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The Willingness to Pay for Improving Drinking water supply in Tamil Nadu: A Case study of Tannery Water Pollution in Vellore District

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Abstract

Tannery pollution and the resulting health impacts are a worldwide problem. Due to the cheap labour availability and tax pollution regulation leather tanning has become a popular export earning industry in countries like India, Pakistan and Bangladesh. Given its huge potential for export earnings and local economic livelihood especially for poor households, its adverse health impacts seem to have been ignored. Also thus far there has been no systematic economic valuation study in India. This also attempts to estimate the health cost of this industry to people including those very households that have made leather tanning their livelihood. Therefore the present research study aims to examine economic valuation of human health impact of the pollution from the tannery industry in Vellore district, using the Willingness to Pay method. Vellore district in Tamil Nadu state of India is purposively selected because of its larger number of tanneries.

1. Introduction:

Water is one of the most important commodities which man has exploited more than any other resource for the surface of his or her life. Most of the water on this planet is stored in oceans and ice caps. The demand for water is fulfilled by rain water which gets deposited in surface and ground water resources (Venkaiah Naidu, 2018). The quantity of this utilizable water is very much limited on the earth. Pollution of water has emerged as one of the most significant environmental problems in recent time. There is an increasing concern for rapidly deteriorating supply of water, but the quantity of utilizable water is also fast diminishing (Varshney, 2002). Geological survey, over 68% of the fresh water on earth is in ice caps and glaciers, while just over 30% is found in ground water. This is no longer a poetic allegory but a sad reality for millions of people around the world who have little access to safe water for their basic needs.

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784 million people around the world are without access to water for even basic needs. Over 2 billion people live in countries experiencing high water stress (UN, 2018). It is estimated that by 2040, one in four of the world's children under 18 i.e. 600 million in all will be living in areas of extremely high water stress (UNICEF, 2017). 700 million people worldwide could be displaced by intense water scarcity by 2030 (Global Water Institute, 2013). Every year 400 million school days lost, 3.4 lakhs children under five die due to water related diseases (UN, 2010).

Indian Context:

A growing population, adequate planning, crumbling infrastructure, indiscriminate drilling of bore wells, large scale consumption of water, and a false sense of entitlement in using water careless are causing water shortages. India current water requirement is estimated to be around 1,100 billion cubic metres per year, which is projected to touch 1.447 billion cubic meters by 2050 (World Bank, 2018). Asian development bank, India will have a water deficit of 50% by 2030. India's water needs are basically met by rivers and ground water. Water scarcity can lead to disastrous consequences impacting food production as most of the farming is rain fed. With ground water catering to about 60% if the country's irrigation, 85% of rural water drinking requirements, and 50% of urban water needs, replenishing the aquifers has to be accorded top priority.

In India, the situation is just as grim, with unsafe water killing more people per year than what the coronavirus pandemic did last year. In India about 200,000 people die every year due to lack of access to safe water. 82 percent of rural households are without pipe water supply to their houses. Over 75 percent of households do not have clean drinking water. The NITI Aayog's composite Water Management Index (CWMI) report released in 2018. The report shows that 21 Indian cities running out of ground water by 2020 affecting 100 million people. The Composite Water Management Index (CWMI) report says that with nearly 70 percent of water is contaminated. India ranks 120th of 122 countries in a global water quality index. India's environmental status was poor, with the country ranked low, 168th out of 180 countries on the global environmental performance index (Zachary et.al. 2020). India accounted for 23.7 lakhs polluted related mortality in 2017 (Richard et.al. 2019).

The urban population has rapid increase globally, particularly in low and middle income countries. Currently it accounts for 55% and is expected to increase to 68% by 2050 (UN, 2018). Urbanization brings with it its own challenges among which have increase in water pollution (Pervin et.al. 2010, Bhardwaj et.al. 2020). In India the water pollution has become a major threat to sustainable development (Thi. Kumar & Lin, 2015).

The lack of clear rules is coupled with poor institutional capacity of the pollution control board. To enforce existing rules and regulations for managing water pollution,

inadequate infrastructure for treatment and disposal of waste tannery water, inadequate technical expertise has made the tannery waste water to control is difficult (Rai et.al. 2019), which has increased health related and environmental problems (Srivastava et.al. 2015) . The current demand, plus augmenting the supply for future demand, has become a real challenge to urban and rural water supply authorities. This challenge is exacerbated by various supply side and demand side factors, such as ever increasing scarcity of water caused by depletion unequal distribution of rainfall due to climate change, urbanization and institutional and political factors (Mckenzie et.al. 2009).

