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A Study on the Effect of Pollution Control Schemes on Output and Prices of Different Goods and Services of the Indian Economy

Debesh Chakraborty and Siddhartha Dutta

Jadavpur University, Kolkata

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A STUDY ON THE EFFECT OF POLLUTION CONTROL SCHEME ON OUTPUT AND PRICES OF DIFFERENT GOODS AND SERVICES OF THE INDIAN ECONOMY

Debesh Chakraborty

Principal Investigator
Department of Economics
Jadavpur University
Calcutta

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Team of the Project

Principal Investigator : Dr. Debesh Chakraborty
Professor
Department of Economics
Jadavpur University,Calcutta

Co- Investigator : Dr. Siddhartha Dutta
Professor
Department of Chemical Engineering
Jadavpur University,Calcutta

Research Staff : Dr. Shibani Maiti
Research Associate
Department of Economics
Jadavpur University,Calcutta

MS.Sanghamitra Majumdar
Research Assistant
Department of Economics
Jadavpur University,Calcutta

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PREFACE

In India industrial pollution in the form of air, water, solids, thermal pollution etc., is assuming alarming proportions with each passing day. Some of the industries have been producing pollution at much higher rate than the Minimal National Standard (MINAS) approved by the Pollution Control Board of India.

Water an abiotic component of our environment though indispensable and playing a vital role in our lives is one of the most badly abused resources. Water pollution is caused due to variety of factors -- e.g., industrial effluent generation, household sewage disposal, and agricultural activities.

A significant number of industries (Livestocks, Oil Refineries, Chemical industries, Distillaries, Man made fibre, Paints & Dye, Leather, Textiles, Paper, Fertilizers, Milk & Milk Products) in India are producing water pollution above MINAS by several times. Though some industries do not generate water pollution directly but these industries produce pollution indirectly in a significant way. Estimation of indirect pollution is necessary, as this would have many policy implications. Thus such a study is needed.

A limited number of industries have been compelled to minimize the water pollution generation. Controlling pollution generation would involve abatement cost, which, in-turn, will affect the price and output of different industries. This needs investigation. Several studies have been conducted [Mehta, Mundle and Sankar (1997), James and Murti (1996), Roy and Ganguly (1997)]. But a quantitative analysis involving interdependence between water pollution and all branches of economic activities is only few. The present researcher (Chakraborty and Maiti 1993,1999) has made a modest contribution in that respect. With detailed and recent data an indepth quantitative study involving the economy and water pollution discharged by different industries is to

be done. The project addresses this problem. The project will make a detailed quantitative analysis of the link between water pollution generated by different industries and various economic activities of the Indian economy.

The present work studies the availability of water resources in India and associated issues. It estimates the total amount of water pollution generation (directly and indirectly) in detail of different sectors of India. It examines the effect of pollution abatement costs on the output and prices of different goods and services of the Indian economy. Further, the work discuss the implications of different proposed policies and estimates the Green GDP.

Though the selection of two research staffs (one Research Associate and one Research Assistant) has been completed on 21st June, 1999, but they joined on 18th August, 1999 due to delay in the arrival of the first instalment of the sanctioned funds.

We would like to submit that, this report, covers the work done during the period (August 1999 to October 2000). Within this period the work has been carried out by two research Staffs (Research Associate Dr. Shibani Maiti and Research Assistant Sanghamitra Majumdar). They have visited different libraries of Calcutta. To collect the required set of data they even visited the Head Office of the Central Pollution Control Board and Central Statistical Organisation, Delhi and National Environmental Engineering Research Institute (NEERI) in Nagpur. They have also helped in model building data analysis and report writing. It would not have been possible for us to submit this report without their sincere and competent research assistance.

We express our sincere thanks for the services rendered by Co-Investigator (Dr. Siddhartha Dutta, Professor, Department of Chemical Engineering, Jadavpur University, Calcutta). He has given us technical guidance. Specially Chapter 5 has been prepared under his guidance.

For the collection of data we have used the facilities offered by the National Library, Centre for Studies in Social Science, CSO Library, Indian Institute of Management, Bureau of Indian Standard, Central Pollution Control Board(Calcutta and Delhi), and NEERI (Calcutta and Nagpur) , Central Library and ,Library Department of Economics, Jadavpur University. We acknowledge with gratitude the services rendered by these organisations.

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DEBESH CHAKRABORTY

Principal Investigator

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Chapter 1

Introduction

Earlier, growth and development topped the development agenda of a nation. Nature and environment were not paid much attention. In recent time, however, the scenario has changed. Now, almost all the countries of the world are becoming concerned with the continued environmental degradation and feel the necessity of controlling further degradation of our environment. As environmental degradation itself poses an increasing threat to the very aspect of economic growth and development prospect world wide, environmental considerations are becoming a part of the overall development policy of every nation.

India, being a developing country, has to resolve massive environmental problems. These are the direct consequences of the very process of development and the range of issues categorized as environmental problems include industrial pollution (i.e. pollution of air, water and soil due to industrial production), vehicular emissions, hospital waste and domestic sewage disposal, etc. At the same time India is also confronted with the global environmental problems, arising from the transboundary pollutants which at least to date are primarily due to economic growth in the industrialised world, which is typical of any developing country. And includes namely green-house effect, acid rain, climatic changes and the threat to the ozone layer. This damaging effect is now so extensive and increasing at such a rapid pace that, apart from politics, pollution is now one of the most widely discussed topic of the world today.

Indian economy, with its present rate of growth of 5% (1997-98), may overcome some of the environmental problems. However, pollution caused due to adoption of developmental measures, will be exacerbated.

Industrial pollution in the form of air, water, solid, thermal pollution, etc., is assuming alarming proportions with each passing day. Thus this category of problems needs immediate attention and calls for appropriate measures before they become severe and get out of hand.

The Indian industries have been producing pollution at much higher rates than the Minimal National Standard (MINAS) approved by the Pollution Control Board of India. Health costs incurred owing to water pollution are extremely heavy and sometimes fatal. It is known from a survey (Chowdhury, 1982) that water pollution causes many deaths in India every year.

India is rich in water resource being endowed with a net work of rivers and vast alluvial basins to hold ground water. Besides India is blessed with snow cover in the Himalayan range which can meet a variety of water requirements of the country. However ,with the rapid increase in the population of the country and the need to meet the increasing demands for irrigation , human and industrial consumption , the available water resources in many parts of the country are getting depleted and the water quality has deteriorated.

Water, an abiotic component of our environment, though indispensable and playing a pivotal role in our lives is one of the most badly abused resources. Water pollution is any physical or chemical change in water that can adversely affect organisms. Water pollution is caused due to variety of factors - e.g., industrial effluent generation, household sewage disposal, agricultural activities. Effluent of organic and inorganic pollutants from industrial activities are a major cause of water quality degradation. So it is often rightly said that pollution is a by product of regular economic activity. Polluting substances include organic matter, metals, minerals, sediments of solid wastes, suspended solids, bacteria, toxic chemicals, acids and alkali. Pollutants like

ammonia, chloride, sulphide, zinc, phenol, phosphate, chromium, sulphate etc., are also found.

Household sewage disposal often remains untreated. Absence of proper sewage disposal system and poor maintenance of septic tanks generate pollution. Sewage contains various types of organic and inorganic matter, suspended particulate and also different micro organism which reacts to form acids or chemicals compounds. Alkalis and acids create disturbance to the pH value of the water resource.

Extensive use of chemicals in agriculture (in the form of fertilisers and pesticides), household activities (through use of soaps, detergents) and industries, are too the source of ground water pollution. It is often found that toxic chemicals, solid wastes from industry effluents, household sewage and agricultural fields, disposed untreated into neighbouring water source and land, mix with rain water and then seeps into ground water reservoirs, thereby polluting it.

Discharge of heated water mostly from industries, thermal power plants and municipal sewage into rivers and sea causes thermal pollution, damages to aquatic life and create taste and odour problems, thus leading to ecological disturbances of water.

Water quality and pollution level are generally measured in terms of concentration or load - the rate of occurrence of a substance in a aqueous solution. BOD (Biochemical oxygen demand) measures the strength of an organic waste in terms of the amount of oxygen consumed (by the micro organism in water) in breaking it down. This is a standard water treatment test for the presence of organic pollutants. Moreover , a number of physical and chemical parameters (which defines the water quality) such as Ph, DO (dissolved Solids, total Solids, inorganic trace elements, that also needs to be monitored for proper assessment of water quality is quite large . Hence , it will be more

convenient to integrate the data pool in some way to produce a single number to reflect the water quality status. Water quality index (WQI) achieves the result.

Water quality Indices have been developed differently by different experts (in the concerned field of water quality management) like - Horton, Robert K ; Robert M Brown, Welsh Parker, David G. Smith , Ved Prakash, Nguyen Trung - as mentioned by Prof. Abbasi (1999).

A significant number of industries (Livestock's, Oil Refineries, Coal & Lignite, Chemical industries, Distilleries, Man made fibre, Paints & Dye, Leather, Textiles, Paper, Fertilisers, Milk & Milk Products) in India are producing water pollution above MINAS by several times. We are able to know the direct pollution generation of these industries from different Government and Semi-Government publications of India and from other sources. An economy consists of a large number of industries. These industries do not exist in isolation from each other, rather are inter dependent. This inter dependence arises from the fact that the output of an industry is generally required as an input by another industry. Though some industries do not produce pollution directly but these industries produce pollution indirectly in a very significant way. A limited numbers of industries in India have been compelled to minimize the pollution generation in industries. Even if a single industry, for example, Chemical industry tries to control the pollution generation by it, production cost is bound to increase. Such an increase in production cost will effect the market price of the product of Chemical industries. Since the products of this industry is being used by other industries, they will also be affected. In this way the prices of all the sectors will also be affected. Pollution Control Scheme will also influence the demand for output of different products which are used as inputs in the above schemes.

The industries are becoming increasingly conscious of environmental problems. The pollution abatement activities alternatively clean water production involve cost, which in turn, will affect the price and output of different industries. There have been several studies [Rossi, Young and EPP(1979), Fraas and Munley(1984), Subrahmanyam (1990) Mehta, Mundle and Sarkar(1993) James and Murty(1996), Mehta , Mundle , & Shankar (1997), Roy and Ganguli(1997), Goldar and Panday(1997), Goldar and Mukherjee(1998) and Misra(1998), Pandey (1999) on the cost of pollution abatement for industries in India in which the cost behaviour has been analysed with the help of an estimated abatement cost function. Some of these studies have used a Cobb-Dougals function, while some others have made an attempt to use the Transcendental Logarithmic(translog) functional form.

