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Abstract

This paper employs a stated preference environmental valuation method, namely the choice experiment method, to estimate local public's willingness to pay (WTP) for improvements in the capacity of a sewage treatment plant (STP) in Chandernagore Municipality, located on the banks of the River Ganga. A pilot choice experiment study is conducted with 100 randomly selected Chandernagore residents and the data are analysed using the conditional logit model. The results reveal that residents of this municipality are WTP significant amounts in terms of higher monthly municipality taxes, in order to upgrade the capacity of the current STP to one that treats higher quantities of wastewater and at a higher quality, before discarding in the Ganga. With the use of the benefits transfer method, the results of this case study can provide information on the economic benefits that might be generated through the improvement of STPs in other similar municipalities located along the banks of the Ganga. Overall, the results reported in this paper have important policy implications for reducing pollution, and hence environmental and health risks that are currently threatening the sustainability of the economic, cultural and religious values this sacred river generates.

Keywords: choice experiment method, conditional logit model, River Ganga, sewage treatment plant, water quality, water quantity

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1. Introduction

The Ganga is a major river in India, flowing east through northern India into Bangladesh, it runs its course of over 2,500 km from Gangotri in the Himalayas to Ganga Sagar in the Bay of Bengal. The Ganga basin covers 861,404 km^2, which is approximately 26 percent of the land area of India. There are 52 cities, 48 towns and thousands of villages located in the basin, where about half a billion people live, and this population is expected to double by 2030. Defined as the 'river of India' by Nehru, Ganga has important economic, cultural and religious values. It accounts for about 31.6 percent of India's annual utilisable water resources, providing water for agriculture, aquaculture, hydro-power generation, industry, and water supply for several settlements comprising 45 percent of the country's population (Sivaramakrishnan, 1993). The Ganga is a major input to agricultural production, as the soil in the river basin is very fertile, and the river provides a perennial source of irrigation to a large area, enabling cultivation of several crops.

The Ganga also provides unique cultural heritage and religious values. According to Nehru 'The story of the Ganges…… is the story of India's civilisation and culture.. .'. The Ganga is mentioned in the earliest Hindu scriptures and it represents an important Hindu Goddess. In the Hindu religion, bathing in the Ganga results in the forgiveness of sins and helps attain salvation, whereas drinking water from the Ganga with one's last breath takes the soul to heaven. Some of the most important Hindu festivals and religious congregations are celebrated on the banks of the Ganga, which also host hundreds of temples.

Even though there are some industries which pollute the Ganga, most notably the leather industry, the main source of pollution is human waste. Untreated raw sewage discharged in the Ganga is estimated to be as much as one billion litres per day (Murty et al., 2000). The Ganga accumulates large amounts of human pollutants (e.g. Schistosoma mansoni and faecal coliforms) as it flows through highly populous areas. These pollutants carry significant health risks for humans, as well as environmental risks for the sustainability of the ecosystem services provides by the Ganga. Proposals have been made to reduce the amount of untreated raw sewage deposited in the Ganga. The most noteworthy of these is the Ganga Action Plan

(GAP). Initiated in 1984 by the Indian Government, and supported by Netherlands, UK and voluntary organizations, the aim of the GAP is to build a number of wastewater treatment facilities for the immediate reduction of sewage in the river. Even though over $33 million has already been spent under GAP, so far no great progress has been achieved.

The question that needs to be addressed is “if the river Ganga is considered sacred by Hindus across India, then why do the people allow it to become polluted” (Alley, 2002). The aim of this study is to investigate whether and how much the Indian public values any efforts to reduce pollution levels in the Ganga via reduction of the amount of untreated raw sewage deposited therein. The public’s valuation is measured in terms of their willingness to pay (WTP) higher municipal taxes for improvements in wastewater treatment facilities. To this end stated preference environmental valuation method, namely a choice experiment is employed to estimate the value of improved wastewater treatment to the residents of case study municipality, namely Chanderganore Municipality in West Bengal. A pilot choice experiment was implemented in April 2007 with 100 randomly selected households located in Chanderganore Municipality. The data are analysed with the conditional logit model, allowing for possible differences in the residents’ WTP due to their income levels.

