Environmental Costs of Industrialisation: A Study of Durgapur Region in West Bengal

Majumder, Rajarshi
Department of Economics, University of Burdwan

October 2009

Environmental Costs of Industrialisation: A Study of Durgapur Region in West Bengal

[preprint version, in Rabindra Bharati University Journal of Economics, Vol. IV, March 2010]

Sk. Samim Firdous

and

Rajarshi Majumder

Abstract

Industrialization is perceived as inseparable part of economic development and developing economies adopt policies for transformation of agro-based underdevelopment regions to industry-based developed regions. However, public awareness about environmental problems emanating from industrialisation has swelled significantly and researchers have been trying to evaluate the consequence of pollution through field studies and quantitative analysis. It is now accepted that the benefit from industrialisation in a region needs to be examined against the perceived costs of increasing pollution and has to be carefully studied before allowing any further industries to come up in that area. This paper attempts to evaluate monetary costs of environmental damages in the rapidly industrialising locality of Durgapur Municipal Corporation in West Bengal. Using WTP and WTA methods, it is inferred from the study that the residents are quite aware of the problems caused by pollution from the present phase of industrialisation in the locality and are willing to pay to protect / clean the environment. The estimated valuation of environment in the area comes out to be around Rs94 million, if the residents seek to protect current environmental standards. If however, the residents want to go back to the situation prevalent before the neo-industrialisation process was set in, then the cost comes out to be a whooping Rs272 million. This is a pointer to the fact that we must look at such costs before embarking on further industrialisation process in the region to protect ecological/environmental balance and keep the system sustainable.

* *PhD Scholar, Department of Economics, University of Burdwan*

** *Corresponding author; Reader, Department of Economics, University of Burdwan; meriju@rediffmail.com*

Environmental Costs of Industrialisation: A Study of Durgapur Region in West Bengal

1. INTRODUCTION

Economic theorists have long since opined that the economic development of a region is mainly determined by the degree of industrialization achieved, and from Lewis onwards, various models, strategies and policies have been framed for transformation of agro-based underdevelopment regions to industry-based developed regions. However, public interest about the Environmental problems emanating from the industrialisation process has recently swelled significantly. It is universally accepted that the increase of CO, CO_2, and $S0_2$, as well as Suspended Particulate Matters (SPM) in atmosphere is a public health concern throughout the world. For decades, epidemiological studies have been a cornerstone of our approach to investigate the health effects of air pollution and have been a principal basis for setting regulations to protect the public against adverse health effects. As the problem has become well recognized, researchers from the field of economics have taken steps to evaluate the consequence of pollution through field studies and quantitative analysis. Whereas there are several studies in the developed countries, studies in Indian context to evaluate damages from air pollution include those by Balakrishnan (2001), Shah and Mehta (2003), Sengupta and Mondal (2005), Gupta (2006), Baby (2009).

Pollution damages the welfare directly (damaging health and drinking water) or indirectly by being detrimental to production elsewhere (reducing crop productivity, fish population and lessening available amenities). The cost of pollution is borne by the people in the form of damages such as health loss and natural resources degradation. In this backdrop, industrialization process in any developing country can not be viewed as an unblemished benefit. While it is necessary for occupational transformation of the economy, increased employment and growth of the economy, it also has substantial impact on environmental degradation, resource depletion and related social costs. It can be argued that every locality has a *'carrying capacity'* in terms of environmental degradation vis-à-vis the benefits accruing from industrialisation process. If the environmental costs reach this threshold level, the industrialisation process in that locality should be limited or

downscaled. The social benefit from increased industrialisation in a particular area needs to be examined against the perceived costs of increasing pollution and has to be carefully studied before allowing any further industries to come up in that area. Regional development plans should also be formulated accordingly. This paper attempts to undertake such a study in a rapidly industrialising locality so that proper regional policies can be drawn up and which may serve as an example of impact assessment studies that should be mandatory in similar localities. We have chosen the Durgapur municipal region of Burdwan district of West Bengal in India to understand how environmental impacts are causing negative externalities to the industrialisation process and how these can be incorporated to arrive at a social benefit cost study.