Engineering analysis of waste water treatment systems suggest that the principal determinants of abatement cost are the volume of waste water stream, the concentration of pollutants in the effluent stream [Fraas and Munley (1984) , Subrahmanyam's (1990)]. Subrahmanyam's study provides information about production process and waste water treatment alternatives in the Indian paper and pulp industry. His study shows that , depending on the production process, product mix and materials used, waste water flow in large paper mills on an average is 220 m^3 of wastes per tonne of paper contains 168 kg of suspended solids, 65 kg of BOD and 246 kg of COD. Based on these considerations Mehta, Mundle and Sankar (1993) have specified a general form for the operating abatement cost function as

$$C = f (F, I, E,P)$$

where

C = operating cost of waste water treatment,

F = flow size of the waste water stream,

E = concentration of pollutants in the effluent stream,

I = concentration of pollutants in the influent stream and

P = vector of prices of variable inputs used in waste waster treatment.

They have identified four major pollutants in the waste water stream, i.e. , BOD, COD, PH and SS. The variable inputs used in waste water treatment are power ,Chemicals and labour. Using an engineering cost function they have estimated the marginal cost of BOD reduction using plant level data of 22 paper and pulp firms.

While environmental concerns have figured prominently in public policy in recent years, not many studies are available to guide formulation of policy in terms of whether incentives or regulations should be viewed as alternatives or as complementary for protecting the environment and controlling pollution resulting from industrialisation and growth. The study which was carried out by a team consisting of Mehta, Mundle and Shankar has assessed the efficacy of alternative instruments with specific reference to waste water treatment. In this study four alternative pollution control regimes were proposed. The first of the four alternative pollution control regimes proposed in this study is a system of abatement charges with the government undertaking clean-up operations through public agency. Firms which satisfy existing source-specific standards (MINAS) pay no charge. Those who violate the standards pay a charge proportional to the volume and concentration of discharge to the public agency. The main limitation of option 1 is that it is excessively dependent on government intervention. Option 2 is a variant where the government still levies a charge on standard violators but contracts out cleaning operations to a third party on the basis of competitive bidding. Option 3 is a typical Pigouvian tax-cum-subsidy scheme. a tax

proportional to excess pollution will be levied on all firms violating MINAS while those going beyond the MINAS level of abatement could be subsidised. The last option is a private permits system. In each of the four alternative pollution control regimes, the marginal cost of abatement plays a central role. It is the explicit anchor for setting charges or taxes and subsidies in the first three options. In the fourth options firms would abate up to the point at which the marginal costs along their respective abatement cost functions are equalised with the market clearing price for pollution permits in the secondary market. Abatement cost functions for BOD reduction were estimated on the basis of a sample of paper plants. The charges/taxes were computed on the basis of marginal abatement cost at the MINAS level for relatively high cost firms. The study lays out certain prescriptions but its main purpose is to survey the literature, suggest feasible approach to pollution control policy and also draw attention to the lack of adequate information and experience in the area. One major premise of the study is that further work and experimentation on a pilot basis are needed to arrive at definitive judgements about the efficacy of incentives vis-à-vis physical regulation as policy instruments in pollution abatement.

The study by James and Murty (1996) has estimated marginal abatement cost using plant level data of 82 firms drawn from 17 major polluting industries identified by the Central Pollution Control Board (CPCB) of India. This study has used the ratio of influent and effluent concentration in the cost function. This cost function can be written as

$$C = f (Q_1 , q_1 / q_e) .$$

The cost function given by Pandey (1999) is close to the specification used by Mehta, Mundle and Sankar (1993). She has made an attempt to estimate abatement costs by analysing plant level data on costs of water pollution abatement in sugar industry. The data used in this study is

in respect of 53 firms. Here the Cobb-Dougals functional forms are used in estimating the abatement cost functions. The cost functions are given as :

$$C = e^{a+b} (Q_i ... q_i)^c (Q_E .. q_E)^d Q_i {}^e P_L P_K {}^g e^u$$

$$c , e, f, g > 0 > d$$

$$C = e^{a+b} Q_i^c \{(q_i - Q_E)/_{q1}\}^d P_L {}^e P_K e^u$$

$$c, e , f > 0$$

Where ,

C = Total cost of treatment

Q_i = Volume of influent

Q_E = Volume of effluent

q_i = Concentration of pollutants in influent

q_E = Concentration of pollutants in effluent

P_L = Annual wages of Labour

P_K = Price of Capital

u = Error term

The marginal abatement cost equations are derived from the total abatement cost function. The analysis in the paper by Pandey demonstrates in case of firms in sugar industry a theoretically sound methodology of determining a set of tax rates to effectively enforce the existing source standards for water quality. Such an analysis can be extended to other polluting industries. The analysis point out the loophole in the existing legislation (MINAS) and suggests the pricing of water be rationalised. Further ,pollution tax would require periodic revision based on consideration such as firms, response, inflation advent of new technology (changes in firms ' production function). Also, as pollution causing activity rises and source specific standards are more stringent in order to maintain the same ambient standards ,pollution tax will have to be revised from time to time.

Study by Roy and Ganguli (1997) attempts to evaluate the efficiency of the standards for controlling BOD and COD of large pulp and paper mill effluent to maintain water quality. Using secondary data on water pollution audit by BICP for large pulp and paper mills, an attempt has been made to estimate marginal cost of abatement curves of BOD-5 and COD of different firms. A large variety of firms with scale of production varying from 40 tonnes per day to 300 tonnes per day, producing a wide variety of paper and paper products, have been covered for estimating marginal cost of BOD-5 removal . Similarly, different large scale firms with capacities ranging from 54 tonnes per day to 255 tonnes per day for estimating marginal cost of COD removal have been studied. An engineering cost function has been estimated using OLS estimator.

The focus of Goldar and Mukherjee's (1998) paper is on methodological and estimation issues for water pollution abatement cost function. They have also suggested an alternative approach to specifying the production function for abatement activity that avoids all these problems and derive the associated cost function.

The study by Misra (1998) provides empirical evidence on economies of scale in water pollution abatement activity at Nandesari Industrial Estate comprising 250 small-scale factories. The study shows that the cost burden of water pollution abatement is much higher for small factories providing greater cost advantage to treat effluents jointly in a Common Effluent Treatment Plant (CETP).

Further , clean water production as resultant of environmental deterioration, clearly has an adverse impact on human welfare. Hence , there is a wide measure of agreement that the conventional system of National Accounts is no longer adequate as a means of measuring the impact of environmental changes on income and welfare. It is so because, the conceptual basis of the National Account is governed by the definition of income and wealth which did not make any allowance for depletion of natural capital or the cost of environmental damage such as pollution. The treatment of environmental issues in the accounting framework was initiated by Nordhares and Tobin (IGIDR,1992) in the United States and the work on developing a natural resource accounting frame work began in Norway in 1974 (Pearce,1989). Physical accounting of resources was later followed by French (beginning 1978) and Canadian government also. The system of Integrated Environmental and Economic Accounting as complied in United Nation's Hand book of National Accounting - Integrated Environmental and Economic Accounting - An Operational Manual (1999), was tested in Canada , Colombia, Ghana, Indonesia, Japan , Mexico, Papua , New Gunea, the Philippines , the Republic of Korea, Thailand and the USA. A frame work of NRA (Natural Resource Accounting) of India was prepared by IGIDR in 1992 who has taken guide lines from United Nations (IEEA,1993).

The main objectives of the paper by Dasgupta and Murty (1985) are to explore some problems related to the control of external diseconomies (damages) inflicted on water resources by various developmental

activities. Their study has shown that paper and pulp industry in India contributes significant environmental pollution which requires additional resources to abate it . The choice between big and small paper mills has implications for environmental pollution. Available technology provides various options for water pollution abatement including process changes in paper production, quality changes and end of the pipe treatment methods. Estimates of costs of water pollution abatement for big and small paper mils show that the comparative capital and operation costs per tonne of paper for the small paper mill is more than double that for the big mill. Pollution abatement costs for big and small paper mils at shadow prices are significantly higher than those at market prices. The estimates of pollution abatement costs of paper mills at shadow prices reveal returns to scale. Water pollution abatement plants of big and small paper mills use significant amount of land which may be otherwise used in agriculture. In this study the opportunity cost of land has been made using farm accounts for Punjab state. They have also attempted an economic evaluation of alternative water pollution abatement technologies as per standards. This study also has mentioned some policies (a tax -subsidy scheme, Discriminatory taxes as a practical proposition, a uniform pollution tax) for the control of water pollution in paper industry. They have suggested that none of these policies can be regarded as a first-best solutions for the control of water pollution , a first best policy has to be designed taking into account both the marginal cost of pollution abatement for all polluting industries (paper as well as others) and the marginal damage to receivers.

James and Murty (1996) have suggested the use of incentives based policies as the most efficient technique for the control of environmental pollution. A seminar organised by FIICI in 1990 by Panandikar (1995) on water pollution control of different Indian industries. The papers mostly dealt with the types of pollution generated in the different industries ,the sources of pollution generation I.E, the process / stages of production

which discharges waste water , different methods /schemes taken by the industries in control / abatement of pollution's and recommended few policies respective to it. The paper by Ecological Economic Unit of Institute for Social and Economic Change (1999) presents and overview the present status of the natural resource environment in Karnataka, namely , forest cover and pastures , land use , Soil erosion , watershed development ,livestock and fisheries ,reserves of mineral ores and their exploitation, industrial pollution and urban environment. Apathy of the government machinery towards these environmental problems has provoked popular movements linked to people's access to natural resources and to health concerns. They also compare the different environmental situation in Karnataka with the country as a whole.

After surveying the main trends in environmental policy from an international prospective , a study has been done by Kuik, Nadkarani, Oosterhuis, Sastry and Akkerman (1996) who have described the various environmental policy instruments adopted in India and Netherlands to control water pollution . These instruments are assessed in terms of effectiveness, administrative burdens, and financial costs. This analysis is supported by in-depth case studies from the textiles ,cement and fertiliser industries of both countries which reveal both the differences and similarities in pollution control policies between the countries. El-Tayeb ,Cummings and Siddique(1995) have suggested that low waste technologies (LWTS) are financially viable and can create revenue for the firm. They also suggested a general framework to be used to evaluate the financial costs and benefits of LWT. Their study supported for the theoretical presuppositions regarding the profitability of LWT. They concluded with their suggestions of ten stages for the evaluation of profitability of LWT. They derived it mainly from their experience and review of current literature on LWT.

A different type of study has been done by Stephenson (1997). He showed in his study that a variety of organic contaminants can potentially have impact on aquatic birds by their affecting surface tension. Avian plumage constitutes a porous barrier to water and the air tapped between the feathers serves as thermal insulation.

Apart from these , mentione , may be made about the studies on pollution Control Acts by Desai (1993) and Central Pollution Control Board (1988). In the volume by Central Pollution Control Board an effort has been made to compile the Acts and Rules concerning protection and improvement of the environment by the Department as well as the Pollution Control Board at the Central and State levels.

Besides above mentioned works a considerable number of studies have been conducted by Parikh and Parikh(1997), Parikh, Muraleedharan and Halder and by Murty, Panda and Parikh(1997) on environmental economics.

