ECONOMIC IMPACTS OF AIR POLLUTION ON HEALTH AND VALUES of PROPERTY

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INTRODUCTION

Industrial revolution and subsequent growth of rapid industrialization have caused serious threats to sustainable development of both developed and developing countries. While modem industries extracted various natural resources, other raw materials and energy from the environment to produce material goods and services, such uses and production processes have resulted in large scale emissions of wastes into the environment causing severe threats to traditional agrarian practices, surprising the values of rural and urban property and reducing the quality of human life. Although most of the developed countries had responded to this social me: lace by developing a variety of technological, economic and legal regimes for regulating the polluting behavior of firms, the developing countries has not. Attained sufficient progress in regulating industrial pollution and its influences on their economy and society due to lack of technological alternatives, failures of markets, institutions, government policies, mass poverty and illiteracy. The urge for attaining rapid industrialization and the immediate transfer of benefits to local
population subdued environmental concerns of sustainable development. Environmental economists, who examined the impacts of industrialization on the natural environment and human health in India, have raised these contradictions of industrialization

KEYWARDS

Statement of the problem, Research Questions, Objectives, Economic Impacts of Air Pollution, Primary survey.

1.1 Statement of the Problem

A four decides long industrial development of the State of Kerala has brought in many changes on the use of natural resources and environment. The initial phase of industrialization in Kerala was based on natural resources like fisheries, cashew, coconut, coir, timber, and bamboo and other small finest produce, handlooms, minerals etc. Most of

these industries were evolved as "clusters" where raw materials were abundant in supply. This scenario has changed since the second five-year plan with the active participation of the State towards industrialization. The industrial revolution led to the emergence of large factories with mass production capacities and majority of them located around river basins and in urban centers where population density is high. The number of working factories has increased to 18621 in 2001 compared to 9104 in 1980 (Government of Kerala, Economic Review 2000; 1980) Recent statistics of the Central Pollution Control Board reveals Kerala ranks fourth in the case of industrial units closed down due to pollution (Govt. of India, Economic Survey, 2000-03). Another major causal factor of air pollution, the number of vehicles, has been growing at a rate of 10 percent per annum, leading to a concurrent increase in air pollution. Moreover, traditional industries and new industries using modern technologies extract natural resources and environmental assets on large scales without paying the relevant price for such uses. It is unfortunate to note that most of the large-scale chemical and petrochemical industries, some in the public sector too, have started polluting the environments. These in turn have led to the degradation of air, water and land, directly affecting livelihood and human health. The 'Kerala Model of Development' has also been silent on these environmental and ecological issues due to its overemphasis on the role of the social sectors and quality of Eifel. However, serious analytical studies on the impact of air pollution on Kerala economy, especially on the health of the people and on the changes in property values are not available. This study attempts to overcome this limitation by undertaking a detailed analysis of the economic impacts of air pollution on human health and property values around the Cochin industrial agglomeration in Kerala.

1.2 Research Questions

This study aims to answer the following questions:

1. What is the relationship between air pollution, human health and property values and
2. How has it affected the prices of property and the health of human population in and around
the industrial agglomeration.

1.3 Objectives

More specifically, the study proposes the following objectives

1. To provide a systematic descriptive documentation of the nature of air pollution of the Cochin industrial agglomeration.
2. To estimate willingness to pay for morbidity reduction due to air pollution in observed and hypothetical markets.

3. To estimate the value of welfare loss in the purchase of property due to reduced air quality.

1.4 Economic Impacts of Air Pollution:

Framework of Analysis Industrial sector in Kerala is one of the major productive and wealth creating sectors. However, it remains as a major polluter, resulting in the degradation of the health of local population and reduction in property values. Pollution is defined as an undesirable state of the natural environment being contaminated with harmful substances as a consequence of hum all activities' (Cognitive Science Laboratory: Princeton University). Air pollution is the contamination of the atmosphere by substances that, directly or indirectly, adversely affect human health or welfare. It results from human activities, both deliberate releases (as from smokestacks) and fugitive emissions (as dust blown from streets or fields), and from natural sources, including sea spray, volcanic emissions, etc'. (National Institute for the Environmental, Washington D.C*) The* problem of pollution and its management is found in *history and* is well debated in various disciplines". Economic definition of pollution is dependent up both physical effect of waste on the environment and the human reaction to that physical effect. In economic parlance, there has been an uncompensated loss of human welfare due to the imposition of an external costly related to emissions into the air (Turner, Kerry; 1994). Environmental economists argue that the damages due to air pollution depend on the assimilative ability of the environment. If the emission loads exceed absorptive capacity, pollutants accumulate in the environment (Hanley, 1997), causing damages to the material well- being of the society.

