Impact of Industrial Water Pollution on Human and Livestock Health in Bhavani River basin of Tamil Nadu

Abstract:

Aim: To study the impact of Industrial Water Pollution on Human and Livestock health in Bhavani River basin of Tamil Nadu

Study Design: The Cost of illness method

Place and Duration of the study: The study was conducted in the Sathyamangalam block of Erode district of Tamil Nadu from September 2020 to December 2022.

Methodology: The Cost of illness method was applied to studythe impact of Industrial Water Pollution on human and Livestock health. For this purpose,180 sample households from Sathyamangalam block of Erode have been selected due to the high intensity of industrial units and significant number of cases related to water pollution were reported frequently in this area. Both primary data and secondary data were collected for the current study.

Results and Conclusion: The industrial water pollution in Bhavani River basin of Tamil Nadu leads to decline in the health status of humans. The number of visits to doctors and expenditure on human health before and after pollution disclose substantial increases. The pollution causes sickness in livestock, decrease the reproductive capacity, milk productivity, loss in the quality of milk and finally lead to death of livestock in the study area. In order to overcome theseissues, it is suggested to develop alternative sources of water for drinking and other purposes.Hence, the study recommends strict regulation of industries to adopt pollution-mitigating technologiesbefore discharging effluents into the river.

Keywords: Economic impact, Industrial water pollution, human health, livestock health.

1. Introduction:

Environmental pollution is an ‘externality’ in welfare economics. An externality is present whenever individual A’s utility and production relationships include real variables (i.e. non-monetary), whose values are determined by others (people, corporations, governments) without special consideration for how their decisions will affect A's welfare. An externality can be either positive (beneficial) or negative (harmful). (Baumol and Oates, 1988) [1].

Industrial pollution, which affects the water we consume, the air we breathe, and the soil we live on, has been and continues to be a key contributor in the deterioration of the ecosystem around us. In some areas, the effects of pollution can even be seen in the food chain (Reddy 1995)[2]. Industries release into the water effluents containing chemicals and biological matter that impose high demands on the oxygen in the water. The polluted water contains low levels of dissolved oxygen (DO) – the result of heavy biological oxygen demand (BOD)and chemical oxygen demand (COD). Apart from this, industrial wastes contain chemicalsand heavy metals such as arsenic, lead, mercury, cadmium and zinc, which are harmful to human health and the ecosystem. When used for irrigation, polluted water has a serious impact on land productivity.The ecology of river systems is adversely affected by the high concentration of metals and pollutants in both surface and groundwater bodies.(Behera and Reddy, 2002)[3].

Many industries in India release their waste into waterways. Industries are thought to have discharged 7,17 million tonnes of hazardous waste between 2016 and 2017. (CPCB, 2017) [4]. In Tamil Nadu, there are about 17,000 polluting industries, of which 700 are larger units, 2200 are medium units, and 14,000 are small units. Depressingly, 450 large units, 1000 medium units and 6,500 small units are all categorised as highly polluting industries (Appasamy, 2007) [5]. Heavy metals, organic compounds, and other toxic substances that are discharged by these industries can have a severe effect on the environment and human health. (TNPCB, 2021) [6]. The diseases such as skin allergy, respiratory infection, allergy, gastritis, joint painwas mostly prevalent in the study area.Thus,the Cost of illness method was applied tostudy the impact of industrialpollution on rural communities especially humanhealth, and livestock health in Bhavani River basin of Tamil Nadu.

2.Review of Literature:

Pearce et al. (1978) [7] reviewed some of the US-based studies that attempted to calculate the consequences of polluted water on the country's health. Outbreaks of the disease were monetarised based on 10 days' lost income and resource costs of a five days stay in the hospital. There are about one million cases of gastroenteritis reported annually in the US, with a unit social cost per case of $100. Acute gastroenteritis and diarrhea account for the lost of two million workdays in the US each year, costing an average of $30 per day in lost wages. It is estimated that the value of the 1,000 deaths due to hepatitis infection per year is around $100,000 per life.