But a quantitative analysis involving interdependence between water pollution and all branches of production and consumption of an economy is only few. Maiti (1994), Maiti and Chakraborty (1989,1993a, 1993b) have made a modest contribution in this respect. They have studied the water pollution problem and the structure of Indian economy in an Input-Output framework. They have analysed in their work the amount of different types of water pollutant generated directly and indirectly in different industries of India. In an another work (1993b) they have analysed the amount of different types of water pollutant generated directly and indirectly in different energy sectors. Some simulations studies based on alternative assumptions have also been done in the work. Further ,they (1999) have also studied the effect of cost of pollution control on the economy.

All their works relate to the year 1979-80 and are of preliminary nature, the availability of the data being a serious constraint. But in recent years the situation has changed. With detailed and recent data an in-depth quantitative study linking the economy and water pollution by different industries of the Indian economy is to be done.

The purpose of the present work is to contribute to this area. The study attempts to make a detailed quantitative analysis of the link between water pollution generated by different industries and the various economic activities of the Indian economy.

Objective Of The Study

The objectives of the present study are

(a) to study the total amount of water pollution generation directly and indirectly in details in different sectors of India,

(b) to develop a water quality index.

(c) to study the effect of pollution abatement scheme on the output and prices of different goods and services and also on the final consumers of the Indian economy,

(d) to suggest some policies and also to study the implications of such policies on pollution generation and pollution management in India.

Arrangement Of The Report

A study on the availability and consumption aspects of water resources has been made in **Chapter 2**. The theoretical model adopted for the present study is outlined in **Chapter 3**. Coverage and analysis of data are

included in **Chapter4. Chapter 5** develops the water quality index. Experiment with model I and discussion on its results has been done in **Chapter6**. In **Chapter 7** we have experimented with model II and made discussion on its results. Certain policy simulation exercises on the basis of alternative assumptions are carried out and the results are presented in **Chapter 8. Chapter 9** has been devoted to find out the Environmentally-Adjusted National Income Account. Summary and recommendations are made in **Chapter 10**.

Chapter 2

Water Resources Of India

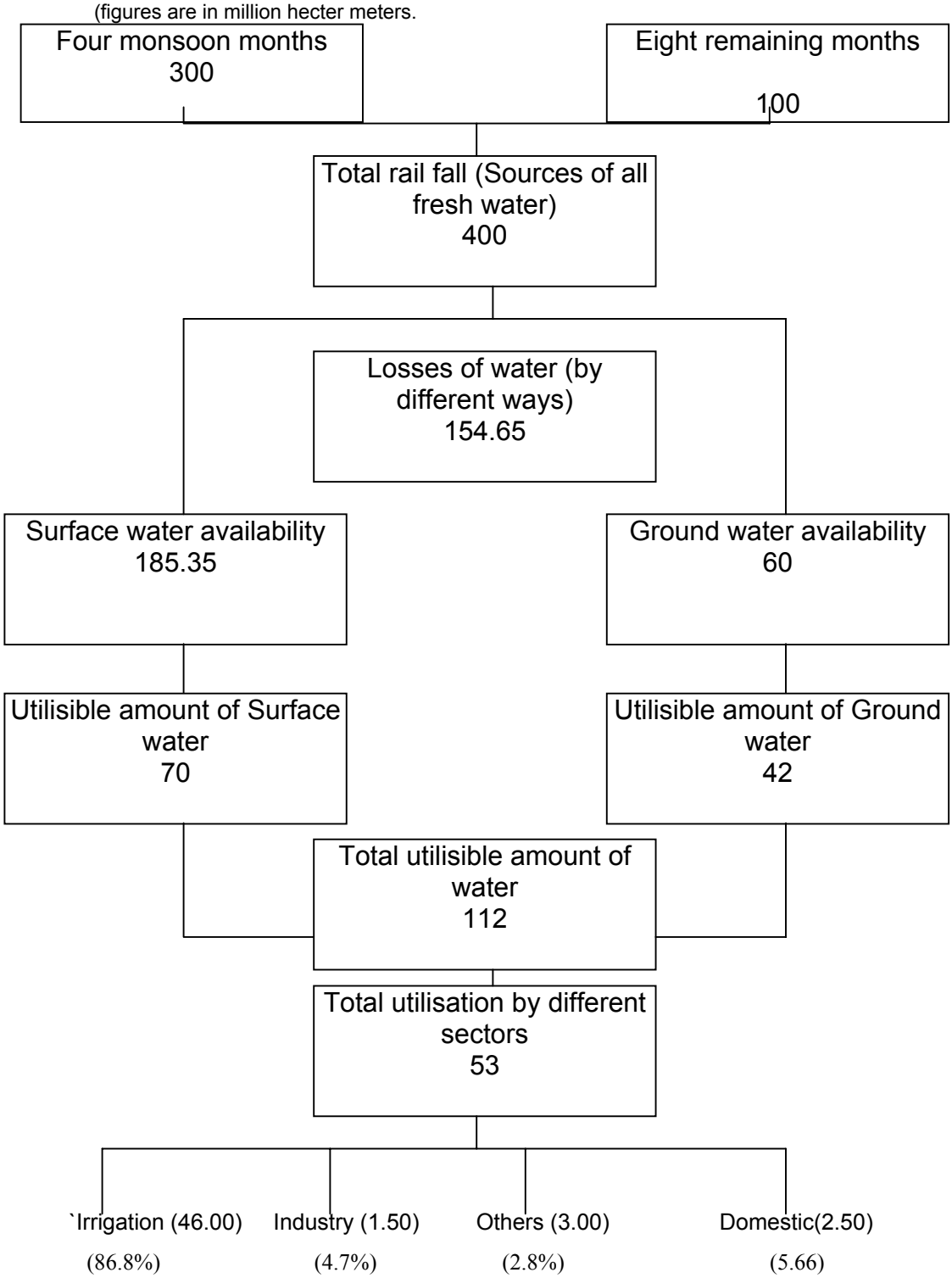
India is rich in water resources, being endowed with a net work of rivers and vast alluvial basins to hold ground water Besides, India is blessed with snow cover in the Himalayan range which can meet a variety of water requirement of the country. However, with the rapid increase in the population of the country and the need to meet the increasing demands for irrigation, human and industrial consumption, the available water resources in many parts of the country are getting depleted and the water quality has deteriorated.

2.1 Water Resources Availability And Consumption In India

Water resources can be classified into two broad categories namely ground water resource and surface water resource. The precipitation which does not infiltrate into the ground ,form surface water while deep percolation of water through soil strata eventually becomes a part of ground water.

It is difficult to prepare an accurate national picture of India's water resources because accurate field data is almost non-existent. Till now we have no arrangements in this country to compile and publish on an annual basis (CSE,1982) , comprehensive data regarding various aspects of water which are important for policy analysis and programme formulation. However, data which are available have been put together and discussed. For better understanding a flow chart has been constructed to give a clear picture about the total availability of water resource and its distribution for different purposes as illustrated in figure 2.1. It appears from figure 2.1 that the total availability of water resource is 400 mham. Out of this 400

FIG 2.I : Flow Chart of the overall water resources availability of India fort the year 1989-90.
(figures are in million hecter meters.



Source : 1) Centre for Science and Environment, 1982.

2) Prof. Balaram Basu, School of Water Resources, Jadavpur University, Calcutta.

The 400 mham of rainfall that India receives every year are distributed in three basic ways: 70 mham evaporate immediately ,115 mham run off into the surface water bodies and 215 mham percolate into the soil.Out of the 215 mham percolating into the soil, 165 mham moisten it and the remaining 50 mham enter to the ground water table. Total surface water availability is 185.35 mham and maximum utilizable amount of surface water is 70 mham , utilisation efficiency of surface water is only 38%.

On the other hand, ground water availability is 60 mham and maximum utilizable amount of ground water is 42 mham. In this case, total utilisation efficiency is 45%. Total utilisible amount of water from both the sources is 112 mham. From this amount only 53 mham of water is used by different sectors of India in the year 1989-90. (Figure 2.I).

It appears from the figure 2.I that main demand for water is for irrigation. In 1989-90, irrigation used about 86.8% of water. Domestic and industrial uses accounted for the remaining 13.2%.

2.2 Overuse And Misuse Of Water Resources

The wastage of water is large . We overuse water in all activities. It is very difficult in India to get an estimated wastage of water for different activities. However, one study has estimated wastage of water in various consumptive uses (Briz – Kishore, 1992). Accordingly, in domestic use such as drinking, bathing, cooking, washing ,cleaning and gardening about 16-25% of water is over used. While in industry and workshop about 20%,

commercial establishments 10%, transportation including road rail and air transport and storage 15-25%, public services like government offices, courts, police etc. 10-25%.

TABLE 2.1

TOTAL WATER AVAILABILITY AND CONSUMPTION OF WATER RESOURCES OF INDIA FOR THE YEAR 1989-90.

(figures in lakhs rupees)

1.Total amount of water resource : 182291.36[a] + 339722.49[b]

=522013.85

2. Consumption of water resources by different sectors

Name of the sector	Amount	Percentage
1. Agriculture + Irrigation	364 + 339722.49 = 340086.49	65.15%
2. Industry	58316.59	11.17%
3. Electricity	7442.00	1.43%
4.Domestic	116168.77	22.25%
Total	522013.85	100%

Source: (1) Input-output Transaction table 1989-90, CSO.
(2) 'a' Input – Output Table(1989-90).
(3) 'b' Ninth Five Year Plan ,1997.

2. 3 Damages To Water Resources

Flowing water streams have self-purification capacity. They replenish their oxygen depletion over a period of time. But inadvertent discharge of wastes may cause severe oxygen deficiency and rate of recuperation may not be enough due to overloading of biological contaminants. As long as human activity is at a level below the regeneration capacity of the natural environment there is no secular decline in the quality of these resources. However, with increasing population and economic activity, the quality of the environmental resources can no longer be taken for granted.

2. 4 Problems Of Water Pollution

Broadly, water pollution can be classified as physical, chemical and biological pollution. Dissolved Oxygen (Do), total dissolved Solids (TDS), suspended Solids (SS), Zinc (Zn), Oil and grease, Bio-chemical Oxygen demand (BOD), chemical Oxygen demand (COD) are the major parameters to ascertain the Quality of Water.

An economy consists of a large number of sectors. These sectors do not exist in isolation from each other , rather are inter- dependent . This inter dependence arise from the fact that the output of an sector is generally required as an input by another sector. Though some sectors do not produce pollution directly but these sectors produce pollution indirectly in a very significant way. Details of different aspects of water pollution need to be studied. In this study an attempt has been made to discuss these in the following chapters, using the methodology of interdependence among sectors of the economy under the frame work of Input-Output Technique of Leontief ((1970). A significant number of industries in India have been compelled to minimise the pollution generation in industries . As a result of pollution control , production cost is bound to increase . Such an increase in production cost will affect the market price of all the sectors of the economy which will also affect the total demand for output of different

goods and services. Overall effects of pollution control schemes on the economy of India require in-depth study. An attempt has also been taken in this direction.

