Chapter-(III)

Literature Review: Health Impact of Air Pollution near Coal Mining Region—-----------------------------------------------------------------------------------(32-53)

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3.1 Introduction

In the recent years, there is a growing worldwide concern over the management of natural resource, environmental pollution and sustainable development. The widespread problem of global integration has led the expansion of economic activities, industrialization and greater intensity of resources extraction. These problems are much more acute in the resource rich developed countries because of the poor technical base.

This environmental pollution has undoubtedly adverse effects on local people, which is well known as environmental externalities in economic literature. These externalities must of time are highly negative on the basis of its contributions on the behavior of third parties. The concept of externalities comes when government fails to account or consider the value into the market price of goods and services. The failure of this market to account for the negative impact of environmental bad has led to the evolution of valuation literature which leads to the estimation of cost and benefits of environmental externalities. This notion of externalities is well accepted as a fundamental pillar for the origin of environmental economics.

In the first section, this chapter presents the key contribution of the normative theory of externalities although this concept is not our primary orientation to describe but the valuation of cost of health hazardous due to air pollution effects is grossly based on this concept. The 1st part of the second section discusses the notable theoretical literature on environmental and health. In the third section, we present the methods for economic valuation of air pollution, which is mostly based on the neo-classical marginal utilitarian concept.
The fourth section of this chapter briefly discusses some important empirical literature on health and air pollution including international, national and provincial. The fifth section focuses on the current literature on coal mining activities, air pollution and health effects. Finally we conclude by discussing some major research gap in the literature review and how our attempt is sincere enough to fulfill some important gap in the literature and may contribute substantially in highlighting the problem and designing policy prescription.

3.2 The Normative Theory of Externalities

In economic literature, externality means the act of production or consumption of one agent (A) which influences the utility of another agent (B) for which he or she not compensated a pay off by agent (A). For example, open cast coal mining activities lead to serious problem which induces sever health hazards on the neighborhood settlement for which the community is not compensated. These overall health damage costs to society not reflected in the supply price of coal. Thus, there is a divergence of social cost of coal production due reflect, which is caused by the presence of serious externalities. Such market failure leading to inefficiency in production and consumption due to price distraction. Two eminent economists were contributed a lot to the concept of ‘externalities’ or ‘spillover effects’. (Henry Sidgwick, 1838-1900) and (A.C Pigou, 1877-1959).

The Environment Protection Act (EPA), 1986 was introduced for the protection of environment including air, water and land. The interconnection between the nature like air, water and land, and other living creatures, plants etc. sometimes produces environmental externalities, which can be positive or negative. The theoretical contribution on this concept is huge in environmental economics literature and
therefore, it is not the intention of this chapter to elaborate all the literature on this theory, rather this section highlights the fundamental notion of this theories on which the environmental valuation (cost and benefit) method is based.

Negative externality theories on environmental bad are the critical area of environmental economics, which substantially contributed in discussing various methodologies for the economic estimation of environmental externalities. We briefly review four outstanding contributions to this theory by Pigou (1920), Coase (1960) and Baumol and Oates (1988) and Cropper & Oates (1992).

Pigou (1920) observed the complication of smoke discharges by a factory affecting adversely the local residents. He suggested the imposition of effluent fees to rectify this negative impact (or externality). This is to charge a per unit tax on product of the firm equivalent to marginal damage cost of the environment. This tax is therefore proportional to the difference between the SMC (social marginal cost) and the PMC (private marginal cost), matching to the social optimal output. By imposing this tax, will obviously increase the product price and decrease the demand and thus internalize the externalities and equate social cost with private cost of environmental pollution.

Coase (1960), addresses the problem of environmental pollution is an externality by well defining the property rights. He suggests that in the absence of transaction cost, if the property rights are well defined in favour of the pollution or the victim, then even though the pollution taken place the agent will decide the compensation and enforce the contract. According to Coase the enforcement mechanisms will evolve between the two parties through compensation which finally internalize the environmental cost.
Baumol and Oates (1988) point out the information issue in enforcing the ‘Pigouvian tax’. To clarify this issue they suggest a two-phase approach: 1st, collect the ambient quality available information, and 2nd, seeks one of the following options, either’ quality and charges approach’ or ‘quality and permits approach’. With the ambient quality, the charges can be determined on the basis of the marginal abatement cost functions.