The results of this pilot experiment reveal that all households, regardless of their income levels, are WTP higher taxes to ensure higher quantity of wastewater is treated to a higher quality in the local STP before being discharged in the Ganga. There is however significant variation in the WTP of different income segments which should be taken into consideration for equity purposes. When the average WTP is aggregated over the population of the Municipality it is observed that the annual taxes the residents are WTP far surpass the operating and upgrading costs of the STP. This result reveals that it would be economically efficient to invest in infrastructure that would treat higher quantities of wastewater to higher quality. The results of this study can be adapted to similar municipalities along the Ganga with the use of the benefits transfer method.

The contributions of this paper to the literature are threefold. First, this paper contributes to the scant although increasing number of choice experiment studies conducted in the developing country context (e.g., Scarpa et al. 2003a, b; Othman et al., 2004; Bienabe and Hearne, 2006; Hope, 2006; Birol et al., forthcoming; case studies in Bennett and Birol, forthcoming). Second, it adds to the studies on the improvements in wastewater treatment, most of which are from the engineering literature (e.g., Abelson, 1996; Idelovitch and Ringskog, 1997; Campbell, 2000; Showers, 2002). Third, it contributes to the increasing number of economic valuation studies which estimate the economic value of improved water quality in general (e.g., Fraas and Munley, 1984; Fernandez, 1987; Wang, 2002; Ha and Bae, 2001; Day and Mourato, 2002; Colombo et al., 2005; Hanley et al., 2005; Hasler et al., 2005; Willis et al., 2005; Hanley et al., 2006a,b; Alvarez-Farizo et al., 2007; Fischhendler, 2007), and the economic value of improved treated wastewater quality in particular (e.g., Desvouges et al, 1987; Green et al. 1991; Choe et al. 1996; Murty et al.,2000, Markandya and Murty, 2004; Barton, 2002; Kontogianni et al, 2003; Cooper et al., 2004; Birol et al., 2008).

The rest of the paper unfolds as follow. Next section presents the case study of Chandernagore Municipality. Section 3 explains the choice experiment method and survey design and administration. The results are presented in section 4 and section 5 concludes the paper with some policy implications.

2. Case Study

Chandernagore Municipality in West Bengal is situated along the banks of the River Ganga. This municipality hosts a conventional sewage treatment plant (STP) built in 1991 following the Ganga Action Plan (GAP). The total volume of wastewater generated by the Chandernagore Municipality is estimated at 11.7 million litres of raw sewage per day while the capacity of the local STP far surpasses this figure, at 22.5 million litres of raw sewage per day. The STP however utilizes only a small fraction of its capacity, treating only 2.8 million litres of raw sewage per day, i.e., 24 percent of the sewage generated by the Municipality.

The 2.8 million litres of raw sewage treated daily is treated to permissible limit standards, which are 30mgl for biochemical oxygen demand (BOD) and 250mgl for chemical oxygen demand (COD), as set by the West Bengal Pollution Control Board in 1999. The current permissible limit standard, however, is not high enough to remove all the pathogens and hence even after treatment, the health and environmental risks remain. The remaining wastewater generated by the municipality (i.e., the 8.83 million litres of raw sewage per day) is semi-treated by the STP. Less than half of the semi-treated water is used for the replenishment of the lake in the Wonderland Park, in which the STP is located, and for local agriculture (specifically vegetable farming) and aquaculture. The use of the semi-treated water for these purposes pose serious health risks to visitors of the Park, as well as for the consumers and producers of fish and vegetables. The remaining semi-treated wastewater is discharged to the Ganga, creating environmental pollution and negatively affecting the sustainability of the ecosystem functions of the River. There is therefore an urgent need to invest in the improvement of the STP of the Chandernagore Municipality to ensure that it functions at its maximum capacity and treats higher quantities of wastewater and also to upgrade its technology to treat wastewater at a higher quality.

