Chapter-(VI)

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6.1 Introduction

Many economists like to state that any preference that influences the environment has no doubt some economic significance. This economic significance would help to make efficient allocation of resources in order to form a rational choice among the alternatives available. This assuring condition is known as Pareto Optimal and the environmental quality would be better off as well. Deriving the cost-benefit analysis in order to get the optimal rational solution to a given situation is the main principle of neo-classical environmental economics. Thus the cost –benefit valuation of environmental deterioration or improvement is the fundamental idea on which the study is based. This study relies on the question that how a unit changes in environmental quality affects the utility function of a representative individual given the income level, price and budget line. Here the main focus is to find out the health impact of environmental deterioration (air pollution) in coal mining area and then to calculate the welfare gain to an improvement in environmental quality (air ambient quality) by following different air pollution control strategy. To be more precise the study tries to analyze what would be the social welfare gain by reducing the air pollution level by adopting different air pollution control techniques in coal mining region.

The chapter one of the study begins with the background of this research, elucidate the environmental externality driven health problems (particularly by ambient air pollution) faced by the people in coal mining area and the subsequent relevance of the study. The second chapter of this dissertation documents the brief profile of study area i.e. - Angul-Talcher coal mining region of Odisha. The third chapter presents the existing literature on the intersection of health and environment that are critically important for our study. The fourth chapter illustrates the theoretical and empirical
methodologies and elaborates the data source and sampling design. The fifth chapter provides the empirical estimation and discusses the model results. Finally the concluding chapter or the sixth chapter presents the conclusions and major findings of the study, policy relevance and future research scope. The first section of this chapter presents a brief summary of the dissertation, the second section presents the major findings of the study, the third section highlights the policy relevance, the fourth section provides the limitation of this study and finally the last section discusses the future scope for this study.

6.2 Major Findings
Given the level of PM10 is consistently at a very alarming level in the Angul-Talcher coal mining region so it is natural to expect that the respiratory health outcome would be very pervasive and critical in the proximity of the coal field area. This is also evident from international and national literature. The air ambient quality in Angul-Talcher coal mining region is much higher than the standard limit, which is prescribed by both the Central Pollution Control Board. This study attempts to analyze the expected marginal health benefits from the reduction of the coal mining induced air pollution in the Angul-Talcher coal mining area. It is evident from the national and international literature that the critical air pollution level (particularly concentration of PM10 in air) affects the respiratory health status (lung and chest problems, cough, bronchial asthma, bronchitis, T.B and other lung related diseases) of the population near in the proximity of the coal field. Thus the respiratory health illness as the outcome of severe air pollution is selected for economic valuation.

According to the objectives of the study, we analyzed the relationship between the number of restricted activity days or sick days of acute respiratory illness and the
level PM10 (as one main parameter of air pollution in coal mining area) by running initially the Poisson regression model and later the Negative Binominal Model to sort out the problem caused by over-dispersion. Before the estimation, the study collected the health diary that represents there is a strong linkage between the exposure of high air pollution (dose) and respiratory illness (response) by using the ‘dose–response’ method. By applying the Tobit regression model the study also tries to find out the association between the RI related mitigating expenses and the PM10 level in the colliery area.

The main findings from the analysis are:

- There is a strong and direct relation between acute respiratory disease related sick days or restricted activity days and the level PM10 (air pollution) in Angul-Talcher coal mining area as this variable is found statistically significant with positive sign. By 68.6 µg /m$^3$ reduction of PM10 level from the average current level PM10 in two seasons (i.e. – 159 µg /m$^3$) to the prescribed standard level (90.4 µg /m$^3$) by OPCB for the Angul-Talcher region, a representative individual can save 0.43 days and Rs. 118. 25 by avoiding the RI related sick days due to reduction in PM10 level per year.

- There is also a robust and positive association found in between the mitigating expenses for avoiding the acute respiratory illness among the sick people and the PM10 level in Talcher coal mining area. The fall in PM10 level from current average level to a national safety level, a representative individual in Talcher coal mining area can gain Rs. 373.4 from the reduction of RI related mitigating cost. By extrapolating this gains for the total population of Angul-
Talcher coal mining area (144935 persons as per the Census, 2011) is calculated as Rs. 60,55,62,70.6 / per annum (lower bound estimation).

- The out of pocket expenditure for mitigating the respiratory illness is found as higher from the educated people. Higher the people are educated more the mitigating expenses for avoiding the respiratory illness. The more aware people (awareness regarding the health effects of environmental pollution) generally maintains their health by taking various precautionary measures. Thus they have less RI related sick days in relation to the unaware people.

- The bigger size of the household members leads to greater respiratory illness related mitigating expenses from members.

- Female household members have greater probability of illness and thus higher mitigating expenses for reducing such illness as compared to male counterpart, but it is not found to be statistically significant for the number of RI related sick days.

- The person who have any chronic diseases like asthma are found more vulnerable person to have more respiratory illness related sick days and higher expenses for mitigating these illness.

- The threshold value of age that explains that the respiratory illness related mitigating expenses decreases up to 48.9 years of age and increases thereafter.

- The individuals who have active smoking habits are more susceptible to the exposure of air pollution and thus respiratory illness related sick days and the mitigating expenses increases for them.