Chapter 3

The Methodology

In this chapter we shall present the methodology which will be used in this work. The frame work is an extension of the basic Input-Output model of Leontief . Input-output model primarily deals with methodology of analysing interdependence among the different sectors of the economy. Thus it becomes a tool to measure inter-sectoral, inter-relationship. In input-output analysis, the economy is broken up into sectors and flows of goods and services among these sectors are recorded, to study the relationship among them in a systematic and quantitative manner.

3.1 The Basic Input-Output Model

The basic Input-Output model can be explained by considering a simple hypothetical economy consisting of 'n' sectors. These 'n' sectors would be interdependent in so far as they would purchase inputs from and sell outputs to each other.

The Input-Output matrix presents inter-industry flows of intermediate inputs among the various sectors of the economy. A column records all the inputs required from the various sectors in the production process of a particular activity, while a row describes the material flows from a particular sector to different sectors. A technology coefficient matrix is derived from the input-output transaction matrix by dividing all elements in the input column by the output level of a sector represented by the column. Thus, if $A = (a_{ij})$ is the input-output coefficient matrix, then a typical element 'a_{ij}' represents the amount of input 'I' required to produce one unit of output 'j'. The direct input-output coefficient matrix is of course,

the core of the model. Since total output is equal to interindustry sales plus final demand, we have

$$X = AX + Y \qquad (3.1)$$

From which

$$X = (I - A)^{-1}. Y \qquad (3.2)$$

is easily derived. This gives the solution for the output vector 'X' given the final demand vector 'Y' and the technical matrix 'A'.

Here

A = n X n matrix of input-output coefficient matrix

X = n X 1 vector of output

Y = N X 1 vector of final demand

I = n X n identity matrix

3.2 Pollution Model

The input-output framework has been extended here to account for water pollution generation.

To study water pollution generation associated with interindustry activity let us consider a matrix of pollution output coefficient, denoted by, W [W_{kj}], each element of which is the amount of water pollutant type 'K', (for example, chloride, sulphide) generated per Rupee's worth of industry 'j's' output. Hence ,the level of water pollution associated with a given vector of total outputs can be expressed as

$$R = WX \qquad (3.3)$$

Where R is the vector of pollution level. Hence by multiplying the traditional Leontief's inverse matrix $(I-A)^{-1}$, we can compute $R^{/}$ that is, the total pollution of each type generated by the economy directly and indirectly by different sectors.

$$R^{/} = W (I - A)^{-1} \qquad (3.4)$$

Here

$R^{/}$ is the direct and indirect water pollution coefficient matrix of different sectors (K X n)

W is the direct water pollution coefficient matrix of different sectors (K X n)

$(I - A)^{-1}$ is the Leontief matrix multiplier of different sectors (n X n).

3.3 MODEL II

3.3.1 MODEL IIa

The model has further being extended to incorporate pollution abatement cost. Incorporating the cost data into the input-output framework applied in our present work, for assessment of abatement cost of direct and indirect pollution and its impacts on output and prices of the economy, is the problem dealt herein.

As first step towards solving the problem, attempts have been made to extend the conventional input-output framework to cover not only production and consumption of ordinary goods and services, but also generation and elimination of water pollution based on Leontief's work in 1970 (Leontief, 1970). It has been achieved by introducing an additional row for water pollutants giving the amount of pollution produced by each

sector per unit of output and a column for antipollution giving the amount of input required from each sector. And this can be presented in the matrix form as formally described below

$$\left[\begin{array}{c|c} I - A_{11} & -A_{12} \\ \hline -A_{21} & I - A_{22} \end{array}\right] * \left[\begin{array}{c} X_1 \\ \hline X_2 \end{array}\right] = \left[\begin{array}{c} Y_1 \\ \hline Y_2 \end{array}\right] \tag{3.5}$$

or,

$$\left[\begin{array}{c} X_1 \\ \hline X_2 \end{array}\right] = \left[\begin{array}{c|c} I - A_{11} & -A_{12} \\ \hline -A_{21} & I - A_{22} \end{array}\right]^{-1} * \left[\begin{array}{c} Y_1 \\ \hline Y_2 \end{array}\right] \tag{3.6}$$

where,

A_{11} is the original input-output matrix (without abatement)

A_{12} is the input structure coefficients of anti pollution activities

A_{21} is the matrix of direct pollution output coefficients

A_{22} is the pollution output coefficients matrix for the anti pollution activity

X_1, Y_1 are respectively the original output and final demand vectors (without abatement).

X_2, Y_2 are respectively the total output and final demand for the abatement sector.

A point of discrepancy relating to a negative sign in the last row, led to the formulation of the model from a different angel (Quyam, 1991).The discrepancy arises because

$-A_{21} X_1 + [I-A_{22}] X_2$

should have resulted in '$-Y_2$'. As $[I-A_{22}]X_2$ denote the total amount of pollution eliminated and sum of $[A_{21}\ X_1]$ denote the total amount of water pollutants generated by the economy, the total amount tolerated i.e., 'Y_2' given by the difference between the former two should have a negative sign.

The model thus formulated can be dealt with in a straight forward manner by introducing a sector of clean water instead of a pollution producing sector with negative entries and a anti - pollution sector. With this alternative designation 'X_2' will be the total amount of clean water produced through pollution abatement activities. This 'X_2' is the same as in the previous treatment, because the amount of water pollution eliminated is equivalent to the amount of clean water produced. And the amount of final delivery of clean water, however, is the opposite of the amount of pollution tolerated by final consumers. That is, if we denote the amount of final delivery of clean water by 'Y_2*' it will be equivalent to '$-Y_2$' of the earlier case.

With this slight reformulation the discrepancy arising due to the negative sign gets solved and the model stands at the same place, as in equation – (3.6). And the interpretation of A_{11}, A_{12}, A_{21}, A_{22}, X_2 and Y_2 becomes as follows

A_{11} is the original input-output matrix (without abatement)

A_{12} is the input structure coefficients of 'clean water ' sector.

A_{21} is the matrix of direct clean water output coefficients

A_{22} is the clean water output coefficient matrix for clean water production

X_2, Y_2 are respectively the total output and final demand for the clean water sector.

Then from the model the impact of the abatement cost on the output can be studied.

3.3.2 Model lib

For expressing the effect of pollution abatement cost on prices of different goods and services, the original input-output model has similarly been extended to account for the 'clean water' sector, as described above in case of output model, and formally presented below

$$\begin{bmatrix} P_1 \\ P_2 \end{bmatrix} = \begin{bmatrix} I - A_{11} & -A_{21} \\ -A_{12} & I - A_{22} \end{bmatrix}^{-1} * \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} \tag{3.7}$$

where,

P_1 is the prices of different goods and services

P_2 is the prices of producing one unit of clean water

ν_1 is the value added coefficients of different products

ν_2 is the value added in clean water sector per unit of clean water produced.

And A_{11}, A_{12}, A_{21}, A_{22} has the same interpretation as discussed earlier in case of output model.

Chapter 4

Data

To work into the various types of water pollutants generated by the different industries of India with the help of the methodology as developed in Chapter 3 we need appropriate data. In this chapter we shall discuss the data. The present study is based on the secondary data. The major data required for the work are

a. the Input-Output table.

b. the different types of water pollutants generated by the different industries of India.

4.1 Input-Output Data

The study has used the latest input-output table of India (1989-90) prepared by the CSO (1997). This table consists of 115*115 sectors. For the sake of convenience the input-output table has been aggregated into 32 sectors. The list of the sectors is shown in table 4.1. Sectors which have a relatively high level of water pollution generation (Livestocks, Oil Refineries, Leather, Paper, Chemicals, Food products etc.,) are presented as separate sectors. But the other sectors have been aggregated.

Table 4.2 presents the aggregated Input-Output Table and the aggregation scheme is given in the Appendix No. 1.

Table 4.1

List Of The Sectors

1. AGRICULTURE
2. MILK & MILK PRODUCTS
3. LIVESTOCK PRODUCTS
4. FISHING
5. COAL & LIGNITE
6. MINING & QUARRYING
7. SUGAR
8. EDIBLE OIL & VANASPATI
9. BEVERAGES
10. OTHER FOOD PRODUCT
11. OTHER TEXTILES
12. WOOLEN TEXTILES
13. JUTE TEXTILES
14. MAN-MADE FIBRE
15. PAPER
16. LEATHER PRODUCTS
17. RUBBER PRODUCTS
18. PETROLEUM PRODUCTS
19. INORGANIC CHEMICALS
20. ORGANIC CHEMICALS
21. FERTILISER
22. PESTICIDES
23. PAINTS
24. DRUGS AND OTHER CHEMICALS
25. NON METALLIC MINERALS
26. IRON AND STEEL
27. MISC. MANUFACTURING
28. OTHER INDUSTRIES
29. CONSTRUCTION
30. ELECTRICITY-GAS WATER SUPPLY
31. TRANSPORT AND COMMUNICATION
32. SERVICES

TABLE 4.2
AGGREGATED INPUT-OUTPUT TABLE OF INDIA FOR THE YEAR 1989-90 (at1989/90 price)
(figures are in lakhs Rupees)

	Sectors	1	2	3	4	5	6	7	8	9	10
1	AGRICULTURE	1065818.24	378654.40	773625.88	259.51	4.73	0.00	376979.56	511751.11	144449.04	290603.08
2	MILK & MILK PRODUCTS	3102.60	2661.38	108.38	17.93		0.00	96.71	926.02	1087.34	178717.10
3	LIVESTOCK PRODUCTS	704963.65	0.00	427.42	0.00	0.00	0.00	350.10	742.52	375.75	62967.67
4	FISHING	529.53		18.50	6293.91		0.00	16.51	158.22	187.78	30504.28
5	COAL & LIGNITE	1998.60		1.81		6422.10	93.87	1512.12	1425.59	5392.00	3320.01
6	MINING & QUARRYING	71.85	0.00	0.00	0.00	5873.62	522.75	2239.50	10.64	1347.83	1159.07
7	SUGAR	1160.47	0.00	35.85	0.00	0.00	0.00	1331.15	314.11	7054.90	59318.86
8	EDIBLE OIL & VANASPATI	1099.22	37307.36	53052.08	0.00	0.00	0.00	1.15	18641.26	11.70	1637.43
9	BEVERAGES	66.20	0.00	0.71	0.00	0.00	0.00	5.87	6.35	44441.90	1398.86
10	OTHER FOOD PRODUCTS	717.32	2565.50	16689.37	1853.30	0.00	0.00	157.06	885.05	7308.98	25532.31
11	OTHER TEXTILES	3862.50	22838.69	1675.41	11882.75	70.34	0.00	1464.24	6063.68	425.77	2620.90
12	WOOLEN TEXTILES	5.22		0.00			0.00	0.00	18.27	0.00	0.00
13	JUTE TEXTILES	3690.01		1.75	701.23		0.00	8727.04	718.16	166.35	4057.51
14	MAN MADE FIBRE	11.66		0.00			0.00	0.00	737.08	5.64	764.62
15	PAPER	3386.93	0.00	12.40	68.05	1188.61	74.88	827.40	1101.60	5368.89	33017.56
16	LEATHER	17.66	0.00	0.00	0.00	0.00	0.00	0.00	4.46	0.00	16.37
17	RUBBER PRODUCTS	2013.13		0.00		299.74	10.11	12.84	10.93	50.19	36.89
18	PETROLEUM PRODUCTS	103707.50	0.00	6.67	11555.10	15522.69	16125.97	2907.07	1510.39	1214.88	13654.99
19	INORGANIC CHEMICALS	168.82		0.64	14.71		1123.66	1045.51	1409.92	1646.55	1126.52
20	ORGANIC CHEMICALS	319.02		0.62	4.03		0.00	3757.65	1603.66	1192.12	1413.82
21	FERTILIZERS	724704.39		0.00			0.00	0.00	376.26	0.00	2237.90
22	PESTICIDES	78960.59		0.00			0.00	0.00	40.97	0.00	453.26
23	PAINTS	17.87		0.00			0.00	31.73	552.66	35.63	80.60
24	DRUGS & OTHER CHEMICAL	202.00	1251.39	4697.55	745.95	20062.17	2184.55	808.74	6980.80	1353.01	9635.24
25	NON METALLIC MINERALS	151.56	0.00	0.90	0.00	0.00	9770.78	2429.18	120.87	2843.22	1634.35
26	IRON & STEEL	320.91	0.00	0.00	244.75	0.00	0.00	175.30	106.74	174.28	68.89