2. PROFILE OF THE REGION

Burdwan district lies in the western part of West Bengal Province of India. Durgapur municipal region is a space covering around 200 square km area in the mid-western part of the district, about 175 km from the state capital Kolkata. The area is bounded by the Ajoy and Damodar rivers in the northern and southern boundaries and the mining town of Ranigunj serve as the western boundary of the region. The Grand Trunk Road (NH 2) and the main Delhi-Kolkata Railway line pass through the region. The Durgapur Barrage on the River Damodar serves flood control, reservoir, water supply and Irrigation purposes. The locational advantage helped the region in being a part of post-independence industrialisation drive and by late 1970s there were more than 30 factories and around 500 other manufacturing units in this area, including two Steel Plants, three Thermal Power Plants, one Glass factory, a Heavy Machinery factory, a Fertiliser factory and a Chemical factory under the public sector. They provided employment to a substantial number of native and immigrant workers and this large and predominantly industrial workforce induced build-up of an impressive social infrastructure. An engineering college, an industrial training institute, three general degree colleges, more than thirty high schools, and the Central Mechanical Engineering Research Institute started fulfilling educational and training needs. However, since mid 1980s, a deceleration of the organised sector set in here and the profile of the area has been changing ever since. From mid 1990s it has emerged as a major educational hub with several engineering

colleges, general degree colleges, professional training institutes, computer training centres coming up to compliment the existing facilities.

Just when one thought that the area is moving from a Industry-dominated region to a Services-dominated one, the local government undertook a strong Industrialisation drive by marketing the locational advantage of the region to potential entrepreneurs. During 2002-2006 there seems to be a hint of industrial recovery with quite a few private enterprises (mainly sponge iron, machine tools, one cement and a few polymer units) being set up in the region. This neo-industrialisation drive has thrown up its own problem – that of environmental degradation. The industrial units are belching fumes, containing substantial amount of harmful gases, toxic chemicals, and SPMs. This has resulted in pollution of air and water in the surrounding areas and health and other damages to both the workers and residents. This paper will attempt to quantify the costs arising out of the industrial activities and arrive at a figure of Net Social Benefit from the industrialisation process in the region.

3. METHODOLOGY

a. Evaluating the Environment

The next question would be how can one value the cost to the individual accruing from the environmental degradation? An economist's answer is to employ Hicksian consumer surplus, determining the equivalent variation in income that leaves each consumer indifferent to the action. When consumers are rational and consumer surplus can be measured reliably from market demand functions, this is a satisfactory basis for welfare calculation, subject to the customary caveats about distributional equity and consistency if compensation is not actually paid. When externalities, public goods, or informational asymmetries interfere with the determination of consumer surplus from market demand functions either simply because the commodities are not traded in the market or because the market demand functions are not reliable/representative, one can try to set up a hypothetical market to elicit an individual’s equivalent variation, or monetary changes required to keep her utility levels unchanged. Environmental economists regard environmental goods as public goods with non-excludability and non-divisibility properties along with strong externalities, and they also do not have any substitutes or

complements traded through the ordinary market. Therefore no real market for environmental goods (or bads) exists and economic valuation of environmental degradation or upgradation is to be undertaken using the hypothetical scenario to reveal the true social value of environmental resources. Two general approaches for such valuation of the environment exist in the literature – the direct and indirect approaches.

Direct approach includes Contingent Valuation Method (CVM) and Contingent Ranking Method (CRM) where people are asked directly to state or reveal their strength of preference for a proposed change. In the former people are asked to state directly what they are willing to pay for some change in the provision of goods/services or to prevent a change and/or what they are willing to accept to forego a change or tolerate the change. The range of application of CVM to environmental impact studies varies from valuation of outdoor recreations (US Water Resources Council, 1983), national parks (Gunning-Trant, 1996), pollution from plant emissions (Bowker and MacDonald, 1993), and applications of new technology (Hudson and Hite, 2003) to subsidizing ago-environmental measurement (Vanslembrouck et al, 2002). An extensive survey of applications of CVM can be found in Carson et a1 (1994) where over 1600 contingent valuation studies have been included.

