, without offering them any bid. So, here the concept of probability to WTP does not apply, rather the concept of maximum WTP does. Here, we have used OLS regression technique to show the factors that determine and influence maximum WTP. The results are shown in terms of table 7.

Table: 7 - Regression Results of Open-ended Referendum

Variables	Coefficients	t values
Constant	-2.594307**	-2.30
Income	0.010825***	17.41
family size	-0.2672501***	-2.65
Age	0.0224171	1.14
edu yrs	0.3071518***	5.03
Sex	0.8682026**	-2.21
Caste	-0.5389407***	-3.35
dom animals	1.222732***	3.26
Dependent Variable: max wtp (Open ended maximum WTP)		
N = 600 F = 128.78 Prob > F = 0.000 Adjusted R^2 = 0.5989		
*** denotes significant at 1% levels,** denotes significant at 5% levels,* denotes significant at 10% levels		

Source: Author's Calculation

From table 7, we observe that the variables which are significant in logit model are also significant here, with same signs before their coefficients. Additionally, Sex as a variable has become significant here, but it is insignificant in logit model. So, male respondents are more willing to pay than females. High value of R^2 implies the fact that almost 60% of the variation in dependent variable is explained by the independent variables included in the model. So, in terms of cross-section data one can say that it is a well-fitted model. Also, the t-values suggest that the parameter estimates are significant at either 1% or 5% level. We have checked for the problem of multicollinearity for this open-ended format as well. Here also, the problem of multicollinearity is within the tolerable limit of less than 5. (The mean VIF is actually 3.58 as shown in the appendix).

In our OLS model, the mean willingness to pay is Rs.5.41 per month. The results of the OLS regression model are very much similar to that of the logit model, regarding the signs and nature of parameter estimates. So, there are similarities in the explanation of the dependent variables of both the models.[27]

From the above two analysis, we have got 'two willingness to pay' (one from logit model and the other one from OLS model). We have tested whether these two WTPs converge or not by performing the convergent validity test. Convergent validity refers to the degree to which two measures of constructs, that theoretically should be related, are in fact empirically tested to be related. [28] From the perspective of the present study convergent validity for the two formats (viz. open-ended and single bounded dichotomous choice) is an important issue primarily for two reasons – First, to check whether the two formats lead to statistically different values for the WTP and second, to check whether *anchoring bias* plays a significant role such when the convergent validity is disturbed. We examine the convergent validity test in terms of paired mean tests of the two variables – max wtp & dc bid. The first variable signifies the open bid elicited by the respondent and the second variable is the bid from dichotomous choice that has been obtained by using the logit regression for each of the respondents. The result of the convergent validity test gives the t value -2.02, with 599 degrees of freedom. This implies the fact that null-hypothesis is rejected at 5% level of significance. This result vividly indicates that the mean WTPs obtained from the two different formats are *significantly different* implying that *anchoring bias* has occurred in the responds of the respondents.

6. Concluding Remarks

In our paper under closed-ended referendum we have found the mean WTP to be Rs. 10.42 per month whereas it is Rs.5.41 per month for the open-ended referendum. In this case, this difference is significant as the test of convergent validity is not passed. We can find an average of the two mean WTPs and name it as 'true WTP' in our model. The 'true WTP' turns out to be Rs.7.91 per month. One can say that for the sake of their own development and to get rid of the problem of drinking water, people of drylands, despite being poverty-stricken, can bear to pay this minimal amount. This amount though appears to be low, is reasonable given the fact that most of the stakeholders in our study area mostly lives below the poverty line. Their WTP for conserving drinking water has important policy implications from the point of development of the dryland areas of West Bengal. It shows the need of the people for drinking water residing in this area and the Government should give special emphasis on this issue. The source of conservation of drinking water follows from conservation of water resources. This in turn can be achieved through conservation of watersheds in the dryland areas of the state. Another way out for conservation of water resources follows from conservation of ground water. We have shown in table 2 of the paper that most of the households in our study areas are dependent on tube wells for drinking water. So the problem of availability of drinking water in our study area can be tackled by giving special emphasis on conservation of ground water. The government should initiate to take measures for expansion of pipeline drinking water in the above-mentioned dryland areas to provide in-house drinking water facilities to the households. If we focus our attention on the issue of conservation along with creation of watersheds in our selected dryland areas we find that such a measure, apart from solving the drinking water problem of the area, helps to increase availability of water for irrigational purposes. So this policy measure will help to promote drinking water facilities along with expansion of agricultural activities in our study area which will help to achieve sustainable livelihood of the people residing in this region. Apart from the district of Purulia the other two districts of our study area, Bankura and West Medinipur, have poor performance so far as functioning of watersheds is concerned. The policy makers should give special attention on this issue.