27	MISC. MANUFACTURING	120271.17	401.56	1892.20	15109.69	83628.64	24091.91	6392.78	3365.59	7362.89	22809.61
28	OTHER INDUSTRIES	1088.87	0.00	5.50	1835.05	2970.54	389.82	374.98	2586.58	8169.33	11408.44
29	CONSTRUCTION	221222.59	1134.87	4257.99		1096.03	3388.25	867.89	378.89	248.96	1238.95
30	ELECTRICITY-WATER-GAS SS	110958.18	0.00	4.34	175.41	37330.07	11586.44	6456.28	8677.89	6925.94	8905.96
31	TRANSPORT & COMMUNICATION	134312.35	10202.07	20712.29	2144.54	15698.15	3730.41	7161.41	11413.34	24175.59	28796.52
32	SERVICES	436346.21	80126.42	140973.66	10258.00	43169.86	34143.53	101434.45	59150.45	44813.28	156833.62
	Total Input at Factor Cost	3725266.83	537143.64	1018201.92	63163.91	233337.29	107236.94	527564.20	641790.05	317829.75	955971.20
	Net Indirect tax	-320224.19	9142.44	13670.60	6744.70	33652.64	18691.37	12659.96	22338.81	21327.49	57398.67
	Total Input(Purchaser Price)	3405042.64	546286.08	1031872.52	69908.61	266989.93	125928.32	540224.16	664128.85	339157.24	1013369.87
	Value added	9487848.76	1931712.97	809350.58	378372.48	324208.58	705941.58	122713.39	44419.92	123668.85	278834.29
	Gross output	12892891.39	2477999.05	1841223.10	448281.09	591198.51	831869.90	662937.55	708548.77	462826.09	1292204.16

Contd… Table 4.2

	Sectors	11	12	13	14	15	16	17	18	19	20
1	AGRICULTURE	412053.14	95.51	48790.65	5785.73	35040.08	2868.54	43467.40	103.87	5024.41	5332.88
2	MILK & MILK PRODUCTS	467.00	0.53			0.72	7.28		0.00	0.56	3.91
3	LIVESTOCK PRODUCTS	43397.66	6501.04	0.38	794.06	216.36	43330.34	120.65	0.00	83.29	81.92
4	FISHING	6.88			7.01	22.43	5.67	30.67	0.00	50.62	43.29
5	COAL & LIGNITE	11859.12	208.21	981.98	787.63	14993.61	233.25	3370.71	52664.14	4905.60	7010.68
6	MINING & QUARRYING	511.17	1.04	0.37	20349.12	543.81	4.55	1027.43	714075.52	7367.68	10857.96
7	SUGAR	1.94	0.00	0.00	23.55	0.00	0.00	0.00	0.00	94.58	656.60
8	EDIBLE OIL & VANASPATI	20.87	0.00	0.00	1.25	0.00	0.00	0.00	0.00	6.63	9.94
9	BEVERAGES	12.25	0.00	0.00	568.57	0.00	96.62	0.00	0.00	43.46	70.70
10	OTHER FOOD PRODUCTS	3822.07	4.44	10.84	76.29	1981.72	71.74	0.00	0.85	120.48	98.15
11	OTHER TEXTILES	915088.87	29862.02	2282.91	13784.72	5959.61	8081.58	25454.29	480.47	320.58	418.79
12	WOOLEN TEXTILES	23268.61	7304.12	1.43	6.26	0.00	2.96	3.90	2.67		
13	JUTE TEXTILES	27419.82	205.21	15312.27	1636.27	3655.10	595.59	225.33	571.01	1070.17	1491.62
14	MAN MADE FIBRE	208517.47	3916.88	90.38	67209.03	3774.80	1251.81	26711.07	559.56	3583.06	5874.31
15	PAPER	16139.50	159.20	188.81	21978.64	256502.67	894.87	1523.97	1329.91	2759.44	9392.32
16	LEATHER	530.06	45.25	0.00	3.30	1.68	84467.06	3384.31	0.00	3.66	2.07
17	RUBBER PRODUCTS	6701.08	24.84	27.60	286.39	103.52	7724.85	3428.46	70.43	24.27	76.42
18	PETROLEUM PRODUCTS	18527.85	296.09	1057.25	3405.64	4502.32	2230.95	3192.67	23405.93	4083.10	9183.34
19	INORGANIC CHEMICALS	13253.32	153.12	107.08	7865.50	14913.52	2070.06	3292.10	329.23	20251.41	24988.20
20	ORGANIC CHEMICALS	27566.81	383.35	209.01	37717.21	6148.76	3728.17	5799.73	336.35	24116.41	46886.79
21	FERTILIZERS	60.55	0.78		2136.53	1.49	0.00	2.44	0.00	2234.49	3767.12
22	PESTICIDES	1.81			5.82	0.00	0.00		0.00	30.74	1018.94
23	PAINTS	45470.43	490.60	100.04	1198.24	13411.75	7301.08	457.83	329.69	967.47	1988.47
24	DRUGS & OTHER CHEMICAL	16723.11	194.04	2656.74	21341.01	13724.21	8472.65	67215.70	2870.38	6021.80	9987.93
25	NON METALLIC MINERALS	2091.53	33.96	105.90	692.60	1081.84	108.49	214.31	74.25	1723.24	1763.16
26	IRON & STEEL	4703.89	50.75	842.42	902.07	1206.75	187.81	947.76	236.73	277.30	561.55
27	MISC. MANUFACTURING	62212.19	1123.70	5456.06	12253.04	31055.73	5652.39	22153.57	5054.62	13710.61	19640.35
28	OTHER INDUSTRIES	17670.57	136.67	140.51	2278.00	2044.86	554.26	1912.33	560.71	2349.05	3037.93
29	CONSTRUCTION	3727.43	53.35	1.00	338.65	575.37	298.12	258.02	229.81	117.92	136.36
30	ELECTRICITY-WATER-GAS SS	163273.55	2062.37	12106.87	28988.43	48847.03	5220.11	13702.93	7832.07	33149.29	45129.23

31	TRANSPORT & COMMUNICATION	141211.43	3378.39	7287.72	14907.42	35651.04	10499.83	14881.98	40560.52	9771.80	15324.24
32	SERVICES	547618.53	16305.43	20587.65	55530.44	115245.40	63289.92	57228.83	92447.73	26450.67	45047.08
	Total Input at Factor Cost	2733930.51	72990.88	118345.88	322858.41	611206.17	259250.55	300008.41	944126.44	170713.79	269882.26
	Net Indirect tax	148518.33	7885.99	5600.03	77109.94	45969.92	21831.09	54443.11	409339.70	24840.94	49516.89
	Total Input(Purchaser Price)	2882448.84	80876.87	123945.91	399968.34	657176.10	281081.65	354451.51	1353466.14	195554.73	319399.14
	Value added	1040311.54	26585.77	50788.61	89554.01	232888.91	83795.17	136956.78	136934.18	41489.54	78121.33
	Gross output	3922760.39	107462.65	174734.52	489522.35	890065.00	364876.82	491408.30	1490400.33	237044.27	397520.47

Contd… Table 4.2

	Sectors	21	22	23	24	25	26	27	28	29	30

1	AGRICULTURE	68.04	1.54	1225.35	163859.97	5115.91	765.08	6840.21	89121.92	248682.41	179.25
2	MILK & MILK PRODUCTS				585.23	3.00		0.93	0.00	208.51	0.00
3	LIVESTOCK PRODUCTS	678.99	72.04	99.33	2482.02	395.18	0.45	8441.35	108.29	6607.33	1500.06
4	FISHING	209.83	0.38	20.29	107.87	75.65	0.13	6280.34	52.16	36.96	0.00
5	COAL & LIGNITE	7697.86	81.57	1305.11	6596.36	68643.75	108191.17	30388.56	622.57	953.61	287423.53
6	MINING & QUARRYING	116225.56	395.16	844.11	3151.22	148048.83	50280.84	73232.26	191.84	313147.87	144723.56
7	SUGAR	2.07	0.00	5.09	8405.14	0.00	0.00	1.96	1.18	88.08	0.65
8	EDIBLE OIL & VANASPATI	0.00	0.00	1.26	2334.20	0.00	0.00	2.75	0.77	21.45	0.00
9	BEVERAGES	0.00	0.00	306.09	208.94	0.00	0.00	0.82	8.06	20.16	0.60
10	OTHER FOOD PRODUCTS	0.00	0.00	56.48	5879.38	164.84	52.02	126.53	58.09	48.07	2.09
11	OTHER TEXTILES	169.85	141.65	594.56	13717.02	1502.74	1018.84	12071.28	5817.70	845.07	562.69
12	WOOLEN TEXTILES				24.65	1.13	0.00	100.21	1.32	16.93	3.41
13	JUTE TEXTILES	20550.95	37.25	9.40	2294.44	29300.84	472.17	2014.06	867.02	11643.75	66.52
14	MAN MADE FIBRE	17.96		8107.76	2797.60	579.83	87.67	65115.10	103786.56	570.53	196.45
15	PAPER	702.59	4362.90	3573.41	61606.63	6230.97	1600.77	43404.80	3692.38	10885.96	3774.29
16	LEATHER	0.00	0.00	1.64	161.80	8.07	4.50	1482.66	150.82	95.22	0.62
17	RUBBER PRODUCTS	24.05	7.71	17.73	988.12	84.69	640.47	76993.10	733.59	2991.19	631.44
18	PETROLEUM PRODUCTS	13727.05	2348.03	2563.73	12343.48	63030.58	86143.77	117168.72	2857.79	116239.70	23961.19
19	INORGANIC CHEMICALS	55056.90	3184.80	19522.72	31410.08	6325.06	3404.69	38645.99	1247.82	290.23	1660.68
20	ORGANIC CHEMICALS	64664.82	4835.56	21829.00	83472.22	11225.55	10980.20	43140.58	13211.59	477.63	140.42
21	FERTILIZERS	63714.65	940.47	1.61	21.86	0.00	0.00	499.05	4.07	14136.82	15.56
22	PESTICIDES	2042.16	23772.93	307.10	19.10	0.00	0.75	188.50	0.00	5808.83	0.00
23	PAINTS	26.28	9.04	23165.55	4008.91	1677.27	1317.60	40365.82	3751.42	85764.00	37.29
24	DRUGS & OTHER CHEMICAL	43237.65	6528.59	26572.17	323854.83	1914.09	1727.31	39334.28	7447.39	536.00	489.20
25	NON METALLIC MINERALS	636.20	675.22	864.84	9912.83	64085.58	7364.80	24727.12	1045.00	592123.12	59.62
26	IRON & STEEL	464.46	59.12	862.55	1296.27	20279.13	646572.23	1002625.15	1592.72	650811.19	2766.13
27	MISC. MANUFACTURING	21429.98	8204.79	20550.60	40365.52	49490.32	297855.66	2161601.33	14942.75	317262.97	62445.52
28	OTHER INDUSTRIES	8293.72	2006.32	2372.97	16689.52	7231.25	2763.06	58855.66	36723.39	113201.58	165.08
29	CONSTRUCTION	204.75	78.95	39.20	623.88	10276.33	3108.66	15101.58	296.04	20392.84	60016.59
30	ELECTRICITY-WATER-GAS SS	39083.53	5170.89	10182.03	43085.62	97275.85	126176.85	315120.63	16090.35	25853.47	553780.45
31	TRANSPORT & COMMUNICATION	30410.22	3023.42	10390.68	52025.14	111634.95	155853.86	379243.95	20158.72	294679.96	179700.86