Pearce and Warford (1993) [8] have argued that the most significant and immediate effects of environmental degradation in developing countries take the form of damage to human health. They further argued that diarrhea, with three million to five million cases reported annually, is a common phenomenon in many developing countries. Nine billion working days are estimated to be lost annually as a result of these cases, which each imply a loss of 3-5 days at work. According to research, developing nations suffer from serious water-borne infections as a result of a lack of safe drinking water.

Indu et al, (2010) [9] conducted a study to examine the impact of groundwater contamination with Arsenic and Fluoride in the semiarid to arid western states of Gujarat and Rajasthan, also in the southern states of Andhra Pradesh, Tamil Nadu and Karnataka. Fluoride contamination of fresh drinking water in these locations suggests that only individuals with high incomes can afford to drink water that is safer to consume. The cost of medications and lost wages accounted for a significant amount of the earnings of the affected households and had a significant influence on their income. Without regard to gender, more than 53% of the total sample population from all locations experience at least one of the symptoms listed diseases between the age group of 16 and 40, and suffer from fluorosis, which results in high medical expenses that can account for 6 to 25% of the annual income of the affected families.

Jefferson et al, (2000) [10] stated that 'the purpose of the cost of illness (COI) study is descriptive to classify, value, and sum the expenses of a specific problem to give an understanding of its economic burden'.

Clabaugh and Ward (2008) [11] argued that 'analysing COI presents valuable chances for communicating with the public and policy makers on the relative importance of particular diseases and injuries'.

3. Methodology: The present study applied the cost of illness method aims to studythe impact of Industrial Water Pollution on human and Livestock health. Based on the discussions held with the government departments like Tamil Nadu Pollution Control Board and Agricultural departments and the competent medical personnels the study area was selected. For the present study, eighteen affected villages which are very near to the industrial area of Sathyamangalam block of Erode district were selected. In total, 180 sample households were selected, constituting ten samples in each affected village. Both primary data and secondary data were collected for the current study. The secondary data collected from the report of the Tamil Nadu Pollution Control Board, Village administrative office, District statistical office, Health report of medical institutions and other relevant data were collected and analysed.

The Cost of illness is aimed at assessing the economic damages that illness causes to mankind [12]. Thus it is essential to understand the different types of costs associated with the cost of illness method (Jefferson et al, 2000) [10]. The cost of illness method is conventionally categorising the costs into two such as direct costs and indirect costs (Changik, 2014) [13]. The direct costs are those which are actually incurred by the individual or society. The direct costs include expenditures incurred towards consulting fees, medical tests and diagnosis, treatment, transportation, increased household expenditure, etc. The indirect costs are those that indicate the value of loss in production or property or productivity foregone due to illness. The direct cost includesthe value of loss in income due to illness. So, depending upon the situation (mortality, morbidity, productivity loss) price methods or their combination are employed (Johansson,1995) [14].

The specifications ofthe cost of illness method are as follows:

$$I_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5$$

here,

Ii = Illness

X1 – No. of livestock affected by the disease in sample farms

X2 –The kind of livestock affected by the diseasein the sample farms

X3 - No. of livestock died in the sample farms

X4 – Average loss in milk productivity

X5 – Average medical expenditure

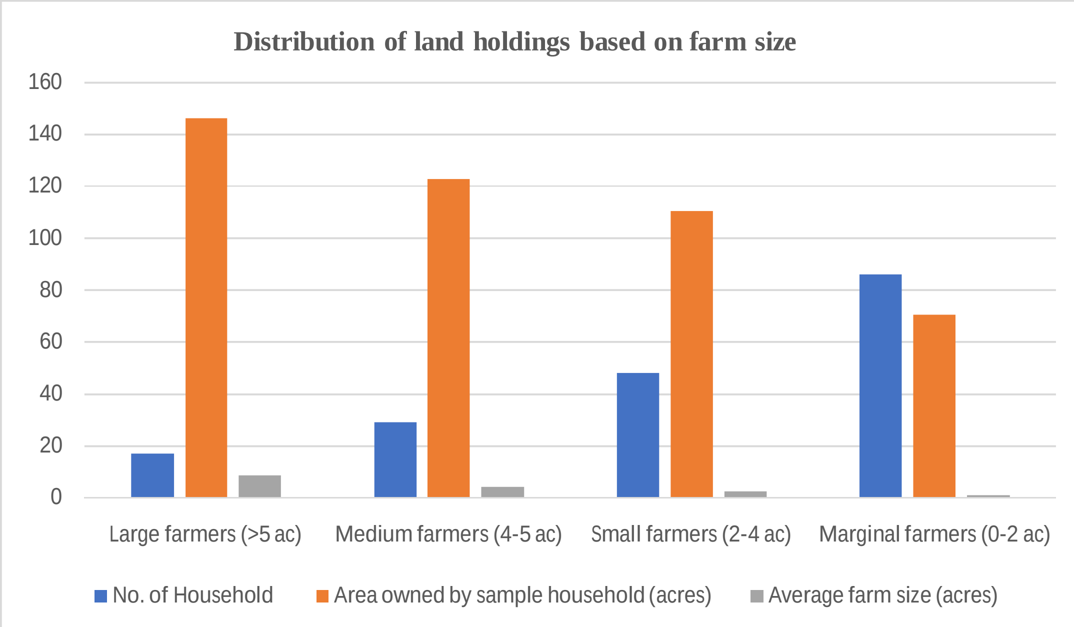
4. Results and Discussion:

The distribution of land holdings based on the farm size of sample respondents are reported in the Table 1. The majority of the population belongs to the marginal farmers (47.78 percent) holdingthe average farm size of 0.82 acres. Whereas the large farmers own 32.50 per cent of the total area with an average farm size of 8.6 acres in the study area.

Table 1: Distribution of land holdings based on farm size

S.No	Category of Cultivators	No. of Household	Area owned by sample household (acres)	Average farm size (acres)
1.	Large farmers (>5 ac)	17 (9.44)	146.2 (32.50)	8.6
2.	Medium farmers (4-5 ac)	29 (16.11)	122.67 (27.28)	4.23
3.	Small farmers (2-4 ac)	48 (26.67)	110.40 (24.54)	2.3
4.	Marginal farmers (0-2 ac)	86 (47.78)	70.52 (15.68)	0.82
Total		180 (100.00)	449.79 (100.00)	2.49

Figures in parenthesis indicate the percentage of the total.



The impact of Industrial Pollution on Human Healthin the study area is presented in Table 2.Women are most adversely affected by the health issues caused by pollution in the study area. Each household has a higher proportion of affected women. This is due to the fact that women do all household work with polluted water. The average number of dayssick and unable to work per household is55.05days and 71.15 days perannum respectively. This implies a loss in income and increased healthcare costs. The incidence of illness is higher for large farmers across all size groups, whereas the number of working days lost due to illness is higher for small farmers. Similarly, considerable increases in visits to doctors and expenses for healthcare were seen before and after pollution. The cost of treatment is influenced by two factors: the severity of the diseases, and the financial situation of the sample households. The average visitsto doctors of marginal farmers are 47.05 per annum and theirmedical expenditure is Rs.7057.5. In the case oflarge farmers, the average of 52.10 visits to doctorsand their medical expenditureis Rs. 10,941 per annum. Large farmers are spendingmore money per visit to the doctor, whichis perhaps due to their better ability to pay.When the cost of treatment is directly related tothe frequency of visits to the doctor, the quality of treatmentis as well.