Given the limitations of our data, the present exercise can be considered as a first attempt to examine the valuation of water resources in the dryland areas of West Bengal. It covers mostly the *'Jangalmahal'* area of West Bengal which is both socially and politically highly sensitive implying that our contribution has special significance for the sociologists, political scientists, economists and the policy makers. Our work suffers from the usual drawbacks of CVM as a valuation exercise that we find in the literature. To avoid the problems of CVM one could use choice modeling techniques which covers a larger sample of households along with advanced ecological modeling. Considerations of such aspects are beyond the scope of the present paper as it is the first attempt to value the use of drinking water in the selected dryland regions of the state. However, introduction of choice modeling in the context of the valuation of drinking water in the dryland areas of West Bengal will definitely be a part of our future research agenda.

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Notes

1. FAO has defined drylands as those areas with a length of growing period (LGP)[1] of 1–179 days (FAO, 2000a); this includes regions classified climatically as arid, semi-arid and dry sub-humid. If the length of LGP per year is between 1-74 days, then the area is termed as 'arid', if this length is between 75 to 119 days, then the area is termed as 'semi-arid', and if LGP is for 120 to 179 days, then the area is referred as 'dry sub-humid'.
2. UNCCD accepted the P/PET ratio indicator, provided by World Atlas of Desertification, for defining drylands.
3. Thus, when P/PET ratio is less than 0.05 and rainfall is less than 200 mm, the dryland is referred to as Hyper arid. Again when P/PET ratio lies between 0.05 to 0.20 with rainfall less than 200 mm. in winter and 400 mm. in summer, it is considered as arid zone. The next categorization is Semi arid zone for which P/PET ratio lies between 0.20 and 0.50 with rainfall less than 200-500 mm. in winter and less than 400-600 mm. in summer. Finally, when P/PET ratio lies between 0.50 and 0.65 with rainfall less than 500-700 mm. in winter and less than 600-800 mm. in summer, it is referred to as Dry sub humid zone.
4. Status report on hydrology of arid zones of India, 1999-2000, Prepared by National Institute of Hydrology.
5. It is rectangle shaped area whose one side extends from Ahmedabad to Kanpur and the other from Kanpur to Jullundur. In this region, rainfall is less than 750mm and at some places it is even less than 400 mm.
6. This area is known as the "rain shadow area" of the Western Ghats; rainfall in this region is less than 750mm and is highly erratic. This region is thickly populated and periodic droughts cause considerable suffering and distress.
7. www.nih.ernet.in/rbis/india_information/drought.htm
8. Prepared by NABARD Consultancy Services Pvt Ltd (NABCONS), West Bengal
9. FAO's classification for categories of dryland areas are on the basis of P/PET ratio and also on the basis of rainfall (in mm.). The State Plan of

West Bengal has considered FAO's classification. Additionally, the plan has classified agro-climatic region on the basis of soil contents.