3. Methodology

3.1 The choice experiment method

The choice experiment method has its theoretical grounding in Lancaster's model of consumer choice (Lancaster, 1966), and its econometric basis in random utility theory (Luce, 1959; McFadden, 1974). Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. To illustrate the basic model behind the choice experiment presented here, consider a local resident's choice for a wastewater treatment programme and assume that utility depends on choices made from a set *C*, i.e., a choice set, which includes all the possible wastewater treatment programme alternatives. The resident is assumed to have a utility function of the form:

$$U_{ij} = V(Z_{ij}) + e(Z_{ij}) \qquad (1)$$

where for any resident *i*, a given level of utility will be associated with any wastewater treatment programme alternative *j*. Utility derived from any of the wastewater treatment alternatives depends on its attributes (Z), such as the quantity and quality of wastewater treated in the STP and the regeneration of the Wonderland Park.

The random utility theory (RUT) is the theoretical basis for integrating behaviour with economic valuation in the choice experiment method. According to RUT, the utility of a choice is comprised of a deterministic component (***V***) and an error component (*e*), which is independent of the deterministic part and follows a predetermined distribution. This error component implies that predictions cannot be made with certainty. Choices made between alternatives will be a function of the probability that the utility associated with a particular wastewater treatment programme option *j* is higher than those for other alternatives.

Assuming that the relationship between utility and attributes is linear in the parameters and variables function, and that the error terms are identically and independently distributed with a Weibull distribution, the probability of any particular wastewater treatment programme alternative *j* being chosen can be expressed in terms of a logistic distribution. Equation (1) can be estimated with a conditional logit model (CLM) (McFadden, 1974; Greene, 1997 pp. 913-914; Maddala, 1999, pp. 42), which takes the general form:

$$P_{ij} = \frac{\exp(V(Z_{ij}))}{\sum_{h=1}^{C} \exp(V(Z_{ih}))} \tag{2}$$

where the conditional indirect utility function generally estimated is:

$$V_{ij} = \beta + \beta_1 Z_1 + \beta_2 Z_2 + ... + \beta_n Z_n \tag{3}$$

where β is the alternative specific constant (ASC) which captures the effects on utility of any attributes not included in choice specific wastewater treatment programme attributes, *n* is the number of wastewater treatment programme attributes considered, and the vectors of coefficients β_1 to β_n are attached to the vector of attributes (***Z***).

3.2 Survey design and administration

The first step in choice experiment design is to define the attributes of the wastewater treatment programme. Following extensive review of the published and gray literature on wastewater treatment in general and on the River Ganga in particular; focus group discussions and informal interviews with residents of the Chandernagore Municipality; as well as consultations with experts, three important wastewater treatment attributes and their levels were identified. These are reported in Table 1.

Table 1: Wastewater treatment attributes and attribute levels used in the choice experiment

Attributes	Definition	Levels
Quantity of treated wastewater	Total volume of wastewater treated by the STP. At the moment the STP is working below its capacity of 22.5 million liters per day (mld), treating only 2.8 mld, which is a small fraction of the quantity of wastewater generated in the municipality. The capacity of the STP can however be increased to treat all the wastewater generated by the municipality. This would significantly reduce the discharge of untreated or semi-treated wastewater in the Ganga.	Low*, High
Quality treated wastewater	The level of pollutants in the wastewater are treated to a permissible limit. At the moment the quality of treated wastewater is low, and when used for agri/aquaculture or discharged to the Ganga low quality treated water creates health and environmental hazards. The quality of the treated wastewater can be increased to a higher level to minimize the health and environmental risks.	Low, High
Regeneration of the Park	Investment in the Wonderland Park to improve its use as a recreational site. At the moment there are no investments to sustain or improve the recreational services provided by the Park, such as walking and picnicking.	No, Yes
A monthly increase in the municipal tax	Payment vehicle in Indian Rupees identified through a pilot contingent valuation survey (1 Euro = 65.93 Indian Rupees)	1.5, 4.5, 12.5, 20

* Levels in italics indicate the status quo level.