Cropper and Oates (1992) explains that environmental pollution as a public "bad" that outcomes from ‘waste ejects’ related with the generation of private goods and services. This linkage or communication can be revealed in following forms:

\[
U = U(X, Q) \quad (2)
\]

\[
X = X(L, E, Q) \quad (3)
\]

\[
Q = Q(E) \quad (4)
\]

The utility function of an individual agent in equation (2) relies on a vector of consumer goods (X) and on the status of environmental pollution (Q). Environmental pollution outcomes from waste discharges (E) in the generation of X, as defined in equation (3). Keeping in mind that the production function in equation (3) is considered to incorporate as inputs a vector of conventional inputs (L), such as labor and capital, the quantity of waste emissions (E), and the status of environmental pollution (Q). In this equation, waste discharges are taken as another factor of production.

3.3 Theoretical Literature on Health and Environment

WHO (World Health Organization) suggests that health is a state of complete physical, mental, and social well-being & not merely the absence of diseases’. This suggestion externalizes the health in the direction of environmental, social, mental, and spiritual well-being rather than only in the prospect of biomedical fitness. While
the classical health theory is scrutinized on account of the individual health without considering the environmental and social background around it.

**Michael Grossman (1972),** “On the Concept of Health Capital and the Demand for Health”, in *Journal of Political Economy*, explained that good health is a commodity and it can be witnessed as a durable capital stock that generates a productivity of healthy time. When we devote more on this commodity then the attractive function we can get as being able to work, to earn more money or to engage in enjoyable activities. It is assumed that individuals inherit an initial stock of health that deteriorates with age and can be boost by investment like medical care and education. Moreover his work defines that person’s diet, physical exercise, and purchase of medical services can strengthen to fight for illness. Thus Grossman’s Human capital theory (1971) thus indicates that the damage function approach, by neglecting the importance of precautionary health care and individual’s willingness to pay for a unit change in air ambient quality.

**While Cropper (1981)** examined the reaction by incorporating pollution variables into the health production function. His work documents a simple model of precautionary health care, likely to Grossman (1971), and only by adding the information on a representative individual willingness to pay for a change in air ambient quality. His paper presumes that a person can strengthen resistance to fight for illness by improving his initial stock of health. On the other hand, health stock downs by the increasing rate of air pollution. For his model, calculated willingness to pay was better than the benefit estimated applying the damage function approach.

The findings of his work advised that if an individual is living in highly polluted region identify their defense power to illness declining, so that they will
attempt to reimburse it by doing more exercise, smoking less and spending more on health care treatment. On the other hand, good air ambient quality can influence to fall in precautionary health care and this gain should be included to the benefits of pollution reduction.

Then in (1986), Gerking and Stanley introduced a health-oriented choice model in which individuals are considered as generator of good health and the good health is demanded for the purpose of both consumption & investment (on medical activities).

An Individual can capable to adapt their consumption on medical activities to safeguard against decreases in air ambient quality. The marginal willingness to pay for increasing the air ambient quality is derived in his model by applying the compensating variation method.

Harrington & Portney (1987) enlarged the framework to a model achieving individual’s choice in account of willingness to pay for mitigating activities or out of pocket expenditure on medical care. they first derived a simple constrained utility maximization model in which illness or health damage not only consumes the time (which can be enjoyed for leisure or can be dedicated to labour) and but also increases medical treatment expenditures and as well as causes illness related discomfort and disutility. He presented that individuals can use some precautionary or averting expenditures to minimize their probability of illness, which can positively influence their health status

“Health Production Function” proposed by Freeman. 1993 (The Measurement of Environmental & Resource values: Theory & Methods) suggested that health as good can be produced by utilizing medical care treatment and averting activities expenditure. Again health as a product depends on the other socio-economic
characteristics of individual and the level air quality. The basic health production function for an individual can be expressed as:

\[ H = H(Q, M, A, Z) \] \hspace{1cm} (5)

Where \( H \) represents the health status that are directly interrelated to the level of air ambient quality \( Q \). \( M \) represents the out of pocket expenditure for health care treatment. \( A \) refers the averting activities and \( Z \) captures other socio-economic characteristics of a representative individual\(^1\).