2. Existing Literatures:

Paravatsu and Nallathiga (2004) conducted a survey on contingency valuation survey in India. The study was to understand economic value of water quality improvement for river Yamuna. 125 households were randomly selected across clusters. The multiple regression analysis showed that the average WTP was Rs.73.86 per capita per year. The survey results showed that people are willing to pay for good quality of water.

Smita Misra and Bishwanatha Golden (2008) conducted a study in Delhi. The objective of the study was the WTP for improved water supply. A total sample survey 8000 households were selected. The CVM has found that the average WTP for improved water services across Delhi was to be Rs. 130 to 240 per month in low income households and Rs. 290 to 368 in high income households. The average willingness to pay for improved services was about Rs. 163 per month, a strong demand among consumers for an improvement in the level of service.

3. Objectives of the study:

1. To assess if and how much households are willing to pay for improved water services in Palar river basin.
2. To identify factors that influence households' willingness to pay (WTP) for improved water services.

4. Profile and Methodology:

The study area selected for the present study is Vellore district in Tamil Nadu. There are 38 districts. Vellore district is the second most populous district in Tamil Nadu The district covers an area of 488664 hectares and comprises of 7 taluks and 20 blocks 753 village panchayats and 4827 villages 9 municipal towns. It receives a rainfall of 1215.3 mm per year.

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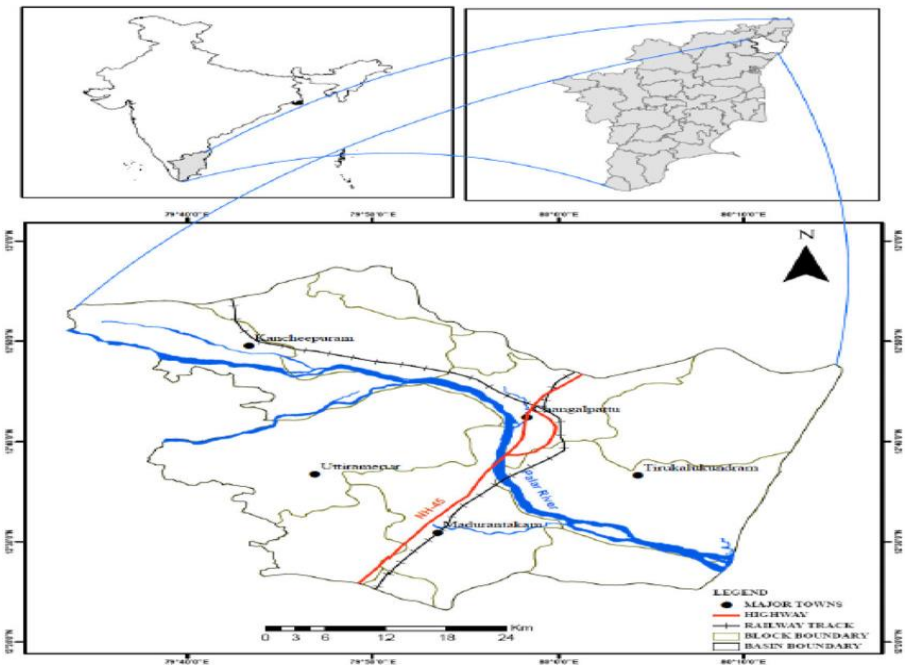
Study site:



Source: Tesfa et.al. (2018)

Where the water pollution caused by tanneries in this district is found to cause substantial amount of health damage to the people. The leather industry is one of the major exporting industries in India with a turnover of about 8000 crores in the year 2009. In specialized Tamil Nadu the total leather product export accounted for 70% in 2009. Vellore district is specialized in turned leather goods. Its small and big tanneries have good market for their products, the total exports accounted for 600 crores (Statistical Handbook of Tamil Nadu, 2018). In the state, there are 662 leather industries in the district there are 230 tanneries this industries they are processing animal skins and hides are converted in to non- biodegradable stable and quality leathers through a process known as tanning. This process includes de hiring removal of flash and fat, and treatment with either plant extracts, (chemicals chrome tanning). Several chemicals including salts and heavy metals are used in chemical tanning. Such processes result in large quantities of effluents (TWAD, 2012).