The total expenditureon health due to pollution was calculated in the present study. The averageexpenditure on health per household iscalculated based on the loss of workingdays due to illness and expenditure incurredto cure the diseases. The averagewage loss due to sickness is estimatedusing the daily market wage rate, that is,Rs.180. Accordingly, the average loss perhousehold is Rs. 12,807. Add the medicalexpenditure, and the average loss perhousehold due to health impact works outto be Rs. 21,659.22 per annum.

Table 2: Impact of Industrial Pollution on Human Health

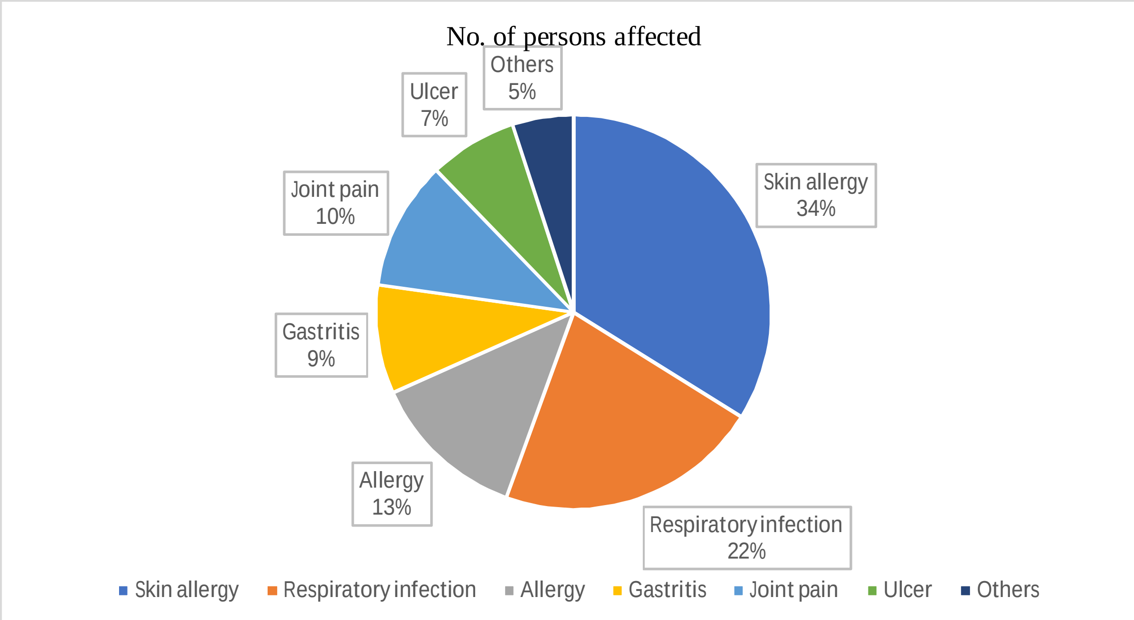
S.No	Particulars	Large farmers	Medium farmers	Small farmers	Marginal farmers	Total
I.	No of people affected					
a.	Male	5	6	13	32	56
b.	Female	12	23	35	54	124
c.	Total	17	29	48	86	180
II.	Average no of days sick/ HH/year	62	54.2	48	56	55.05

III.	Average no of days unable towork/HH/year	59.8	75.33	77	72.5	71.15
IV.	Wage losses/HH/year (A)	10764	13559.4	13860	13050	12807
V.	Average no of visits todoctor/ HH/year					
a.	Before pollution	-	-	-	-	-
b.	After pollution	52.10	45.54	40.33	47.05	46.25
VI.	Average amount (Rs) spent onmedical/ HH					
a.	Before pollution	-	-	-	-	-
b.	After pollution (B)	10941	9335.7	8069.3	7057.5	8950.87
c.	**Total Losses (A+B)**	**21705**	**22895.1**	**21929.3**	**20107.5**	**21659.22**

The percentages of persons affected by each category of diseases identified in the study area are presented in Table 3. Out of the total patients identified, most of them were agricultural laborers and daily wage earners. 33.89 per cent of the patients were suffering from skin allergy problems. 21.62 per cent of the patients had respiratory infections. There was general allergy in the case of 12.78 per cent, gastritis for 8.89 per cent of patients, 10.55 per cent had joint pain, 7.22 per cent had ulcer problems and 5 per cent had other general ailments. The study observed that most of the villagers were avoiding the consumption of polluted water in the wells. Otherwise, the percentage might have been higher.