Contingent Ranking Method is similar to contingent valuation except that here the questioner is content to obtain a ranking of preferences which can later be anchored by the analyst in a real price observed in the market. In case of Indirect approaches the preferences for environmental goods are revealed indirectly when an individual purchases marketed goods to which the environmental good is related in some way.

In the present study the CVM has been used.

b. Survey Techniques

The sample design was aimed at reducing errors and ensuring the validity of the study in a cost effective manner. Therefore Stratified Random Sampling method was used to acquire precise and representative information from the population. Personal interview method of survey was used with a structured questionnaire.

i) The Questionnaire

The questionnaire was designed to reduce non-response errors and measurement errors.

The first section included questions on Socio-Economic Characteristics of the respondents including demographic information on age, education, and gender.

Section 2 included questions on Health and Environmental Effects, information on medical expenditure per month.

Section 3 and 4 were the hypothetical segments of our questionnaire. Both WTA and WTP questions were used to elicit monetary values for air quality, but from separate households so as to control survey bias. The questionnaire depicted a close-ended format.

Two separate hypothetical scenarios were verbally provided by the field investigators conducting the survey.

(1) For the WTA question, the respondents were reminded of the current situation of rising air pollution due to increased industrialization, which showed up as health hazards and other problems in their livelihood. Given the costs of such problems, it was proposed that the local government would compensate, that is, pay certain sums to the respondents in the affected area for accepting the current levels of pollution. The respondents were asked whether they were willing to accept a certain amount as compensation for the degraded environment. If they answered affirmatively then the amount was further reduced till an amount below which they were not willing to go was arrived at. This gave us their minimum WTA for the current environmental condition.

(2) For the WTP question, a hypothetical situation of an organization working for a reduction in air pollution in the respondents' residential locality was given and they were asked their willingness to share a part of the costs incurred for reducing air pollution in their locality. Two scenarios were depicted – one in which the pollution would remain at last year's standards, and the other where pollution would be curbed back to levels as was in year 2000. Once again, the monetary amounts though were clearly mentioned in the questionnaire, expressed preferences were collected through bidding upward/downward the monetary amounts as stated by the respondents in order to reach a more or less accurate elicited amount. This gave us their maximum WTP for a Minor and a Major improvement in air quality.

c. Secondary Data Sources

The Secondary Sources of data that helped in our study include the following:

(a) Town Maps from the District Sub-Registrar's Office;

(b) Data on Industrial Units, employment therein, and other financial details from the Office of the District Industrial Centre at Durgapur and Bureau of Applied Economics and Statistics, Government of West Bengal;

(c) Data on population from Census of India;

(d) Various publications of West Bengal State Pollution Control Board.

4. COVERAGE & DESCRIPTIVE FEATURES

After careful study of the industrial and residential locational pattern in the study area, the survey was conducted in Eight locations situated within the Durgapur Municipal Area. In all, 732 persons from 177 households were surveyed, of which 504 were males, rest females. Broad descriptive statistics of the sample is provided in Table 1.

Table 1

Descriptive Features of the Sample

Variable		*Respondents for WTA*		*Respondents for WTP*	
		Number	***Proportion***	***Number***	***Proportion***
Total Respondents		**732**		**772**	
Gender - Males		504	68.9	524	67.9
Females		228	31.1	248	32.1
Educational Status – Illiterate		0	0.0	10	1.3
Literate below 10th Standard		372	50.8	382	49.5
12th Standard Passed		331	45.2	341	44.2
Graduate & Above		29	4.0	39	5.1
Staying at -	Personal Home	422	57.6	432	56.0
	Quarter	227	31.1	237	30.7
	Rented House	83	11.3	103	13.3
Occupation –	Businessman	136	18.6	150	19.4
	Small Shopkeeper	285	38.9	300	38.9
	Service / Casual Worker	310	42.3	322	41.7
Family Size -	Less than 3	223	30.5	233	30.2
	4 – 5	451	61.6	461	59.7
	6 – 7	41	5.6	51	6.6
	8 and more	17	2.3	27	3.5