A structured interview schedule was used to elicit information and data from the selected respondents. By conducting personal interviews at the houses of respondents and by discussion with the members of their families data were obtained. Random sampling technique was used to determine the total sample size of 410

households in the study area out of which 234 are rural households and 176 are urban households.

Theoretical Framework:

WTP Model

The WTP willingness to pay value is estimated utilizing the CV method. The elicitation format of the single- bounded dichotomous choice approach was used. In this approach, a respondent was asked if he or she would be willing to pay a single bid amount in exchange of the improved water services he/she would get.

In contingent valuation, the assumption of the utility maximization is made. That is households are assumed to maximize their utility while making their choice of yes or no to paying the specified bid amount in exchange for the improved services (Baral et.al. 2007). In other words, given a fixed income of Y and a bid amount of A, a household would pay the bid amount if the utility from enjoying the improved water services and all other goods. Households buy with the left income of (Y-A), exceeds the utility from enjoying the goods a household buys with income of A (Hanemann, 1984). Following the standard Contingent Valuation Methodology (Hanemann, 1984). The probability of that the residential water users say they would pay a given amount of price for the use of new water supply system is assumed to follow the probit regression model below.

$$P(YES) = (1 + e^{(b0+\beta A+\varphi X+E)}) - 1$$

Where b_o= intercept

β= coefficient of bid variable A

φ= the coefficient of the independent variable being tested.

X= the value of the independent variable being tested.

The answer yes is coded as I and no as 0, forming the binary dependent variable.

Using the parameter estimated from the above equation, Median WTP is computed from the following equation.

$$WTP = \frac{bo + \bar{X}\varphi}{\beta}$$

Where, $\bar{X}$ is the vector of sample means of all the non-bid independent variables.

In the previous studies of WTP for water services (World Bank, 1993; Genius et.al. 2008; Kayaga et.al. 2003). Some variables such as gender, household income and

experience of using water vendors have been revealed as significant determinants of WTP.

The expected effects of the independent variables on the probability that the respondents would buy water from public tap. These effects were hypothesized based on the literature review. Contingent valuation method, the bid amount is usually expected to have negative effect. Commonly in the research of WTP on water services, the variables of education, shortage of water, water deterioration and time spent on water collection or cost of water uses at alternative water sources are expected to have positive effect. (Kagaya, 2003) indicated that the respondents in the owned houses had higher WTP than the respondents in the rented houses. The variable of family size was hypothesized to have positive effect, based on the hypothesis by (Kayaga et.al. 2003) that an absence of water in a home would cause more inconvenience for a larger family.

5. Results and Discussions:

Socio Economic Characteristics:

The distribution of socio-economic characteristics (Table-1) in the study area shows that out of 410 respondents the majority of 297 respondents are male and 113 respondents are female. In age category, majority of 151 respondents from 36 to 45 age group followed by 114 respondents from 26 to 35 age group, 102 respondents from 46 to 55 age group. In educational status, majority of 123 respondents are illiterate out of which 77 respondents are from rural and 46 respondents from urban. Followed by 118 respondents have completed their secondary education and 116 respondents have completed their primary education. The occupational status of the household head encompasses government, private, agricultural worker, daily wage labour and others in which majority of the 252 households head are engaged in daily wage labour followed by 59 of them are working in private, 50 of them in agricultural work and only 14 of them are working in government. Household annual income is the main indicator that determines the standard of living; as far as household annual income is concerned, majority of 243 households' annual income is in the range of 50001 to 100000 followed by 122 households' annual income of 100001 to 300000, only 36 households annual income is less than 50000.

Drinking Water Facilities:

Table-2 shows the household water facilities in the study. Public tap is the major source for drinking water in 259 households including rural and urban areas out of which, 151 households from rural and 108 households from urban followed by 102 households consuming water from public tap, bore well, rented water out of which 52 households in rural and 50 households in urban. As far as distance to the drinking water source is concerned, majority of 202 households distance to water source is far away

from their place i.e. 1 to 5 km followed by 131 households distance to water source is less than kilometer and only 77 households distance to water source is more than 5 km.