Experimental design techniques (Louviere et al., 2000) and SPSS Conjoint software were used to obtain an orthogonal design, which consisted of only the main effects, and resulted in 32 pair wise comparisons of alternative wastewater treatment programmes. They were randomly blocked to four different versions, each with eight choice sets. Each set contained two wastewater treatment scenario and an 'opt out' option which is considered as a status quo or baseline alternative whose inclusion in the choice set is instrumental to achieving welfare measures that are consistent with demand theory (Louviere et al., 2000; Bateman et al., 2003)

The pilot choice experiment survey was implemented in April 2007 with face-to-face interviews with a total of 100 randomly selected households located in Chandernagore Municipality. The choice experiment survey was administered to be representative of the sample population in terms of income, social status, proximity to the River Ganga and the Wonderland Park. In each household the household heads were interviewed. An introductory section explained to the respondents the context in which the choices were to be made and described each attribute, their present status and implications on public and environmental health. Respondents were reminded that there were no right or wrong answers and that we were only interested in their opinions. They were also told that the Municipality did not have sufficient funds to improve the wastewater treatment facilities of the STP, and to invest in the regeneration of the Park, and therefore it would be necessary to increase the monthly municipal taxes paid by the households. The respondents were also reminded of their budget constraints as well as other public goods which could be funded through their taxes.

In addition to the choice experiment questions, data on the households' social, economic and demographic characteristics were collected. Descriptive statistics reveal that on average the households interviewed in this survey have been residents in the Chandernagore Municipality for 24 years and they are located 12.4 minutes walking distance from the Wonderland Park. Average number of household members is 4.7 persons, which is same as the West Bengal average of 4.7 members per household (Indiastat). Over half (55 percent) of the households have at least one child younger than 18 years of age. A great majority (92 percent) of the household heads are male and their average age is 59 years. Almost half (47 percent) of the household heads have minimum or less than minimum level of education, whereas 31 percent have technical school or university degrees. The average household monthly expenditure (proxy for disposable income in developing countries) is Rs

5836.59 (104.44 Euro) and the average per capita monthly expenditure is Rs 1296.7 (23 Euro). Majority of the household expenditure is spent on food, followed by health and personal care, and transport. This figure is similar to the average monthly per capita income for Hugli District (under which the Chandernagore Municipality falls) which was estimated to be Rs 1127 in 2005 (Bureau of Applied Economics & Statistics, Government of West Bengal, 2005). The sample averages are therefore similar to the population averages for the Chandernagore Municipality, and hence the results reported in this paper could be generalised for the entire population of the municipality.

4 Results and Discussion

4.1 Data Coding

The CE data were coded according to the levels of the attributes. Binary attributes, i.e., quantity and quality of treated water and the regeneration of the park, entered the utility function as binary variables that were effects coded (Louviere et al., 2000). For quality (quantity) of treated wastewater, for example, the higher quality (quantity) level was coded as 1 and the low quality (quantity) level was coded as –1. Similarly for the regeneration of the park attribute, yes (i.e., investment in the regerenartion of the park) was coded as 1 and no (i.e., no investment in the regerenartion of the park) was coded as –1. The levels for the attribute with four levels, i.e., (monthly increase in the municipal tax) were entered in cardinal-linear form, i.e. as 1.5, 4.5, 12.5, 20. The attributes for the status quo '"Neither wastewater treatment programme" were coded with 0 values for each attribute. Since this choice experiment involves generic instead of labelled options, the alternative specific constants (ASC) were equalled to 1 when either wastewater treatment programme A or B was chosen and to 0 when respondents chose neither alternative (Louviere et al., 2000). In this choice experiment the ASC is specified to account for the proportion of participation in wastewater treatment programme. A relatively more negative and significant ASC indicate a higher propensity to choose to pay for improved wastewater treatment programmes.