Source: *Field Survey during 2008*

It is observed that educational status of the sample population is better than the state or national average and all of them have some education. While half of those surveyed have education level upto 10th Standard, about 45 per cent have completed 12th standard, while 4 per cent are Graduates. Most of the respondents live in their own home while about 30 per cent live in Quarters provided by the organisation where they work. Family size is

generally small, with more than 90 per cent households having 5 or less members. As regards occupational group of the respondents, about 42 per cent are Regular / Casual workers in the various factories or institutions in and around Durgapur. Another 18 per cent are medium or large businessmen while about 40 per cent are small shopkeepers. As befitting with the characteristic of the area, there are no agricultural households.

a. Income Status

The study area is frequented by both high income wage earners and businessmen as well as middle and low income workers and shopkeepers (Table 2). The average monthly per capita income level of the respondents is Rs3698. This average is lowest in Gopalpur and highest in Rabindra Pally. Income distribution shows that most of the respondents are in the Rs. 2000-3000 monthly per capita income group. Only about 25 per cent respondents have monthly per capita income more than Rs4000. This income distribution is different across locations – maximum number of people is in the income group of less than Rs2000 in Gopalpur, Karangapara, and Sukanta Pally; in the income group of Rs3000-4000 in DCL More, Maya Bazar, and Sagarbhanga; in the income group of Rs3000-4000 in Angadpur; in the income group Rs5000-6000 in Khatpukur; and in the income group Rs6000-7000 in Rabindra Pally. Only in Rabindra Pally and Sagarbhanga there are some people earning Rs8000 & above.

Table 2

Distribution of Respondents into Monthly Income groups by Location

Location	Total Number	Percentage of population in Income Groups (Rs)								Average Income (Rs)
		Less than 2000	2000-3000	3000-4000	4000-5000	5000-6000	6000-7000	7000-8000	8000+	
Angadpur	228	14.3	28.6	39.3	17.9	0.0	0.0	0.0	0.0	3589
DCL More	119	21.4	57.1	21.4	0.0	0.0	0.0	0.0	0.0	3000
Gopalpur	87	54.5	27.3	18.2	0.0	0.0	0.0	0.0	0.0	2636
Karangapara	131	41.2	17.6	5.9	11.8	17.6	5.9	0.0	0.0	3588
Khatpukur	75	20.0	0.0	0.0	20.0	30.0	20.0	10.0	0.0	5350
Maya Bazar	367	20.5	45.5	29.5	4.5	0.0	0.0	0.0	0.0	3091
Rabindra Pally	137	7.1	21.4	0.0	14.3	14.3	21.4	14.3	7.1	5786
Sagarbhanga	151	14.3	21.4	14.3	14.3	14.3	14.3	0.0	7.1	4643
Sukanta Pally	209	36.0	20.0	12.0	20.0	8.0	4.0	0.0	0.0	3460
Total	**1504**	**23.7**	**30.0**	**19.6**	**11.4**	**6.8**	**5.4**	**1.8**	**1.3**	**3698**

Source: *Field Survey, 2008*

5. POLLUTION AND ASSOCIATED PROBLEMS

a. Pollution Trends

According to data obtained from the regional office of the West Bengal Pollution Control Board, the level of Respirable Particulate Matter (RPM) in Durgapur is constantly increasing and way above the national standard. The RPM level at Durgapur stood at 114 mg/m^3 in 2007, almost double the normal level of 60 mg/m^3. The nitrogen dioxide level stood at 51.5 mg/m^3 in 2007 and has been also increasing. This has been reflected in the perception of the respondents regarding levels, trends, and behavioural impacts of pollution (Table 3). It is seen that while 28 per cent of the respondents report the pollution level as Unbearable, 70 per cent are of the opinion that the pollution level is high but tolerable. However, almost all respondents argue that the pollution level has increased over the last year. Thus, it is quite conceivable that the problems will go on to become intolerable in the times to come.