Table-1, Socio Economic Characteristics

Socio Economic Variables	Rural (N= 234)	Urban (N= 176)	Total (N=410)
Gender			
Male	173	124	297
Female	61	52	113
Age			
Less than 25	3	3	6
26 to 35	54	60	114
36 to 45	88	63	151
46 to 55	65	37	102
Above 55	24	13	37
Educational Level			
Illiterate	77	46	123
Primary	66	50	116
Secondary	60	58	118
Higher Secondary	25	19	44
Diploma	2	2	4
Degree and above	4	1	5
Occupation			
Government Employees	7	7	14
Private Employees	23	36	59
Agricultural workers	31	19	50
Daily wage labour	151	101	252
Others	22	13	35
Household Income			
Less than 50000	13	23	36
50001 to 100000	140	103	243
100001 to 300000	77	45	122
300001 to 500000	4	3	7
Above 500000	0	2	2

Source: Primary data

Time taken for fetching water is the major problem among households, majority of 247 households are spending 1 hour to fetch the water followed by 100 households are spending less than hour and only 63 households spending more than one hour for fetching the drinking water. As far as water consumption is concerned, majority of 193 households consumes more than 250 litres per week followed by 174 households consumes 201 to 250 litres of water per week.

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Table-2, Household Water Facilities in the study area

Water Facilities	Rural (N= 234)	Urban (N= 176)	Total (N=410)
Water Source			
Public Tap	151	108	259
Bore well	30	18	48
Rented water	1	0	1
All the above	52	50	102
Distance to water			
Less than kilometer	74	57	131
1 to 5 km	114	88	202
More than 5 km	46	31	77
Time taken for water			
Less than hour	62	38	100
1 hour	139	108	247
More than 1 hour	33	30	63
Consumption of water per week (in litres)			
50 to 100	1	3	4
101 to 150	0	2	2
151 to 200	26	11	37
201 to 250	87	87	174
More than 250	120	73	193
Quality of Water Colour			
Very Good	17	17	34
Good	119	131	250
Bad	98	28	126
Quality of Water Taste			
Very Good	5	1	6
Good	102	68	170
Bad	127	107	234
Quality of Water Dust			
Very Good	2	3	5
Good	38	37	75
Bad	194	136	330
Water Storage Facility			
Yes	170	162	332
No	64	14	78
Usage of Boiled Water at home			
Yes	98	105	203
No	136	71	207

Source: Primary data

Drinking water quality is the most important factor that was measured in terms of colour, taste and dust. The majority of 250 households reported colour of water is good, 234 households reported taste of the water is bad and 330 households reported water contains dust. In household water storage facility, majority 332 households have water

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storage facilities and 78 households don't have water storage facilities. Majority of 105 households in urban are have the habit of boiling the drinking water.

Table-3, Health impacts of Tannery in the study area

Health Impacts	Rural (N= 234)	Urban (N= 176)	Total (N=410)
Illness			
Yes	221	152	373
No	13	24	37
Sickness			
No problem	13	22	35
Headache	58	47	105
Skin infection	47	30	77
Body Ache	20	6	26
Fever	65	36	101
Eye irritation	4	4	8
Vomiting	12	12	24
Others	15	19	34
Type of Disease			
No disease	68	39	107
Waterborne diseases	17	25	42
Bacterial diseases	3	4	7
Skin diseases	98	69	167
Eye problems	11	11	22
Fever	37	28	65
Do you think diseases caused because of tannery waste?			
No disease	68	39	107
Yes	105	120	225
No	61	17	78
Mode of Treatment			
Not Applicable	68	39	107
Government Hospital	86	46	132
Private Hospital	42	54	96
PHC	13	16	29
Medical stores	14	17	31
Self	9	3	12
Siddha	2	1	3
Total number of days lost due to sickness			
Not applicable	72	53	125
5 days	76	46	122
10 days	51	37	88
15 days	17	22	39
1-3 months	11	11	22
More than 3 months	7	7	14

Source: Primary data

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Health Impacts of Tannery:

Table-3 determines the health impacts of tannery in the study area. Among 410 households, 373 households' family members are become victim illness due to tannery water pollution out of which majority of 221 households from rural and 152 households from urban. As far as sickness is concerned, majority of 105 households family members are having headache followed by 101 households family members are have fever and 77 households are having skin infection caused due to water pollution in the study area. Majority of 167 households reported that skin diseases are the major health problems in the study area out of which majority of 98 households from rural and 69 households from urban. Households perceptions of diseases were measured, majority of 225 households have chosen that diseases are caused because of tannery waste. Majority of 132 households are taking treatment in government hospitals during their illness followed by 96 households from private hospitals, 31 households from medical stores and 29 households from primary healthcare centre. As far as the mandays lost is concerned, majority of 122 households family members lost 5 days due to illness followed by 88 households family members lost 10 days, 39 households family members lost 15 days and only 36 households family members lost more than one month.