32	SERVICES	90863.09	13741.14	39418.91	193003.54	137959.38	265466.46	1128447.01	67292.31	544174.65	194585.02
	Total Input at Factor Cost	580203.22	79679.47	194811.27	1087333.38	842560.77	1771850.00	5691562.29	391875.61	3378616.09	1518888.79
	Net Indirect tax	59018.41	9349.94	39407.98	149573.22	76211.95	199322.85	842413.81	81848.18	283489.22	142077.83
	Total Input(Purchaser Price)	639221.64	89029.41	234219.25	1236906.60	918772.73	1971172.85	6533976.11	473723.79	3662105.31	1660966.62
	Value added	73311.65	30256.33	31452.75	328827.19	264390.32	372217.51	2978058.45	184615.61	2331394.37	842226.51
	Gross output	712533.28	119285.74	265672.01	1565733.79	1183163.05	2343390.35	9512034.55	658339.40	5993499.68	2503193.12

Contd.. Table 4.2

	Sectors	31	32	TOTAL	PFCE	GFCE	GFCF	CIS	EXP.	Less	GROSS
											OUTPUT

1	AGRICULTURE	74580.56	342971.14	5034119.12	7685661.16	16738.78	0.00	150644.40	126318.32	120590.38	12892891.39
2	MILK & MILK PRODUCTS	0.00	81243.27	269238.41	2151843.58	56917.05					2477999.05
3	LIVESTOCK PRODUCTS	0.00	70898.45	955636.30	856844.54	342.64	28126.77	17815.00	5479.63	23021.76	1841223.10
4	FISHING	0.00	2004.62	46663.50	401991.83	212.59		523.00	794.16	1904.00	448281.09
5	COAL & LIGNITE	14211.50	24567.12	667863.75	11689.53	119.29		-35118.00	1009.94	54366.00	591198.51
6	MINING & QUARRYING	0.00	40581.64	1656786.78	0.00	430.09	0.00	14842.00	70604.76	910793.73	831869.90
7	SUGAR	0.00	21971.09	100467.26	550734.85	0.00	0.00	18642.00	2825.42	9731.97	662937.55
8	EDIBLE OIL & VANASPATI	130.12	39512.82	153792.27	523422.69	0.00	0.00	6540.00	46738.74	21944.93	708548.77
9	BEVERAGES	1330.81	27292.29	75879.26	296348.08	20.95	0.00	5360.00	86322.61	1104.81	462826.09
10	OTHER FOOD PRODUCTS	1332.59	22350.76	91966.33	1077267.54	597.07	0.00	-261.00	140944.69	18310.48	1292204.16
11	OTHER TEXTILES	3290.68	93537.50	1185907.67	2257723.22	5352.47	2306.84	34745.00	490414.78	53689.59	3922760.39
12	WOOLEN TEXTILES	602.25	1932.55	33295.88	72096.17			2669.00	4225.12	4823.53	107462.65
13	JUTE TEXTILES	291.71	10517.88	148310.42	4424.64	1542.28		-2953.00	23559.12	148.94	174734.52
14	MAN MADE FIBRE	48.29	33384.44	537699.55		43235.70		7908.00	12663.92	111984.82	489522.35
15	PAPER	28341.74	214371.92	738464.03	167282.12	77368.62	0.00	-4607.00	24779.16	113221.92	890065.00
16	LEATHER	687.62	10411.42	101480.27	106682.58	0.00	0.00	1075.00	164017.92	8378.95	364876.82
17	RUBBER PRODUCTS	124155.83	10438.57	238608.20	82321.18	2133.57	154589.36	4886.00	17468.12	8598.13	491408.30
18	PETROLEUM PRODUCTS	553491.17	39128.79	1269094.42	387473.87	58162.96	0.00	8386.00	58682.41	291399.34	1490400.33
19	INORGANIC CHEMICALS	114.32	12966.38	267589.54		1498.61		7242.00	39116.93	78402.80	237044.27
20	ORGANIC CHEMICALS	3.71	26076.90	441241.69		42465.14		9749.00	36552.77	132488.13	397520.47
21	FERTILIZERS	0.00	9769.96	824625.99		1897.79		9388.00	38.31	123416.81	712533.28
22	PESTICIDES	292.55	1118.42	114062.45		36.41		228.00	9130.11	4171.23	119285.74
23	PAINTS	3148.04	11873.70	247579.01				3838.00	30096.44	15841.45	265672.01
24	DRUGS & OTHER CHEMICAL	1721.12	325575.08	976066.68	372623.99	44398.67	0.00	123346.00	132606.23	83307.78	1565733.79
25	NON METALLIC MINERALS	4258.25	13237.96	743830.67	141037.78	6.43	5758.12	4899.00	305074.93	17443.88	1183163.05
26	IRON & STEEL	14132.37	108306.95	2460776.18	0.00	3.12	101796.78	64225.00	44955.47	328366.20	2343390.35
27	MISC. MANUFACTURING	429772.97	406900.97	4294461.69	1051974.83	382632.03	3921890.50	355243.00	625707.78	1119875.28	9512034.55
28	OTHER INDUSTRIES	22202.29	66174.27	396193.13	56394.93	49795.18	17739.42	138061.00	15423.72	15267.98	658339.40
29	CONSTRUCTION	106137.44	384964.57	840811.28		397913.30	4754775.10				5993499.68
30	ELECTRICITY-WATER-GAS SS	98765.72	254765.62	2136683.43	263719.03	101111.09	0.00	387.00	1292.57	0.00	2503193.12
31	TRANSPORT & COMMUNICATION	254117.54	1014463.50	3057523.84	1745797.69	372132.75	115140.92	0.00	332105.96	239066.00	5383635.16
32	SERVICES	563282.45	1592704.70	6977939.81	7497514.03	3729262.89	417946.96	0.00	809591.54	109571.00	19322684.24

	Total Input at Factor Cost	2300443.65	5316015.25	37084658.83							80338939.10
	Net Indirect tax	309153.3271	352257.8612	3264583.012							
	Total Input(Purchaser Price)	2609596.98	5668273.114	40349241.84							
	Value added	2774038.178	13654411.13	39989697.26							
	Gross output	5383635.158	19322684.24	80338939.1							

4.2 Water Pollution Data

Data on water pollution are scanty and are not available in the required form. However, Central Pollution Control Board (CPCB) and Bureau of Indian Standard (BIS) publish certain documents which have been of great use in attaining different types of water pollutants generated from different industries. We have obtained 10 types of water pollution data. The work is constrained by the fact that the sectors mentioned in these documents have to be dealt, corresponding with input-output classification. However, the correspondence between the set of information could be done without much complications as illustrated in table 4.3. Water pollutants generated by the different Indian industries are mentioned below

1. Suspended solids(SS)
2. Dissolved solids (DS)
3. Chloride
4. Sulphide
5. Zinc
6. Phenol
7. Oil and Grease
8. Biochemical Oxygen Demand(BOD)
9. Chemical Oxygen Demand(COD)
10. Other Pollutants such as nitrogen, chromium, cyanide, Alkalinity, etc.,

TABLE 4.3

Correspondence Between Sectors In Input-Output Table & The Sectors Mentioned In Coinds And Bis

AGRICULTURE	(CPCB)
MILK & MILK PRODUCTS(2)	Dairy Industry (BIS)
LIVESTOCK PRODUCTS(3)	Slaughter House (CPCB)
FISHING(4)	Sea & Fresh Fish (CPCB)
COAL & LIGNITE(5)	Coal & Lignite
SUGAR(7)	Sugar Industry (CPCB)
EDIBLE OIL & VANASPATI(8)	Edible Oil & Vanaspati (CPCB)
BEVERAGES(9)	Soft Drink, Fermentation (CPCB)
OTHER FOOD PRODUCT(10)	Confectioneries, Bakeries Fruits & Vegetable processing (CPCB)
OTHER TEXTILES(11)	Cotton textiles (BIS)
WOOLEN TEXTILES(12)	Woolen textiles (BIS)
JUTE TEXTILES(13)	Jute processing Industry(CPCB)
MAN-MADE FIBRE(14)	Man made Fibre (CPCB)
PAPER(15)	Paper Industry (CPCB)
LEATHER PRODUCTS(16)	Tanneries (CPCB)
RUBBER PRODUCTS(17)	Natural Rubber Processing Industry (CPCB)
PETROLEUM PRODUCTS(18)	Oil Refineries (CPCB)

INORGANIC CHEMICALS(19)	Inorganic Chemical Industry (CPCB)
ORGANIC CHEMICALS(20)	Petrochemical Products (CPCB)
FERTILISER(21)	Fertilizers (CPCB)
PESTICIDES	Pesticides (CPCB)
PAINTS(23)	Paints,Varnishes & Dyes (CPCB)
DRUGS AND OTHERS(24)	Pharmacuetical & Fermulation (CPCB)
NON METALLIC MINERALS(25)	Ceramic Industry & Cement (CPCB)
IRON AND STEEL(26)	Iron steel (PROBES- CPCB)
ELECTRICITY-GAS(30)	Thermal Power Plant (CPCB)

Following libraries have been visited for the purpose of data collection.