4.2 Conditional Logit Model: Pooled Data

The choice experiment was designed with the assumption that the observable utility function would follow a strictly additive form. The model was specified so that the probability of choosing a particular wastewater treatment scenario was a function of the attributes and the ASC (equation (3) above). Using the 800 choices elicited from 100 households the CLM was estimated with LIMDEP 8.0 NLOGIT 3.0. The results for the entire sample are reported in the first column of Table 2.

Table 2: Conditional logit model estimates for wastewater treatment programme attributes

Attributes	Pool	Richer households	Poorer households
		Coeff. (s.e.)	
ASC	-1.7***	-1.78***	-1.77***
	(0.233)	(0.336)	(0.339)
Quality of treated wastewater	0.713***	0.899***	0.567***
	(0.945)	(1.141)	(0.132)
Quantity of treated wastewater	0.367***	0.232*	0.513***
	(0.088)	(0.121)	(0.134)
Regeneration of the park	-0.292***	-0.284**	-0.248**
	(0.083)	(0.125)	(0.115)
Monthly increase in municipality tax	-0.131***	-0.119***	-0.142***
	(0.015)	(0.22)	(0.022)
Pseudo ρ^2	0.406	0.404	0.422
Log-likelihood	-521.731	-256.571	-258.918
Sample size	800	392	408

Source: River Ganga Wastewater Treatment Choice Experiment Survey, 2007

*** 1% significance; **5% significance and *10% significance level with two-tailed tests.

The McFadden's ρ^2 value in CLM is similar to the R^2 in conventional analysis except that significance occurs at lower levels. According to Hensher et al. (2005, p. 338) values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits. According to this criterion the overall fit of the pooled model (0.406) indicates an extremely good fit, and all the coefficients are statistically significant and intuitively correct. Treated wastewater quantity and quality are significant factors in the choice of a wastewater treatment programme, and ceteris paribus, these two attributes increase the probability that a wastewater treatment programme is selected. In other words, households value those wastewater treatment programmes that result in higher quality and quantity of wastewater treated.

The coefficient on the wastewater quality is about twice the magnitude of the coefficient on wastewater quantity. This result can be explained by the fact that even though residents recognize the need to increase the capacity of the current STP so that all of the wastewater generated by the residents of the Municipality can be treated, they are especially concerned about treating wastewater to a higher quality level before discharging in the River Ganga and/or before using it for irrigation or aquaculture. This result reveals that residents acknowledge that the quality of treated wastewater has implications for health and environmental risks, and for the conservation of the cultural heritage and religious values of the River. Therefore plans for improvements to the STP should not only include expansion (or full use of its current) capacity, but also upgrading of the current technology so that wastewater can be treated to a higher quality to minimize any risks to health or to the sustainable management of the Ganga.

Households prefer those wastewater treatment programmes which do not propose additional investments in the regeneration of the Wonderland Park to improve its use as a recreational Park. This result is also not surprising given that 98 percent of the households interviewed agree that the Park is already an attractive recreational site and since its opening in 1999, and 71 percent of them have visited it for recreational purposes an average 9.5 times. The coefficient on ASC is negative and significant implying that there is some degree of status quo bias – all else held constant, respondents would prefer to move away from the status quo situation (Hanley et al., 2005) and take part in improved wastewater treatment programmes even if they would have to pay higher monthly taxes for these. Finally, the sign of the payment coefficient indicates that the effect on utility of choosing a choice set with a higher payment level is negative, as expected.

