

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: Cost of illness method

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

Methodology: Cost of illness method was applied to study the 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 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 health status of human. 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 quality of milk and finally lead to death of livestock in the study area. In order to overcome these issues, 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 technologies before discharge 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 chemicals and 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 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]. Thus, the paper attempts to study the impact of industrial pollution on rural communities especially human health, and livestock health in Bhavani River basin of Tamil Nadu.

2. Review of Literature:

Pearce et al. (1978) [7] reviewed some of US-based studies that attempted to calculate the consequences of polluted water on the country's health. Outbreaks of the disease were monetarised on the basis of 10 days' lost income and resource costs of a five day stay in 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 diarrhoea account for 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 the developing countries take the form of damage to human health. They further argued that diarrhoea, 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 with 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 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 cost of illness (COI) study is descriptive to classify, value, and sum the expenses of a specific problem with the aim of giving 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: Cost of illness is aimed at assessing the economic damages that illness causes to the 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 indicate value of loss in production or property or productivity foregone due to illness. The direct cost includes 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 present study applied Cost of illness method aims to study the 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 specifications of cost of illness method is 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,

I_i = Illness

X_1 – No. of livestock affected by the disease in sample farms

X_2 – Kind of livestock affected by disease in the sample farms

X_3 - No. of livestock died in the sample farms

X_4 – Average loss in milk productivity

X_5 – Average medical expenditure

4. Results and Discussion:

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

The impact of Industrial Pollution on Human Health in the study area are presented in the 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 perform all household work with polluted water. The average number of days sick and unable to work per household are 55.05 days and 71.15 days per annum respectively. This implies 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 visit 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 visits to doctors of marginal farmers are number 47.05 per annum and their medical expenditure is Rs. 7057.5. In case of large farmers, the average of 52.10 visits to doctors and their medical expenditure is Rs. 10,941 per annum. Large farmers are spending more money per visit to the doctor, which is perhaps due to their

better ability to pay. When cost of treatment is directly related to frequency of visits to the doctor, quality of treatment as well.

The total expenditure on health due to pollution was calculated in the present study. The average expenditure on health per household is calculated on the basis of loss of working days due to illness and expenditure incurred to cure the diseases. 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. Add the medical expenditure, and the average loss per household due to health impact works out to 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 effected | | | | | |
| 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 to work/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 to doctor/ HH/year | | | | | |
| a. | Before pollution | - | - | - | - | - |
| b. | After pollution | 52.10 | 45.54 | 40.33 | 47.05 | 46.25 |
| VI. | Average amount (Rs) spent on medical/ 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 from each category of diseases identified in the study area are presented in the Table 3. Out of the total patients identified most of them were agricultural labourers 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 from 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 important sources of rural income. Since all of the water sources are contaminated, the animals in this area also experiencing severe health issues. In the absence of sufficient municipal water supplies, livestock are forced to depend on polluted river water and graze on contaminated grasses. It was reported by the villagers that 37 cattle have died (Table 4) after drinking 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. Reduction in milk productivity of the livestock (3.53 litres to 2.33 litres) is also reported. As a result of grazing on contaminated grasses the quality of dung has 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 very cheaper cost.

Table 4: Impact of Pollution on Livestock health

| S.No | Particulars | Large farmers | Medium farmers | 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 percentage to total.

The percentage of Decline in Livestock Holdings Due to Pollution in the Sample Households are presented in Table 5. As a consequence of the impact of pollution on livestock, there is a drastic change in the composition and holding of livestock before and after the pollution. The change could be either because the livestock have died by drinking polluted water or because the people would have sold their cattle due to fear of death. The percentage decline in livestock holdings due to pollution seems to be very high in case of large and small farmers, as far as the holding of cow and buffaloes is concerned. On the other hand, the per centage of total cattle affected in case of marginal farmers is the highest, at 72.04 per cent (Table 4). This indicates that the marginal farmers are badly hit by pollution. 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:

It is concluded from the present study that the industrial units in Bhavani River basin of Sathyamangalam block causes water pollution and impacts the human health and livestock health as well. In the unaffected villages, women's health status was the worst affected due to pollution. The significant number of days sick and unable to work per household per annum were reported in the study area respectively. This denotes loss of income and increased healthcare costs. 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 are also facing serious health problems. In the absence of sufficient municipal water supplies, livestock are forced to depend on polluted river water and graze on contaminated grasses which leads to sickness, decrease the reproductive capacity, milk productivity, loss in quality of milk and finally the livestock have died in the study area. As a consequence of the impact of pollution on livestock, there is an extreme decline in the composition and holding of livestock after the pollution.

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

References:

1. William Baumol and Wallace Oates, *The Theory of Environmental Policy*, Cambridge University Press, 1988.
2. Reddy, V Ratna, 'Environment and Sustainable Agricultural Development: Conflicts and Contradictions', *Economic and Political Weekly*, (1995) Vol XXX, No 12.
3. Bhagirath Behera, Reddy, V. Rathna, "Environment and Accountability - Impact of Industrial Pollution on Rural Communities", *Economic and Political Weekly* (2002), Jan.19.
4. Status of water quality in India, Central Pollution Control Board, (www.cpcb.nic.in), 2017.
5. Paul P. Appasamy & Prakash Nelliya, (2007), *Compensating the Loss of Ecosystem Services Due to Pollution in Noyyal River Basin, Tamil Nadu*, Development Economics Working Papers 22493, East Asian Bureau of Economic Research.
6. Annual report of Tamil Nadu Pollution control Board, 2020-21.
7. Pearce, D W *et al*, *The Valuation of Social Costs*, George Allen and UNWIN, (1978), London.
8. Pearce, D W and J.J.Warford, *World Without End: Economics, Environment and Sustainable Development*, Oxford University Press, (1993).

9. Indu, R., Krishnan, S. and Shah, T., Impacts of Groundwater Contamination with Fluoride and Arsenic: Affliction Severity, Medical Cost and Wage Loss in some villages of India, International Water Management Institute, Srilanka,(2010): 5-34.
10. Jefferson T, Demicheli V, Mugford M., Cost-of-illness studies, elementary economic evaluation in health care. 2nd Ed. London: BMJ Publishing Group; (2000), pp. 17–29.
11. Clabaugh G, Ward MM. Cost-of-illness studies in the United States: a systematic review of methodologies used for direct cost. Value Health, (2008), 11:13–21.
12. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4278062/>.
13. Changik Jo, Cost-of-illness studies: concepts, scopes, and methods, Clinical and Molecular Hepatology, (2014), 20(4): 327–337.
14. Johansson PO., Evaluating health risks-an economic approach, New York, Cambridge University Press (1995).

UNDER PEER REVIEW