Willingness to Pay for Drinking Water:

Table-4, Probit Regression- Willingness to Pay for Drinking water

Variables	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Area						
Rural (Base)						
Urban	.48	0.18	2.65	0.008***	.12	0.84
Household Size	-.07	0.05	-1.3	0.193	-.18	0.03
Gender						
Male (Base)						
Female	.46	0.24	1.92	0.055*	-.00	0.93
Age	.004	0.01	0.36	0.717	-.02	0.03
Educational Level						
Illiterate (Base)						
Primary	.00	0.24	0.03	0.976	-.48	0.49
Secondary	.60	0.25	2.37	0.018**	.10	1.10
Higher Secondary	.28	0.32	0.9	0.368	-.33	0.91
Diploma	-3.81	116.42	-0.03	0.974	-232.00	224.36
Graduate and above	.95	0.88	1.08	0.280	-.77	2.68
Employment						
Other Employment (Base)						
Government	.40	0.58	0.69	0.489	-.74	1.56
Private	.21	0.38	0.57	0.567	-.52	0.96

Agriculture	-.09	0.39	-0.24	0.810	-.86	0.67
Daily wage	-.00	0.31	0	0.998	-.61	0.61
Family Annual Income	.00003	3.20	9.75	0.00***	.00	3.75
_cons	-4.09	0.81	-5.02	0.000	-5.68	-2.49
Dependent Variable- WTP						
Number of obs =410 LR chi2(14) =228.29 Prob > chi2 =0.000 Pseudo R2 =0.4406 Log likelihood = -144.93722						

*** represents 1% level of significance, ** represents 5% level of significance, * represents 10% level of significance

$$\mathbf{WTP}_I = \alpha_1 + \beta_1\mathbf{URB} + \beta_2\mathbf{HOUSZE} + \beta_3\mathbf{FEM} + \beta_4\mathbf{AGE} + \beta_5\,\mathbf{EDUC} + \beta_6\mathbf{EMP} + \beta_7\mathbf{FAMINC} + \varepsilon_i$$

Where, WTP_I = willingness to pay for drinking water; URB= Area of the household; HOUSZE= household size; FEM= Female respondent; AGE= Age of the respondent; EDUC= Educational level of the respondent; EMP= Employment status of the household head; FAMINC= annual income of the household; α = constant; β= vector of coefficients and ε_i = error term.

Probit regression is used when dependent variable is dichotomous (Yes/No). Probit regression was performed to determine the factors influencing households' willingness to pay drinking water in the study area. From the table-4 it can be noted that, household annual income and urban households are statistically significant at 1% level whereas secondary education of the respondents and female respondents are statistically significant at 5% and 1% level respectively.

Level of Willingness to Pay:

The initial step is to fix a slab to which the beneficiaries are willing to adhere. That is, payment options for example per month payment for improved drinking water. In this aspect, the sample households were asked about their willingness to pay an amount and that they were ready to forego to get the improved drinking water. Based on the existing literature, researcher fixed the amount for willingness to pay (WTP) in four categories i.e., Rs. 30 to 50, Rs. 51- 100, Rs. 101 to 150 and more than Rs. 150 are shown in the table-5. It was found that, out 410 households 136 households were ready to pay some amount of money for improved drinking water.

Table-5, Willingness to Pay

WTP Amount	Freq.	Percent	Cum.
No WTP	274	66.83	66.83
Rs. 30 to 50	4	0.98	67.8
Rs. 51 to 100	30	7.32	75.12
Rs. 101-150	51	12.44	87.56
More than Rs. 150	51	12.44	100
Total	410	100	

Source: Primary data

6. Conclusions:

In developing countries, there is inadequate good quality and quantity water in rural and urban areas to reduce health problems and to increase the welfare. The present study suggests that private water vendors do play an important role in supplying the drinking water requirements in the study area. This study finds that people around palar river basin are spending a significant portion of their water costs. Nearly 33.18% would be willing to pay more for improved public tap water supply out of which 24.88% of households willing to pay Rs. 101-150 and More than Rs.150 for good quality water. The major findings from the study are that there is a significant potential to improve human welfare especially to improve the health of the rural and urban people. if the government agencies and institution. To make adequate efforts to control water pollution and to improve the quality of water supply to a satisfactory level. The study result also suggests that pipe water connection to each household has to improve, finally adequate supply of water to the study area. The government, non-government and local bodies to promote water conservation and to prevent pollution of water bodies.

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