4.3 Conditional Logit Model: Poor vs. Rich Households

In order to investigate whether there is any heterogeneity in the preferences of the sample, it is divided into two subsamples according to the households' total monthly expenditure per capita. Those households with total monthly expenditure per capita level below average (Rs 1296.7) were denoted as poorer households and those with total monthly expenditure per capita level above average were denoted as richer households. Separate CLM were estimated for each subsample, and the results are reported in the second and third columns of Table 2. The Swait-Louviere log likelihood ratio test rejects the null hypothesis that the regression parameters are equal at 5 percent significance level. Hence, poorer and richer households have distinct preferences for wastewater treatment programme attributes. The signs and significance of the attributes do not differ much across the two subsamples, however there are some significant differences in the coefficients' relative magnitude within each subsample, which becomes more obvious when the WTP values are estimated.

4.4 Estimation of Willingness to Pay

The choice experiment method is consistent with utility maximisation and demand theory. Once the parameters are estimated with the CLM, welfare measures for changes in wastewater treatment attributes can be calculated by using the following formula (Hanemann, 1984; Bateman et al., 2003):

$$CS = \frac{\ln \sum_i \exp(V_{i1}) - \ln \sum_i \exp(V_{i0})}{\alpha} \tag{4}$$

where CS is the compensating surplus welfare measure, α is the marginal utility of income (represented by the coefficient of the monetary attribute in the choice experiment) and V_{i0} and V_{i1} represent indirect utility functions before and after the change under consideration.

The marginal value of a change in a wastewater treatment attribute can be estimated as a ratio of coefficients, which represents the marginal rate of substitution between the monetary variable and the wastewater treatment attribute in question, or the marginal welfare measure (willingness to pay (WTP)) for a change in that attribute. For the effects-coded wastewater treatment attributes with two levels, equation (4) reduces to part-worth (or implicit price) formula:

$$W = -2\left(\frac{\beta_{attribute}}{\beta_{monetary\,variable}}\right) \tag{5}$$

Wald Procedure (Delta method) in LIMDEP 8.0 NLOGIT 3.0, is employed to estimate the WTP values for the pool and rich and poor subsamples. These results are reported in Table 3. The estimated WTP values for the pool indicate that the households value improvement in water quality the most, as they are WTP Rs 10.86 more in monthly municipal taxes to ensure that the quality of the water discharged to the River is high. They are WTP about half as much to increase the treatment capacity of the STP to double the quantity wastewater treated. The households, however, derive negative values from investment in the regeneration of the Park, given that they are already satisfied with the present facilities (status quo) provided.

When the WTP of richer and poorer households are estimated and compared, t-tests reveal that these two subsamples exhibit significantly different WTP values for each attribute. Richer households are WTP more for higher wastewater treated to a quality, whereas poorer households are WTP more for higher quantity of wastewater treated. This result can be explained by the fact that richer households are more concerned about the quality of the wastewater discharged in the Ganga. This result can be explained by the fact that richer households are better educated than their poorer counterparts, and therefore they are more aware of the fact that the wastewater quality has important implications for health and environmental risks. Several previous studies have found that respondents' demand (or WTP) for higher water quality increases in their income (see e.g., Ready et al., 2002; Kostas and Chrysostomos, 2006).

Poorer households are on the other hand WTP similar amounts to ensure the STP treats higher quantity of wastewater and to high quality. This can be explained by the fact that the great majority of the poorer households are more likely to consume food produced with such water since such food tend to be cheaper. Therefore these households prefer that the water used for food production is treated at least to the currently acceptable levels rather than the current situation which is semi-treated or no treated at all. In other words for these households improvement of the quality of wastewater to a higher level is as important as the treatment of the entirety wastewater they are currently using directly or indirectly.

Finally, poorer households dislike investment in the regeneration of the Wonderland Park less than their rich counterparts, which can be explained by the fact that with its low entry fee (Rs 5 (0.09 Euro)) it is generally the poorer households who enjoy the recreational activities in the Park, whereas the richer households have access to substitute recreational areas, and hence poor households would be less likely to protest investments made to sustain the Park as an attractive recreational site.

Table 3: Marginal WTP for wastewater treatment programme attributes, Rs per household per month (95% C.I.)