### 3.4 Valuation of Environmental Quality Improvement

The valuation of air pollution reduction benefit presumes that an individual is the best guide for his own prosperity. The reduction in air ambient quality has no doubt some adverse impact on the level of utility function, which an individual is acquiring with given income level and budget constraints. The changes in air quality level certainly can be mirrored by his/her welfare changes. The change in welfare can be estimated by the help of neo–classical utilitarian framework. This welfare changes can be estimated by asking one question –what will be the impact of reducing the air pollution from current critical level to minimum standard level. Or how the change in status quo impacts on the change in welfare? The neo-classical utilitarian thought advocates that rational individual can preserve the same level of utility while bargain different bundles of goods and services. (William Stanley Jevons's Theory of Political Economy (1871), Carl Menger's Principles of Economics (1871), and Léon Walras's Elements of Pure Economics (1874–1877). The intension of this section is to elaborate the valuation method for environment improvement or degradation, which are available in environmental economics literature. Broadly there

\(^1\) Detail on this model is discussed in methodology chapter(chapter-IV)
are two types of method namely direct and indirect method, which includes all the existing valuation methods’ in literature. The purpose of both the methods is to highlights the individual’s value on account of welfare gain or loss for a reduction or improvement of environmental quality. But in all the cases the impact analysis should be carried out then only the economic valuation can be estimated.

Indirect valuation method for non-marketed commodities depend upon the consumer’s preference of choice thus the revealed preference theory of consumer behavior plays a significant role in indirect valuation method. This theory explains that an individual chooses a particular consumption bundle (that is mostly preferred) to all other available bundles at a particular prices with given his income line (Samuelson, 1938). It is similarly appropriate in acquiring the welfare gain for the change of environmental quality. The available indirect methods in literature are briefly discussed in this section. The change in valuation method defines that the researcher tries to evaluate the impact that consequences in productivity changes. While both revealed preference (indirect method) and stated preference (direct method) methods can used for measuring use values, only stated preference can be employed to measure nonuse values.

**Indirect method:** (Hedonic method)

Hedonic method tries to elaborate price heterogeneity by collecting information on the various attributes of a marketed good taking into consideration the environmental quality. A hedonic method can be employed when environmental characteristics straightly influence the price of marketed goods. Generally this method is used to value environmental aspects, such as ambient air quality, water quality and noise that directly or indirectly influence the price of residential lands. Willingness to pay for a fixed asset or land always reflected from the return utility which is anticipated from it.
Other things remaining constant, the land value for a highly polluted area will be minimum in relative to other areas. The price heterogeneity between the two lands will be an implicit value of their attributes which consumers are willing to pay. Thus Hedonic method has been found widely in the literature of environmental problems and property values.

**Recreation demand method:**

The recreation demand method or the standard travel cost method was first developed by H. Hotelling (1947). This method considers the visitors to a particular site willing to pay an implicit price that include the value of environmental attributes and the opportunity cost of their travel and time. It is called recreation demand method because Environmental quality can influence recreation chances at a particular site. This method is often used when the environmental attribute can influences the recreational use of a particular site. This method is well fitted when a transportation project influences the environmental quality at a recreational site, and also involves the traveling costs to that site.

**Averting behavior method**

Averting behavior method tries to derive values of non-marketed environmental attributes on the basis of individuals’ willingness to pay to reduce the chances of being illness from environmental deterioration. Averting behavior method presumes that individuals involve in avoiding behaviors to attain a standard quality of health while considering for the cost of avoiding action. Since the encouragement for the averting action is to defend health and well-being, the general utilization of the averting behavior method is relevant to account the values for risk of an illness.
Market price method

According to this method, information on change in price and productivity of marketed goods is required to derive the value of the changes in an environmental attributes that provides to produce the marketed good. This method suggests that environmental condition is an ingredient in the production function of the marketed good. This method argues that the quality of the environmental conditions influences the cost of the marketed goods, thus the value of the environmental attribute can be included to the production cost of the marketed good.