1. National Library, Calcutta.
2. Indian Institute of Management(IIM), Joka.
3. Center for Studies in Social Sciences, Calcutta.
4. Library, Central Pollution Control Board, Calcutta and New Delhi.
5. Library, Central Statitical Organisation, Calcutta and New Delhi.
6. Bureau of Indian Standard(BIS), Calcutta.
7. Central Library, Jadavpur University.

8. Library, Department of Economics, Jadavpur University.

9. National Enviornmental Engineering Research Institute

(NEERI), Calcutta and Nagpur.

Beside these a discussion has been held with the Faculty member of Chemical Engineering Department, Jadavpur University, Calcutta.

BSI issue some publications under the heading "Guide for treatment and disposal of effluents " which have provided us with data regarding waste generation (Quantity and Quality) of selected industries.

A. Central Pollution Control Board has a series of publications such as

1. Comprehensive Industry Document on Man-Made Fibre Industry : COINDS/1/1979-80.

2. Comprehensive Industry Document - Oil Refineries : COINDS/3/1980-81.

3. Comprehensive Industry Document -Chlor-Alkali Industry : COINDS/5/1981-82.

4. Comprehensive Industry Document - Sugar Industry : COINDS/8/1980-81.

5. Comprehensive Industry Document - Fermentation (Maltries, Brewaries and Distilleries) Industries : COINDS/10/1981-82.

6. Comprehensive Industry Document - Brick Kilns : COINDS/16/1995-96.

7. Comprehensive Industry Document - Large Pulp & Paper Industry : COINDS/36/1991.

8. Comprehensive Industry Document - Slaughter House, Meat and Sea food Processing :COINDS/38/1992.

9. Comprehensive Industry Document - Edible Oil & Vanaspati Industry : COINDS/39/1993-94.

10. Comprehensive Industry Document - Ceramic Industry : COINDS/48/1994-95.

11. Comprehensive Industry Document - Soft Drink Manufacturing Unit, Bakeries and Confectioneries : COINDS/52/1995-96.

12. Comprehensive Industry Document - Rice Mills : COINDS/55/1995-96.

13. Comprehensive Industry Document - Fruit & Vegetable Processing Industry : COINDS/56/1996-97.

14. Comprehensive Industry Document - Cement Industry : COINDS/49/1994-95.

15. Minimal National Standards : Complex Fertilizer Industries (with or without Nitrogenous and Phosphate Fertilizer) :COINDS/25/1984-85.

16. Minimal National Standards : Pharmaceutical Manufacturing and Fermulation Industry : COINDS/29/ 1988-89.

17. Minimal National Standards : Petrochemicals Industry : COINDS/30/1988-89.

18. Minimal National Standards - Selected Inorganic Chemical Industry : COINDS/32/1989-90.

19. Minimal National Standards - Paint Industry : COINDS/33/1990-91.

20. Minimal National Standards - Dye and Dye Intermediate Industry : COINDS/34/1990.

21. Minimal National Standards - Tanneries : COINDS/35/ 1991-92.

22. Minimal National Standards - Jute Processing Industry : COINDS/37/1991.

23. Natural Rubber Processing : COINDS/53/1995-96.

B. Control of Urban Pollution Series(CUPS).

C. Programme Objective Series(PROBES).

D. Pollution Control Acts, Rules & issued thereunder :

PCLS/2/1992 .

Out of the above list COINDS have been relevant for our work in the sense that these publications have provided us with detail data on waste generation (quantity and quality) and also cost data of water pollution abatement schemes of different industries. In this regard Calcutta ,Zonal Office could only help us to have few of these issues. In order to collect the required set of these series ,our research staffs have to visit the Head Office of the Central Pollution Control Board, Delhi. From this office the data on water pollutants have been collected. But data for the full set of 32 sectors as mentioned in Table 4.1 were not available. Of the 32 sectors data could be obtained for 26 sectors of the mentioned list, keeping out Mining & Quarrying, Metal industry, Other industries, Construction, Transport & Communication and Services. Further collection of data has been made possible by our research staff through visit in Nagpur , NEERI.

4.3 Derivation Of Different Types Of Water Pollutants

We could not get the data of water pollution generation directly of any sector. These data have been analysed on the basis of available information following the procedure mentioned below For each sector the following information of pollution generation have been collected

a. Flow of waste water(F) = $\frac{\text{amount of waste water in litre}}{\text{tonne of production}}$

b. Amount of different types of water pollutants(W)Per Litre

$$= \frac{\text{amount of different types of pollutants(in milligrams)}}{\text{litre of waste water}}$$

c. total amount of production of each sectors(P) in tonnes

From these parameters we have been able to derive the total amount of different types of water pollution generation by different sectors, by the following steps

1. Total amount of waste water flow in litres($F^{/}$)

$$F^{/} = F*P$$

2. Total amount of each types of water pollutants($W^{/}$)

$$W^{/} = F^{/}*W$$

To illustrate the method of calculation of pollution generation of composite industry we use the beverage industry can be used as an example. Beverage industry is a composite industry comprising of many units, but due to our limited availability of data we have used Soft Drinks, Maltries, Breweries and distilleries industries as representative of the sector. Here, the combined waste water characteristics have been

derived by giving weights, with respect to their production level and then arriving at an average for the four industries considered for the specified sector i.e., Beverages. It has been so done due to non availability of data on the other industries, as is the case for Tea & Coffee processed industry. Similar method has been used for the other composite sectors, such as Other Food Products (represented by Fruits & Vegetables, Bakeries, Confectioneries), Other Textiles (only Cotton Textile is considered), Drugs & Other Chemicals (Drugs & Medicine), Non metallic minerals (Structural clay) and Electricity water gas supply sector(thermal power plant).

4.4 Unit Used

This work has been done in hybrid units. Sectors are treated in value units (Lakh Rs.) and the different types of water pollutants generated are treated in physical units ('000 tonnes).

4.5 Construction Of The Matrix Of Water Pollutants

Ten types of water pollutants generated by the industries of the Indian economy are shown quantitatively in table 4.4. The entries in the 2nd row indicates that Milk & Milk Products generated 343.78 thousand tonnes of suspended solids, 479.48 thousand tonnes of dissolved solids, 131.18 thousand tonnes of oil & grease and 314.69 thousand tonnes of other pollutants which include within itself in this case only alkalinity. Similarly, the entries in the 21st row show that Fertilizer industry generates 130.2 thousand tonnes of suspended solids and 33.467 thousand tonnes of other pollutants such as ammonium nitrogen, urea nitrogen, phosphate, floride and arsenic. Thermal power plants contributes to atmospheric pollution by discharging fly ash,

smoke, gases of oxides of sulphur, carbon and nitrogen. Over 12 million tonnes of fly ash are generated (Iyer, 1986) from thermal power station which is mostly dumped in nearby rivers and lakes causing pollution. Fly ash contains toxic metals, zinc (6%), barium (12.2%), vanadium (.08%), copper (1.3%), arsenic (0.02%), manganese (0.23%), thalium (1.2%), phosphorous, sulphur and silica. It also produces water pollution [CPCB, (PROBES/51/1993-94)] to the extent of 44.21 thousand tonnes of suspended solids, major part of which constitutes of fly ash, as depicted through entries in the 30th row of table 4.4.

The similar calculation has been done for the other sectors of the Indian economy. BOD (Biochemical oxygen demand) and COD (Chemical Oxygen demand) measure the strength of organic and chemical waste respectively, in terms of the amount of oxygen consumed (by the micro organism and chemical present in water) in breaking it down. These are a standard waste water treatment test for the presence of organic and chemical pollutants. The reliable estimate of BOD can be made after 5 days whereas COD can be estimated within two hours. Available data of BOD and COD content of waste water from different industries are given in the table 4.5. It appears from the table that BOD and COD content of water of Milk & Milk products are 560 and 1323.09 thousand tonnes respectively, while for Drugs & Other chemical industry it is of waste water containing 0.00014 and 0.00006 thousand tonnes of BOD and COD respectively.

TABLE 4.4
AMOUNT OF WATER POLLUTION FROM DIFFERENT INDUSTRIES

	SECTORS	SS	DS	CHLORIDE	SULPHIDE	OIL/GREASE	PHENOL	ZINC	OTHERS
1	AGRICULTURE	0	0	0	0	0	0	0	1568.75
2	MILK & MILK	343.78	479.49	47.49	0	131.18	0	0	314.69
	PRODUCTS								
3	LIVESTOCKS	985.9398	0	0	0	203.7018	0	0	2721.92
4	FISHING	0.94	0	0	0	0.41	0	0	0.26
5	COAL & LIGNITE	0	0.056	0.0046	0.0093	0	0	0	0.0104
6	MINING &	0	0	0	0	0	0	0	0
	QUARRYING								
7	SUGAR	302.533	669.89	0	0	4.3219	0	0	15.127
8	EDIBLE OIL &	7.26	0	0	0	5.03	0	0	0
	VANASPATI								
9	BEVERAGES	41.105	106.226	0	0	0	0	0	5.655
10	OTHER FOOD	0.24	0	0	0	0.002	0	0	
	PRODUCTS								
11	OTHER TEXTILES	0	235.43	0	0	0	0	0	1.14
12	WOOLEN TEXTILES	20.37	76.93	0	0	11.29	0	0	1.552
13	JUTE TEXTILES	.0053	.123	.0392	0	.0044	0	0	.0664
14	MAN MADE FIBRE	10.43	77.46	20.15	0	0	0	1.7	749.47
15	PAPER	499.9	0	0	0	0	0	0	212.77
16	LEATHER	56.25	258.75	82.5	0.45	0	0	0	25.725
	PRODUCTS								
17	RUBBER	28.25	78.12	0	.1.68	0	0	0	3.72

	PRODUCTS								
18	PETROLEUM	0	0	0	11.77	88.38	1.33	0	0
	PRODUCTS								
19	INORGANIC	.45	58.752	0	0	0	0	0	31.105
	CHEMICALS								
20	ORGANIC	16.77	0	0	0	17.82	5.66	0	2.46
	CHEMICALS								
21	FERTILIZERS	130.2	0	0	0	0	0	0	33.467
22	PESTICIDES	0.0065		3.04			0		1.026
23	PAINTS	0.69	0	0	0	0.078	.036	0	0
24	DRUGS & OTHER	.000014	0	.000004	.000005	0	0	0	0
	CHEMICALS								
25	NON METALLIC	0.1143	0	0	0	0	0	.072	.0022
	MINERALS								
26	IRON & STEEL	0	0	17.81	.065	0	3.258	0	5.91
27	MISC.	0	0	0	0	0	0	0	0
	MANUFACTURING								
28	OTHER	0	0	0	0	0	0	0	0
	INDUSTRIES								
29	CONSTRUCTION	0	0	0	0	0	0	0	0
30	ELECTRICITY GAS	44.21	0	0	0	0	0	0	0
	WATER SUPPLY								
31	TRANSPORT &	0	0	0	0	0	0	0	0
	COMMUNICATION								
32	SREVICES	0	0	0	0	0	0	0	0

All parameters are in thousand tonnes.