Table 3: Percentage of persons affected by different diseases

S.No	**Disease**	**No. of persons affected**	**Percentage**
1.	Skin allergy	61	33.89
2.	Respiratory infection	39	21.62
3.	Allergy	23	12.78
4.	Gastritis	16	8.89
5.	Joint pain	19	10.55
6.	Ulcer	13	7.22
7.	Others	9	5.00
Total		180	100.00



Livestock is one of the importantsources of rural income. Since all of the water sources are contaminated, the animals in this area also experience severe health issues. In the absence of sufficient municipalwater supplies, livestock are forced todepend on polluted river water and graze on contaminated grasses. It was reported bythe villagers that 37 cattle died (Table 4) afterdrinking polluted water during the study period. (September 2020 to December 2022).A majority of the cattle (64.66 percent)have fallen sick over the years. The loss of reproductive capacity in some cows is another severe issue. Reductionin milk productivity of the livestock (3.53 litres to 2.33 litres)has also been reported. As a result of grazing oncontaminated grass, the quality of dunghas been reduced to an unusable level. The medical expenditure on cattle per sample household is Rs. 2,841.25 after the pollution in the study area. Due to fear of further deaths, people have started selling their cattle at a very cheaper cost.

Table 4: Impact of Pollution on Livestock health

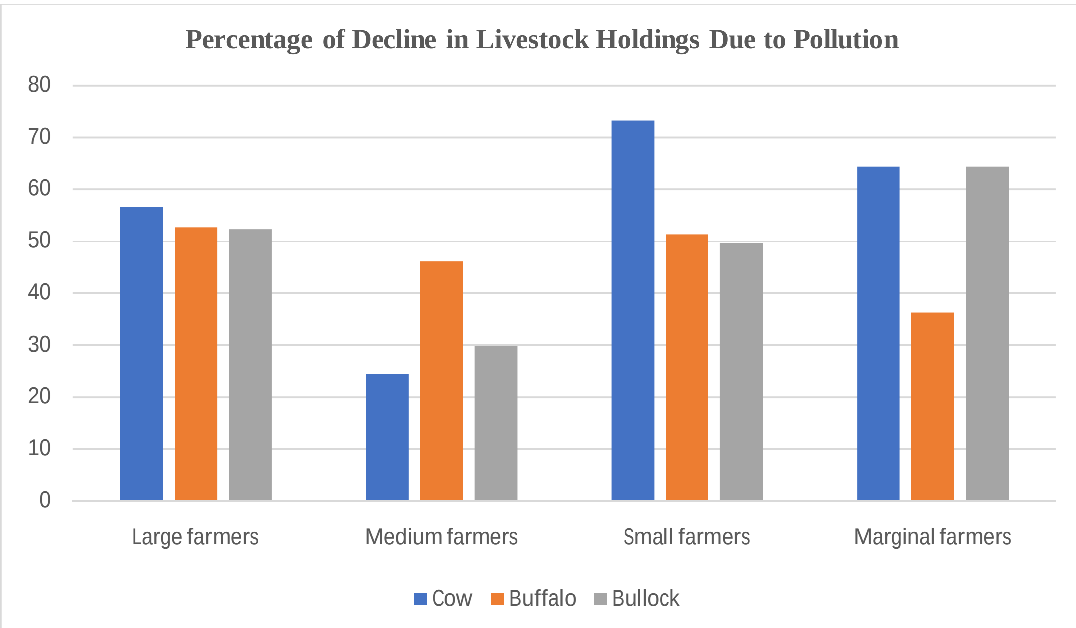
S.No	**Particulars**	**Largefarmers**	**Mediumfarmers**	**Small farmers**	**Marginal farmers**	**Total**
I.	Total livestock	136	116	122	93	467
a.	No.of livestock affected	85	78	72	67	302
b.	Percentage of cattle affected	62.50	67.24	59.01	72.04	64.66
c.	No. of livestock died	13 (9.55)	11 (9.48)	8 (6.55)	5 (5.15)	37 (7.92)
II.	Milk productivity (ltrs/cattle)					
a.	Before pollution	4.7	4.2	3.12	2.1	3.53
b.	After pollution	3.2	2.7	2.23	1.2	2.33
III.	Medical expenditure on cattle per HH (Rs/annum)					
a.	Before pollution	-	-	-	-	-
b.	**After pollution**	**3350**	**2720**	**1332.5**	**3962.5**	**2841.25**