Stated preference methods (or direct method)

Direct methods indicate preferences based on the motive declared by individuals in a hypothetical market situation. This is a method which is generally based on survey for extracting values of human place on goods, services, and amenities. There are two types of stated preference methods available in literature namely- contingent valuation method (CVM) and conjoint analysis. Both the method involves construction in hypothetical market. This valuation method depends upon the people’s exposure to the problem and the level of awareness and information on the concern they have obtained. Again, willingness to pay can certainly rely on the income levels of a person.

The contingent valuation method particularly focuses on the estimation of the value of specific environmental quality changes. The contingent valuation method typically focuses on estimating the value of one particular environmental quality change. A contingent valuation survey starts by assuming that there is a change occurs in environmental goods or services, then it inquires individual’s willingness to pay for
such changes in environmental quality. Especially it focuses on how much individuals are interested to pay or accept for an exact change in environmental qualities.

### 3.5 Health Impact of Air Pollution

Literature on Air pollution and its hazardous impact on human health are enormous. This adverse impact and the estimation of monetary gain (or welfare gain) of this impact has been carried out by many economist, environmentalist and other policy makers. Our focus on this section is to outline the outdoor the literature on outdoor air pollution and its related health impact and its economics valuation.

**Adhikari, N. (2012)**, estimates the health improvement to a representative individual from a fall in present air pollution level to a standard level in the Kathmandu valley of Nepal. For the purpose of estimating the economic benefits of reduced air pollution level, he used the dose response function and a medical expenditures function. They collected primary data for four seasons in three different locations. Total 120 households were surveyed and aggregate 641 household members were answered. by matching the survey data with pollution data they estimated the monetary benefits of air pollution reduction. The finding of this revealed that the annual gain to a household person can be NPR 266 per year for a reduction air pollution level to a safe line.

**Alberini, A., Cropper, M., Fu, T. T., Krupnick, A., Liu, J. T., Shaw, D., & Harrington, W. (1997)**, explained to obtain the willingness to pay (WTP), a simple contingent valuation survey is required to organize. They projected a model where WTP for Taiwan people, which relies on the characteristics of the illness and kinds of symptoms, and severity of the illness.
Krupnik, A. and A. Alberini (1997), tries to explore the usefulness of concentration-response function transfers in Los Angeles and Taiwan by conducting two health studies in similar way. A daily health diary from epidemiological survey was collected to predict the relationship between the minor acute respiratory symptoms and the pollution and weather variables. The logit regression model was used to find out the probability of respiratory symptoms as a function of pollution.

Alberini, A. and A. Krupnick (2000), using primary data from a field survey in Taiwan in 1991 and 1992 tried to compare cost-of-illness (COI) and willingness-to-pay (WTP) estimates for damages due to respiratory symptoms caused by air pollution. In order calculate willingness to pay to avoid respiratory illness, a contingent valuation survey was conducted in the study regions. The collected health diaries were used to predict the probability of illness and mitigating cost and missing work due respiratory symptoms. As it is expected in the economic theory, the WTP should be greater than the COI (WTP>COI), this study shows that the ratio of WTP to COI ranges from 1.61 to 2.26 depending on pollution levels.

Chowdhury, T., & Imran, M. (2010), calculated the benefit from reducing morbidity costs due to reduction in vehicular air pollution in Dhaka city of Bangladesh. By using the Cost-of-Illness (COI) approach, where COI was calculated by adding the lost earnings from workdays lost and the mitigation cost generated for avoiding illness. The collected data on seasonal health diary from a household survey. They used a random-effects Zero Inflated Poisson regression model to predict the loss of earnings and used a random-effect Tobit Regression to solve the equation for mitigation cost for illness.

Cropper, Maureen, et al., (1997), reports the findings on the impact of particulate matter (PM10) in air on the daily mortality rate in the capital of India in between 1991
and 1994. They compared their study findings with the United States and concluded that the total non-trauma death due to high particulate matter in Delhi is lesser than the impact found in the United States. Secondly they identified the effect of particulate matter on deaths on the basis of age group was different for both countries. For the United States, the highest effects happen among the (65 years and older people), while for Delhi it showed between the age group (15 to 44) years. Thus they concluded the death related particulate matter in Delhi is more serious than the United States as it causes more life years to be lost.

Dickie, M., & Gerking, S. (2002), provided some critically reviews on the methods for deriving the value of reduced morbidity and paved the path for further research. This review focuses on the three methods namely cost-of-illness, contingent valuation, and averting behavior, which have been found in most of standard literatures.