Table 3

Perception of Pollution Level among Surveyed Population

Indicator	*Respondents for WTA*		*Respondents for WTP*	
	Number	*Proportion*	*Number*	*Proportion*
Level of Pollution - Unbearable	207	28.2	224	29.0
High but Tolerable	517	70.6	518	67.1
Moderate	8	1.1	30	3.9
Pollution over last year – Has Increased	710	96.9	707	91.6
Remained Same	22	3.1	65	8.4
Doors/windows closed due to pollution				
Morning 6 am to 9 am	103	14.1	115	14.9
Night 9 pm to 6 am	463	63.3	478	61.9
Whole Day & Night	166	22.6	179	23.2

Source: *Field Survey, 2008*

b. Medical Expenses

One of the foremost impacts of increased pollution level is on the health of the residents. Though it is difficult to ascertain what part of ill-health is due to pollution and what part is due to other factors (e.g. characteristics intrinsic to the respondents), some idea can be had from the medical expenses incurred by the respondents. It is observed that most of them spend Rs500-1000 per month as medical expenses (Table 4). The expenses range from Rs494 in Karangapara to Rs1200 in Rabindra Pally, the average being Rs540.

Table 4

Distribution of Respondents into Monthly Medical Expense groups by Location

Location	Total Number	% of population in Expense Groups (Rs)					Average (Rs per person)
		Less than 500	500 – 1000	1000-1500	1500-2000	Above 2000	
Angadpur	228	25.0	75.0	0.0	0.0	0.0	
DCL More	119	0.0	100.0	0.0	0.0	0.0	729
Gopalpur	87	18.2	81.8	0.0	0.0	0.0	527
Karangapara	131	29.4	70.6	0.0	0.0	0.0	494
Khatpukur	75	0.0	60.0	0.0	40.0	0.0	970
Maya Bazar	367	0.0	100.0	0.0	0.0	0.0	730
Rabindra Pally	137	14.3	42.9	14.3	28.6	0.0	1200
Sagarbhanga	151	28.6	50.0	7.1	14.3	0.0	823
Sukanta Pally	209	32.0	68.0	0.0	0.0	0.0	1000
Total	**1504**	**15.8**	**76.8**	**1.7**	**5.7**	**0.0**	**540**

Source: *Field Survey, 2008*

6. EVALUATING ENVIRONMENT

a. Willingness to Accept

How does the residents value their environment? It has already been noted earlier that we can directly ask people to state what sum of money they are willing (demanding) to accept to tolerate the pollution level at the current level. This would give us the Willingness to Accept (WTA) values.

Table 5

Distribution of Respondents into Bands of Willingness to Accept (monthly)

Location	*Sample Size*	% of population demanding (Rs) per month					Average (Rs per person)
		Less than 500		1000-1500	1500-2000	Above 2000	
Angadpur	112	25.0	75.0	0.0	0.0	0.0	339
DCL More	57	0.0	100.0	0.0	0.0	0.0	250
Gopalpur	41	18.2	81.8	0.0	0.0	0.0	263
Karangapara	64	29.4	70.6	0.0	0.0	0.0	276
Khatpukur	35	0.0	60.0	0.0	40.0	0.0	350
Maya Bazar	181	0.0	100.0	0.0	0.0	0.0	386
Rabindra Pally	66	14.3	42.9	14.3	28.6	0.0	214
Sagarbhanga	73	28.6	50.0	7.1	14.3	0.0	121
Sukanta Pally	103	32.0	68.0	0.0	0.0	0.0	216
Total	**732**	**15.8**	**76.8**	**1.7**	**5.7**	**0.0**	**207**

Source: *Field Survey, 2008*

It is observed that the monthly WTA values for most of the respondents fall within the Rs500-1000 band, the average being Rs207 per month. However, Khatpukur and Rabinra Pally seem to be outliers in this regard as there are substantial number of respondents in these to areas (40 per cent and 29 per cent respectively) who demand Rs1500-2000 per month to accept the current levels of pollution. The average figures are quite high for

Maya Bazar and Angadpur too. This may be a reflection of higher pollution levels in these two areas, or may be determined by the characteristics of the respondents therein.