10. Major part of 'Chhotanagpur plateau' lies in Jharkhand.
11. The problem of drinking water in the district of Birbhum is not so acute as compared to the districts of Purulia, Bankura and west Medinipur. So we have not considered the district of Birbhum for valuing drinking water in the context of our study.
12. See FAO (2000) Corporate Document Repository. Survey done by the Economics and Social Development Department on Applications of CVM justifies the use of CVM for drinking water. See also the work of Pour and Kalashami (2012) for applying CVM for evaluation of drinking water in Iran.
13. Here we have not considered the problem of water for irrigation (and also the valuation of water for irrigation) because all the households do not possess land and as most of the area are drought prone, along with the nature of soil, the land areas are not suitable for agricultural purposes implying availability of water for irrigational purposes is not a more attractive proposition compared to the availability of drinking water. The main need for water is for drinking purposes as all the people living in this area suffer severely from its scarcity. Although one cannot deny the fact that scarcity of availability of water for irrigation is an important issue in this area but the problem of drinking water is even more serious.
14. In West Bengal the concept of developing watershed got importance after 2011-12. New watershed projects have been undertaken by the government since that time period. The Government has decided to develop 13 projects in Purulia, 16 in West Medinipur, 15 in Bankura and 4 in Birbhum. So, as the concept is newly introduced in the State and especially in the dryland areas of the state, people do not have proper perception about its benefits and especially about the benefits of availability of drinking water and water for irrigation purposes from the watershed. See also note 14.
15. Although the entire dryland area suffers from the lack of availability of drinking water.
16. One can refer to Saha(2015) for a similar type of bidding procedure. Saha (2015) followed the methodology as shown by Harou, Markandya, Bellu and Cistulli(1998). However, the present bidding strategy is different from the bidding strategy followed by Saha(2015). In our case anchoring has been done in offering bids in terms of a dice throwing first and then the bids are offered again by throwing a dice for the second time. On the other hand in Saha (2015) first a dice has been thrown and then the bids are offered in terms of tossing a coin. In her *unpublished* PhD dissertation

Saha (2015) has considered valuation of forestry in the context of Indian Sunderbans by using CVM. However, our work is *widely* different from the work of Saha (2015) as she has focused on valuation of mangrove forest (or mangrove swamps) whereas we have considered valuation of drinking water in the dryland areas of West Bengal. Though we have considered the same methodology our approach is totally different from the work of Saha(2015).

17. Protest bidders are those who do not prefer the stated programme and therefore provide zero WTP value.
18. This procedure of throwing a dice twice before offering a particular bid to the respondent was followed for bringing simplicity in the survey process.
19. We have followed the methodology as shown by Harou, Markandya, Bellu and Cistulli(1998). See note 16 in this context. Interested readers are advised to go through the literature on RUM. See also Harou, Markandya, Bellu and Cistulli(1998). See also Hanemann (1984).
20. This part briefly describes the theoretical methodology of Harou, Markandya, Bellu and Cistulli(1998) and naturally the methodology part, as mentioned in note 17, is similar to the work of Saha(2015)
21. The choice of the model depends on the probability distribution of the error term where probit is used if the error term follows a normal distribution and logit is used if the error term follows a logistic distribution. However, most of the studies that used DC format follow the logit model since the difference between the two is minor and the logistic function is simpler to deal with.
22. Most of the variables used in this model have been selected after going through the literature on CV technique. We have taken the variable ‘Caste’ to show people of which caste are more willing to contribute and we have taken the variable ‘domestic animal’ to see whether the presence of this economic asset has influence on the willingness to pay or not.
23. The ratio of probability of willingness to pay (P_i) and non-willingness to pay (1- P_i). It is to be noted that as Pi increases, the log-odds ratio increases.
24. Variance inflation factors (VIF) measure how much the variance of the estimated regression coefficients are inflated as compared to when the predictor variables are not linearly related. This is used to describe how much multicollinearity (correlation between predictors) exists in a regression/logit analysis. When there is no collinearity, VIF will be 1.
25. 1/VIF is known as tolerance.
26. As ‘the rule of thumb’, if 1<VIF<5, it implies variables are moderately correlated and if 5<VIF<10, then the variables are highly correlated.

27. Only Sex is additionally significant in linear model, but it is insignificant in logit model.
28. Convergent validity, along with discriminant validity, is a subtype of construct validity. Convergent validity can be established if two similar constructs correspond with one another, while discriminant validity applies to two dissimilar constructs that are easily differentiated. In our study, the convergent validity is attained when the WTP values from two elicitation formats are not statistically different for a particular valuation situation. Although, in some of the studies it is observed that estimated mean WTPs across different instruments do show a discrepancy. The principal reason for such a difference between the results might be due to the fact that respondents' perception about the two or multiple formats is different.