One of the most important sources of market failure is the presence of externalities or spillovers. There are many other cases of market failure for environmental assets, such as, incomplete markets, non-exclusion. Non-rival consumption. Non-convexities and asymmetric information.

Pollution externalities alter natural ecosystems and human life in many ways. For instance, air pollution influences natural vegetation, productivity of land, other economic activities, human health, property prices and very many varieties of ecosystem services. Although all these issues demand detailed critical examination, the major focus of our thesis, however. Is on how air pollution influences human health and property values.

The incidence of air pollution on human health ranges morbidity l4 to mortality. (Murty and Kumar, 2002). Morbidity can be c1assificd in a variety of ways based on the duration or intensity of illness as chronic or acute, on the degree of impairment of activity which decides the inability of the attested person to undertake normal work or on the type of symptoms that varies from person to person. The degree of impairment of activity is an important way of measuring morbidity. There are several categories of degrees of activity impairment, namely.

Both morbidity and mortality have attained considerable importance for festinating willingness to pay for improved health. However, this work is concentrated on morbidity alone because it has varying degrees of illness or injury, with multi dimensional impacts.

The second issue examined in this inquiry is on the relationship between air pollution and the value of residential property. This relationship depends mainly on various environmental, structural and neighborhood characteristics they possess. Environmental characteristics include the factors which determine environmental quality, such as, S02, NOX, and SPM, distance to lake or river etc. Structural Characteristics include plot size, number of rooms, garage space, type of f1ooring. Type of roofing, age if house etc. and neighborhood characteristics include level of traffic, distance to central business district, distance to nearest industrial zone, slope of property etc.

In absence of ownership and efficient pricing, special techniques are needed to analyze economic impacts of environmental changes. One of the popular approaches! To analyze the economic impacts of air pollution on the health of" human population and residential property values is centre on identifying and monetizing the relevant costs and benefits of an environmental change. Monetary values of changes in human health that are associated with environmental changes are estimated either using 'indirect observed' approach [household production function] or the 'hypothetical market approach' [Contingent Valuation Method (CVM)] (Murty, 2000). While a standard production function approach is adopted in the fanner method to estimate the willingness to pay (WTP) for restricted activity days affected by air pollution, the latter method resorts to hypothetical markets for the elicitation of values

1.4.1 Air Pollution and Health:

The Production Function Model Environmental pollution reduces people's well being through
the following ways.

(1) Medical expenses associated with treating pollution-induced diseases including the opportunity cost of time spent for obtaining the treatment,

(2) Lost wages

(3) Defensive or averting expenditures associated with attempts to prevent pollution induced disease,

(4) Changes in consumption pattern,

(5) Disutility associated with the symptoms and lost opportunities due to diseases and

(6) Changes in life expectancy or risk of pre-mature death. Therefore, the welfare is due to air pollution could be estimated in terms of increased morbidity. Economists have used a number of approaches to determine the monetary value of replaced morbidity. A formal model used for deriving values of reduced morbidity, based on health production function, was first developed by Grossman (1972). Cropper (1981) introduced a pollution variable into the function and later Harrington and Portney (1987) extended the model to examine explicitly the relation between willingness to pay (WTP) and a reduction in pollution.

More specifically, the health production function is expressed as

$S=s(C,M,H,K)$

Where,S=Number of Sick Days

C= Environmental quality

M= Mitigating Activities

K = Stock of social capital (such as education, sex….)