It should be mentioned that about 7 per cent of the respondents have mentioned that they do not want any compensation as they are not ready to barter environment with money. Their WTA values are thus Zero.

b. Willingness to Pay

In contrast to WTA, Willingness to Pay (WTP) elicits from the respondents the monetary value they are willing to pay to appropriate authorities either for protection of good environment or removal of pollution. In our study the hypothetical situation posed to the respondents was –

a) minor improvements in environmental situation (going back to previous year's level) through imposition of stricter rules on the polluting units by the Durgapur Municipal Corporation for which they would be charged a sum; and,

b) Major improvement in environmental situation (going back to the environmental situation of 2000 AD) through relocation of polluting units for which the respondents would be charged a higher sum.

In both cases values of WTP are obtained and reported below.

Table 6

Distribution of Respondents into Bands of Willingness to Pay for minor changes (yearly)

Location	*Sample Size*	% of population willing to pay (Rs) per year				Average (Rs per person)
		100 – 300		500 – 800	Above 800	
Angadpur	116	67.9	32.1	0.0	0.0	241
DCL More	62	78.6	0.0	21.4	0.0	217
Gopalpur	46	100.0	0.0	0.0	0.0	140
Karangapara	67	94.1	5.9	0.0	0.0	170
Khatpukur	40	90.0	10.0	0.0	0.0	130
Maya Bazar	186	79.5	0.0	20.5	0.0	222
Rabindra Pally	71	85.7	14.3	0.0	0.0	135
Sagarbhanga	78	92.9	7.1	0.0	0.0	114
Sukanta Pally	106	88.0	12.0	0.0	0.0	168
Total	**772**	**83.6**	**9.6**	**6.8**	**0.0**	**171**

Source: *Field Survey, 2008*

It is observed that most of the respondents are willing to shell out not more than Rs300 per year, or about Rs25 per month for minor changes in environment situation, the average being Rs171 per year (Tables 6). Only at Angadpur, DCL More and Mayabazar there are some people willing to shell out more for improvement in environment.

Table 7

Distribution of Respondents into Bands of Willingness to Pay for major changes (yearly)

Location	*Sample Size*	% of population willing to pay (Rs) per year					Average (Rs per person)
		0 – 300	300 – 500	500 – 1000	1000 – 1500	Above 1500	
Angadpur	116	0.0	60.7	35.7	3.6	0.0	516
DCL More	62	0.0	71.4	28.6	0.0	0.0	510
Gopalpur	46	0.0	81.8	18.2	0.0	0.0	327
Karangapara	67	0.0	82.4	17.6	0.0	0.0	344
Khatpukur	40	0.0	40.0	40.0	20.0	0.0	725
Maya Bazar	186	0.0	70.5	27.3	2.3	0.0	520
Rabindra Pally	71	7.1	50.0	21.4	21.4	0.0	628
Sagarbhanga	78	7.1	64.3	14.3	14.3	0.0	503
Sukanta Pally	106	4.0	76.0	16.0	4.0	0.0	384
Total	**772**	**1.7**	**67.8**	**24.9**	**5.7**	**0.0**	**495**

Source: *Field Survey, 2008*

If we consider major changes and reverting back to a situation existing 8 years back, people are willing to pay more and most of the respondents have a WTP within the band of Rs300-500 (Tables 7). The average WTP is Rs495 per year for major changes. There are however substantial number of respondents who are willing to pay Rs500-1000 or Rs1000-1500 per year for major improvements in the environmental situation and reduction in pollution levels. None of the residents are however willing to shell out more than Rs1500.