Gupta, U. (2008), estimates the health benefits (in monetary terms) to a representative individual from the reduction in urban industrial air pollution in Kanpur city of India. An important aspect of this study is that it collects primary data by using weekly health-diaries for three seasons. This estimated the monetary benefits of two important factors of health cost i.e. the wage loss caused by workdays lost (due to illness) and the out of pocket expenses incurred on avoiding activities. The study found that an individual can gain Rs. 165 annually due to air pollution reduction to a safe level and the extrapolated value per year was are Rs 213 million for the total population of Kanpur city.

Kumar, P., & Kumar, S. (2010), estimate the health impacts due to the crop residue burning induced air pollution for the rural people in Punjab, India. Consumer choice model is employed to value the monetary gain of air pollution reduction to the safe
level. The data of 625 individuals from 150 households were collected from three villages in Punjab. To calculate the monetary values of work days lost and mitigating cost Poisson regression model and Tobit models are used respectively. The annual welfare loss in term of monetary value of health damages due to crop residue burning induced air pollution in rural Panjab accounts to 76 million.

Kumar & Rao (2001), estimate the economic benefits of improved air quality in the residential complex (consisting 2400 families) of Panipat Thermal Power Station. Based on theoretical model by Gerking & Stanley (1986), they calculate the monetary costs from morbidity due to higher levels of PM$_{10}$ emission. This study suggests that for a 67% reduction in the level of PM$_{10}$, the households in Panipat, India are willing to pay on an average of Rs.12 - 53 per month.

In recent study in India, Murty, et al., (2003) use household data that relates to a recall period of six months. The study analyses the impact of higher levels of suspended particulate matter in the Indian metropolitan cities of Delhi & Kolkata. Using the three stages least square method, a system of simultaneous equations consisting of the health production function & demand functions are estimated. This study reveals that the annual marginal benefits to typical household is Rs. 2086 in Delhi & Rs. 950 in Kolkata if the level of SPM is reduced to prescribed safe level.

Ostro (1983; 1987), estimated a damage functions to observe the effect of air pollutants on morbidity & showed that particulates affect the work loss days (WLD). He suggests that a one % increase in particulate matter will increase WLD by about 0.5%.
Ostro, Bart D. et al. (1998), tries to estimate the dose-response functions for respiratory disease among Santiago’s children. They collected the health data from public clinics in Santiago. They found that air pollution measured PM10 or small dust particles affect significantly to the occurrences of respiratory disease among Santiago’s children. This effect for the age group less than 15 years children was highly significant. While another pollution variable like ozone is also found to influences respiratory.

Ostro, B. (1994), elaborates a method for estimating the welfare gain of air pollution (such as ozone and particulate matter) reduction basically in urban areas worldwide. This study suggests the magnitude of welfare gain due to pollution control rely on the level of air ambient quality, the expected health impacts (dose-response), the targeted population size, and then the proper economic valuation is required to follow. The research findings for Jakarta that there is a significant welfare gain derived from the reduction of exposure to outdoor pollution. Clearly they conclude that the air pollution reports a serious health impacts to the people of Jakarta.

The relationship of vulnerability to air pollution and the increasing rate in premature mortality and different morbidity impacts have been well reported (Pope et al., 1995; Cyril Bogahawatte and Janaranjana Herath, 2008; Krzyzanowski, et al., 2002). It is found that the significant problems on human health due to air pollution in worldwide include mortality, bronchitis, and asthma, respiratory and cardiovascular diseases.
3.6 Coal Mining Activities, Air Pollution and Health Effects

T. Yoge Baggio et al. (2009), attempt to calculate the effects of vulnerability to air pollution by NO$_x$ and SO$_2$ on the children’s pulmonary function (PF) by taking into consideration of different health status. Total 1181 schoolchildren, near the coal fired power plant in the Hadera district of Israel were surveyed under different health status (1$^{st}$ taken healthy children 2$^{nd}$ children experiencing chest symptoms and last taken asthma or bronchitis having children) in 1996 and 1999 time period. After controlling the socio-demographic features, the living condition of children, the study found that there is inverse relation between the PF results and the children’s exposure to air pollution in coal fired area.