- The indoor air pollution has statistically significant and positive impact on aggravating the respiratory illness and its related sick days.
The presence of respiratory illness in the previous week among the individual increases the risk of experiencing more RI related sick days and in case of avoidance of medical treatment cost in the preceding week will have a positive bearing for the next week.

The higher the RI related mitigating expenses of an individual in the previous week, the lower is the likelihood of RI related expenditure of the individual in the following week.

6.3 Policy Recommendation

Given the backdrop of the study area, the intensity of the environmental externality and the major findings, it demands a strong policy intervention for reducing the adverse health effects of air pollution in open cast coal mining region. The suggested policy intervention may be classified as primary (direct way) and secondary (indirect way).

Primary intervention:

- Improvement in air ambient level (PM10) to a standard safety level (as prescribed by the Pollution Control Board) is advised or recommended. Because this environmental quality improvement will achieve the welfare gain (in monetary terms) of Rs. 60,55,62,70.6 / per annum for Talcher coal mining region. Although the welfare estimate provides lower bound figures and it only evaluates the one aspect of environmental quality i.e. - air pollution and its impact on particular health diseases i.e. - respiratory illness for very confined population who are living in the proximity to Talcher coal field. Moreover it is a lower bound estimation as we conjecture a portion of the RI related health care service provided by the public health system prevailing in
the Mahanadi Coal field area. Moreover the total estimation including the averting activities cost, opportunity cost of time, discomfort or disutility cost, school days loss cost, other health condition including chronic health cost can be calculated aggregately for the entire population of Angul district as this entire areas are identified as the alarmingly polluting place for the living creature by PCB.

These exact cost- benefit analysis of the major environmental pollution including water pollution, forest loss, land degradation would suggest that the welfare (benefits) may exceeds the costs when the appropriate policy intervention takes place to improve the quality of environment. Thus each attribute of environmental issues have the alternate externalities (this may be positive or negative) irrespective of micro or global level. Thus to build up the sustainable development (tradeoff between the present and future generations), a balanced decision in between the economic interests and environmental responsibility is required to maintain.

- Green belts and afforestation in coal mining clusters should be a regular activity by the government of Odisha and the stock holders of mining company. Then this green zone will serve as additional carbon sink and can contribute towards building local environmental benefits.

- Compensatory Afforestation Scheme, which already is declared by government of India should be implemented in the open cast coal mining area on a top priority basis.

- Attention for small mines (low technology based) in unorganized sector is urgently required as they are more polluting due to their old technology base.
While innovative/developed technology can reduce the pollution to some extent.

- **Regional Environmental Impact Assessment** is to be periodically taken up on a serious note. First the affected mining cluster will be identified at micro level, then a robust environmental monitoring system will be established there.

- **Secondary Intervention**: Particular focus is required to improve the education quality as this will bring the awareness on the adverse effect of pollution on health among the people. So that they can take precaution to avoid the pollution related illness and on mitigating expenditure due to the respiratory illness.

- As the active smokers are more vulnerable because they have poor lung functioning, spreading awareness against smoking may reduce the RI disease burden and the subsequent mitigating expenditure.

- Special priority should be given to gender health as this study depicts that female household members are having higher probability of illness and thus higher medical expenses compared to male.

- Although coal is easily available in that area so that many of the households use coal as their cooking fuel which again adversely affect the respiratory health and increase their indoor pollution also. Thus strict vigilance is required to change the mode of cooking as more subsidiary LPG gas facilities should be provided from the coal India side, so that they can motivate to stop the pollution intensive cooking fuel or coal.

- Local bodies should be encouraged to participate in mitigating the pollution such as- water sprinkling to prevent air pollution from dust generated during mining process.
6.4 Limitation of the study

- These impact estimation do not include expenditure on averting activities, the school days loss cost of children’s and opportunity cost of time associated with medical care. Also the estimates are lower bound estimates because the household health production function model does not take into consideration the losses that are incurred due to reduced efficiency and the discomfort caused by illness.

- This study based on very small district of Odisha thus it is a micro level study and has limited scope to generalize the macro or global issues.

- We have considered only the PM10 as the main parameter of air pollution (because of the unavailability of other parameters of air pollution data at the very micro level), while the parameter like SO2, CO2, PM 2.5, weather and climatic variables can also be incorporated to analyze the health impact of air pollution clearly.

- Sample size and time period may be expanded for checking the seasonal impact of air pollution but as an individual researcher, this is the limitation of this study.

6.5 Future Scope for Research

- Basically the study at micro level on the environment-health linkages are scanty and not an easy task because of its nature of data requirement and the unavailability of the data. The study can be further extended to analyze the other major health impacts (like chronic asthma which is widely prevailing among the residents near the coal field) of air pollution by conducting a good quality survey with including large sample size. So that this can help to highlight more strongly the impact of air pollution in mining region.
➢ The CVM (contingent valuation method) method can be applied to evaluate the serious chronic health i.e. the asthma and how much they are willing to pay for the improvement of air quality to standard level.

➢ More time period (rather than 6 weeks) can be undertaken for analyzing the seasonal influence of air pollution on health in opencast mining belt.

➢ Water pollution is also identified as major problem in coal mining region which may lead more epidemic diseases including diarrhea and malaria etc., thus this study can be further extended to analyze these effects in Talcher coal mining region.