It is again observed that residents of Khatpukur and Rabindra Pally are willing to pay significantly higher amount relative to others for major improvements in environment. This confirms our earlier notion that either pollution level is worst in these locations or residents herein value the environment more than others. If we consider the fact that residents of these locations did not have high WTP values for minor changes, it emerges that they want major changes in environment and supports the notion of high pollution in these localities.

Another significant observation was the presence of *"Protest Zeros"* during the survey. It is observed that about 2 per cent of the respondents are not willing to pay for improvement in environment because they don't believe that the situation will change and feel that the environment will go from bad to worse. They are also of the opinion that such hypothetical situation with DMC, a local self-government organisation, at the helm of affairs will never succeed in controlling pollution as non-action by West Bengal Pollution Control Board is responsible for the environmental mess in Durgapur.

c. Occupational Background and Environmental Valuation

We can also explore how people from different occupational background value their environment. Since we had earlier categorise our sample respondents into three broad Occupation groups – Businessman, Small Shopkeeper, and Service / Casual Worker, we can report their mean WTA and WTP (Table 8).

Table 8

WTA and WTP for Broad Occupation Groups

Occupation Groups	*Yearly WTA*	*Yearly WTP for*	
		Minor Changes	*Major Changes*
Businessmen	12666	178	348
Small Shopkeepers	10956	196	444
Service / Casual Workers	15026	201	593

Source: *Field Survey, 2008*

It is observed that respondents engaged in service or as casual workers have the highest WTA and WTP, indicating that they value the environment more than others. WTP is lowest for the Businessmen. This may be associated with the profile of the occupational groups – whether they are Risk-lovers or Risk-averse. The working class are basically risk-averse and therefore they are more concerned about the damages caused by pollution to their health. They are also exposed to pollution everyday during their work or during commuting. Consequently, they have highest WTA and WTP. The Businessmen are by nature Risk-lovers and therefore they do not consider their future in as high esteem as others. Also they have higher valuation for money, and thus have lowest WTP. The small shopkeepers are in between these two, and have medium WTP and low WTA.

d. Factors affecting Environmental Valuation

How respondents value the environment as reflected by the WTA and WTP figures may be dependent on their background or other characteristics like – Educational Status, Income Level, and Family size. Educational Status can be represented by completed years of formal schooling; Income level by Annual per capita income; and Family size by total number of family members (including children). The interlinkage between these variables and the WTA and WTP values may be explored through Correlation Coefficients.

Table 9

Correlation between Background Variables, WTA and WTP

Background Variables	*Yearly WTA*	*Yearly WTP for*	
		Minor Changes	*Major Changes*
Educational Status	0.161*	0.052	-0.008
Family Size	0.243**	0.282**	0.166*
Income Level	0.014	-0.074	0.235**

*Note: * and ** indicates significance at 1 per cent and 5 per cent levels respectively.*

Source: Field Survey, 2008

The results indicate that family size and educational status are closely and positively related to WTA. More educated persons and respondents from large family have higher WTA. Large family size also leads to higher WTP, indicating that valuation of environment is higher for these families, perhaps because of concern for their children. On the contrary, WTP is not affected by educational status, indicating perhaps a perception among educated respondents that once the environment is polluted there are no real chances of improving it irrespective of how much they are ready to pay. This cynicism among the educated is a mjor cause of worry for the local civil society.

On the other hand, income does affect WTP for major changes, and respondents with higher PCI willing to pay more for substantial improvement in the environment.

Table 10

Estimates of Environmental Cost of Industrialisation in Durgapur

Indicator	*Value*
Average Willingness to Pay for minor changes (A) ***(Rs per person per year)***	171
Average Willingness to Pay for major changes (B) ***(Rs per person per year)***	495
Total Population of DMC Area (projected)[a] (P)	550000
Estimated Valuation of Environment (A) X (P) ***(Current, in Rs)***	94 million
Estimated Valuation of Environment (B) X (P) ***(reverting back to situation in 2000, in Rs)***	272 million

Source: Field Survey, 2008

Notes: a – Population of Durgapur Municipal Corporation area as per Census 2001 was 492996; As per District Magistrate's Office of Bardhaman district, projected population growth rate during 2001-2009 has been about 1.7 per cent per annum.