H= Stock of health capital

The Utility function of the individual can be defined as Where,

$U=u(Y,S,C,L,l)$

Y= any private good, taken as numeraire

L= leisure

l = Income

Individual's budget constraint is written as,

$I=I^* + Pw (T-L-S) = Y + Pm M$

Where,

Pw= Wage rate

I* =Non labour income

T= total time available

Pm= price of mitigating activities

Individual maximizes Utility (2) subject to the budget constraint,

Max Z+11(Y,S,C,L,J) + A. (l* +Pw (T-L-S) – Y-Pm.M)

Estimating the demand function for mitigating activities, one obtains the marginal Willingness to pay as:

MWTP,
au/

~=p. as +p aM _~ as

ac IV ac M ac A.' ac

1.4.2 Air Pollution and Property: The Hedonic Model. The welfare benefit in property values due to reduced air pollution is estimated using the hedonic property value model. The model used here for observing the relationship between air pollution and property value is based on Freeman (1979).
Following Freeman, Pearce and Turner (1990) and Bateman (1993) Parikh *et al.* (1994) have applied the model to estimate property values. Based on this basic model, the study also estimates Marshalling consumer surplus, as a measure of welfare benefits from reduced levels of air pollution. The model is specified below.

Consider the price of a residential location (Phi) as a function of structural (Si),

Neighborhood (Ni) and environmental characteristics (Qi).

Phi = Ph(Si,Ni,Qi)

The utility function of the individual who occupies the house is,

u(X,Si,Ni,Qi)

If there is an improvement in environmental characteristics from q/ to {Ii'. The value the individual places on such improvements (Bij) could be estimated by integrating the implicit price function with respect to aj.

(Ul)

Bij = fbij(qj,Qi*,Si,Ni,Gi)8qj

Where, Gi is the socio-economic characteristics. The value obtained by integrating the inverse demand function with respect to the implicit price is interpreted as the consumer surplus. The inverse demand function assumes the form, Consumer surplus is calculated by integrating the inverse demand curve with respect to the implicit price and calculating the definite (Reimann) integral by observing the old and new level of Qi, planned by the policy maker.

1.5 Methodology

This study begins with a detailed description of the basic characteristics of the selected industrial agglomeration including the nature and incidence of air pollution caused by industrialization of Kerala economy in the recent past. It then concentrates on the identification, quantification and analysis of the major economic impacts of air pollution in the study area.

1.5.1. The Study Area The study is conducted in the Cochin industrial belt in the state of Kerala. Cochin Industrial agglomeration is a geographical space, consisting of the Cochin Corporation, the Kalamassery Municipality and three panchayaths, viz, Vadavucode-Puthercruz, Thiruvankulam and ElIor. This area has been identified as the industrial capital of Kerala and hence inhabits a large number of factories both in the private and public domain. The Central Pollution Control Board in collaboration with the State Pollution Control Board identities Cochin as one of the problem areas in the country. It ranks first in both number of vehicles and number of registered factories. It is also reported that potential air pollutants like suspended solids, dissolved fluorides and phosphates, free ammonia, ammoniac nitrogen, carbon powder, hexavalent chromium, acidic chemicals like S02, *C02 C\2*, HCL, etc. emitted by these factories in to the environment are one of the highest compared to other districts of the State and are even beyond the level of tolerance. It is further noted that most of these pollutants recorded in this area are found to be harmful in many ways to the life and property of human population (Pollution Control Board (peB): 2000; National Environmental Engineering and Research Institute (NEERI), 2000).

1.5.2 Population and Sample

The universe of the study Cochin industrial agglomeration, constitute, 130780 households including 695357 number of population. The households chosen to participate in the survey was selected using a two stage stratified sampling procedure. In the first stage, the agglomeration is divided into six strata according to the distribution of air quality monitoring stations of the State Pollution Control Board. These stations are Ambalamugal, Eloor, Port Trust, CSIR Complex, Emakulam North and lrumpanam. From these regions 100 households with in a radius of 1000 meters from the respective monitoring stations have been selected for intensive examination in the second stage.