Tanja Pless-Mulloli, et al., (2000), tried to answer the question whether acute and chronic respiratory health are more serious issue among the residents who are living near opencast coal mining sites affects. Within the age group 1 to 11 years, total 4860 children aged from different five socioeconomically communities close to active opencast sites were choose for survey. To compare the treatment groups’ effects with control groups, control sites away from them were selected. This study found that the living children in opencast communities were exposed to a small but the PM10 was found as a measure contributor to respiratory respiratory diseases in opencast coal mining sites. It was identified that the respiratory condition were sever in opencast residents during the study time period.

Colagiuri R, Cochrane J and Girgis S.(2012), attempts to provide a brief profile of the existing international literature (evidence from the health and medical literature) on the social injustice and health effects of coal mining on proximity residents and tried to discuss how this issue is a serious concern to the Hunter Region of New South Wales. This review found a clear expression from the international studies that there
are serious social harms and health hazardous related with coal fired power station for the nearest residents.

**Emily, Morrice. & Ruth, Colagiuri. (2013)**, provides a strong theoretical base for understanding the social and political injustices in context of health problems by reviewing the existing international health literature. It seeks and explains the mechanisms of social and political injustice caused by coal mining’s, discussed how power asymmetries happen between political and corporate company passions versus dwellers of coal mining communities.

**M.K Ghose and S.K Banerjee (1995)**, selected four coal washery projects, out of 23 coal washeries in India were surveyed to examine their air pollution attributes. To identify the air pollution characteristics, air pollution samples were collected with other meteorological data by establishing air monitoring station in coal mining residential areas. The study found that coal washeries contribute huge amounts of particulate matter into the air due to different activities like burning, crashing, loading, unloading of the washed coal and all screening process.

**Das and Mishra. (2015)**, tried to outlines how the coal mining activities affecting the diversified sources of livelihood for the local dwellers by conducting one qualitative survey in the Ib valley coalfield area of Odisha. To identify the severity of air pollution, six villages were selected near three different opencast mines. A ‘recall method’ was employed to find out the information on pre and post mining operation. In order to highlight the impacts of coal mines activities on livelihood of local people, two other control villages were also chosen in the same agro-climatic zone but without coal mines operation. A systematic random sampling was used to collect the
household’s information’s. From the mining villages, 300 households were surveyed and 100 households were surveyed from the control villages in 2012. The study suggests that mining activities has seized the diversified sources of livelihood that ride outs a basic component for rural livelihood creation. This study found that there were ample changes happened in both pre and post mining stage. Specially in post mining period, it was noticed that their livelihoods dependences shifted from natural vegetation, community forestry, social connectedness and overall healthy environment to cost effective and technology based industrial activities.

**Mishra, Prajna Paramita. (2009),** attempts to analyze the diverse impacts of coal mining on the livelihoods of local residents of the lb valley coalfield, Orissa. For gathering the information on socio-economic and livelihoods conditions of local people, a primary survey was conducted in 2005 by following the circular systematic sampling method. The study chooses 5 villages as ‘mining villages’ and 2 villages as ‘control villages’ but all the villages were situated in one district. Total 360 households were surveyed for the study, where 260 households from 5 villages and 100 from 2 villages were selected. This study suggests that coal mining in the form of physical capital undoubtedly generates financial capital. Utilizing the sustainable livelihoods framework, the study concludes that coal mining has an inverse impact on human and natural capital and a blended impact on physical and social capital.

**Debasish Sarkar, Zakir Husain, Barun Kanjilal and Rabindra N. Bhattacharya (2004),** tries to estimate the risk of being affected by occupational diseases for the workers of coal mines field in West Bengal, India. The risks are calculated by employing the odd-ratio method. To find out the association between the socio-economic determinants with risk(being suffered from occupational diseases) experienced by the coal mine workers, a Tobit model is used. This study found that
the health care policy granted by the management is very not sufficient in comparison to socially optimal level. Thus this study suggested that private measures should be appreciated by perfect state intervention in particularly socio-economic sphere.