Attributes	Pool	Rich households	Poor households
Quality of treated wastewater***	10.86	15.06	7.98
	(9.19-12.53)	(11.83-18.29)	(6.01-9.95)
Quantity of treated wastewater***	5.6	3.88	7.22
	(4.24 -6.96)	(1.92-5.84)	(5.22-9.22)
Regeneration of the park***	-4.46	-4.77	-3.49
	(-5.76- -3.16)	(-6.96- -2.58)	(-5.16- -1.82)

Source: River Ganga Wastewater Treatment Choice Experiment Survey, 2007 T-tests show significant differences (***) at 1% significance level.

5. Conclusions

This paper contributes to the limited literature on the estimation of economic values generated by improved wastewater treatment by using the choice experiments method. Moreover, it presents one of the first choice experiment studies implemented in India. There are to date very few albeit an increasing number of choice experiment studies carried out in developing countries (Bennett and Birol, forthcoming). Following the findings of these emerging developing country choice experiments (e.g., Scarpa et al. 2003a, b; Othman et al., 2004; Bienabe and Hearne, 2006; Hope, 2006; Birol et al., forthcoming; case studies in Bennett and Birol, forthcoming), this study reveals that the CE method can be successfully employed in a developing country context with careful construction of the choice sets and effective field data collection.

The average monthly expenditure (proxy for income) in Chandernagore Municipality is 23 Euros, which is significantly lower than the monthly GDP per capita in India, which was estimated to be 49.2 Euros in 2006 (World Fact Book, 2007). The results of the pilot choice experiment study implemented in this Municipality reveal that even though the residents of the Chandernagore Municipality have lower disposable incomes compared to national standards, they are willing to pay (WTP) higher taxes for improvements in the quality and quantity of the wastewater treated in their local sewage treatment plant (STP). Comparison of richer and poorer households' preferences for wastewater treatment programme attributes reveal that richer households are WTP significantly higher amounts for improvements in the quality of wastewater treated, whereas poorer households value improvements in quality and quantity of water treated by the STP almost equally. Overall, these results confirm that even though constrained by tight budget constraints, the residents of this Municipality value the quality and quantity of water in the Ganga, and derive positive benefits from the economic, religious and cultural values the River provides.

The benefit estimates reported in this study reveal that an average household in this municipality would be WTP Rs 16.46 per month (Rs 197.52 per annum) additional municipal taxes in order to improve the capacity of the STP to one that increases the quantity and quality of wastewater treated to higher levels before discharging the treated wastewater into the Ganga or to be used for other purposes. According to the latest census (2001) there are 32,939 households in the Chandernagore Municipality. When aggregated over the entire population, the Chandernagore Municipality residents' WTP for increasing the capacity of the STP is as high as Rs 6,506,111.3 per annum.

Currently the STP treats 24 percent of the wastewater generated by the municipality with running costs of Rs 2,500,000 per annum. Considering constant economies of scale had the current STP treated 100 percent of the wastewater generated by the residents of the Municipality, the running costs would amount to Rs 10,416, 666 per annum. That is, the increased taxes would not be sufficient to cover treatment costs of all the wastewater generated by the Municipality. Moreover, it is expected that in order to be able to treat wastewater to a higher quality, investment in the upgrading of the technology of the current STP is required. Therefore an increase in municipal taxes by a maximum of Rs 16.46 per month may not be sufficient to cover the costs of upgrading of the technology and capacity of the current STP. This simple cost benefit analysis reveals that even though the residents' welfare would increase as a result of an improvement of the current STP, there are budget constraints and hence additional financial sources should be sought for the financing of this endeavour.

With the use of the benefits transfer method, the results of this case study can provide municipality level policy-makers with useful information for improvement of STPs in other similar municipalities along the Ganga. The results reported in this paper are timely and important, since the current practice of discarding of semi or untreated wastewater in this sacred River creates high levels of environmental and health risks, and thereby decreases the economic, cultural and religious values the Ganga generates.

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