7. CONCLUSION

Our earlier discussion led us to believe that the residents of Durgapur Municipal Corporation area are quite aware of the problems caused by pollution from the present phase of industrialisation in the locality. They value their environment and are willing to

pay to protect / clean the environment. From this, some indirect valuation of environmental costs of industrialisation in the locality can be obtained. The sum, represented in Table 10, provides us an estimate of total environmental cost of industrialisation in the region.

It thus emerges that the estimated valuation of environment in the Durgapur Municipal Corporation area comes out to be around Rs94 million, if the residents seek to protect current environmental standards. If however, we are concerned about the environmental damages caused by neo-industrialisation in the last decade, i.e. if the residents want to go back to the situation prevalent in the year 2000AD, then the cost comes out to be a whooping Rs272 million. Compared to the monetary benefit generated by the industries annually, this is not a large sum – about 2 per cent of the total benefits (salaries due to employment generated and profits accrued) from the industrialisation process. However, this is a pointer to the fact that we must look at such costs before embarking on further industrialisation process in the region to protect ecological/environmental balance and keep the system sustainable.

[The authors acknowledge suggestions from Atanu Sengupta, Anindita Sen, and Rabindranath Bhattacharya on earlier drafts of the paper; disclaimers apply]

References

Baby, P.K. (2009) – "Valuing Health Effects of Air Pollution: Contingent Valuation Survey Results from Kerala", *The Icfai University Journal of Environmental Economics*, Vol. VII, Issue 1, pp 7-16.

Balakrishnan, Kalpana (2001) – "Economic Valuation of Health Damage in North Chennai Using a Comparative Risk Assessment Framework", *Environment, Health and Economics EERC Working Paper Series: EHE-2*, IGIDR

Bowker, J.M. and H.F. MacDonald (1993) – 'An economic analysis of localized pollution: rendering emissions in a residential setting', *Canadian Journal of Agricultural Economics*, Vol 41: 45-59.

Carson, Richard T., Jennifer L. Wright, Nancy Carson, A. Alberini, and N. Flores (1994) – *A Bibliography of Contingent Valuation Studies and Papers*, Natural Resource Damage Assessment Inc., La Jolla, CA, March.

Gunning-Trent, C., and Rollins, K. (1995) – '*Measuring the Existence Values of National Parks in the Northwest Territories*', Unpublished Thesis presented to the Faculty of Graduate Studies, University of Guelph, Guelph.

Gupta, Usha (2006) – "Valuation of Urban Air Pollution: A Case Study of Kanpur City in India", *SANDEE Working Paper No. 17-06*, South Asian Network for

Development and Environmental Economics (SANDEE), Kathmandu, Nepal.

Hudson, D., & Hite, D. (2003) – 'Producer Willingness to Pay for Precision Application Technology: Implications for Government and the Technology Industry', *Canadian Journal of Agricultural Economics*, Vol. 51, 39-53, US Water Resources Council 1983

Sengupta, Ramprasad and Subrata Mandal (2005) – "Health Damage Cost of Automotive Air Pollution : Cost Benefit Analysis of Fuel Quality Upgradation for Indian Cities, *Working Paper 2005-39, National Institute of Public Finance and Policy, New Delhi*

Shah, Maya and Ashir Mehta (2003) – "Estimating the Environmental Cost of Industrialisation in Gujarat: A Case Study of Ankleshwar GIDC", *Environment, Health and Economics EERC Working Paper Series: EHE-4*, IGIDR

U.S. Water Resources Council (1983) – '*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*', Washington, D.C.: U.S. Government Printing Office

Vanslembrouck, I., Van Huylenbroeck, G., Verbeke, W. (2002) – 'Determinants of the Willingness of Belgian Farmers to Participate in Agri-environmental Measures', *Journal of Agricultural Economics*, Vol. 53, No. 3, pp489–511.