1.5.3 Variables and Collection of Data.

The study is based on both secondary and primary data. The National Ambient Air Quality Monitoring data has been collected from the publications of Central Pollution Control Board. These data were used as the measure of air pollution. Details regarding study area are collected from the records of respective local panchayath/ municipality corporation and zonal office of Pollution Control Board at Cochin. Other relevant secondary data, regarding pollution health impacts, epidemiological data etc. are collected from various published and unpublished sources, institutions such as State Pollution Control Board (PCB), National Environmental Engineering Institute (NEERI), NGOs such as, Kerala Sashtra Sahitya Parishat, Green Peace, Periyar Malineekarana Virudha Smithy and Industrial units.

The primary data on averting/mitigating activities (medication, doctor visits, use of folk medicines, installing air purifier etc.), workdays lost, number of sick days, family details, averting and mitigating costs, factors affecting property values, sales price of residential property, health status, habits, hospital admissions, and other socio economic variables, such as, education, household income etc. are collected using a structured schedule (see Appel/dix I/or schedule).

1.5.4 Primary Survey

A primary survey covering family details, environmental quality, factors influencing human health, other socio economic variables, willingness to pay for avoided heath risks and factors affecting property values was conducted among 600 households at six centers in the Cochin industrial agglomeration during the period of June 200 I - January 2002 in a face to face interviewing method. To estimate their WTP to avoid symptom days, five symptoms (coughing, itching and smarting eyes, breathing trouble, acute bronchitis and asthma attack) were given. The descriptions of these symptoms were given in five separate cards and were distributed. After giving a detailed picture of the exposure-response functions in the area, people were asked to choose one of the symptom slip, which ranked as the worst one in the

light of previous disease experience. The first part of the question explicitly reminds people about their costs on mitigating and averting activities and how it affects their family budget constraint. Then they were asked, their willing to pay Rs. 200 to eliminate these symptom days. Rs. 200 was obtained as an average minimum cost of I1Iness from the preliminary survey. In the next iteration, to obtain their maximum WTP, people were asked to bid an amount to avoid the symptoms fOl 1-7 days for the next 12 months. If the answer was in the affirmative, people wue asked to increase amounts from Rs. 200 to a maximum, using the bids and if the answer was in the negative, the amount was reduced by a certain rate down to what the respondent was actually willing to pay.
The survey was conducted among 100 respondents each from SIX strata of the sample.

1.5.5 Estimation

SPSS and E-views were used for statistical calculations.

1.6 Scope of the study

Industries pollute environment and the society incurs significant loss of welfare from this, due to reduced assimilative capacity of the environment. This study highlights that air pollution generates costs which are external to the industry (Tintenberg: 1988). As emphasized in the beginning of this chapter, pollution being an externality creates serious damages to human health, agriculture, livestock, fisheries and property values. It is unfortunate, however, that such issues are often marginalized in academic discourses on development, even while environment friendly industrialization policies are formulated. Our study has some definite advantages in understanding the manner in which air pollution affects the economic activities of one of the most important industrial agglomerations of the state of Kerala. For instance, the welfare losses due to the incidence of air pollution have been estimated using established environmental
economic methodologies. These results can be used for evolving environmentally friendly industrialization strategies for Kerala economy. In fact a number of people's science movements and the civil society have been demanding such redressed packages for the sustainable development of Kerala. At the same time, this study is probably the first attempt to conceptualize and quantify the environment-economy interaction of air pollution in Kerala. It may however, be mentioned that our study concentrates only on the economic impacts of air pollution on human health and property values while many other parameters remain outside the domain of our limited scientific inquiry. More detailed fonnulations and studies are therefore required to understand these processes 111 order to formulate policies for a sustainable Kerala model of development.

1. Plan of the Thesis

The thesis is divided into six chapters. The first chapter introduces the study, a framework for analysis and the underlying methodology adopted in the study. The second chapter reviews the relevant literature. It aims to establish the complex interaction among air pollution, human health and property values. In the third. Chapter we outline the status of air pollution in the Cochin industrial agglomeration. The fourth chapter presents an analysis on the influence of air pollution on human health in the study area. An attempt is also made in this chapter to quantify these relations using production function and contingent valuation methods. This is followed by a detailed analysis of the impact of air pollution on property values in chapter five. Chapter six provides the summary and conclusions of our study.

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