Note: HH = household.
Figures in parenthesis indicate the percentage of the total.

The percentage of Decline in Livestock Holdings Due to Pollution in the Sample Households is presented in Table 5.As a consequence of the impact ofpollution on livestock, there is a drasticchange in the composition and holding oflivestock before and after the pollution. The change could be eitherbecause the livestock has died from drinkingpolluted water or because the peoplesell their cattle due to fear ofdeath. The percentage decline in livestockholdings due to pollution seems to be veryhigh in the case of large and small farmers, asfar as the holding of cows and buffaloes isconcerned. On the other hand, the percentage of total cattle affected in the case ofmarginal farmers is the highest, at 72.04per cent (Table 4). This indicates thatmarginal farmers are badly hit bypollution. Due to the significant risks of mortality, farmers now rely more on tractors than bullocks to cultivate their property.

Table 5: Percentage of Decline in Livestock Holdings Due to Pollution in the Sample Households

S.No	Cultivators	Cow	Buffalo	Bullock	Goat	Sheep
1.	Large farmers	56.58	52.58	52.32	15.88	21.33
2.	Medium farmers	24.33	46.17	29.81	10.35	62.58
3.	Small farmers	73.27	51.28	49.62	36.87	14.33
4.	Marginal farmers	64.33	36.34	64.33	26.58	12.62
Total		**54.62**	**46.59**	**49.02**	**22.42**	**27.71**



5. Conclusion:

The present study concludes that industrial units in the Bhavani River basin of the Sathyamangalam block pollute the water and negatively affect both human and animal health. The diseases such as skin allergy, respiratory infection, allergy, gastritis, joint pain were mostly prevalent in the study area. In unaffected villages, pollution had the greatest impact on women's health. In the study area, a significant number of days sick and unable to work per household per annum were reported. This indicates a reduction in income and an increase in medical expenses. Similarly, significant increases are shown in both the number of doctor visits and health care expenditure before and after pollution. Among the size class, large farmers are spending more money per visit to the doctor, which is perhaps due to their better ability to pay. The average wage loss due to sickness is estimated using the daily market wage rate, that is, Rs.180. Accordingly, the average loss per household is Rs. 12,807. The sum of medical expenditure and the average loss per household due to health impact works out to be Rs. 21,659.22 per annum.

Since all the local water sources are polluted, livestock is also facing serious health problems. In the absence of sufficient municipal water supplies, livestock is forced to depend on polluted river water and graze on contaminated grasses, which leads to sickness, a decrease in reproductive capacity, milk productivity, loss in quality of milk, and finally, the livestock has died in the study area. As a result of the impact of pollution on livestock, the composition and holdings of livestock drastically decline after pollution.

Hence, it is suggested to develop alternative sources of water for irrigation and drinking purposes in the study area. The government authorities should take the appropriate measures to adopt pollution-mitigating technologies to ensure that industrial water pollution has been treated before discharging into the river.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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