Ghose, M.K. and Majee S. R.(2007), suggests that Surface coal mining activities produced serious air pollution problems in respect to coal dust with compassion to underground mining. A survey was conducted to examine the attributes of the airborne dust generated by surface coal mining activities in the Jharia Coalfield in Dhanbad district of Jharkhand state, India. Total suspended particulate matter (TSP) level was identified as highest (3,723 µg/m³) and respirable particulate matter (PM10) was found as 780 µg/m³ in working zone. While the average maximum level of TSP was found as 837 µg/m³ and PM10 as 170 µg/m³ in air ambient level. This study concludes that more demanding air quality standards should be maintained in coal mining areas and positive and perfect attention should be focused on the size of particle distribution of the air-borne dust when designing control equipment.

Mishra, Sujit Kumar. (2012), focuses on the economic valuation of coal mining impacts on the local communities in the proximity or vicinity of Basundhara Coal field of Odisha. This study assesses the economic valuation by taking account the losses to human health and agricultural productivity due to coal mining. In total 140 households from 3 villages (considered as mining village) and 52 households from 1 village (taken as control village) were surveyed for the study. To evaluate the health impacts of coal mining, Cost of Illness (COI) and to identify the differences in agricultural productivity, Tornqvist index number for Total Factor Productivity (TFP) have been employed. After field observation and interviews with doctor and
local peoples, the study concludes that different types of health hazards were identified among the mining villagers in comparison to control villagers.

### 3.7 Research Gap

The current literature is mostly confined to estimating the morbidity and health impact costs of urban air pollution, vehicular pollution etc. While there are some studies on the health impact of air pollution on cement industry (Bogahawatte, 2008), iron mining (Pattanayak, et al., 2011) and health impact of occupational hazards (i.e.-direct impact) on coal mining (Sarkar, et al., 2004), but to the best of my knowledge there are a few worth mentioning study (Mishra, 2012; Singh et al., 2010, Hota & Mishra, 2010) in India on the health impact of air pollution induced by coal mining.

Given that coal is the most polluting natural resources & its dust is more contaminant and hazardous in nature in comparison to other minerals, the health outcomes by this exposure is supposed to be very critical and demand serious policy intervention. The absence of research in this area is a serious gap in the literature. It is necessary to have an appropriate mechanism to establish linkages between environmental pollution (with special focus on air pollution) & its health impact due to opencast coal mining activities.

There is no empirical study on health and air pollution (i.e.- environmental health or indirect health impact)) in opencast coal mining region particularly in Angul-Talcher area. We find a couple of occupational health impact in coal mining region (Sarkar, et al., 2004), coal mining externalities in case of Basundhara coal field (Mishra, 2012) and one study on iron ore mining & health (Pattanayak, et al., 2011) in this highly mineral rich mining area.
Moreover most of the related studies in India are based on underground coal mining (Sarkar, et al. 2006, Naik, et al., 2009). There are very less study on the incidence of air pollution & its health impact due to opencast coal mining, which we know is more polluting as compared to underground mining. Hence the present study focuses on the negative health outcomes due to opencast coal mining induced air pollution in Angul-Talcher region of Odisha.

The literature on pollution related health cost estimation have mostly used cost-benefit method like CVM (Contingent Valuation Method), productivity damage function and COI or Cost of Illness method, however the present study is based on the Dose-Response methodology. The advantage of this methodology will be discussed in the methodology part\(^2\).

### 3.8 Conclusion

This chapter has considered four things for review, theory of externalities of coal mining induced pollution, existing notable economic theories on health and environment, economic valuation of costs and benefits related to air ambient quality improvement and empirical literature on air pollution and health in context to international, national and regional. The first section explains mining induced pollution has both positive and negative impacts. In one side it generates income and employment opportunities, and on the other side’s it produces toxic pollutants to atmosphere in the time of mining process, which harms the neighborhood peoples. The second section of this chapter discusses the distinguished economic theories on health and environment. And discusses how it shifted from traditional health theories, which was based on the only biomedical or physical domain health to a new paradigm, where the quality of environment plays important role in determining good

\(^2\) For detail see the Chapter-(IV)(Methodology Part)
health. The third section elaborates the available valuation methods for calculating the environmental changes and its impact on the well-being of society. The fourth section documents briefly all the available empirical literature on air pollution and health impact. It is concluded with some research gap and discusses how this gap can again be extended for more specific and regional based study with appropriate attention to opencast coal mining induced air pollution and its health effects.