TABLE 4.5

BOD & COD CONTENT OF WASTE WATER

	SECTORS	BOD	COD
1	AGRICULTURE	0	0
2	MILK & MILK	560	1323.09
	PRODUCTS		
3	LIVESTOCKS	2770.3	5127.65
4	FISHING	1.82	3.89
5	COAL & LIGNITE	0	0
6	MINING &	0	0
	QUARRYING		
7	SUGAR	864.38	1512.67
8	EDIBLE OIL &	29.04	61.04
	VANASPATI		
9	BEVERAGES	130.117	251.365
10	OTHER FOOD	1.42	2.68
	PRODUCTS		
11	OTHER TEXTILES	29	54.11
12	WOOLEN TEXTILES	28.82	50.19
13	JUTE TEXTILES	0.0288	.048
14	MAN MADE FIBRE	22.30	50.05
15	PAPER	250.27	815.43
16	LEATHER	27.75	67.5
	PRODUCTS		
17	RUBBER	67.53	115.44
	PRODUCTS		
18	PETROLEUM	22.48	616.35
	PRODUCTS		
19	INORGANIC	0	0

	CHEMICALS		
20	ORGANIC	318.75	684.99
	CHEMICALS		
21	FERTILIZERS	0	0
22	PESTICIDES	1.58	1.37
23		2.35	2.94
24	DRUGS & OTHER	.00014	.00006
	CHEMICALS		
25	NON METALLIC	0	.044
	MINERALS		
26	IRON & STEEL	3.69	7.67
27	MISC.	0	0
	MANUFACTURING		
28	OTHER	0	0
	INDUSTRIES		
29	CONSTRUCTION	0	0
30	ELECTRICITY GAS	0	5.1
	WATER SUPPLY		
31	TRANSPORT &	0	0
	COMMUNICATION		
32	SREVICES	0	0

All figures are in ‘000 tonnes

4.6 The Extended Input-Output Table

The extended input-output table of different sectors with total amount of different (8) types of pollutant generated by different industries of Indian economy in the year 1989-90 have been presented in the table 4.6.

Table 4.6
Extended Input-output Table Of India
(figures are in Lakh Rs. Except for water pollutants figures which are in '000 t)

	Sectors	1	2	3	4	5	6	7	8	9	10
1	AGRICULTURE	1065818.24	378654.40	773625.88	259.51	4.73	0.00	376979.56	511751.11	144449.04	290603.08
2	MILK & MILK PRODUCTS	3102.60	2661.38	108.38	17.93		0.00	96.71	926.02	1087.34	178717.10
3	LIVESTOCK PRODUCTS	704963.65	0.00	427.42	0.00	0.00	0.00	350.10	742.52	375.75	62967.67
4	FISHING	529.53		18.50	6293.91		0.00	16.51	158.22	187.78	30504.28
5	COAL & LIGNITE	1998.60		1.81		6422.10	93.87	1512.12	1425.59	5392.00	3320.01
6	MINING & QUARRYING	71.85	0.00	0.00	0.00	5873.62	522.75	2239.50	10.64	1347.83	1159.07
7	SUGAR	1160.47	0.00	35.85	0.00	0.00	0.00	1331.15	314.11	7054.90	59318.86
8	EDIBLE OIL & VANASPATI	1099.22	37307.36	53052.08	0.00	0.00	0.00	1.15	18641.26	11.70	1637.43
9	BEVERAGES	66.20	0.00	0.71	0.00	0.00	0.00	5.87	6.35	44441.90	1398.86
10	OTHER FOOD PRODUCTS	717.32	2565.50	16689.37	1853.30	0.00	0.00	157.06	885.05	7308.98	25532.31
11	OTHER TEXTILES	3862.50	22838.69	1675.41	11882.75	70.34	0.00	1464.24	6063.68	425.77	2620.90
12	WOOLEN TEXTILES	5.22		0.00			0.00	0.00	18.27	0.00	0.00
13	JUTE TEXTILES	3690.01		1.75	701.23		0.00	8727.04	718.16	166.35	4057.51
14	MAN MADE FIBRE	11.66		0.00			0.00	0.00	737.08	5.64	764.62
15	PAPER	3386.93	0.00	12.40	68.05	1188.61	74.88	827.40	1101.60	5368.89	33017.56
16	LEATHER	17.66	0.00	0.00	0.00	0.00	0.00	0.00	4.46	0.00	16.37
17	RUBBER PRODUCTS	2013.13		0.00		299.74	10.11	12.84	10.93	50.19	36.89
18	PETROLEUM PRODUCTS	103707.50	0.00	6.67	11555.10	15522.69	16125.97	2907.07	1510.39	1214.88	13654.99
19	INORGANIC CHEMICALS	168.82		0.64	14.71		1123.66	1045.51	1409.92	1646.55	1126.52
20	ORGANIC CHEMICALS	319.02		0.62	4.03		0.00	3757.65	1603.66	1192.12	1413.82
21	FERTILIZERS	724704.39		0.00			0.00	0.00	376.26	0.00	2237.90
22	PESTICIDES	78960.59		0.00			0.00	0.00	40.97	0.00	453.26
23	PAINTS	17.87		0.00			0.00	31.73	552.66	35.63	80.60
24	DRUGS & OTHER CHEMICAL	202.00	1251.39	4697.55	745.95	20062.17	2184.55	808.74	6980.80	1353.01	9635.24
25	NON METALLIC MINERALS	151.56	0.00	0.90	0.00	0.00	9770.78	2429.18	120.87	2843.22	1634.35

26	IRON & STEEL	320.91	0.00	0.00	244.75	0.00	0.00	175.30	106.74	174.28	68.89
27	MISC. MANUFACTURING	120271.17	401.56	1892.20	15109.69	83628.64	24091.91	6392.78	3365.59	7362.89	22809.61
28	OTHER INDUSTRIES	1088.87	0.00	5.50	1835.05	2970.54	389.82	374.98	2586.58	8169.33	11408.44
29	CONSTRUCTION	221222.59	1134.87	4257.99		1096.03	3388.25	867.89	378.89	248.96	1238.95
30	ELECTRICITY-WATER-GAS SS	110958.18	0.00	4.34	175.41	37330.07	11586.44	6456.28	8677.89	6925.94	8905.96
31	TRANSPORT & COMMUNICATION	134312.35	10202.07	20712.29	2144.54	15698.15	3730.41	7161.41	11413.34	24175.59	28796.52
32	SERVICES	436346.21	80126.42	140973.66	10258.00	43169.86	34143.53	101434.45	59150.45	44813.28	156833.62
	Total Input at Factor Cost	3725266.83	537143.64	1018201.92	63163.91	233337.29	107236.94	527564.20	641790.05	317829.75	955971.20
	Net Indirect tax	-320224.19	9142.44	13670.60	6744.70	33652.64	18691.37	12659.96	22338.81	21327.49	57398.67
	Total Input(Purchaser Price)	3405042.64	546286.08	1031872.52	69908.61	266989.93	125928.32	540224.16	664128.85	339157.24	1013369.87
	Value added	9487848.76	1931712.97	809350.58	378372.48	324208.58	705941.58	122713.39	44419.92	123668.85	278834.29
	Gross output	12892891.39	2477999.05	1841223.10	448281.09	591198.51	831869.90	662937.55	708548.77	462826.09	1292204.16
33	SUSPENDED SOLIDS(SS)	0.00	343.78	985.94	0.94	0.00	0.00	302.53	7.26	41.11	0.24
34	DISSOLVED SOLIDS(DS)	0.00	479.48	0.00	0.00	0.06	0.00	669.89	0.00	106.23	0.00
35	CHLORIDE	0.00	47.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	SULPHIDE	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
37	OIL & GREASE(O/G)	0.00	131.18	203.70	0.41	0.00	0.00	4.32	5.03	0.00	0.00
38	PHENOL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	ZINC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	OTHER POLLUTANTS	1568.75	314.69	2721.92	0.26	0.01	0.00	15.12	0.00	5.66	0.00

Contd… Table 4.6

	Sectors	11	12	13	14	15	16	17	18	19	20
1	AGRICULTURE	412053.14	95.51	48790.65	5785.73	35040.08	2868.54	43467.40	103.87	5024.41	5332.88
2	MILK & MILK PRODUCTS	467.00	0.53			0.72	7.28		0.00	0.56	3.91
3	LIVESTOCK PRODUCTS	43397.66	6501.04	0.38	794.06	216.36	43330.34	120.65	0.00	83.29	81.92
4	FISHING	6.88			7.01	22.43	5.67	30.67	0.00	50.62	43.29
5	COAL & LIGNITE	11859.12	208.21	981.98	787.63	14993.61	233.25	3370.71	52664.14	4905.60	7010.68
6	MINING & QUARRYING	511.17	1.04	0.37	20349.12	543.81	4.55	1027.43	714075.52	7367.68	10857.96
7	SUGAR	1.94	0.00	0.00	23.55	0.00	0.00	0.00	0.00	94.58	656.60
8	EDIBLE OIL & VANASPATI	20.87	0.00	0.00	1.25	0.00	0.00	0.00	0.00	6.63	9.94
9	BEVERAGES	12.25	0.00	0.00	568.57	0.00	96.62	0.00	0.00	43.46	70.70
10	OTHER FOOD PRODUCTS	3822.07	4.44	10.84	76.29	1981.72	71.74	0.00	0.85	120.48	98.15
11	OTHER TEXTILES	915088.87	29862.02	2282.91	13784.72	5959.61	8081.58	25454.29	480.47	320.58	418.79
12	WOOLEN TEXTILES	23268.61	7304.12	1.43	6.26	0.00	2.96	3.90	2.67		
13	JUTE TEXTILES	27419.82	205.21	15312.27	1636.27	3655.10	595.59	225.33	571.01	1070.17	1491.62
14	MAN MADE FIBRE	208517.47	3916.88	90.38	67209.03	3774.80	1251.81	26711.07	559.56	3583.06	5874.31
15	PAPER	16139.50	159.20	188.81	21978.64	256502.67	894.87	1523.97	1329.91	2759.44	9392.32
16	LEATHER	530.06	45.25	0.00	3.30	1.68	84467.06	3384.31	0.00	3.66	2.07
17	RUBBER PRODUCTS	6701.08	24.84	27.60	286.39	103.52	7724.85	3428.46	70.43	24.27	76.42
18	PETROLEUM PRODUCTS	18527.85	296.09	1057.25	3405.64	4502.32	2230.95	3192.67	23405.93	4083.10	9183.34
19	INORGANIC CHEMICALS	13253.32	153.12	107.08	7865.50	14913.52	2070.06	3292.10	329.23	20251.41	24988.20
20	ORGANIC CHEMICALS	27566.81	383.35	209.01	37717.21	6148.76	3728.17	5799.73	336.35	24116.41	46886.79
21	FERTILIZERS	60.55	0.78		2136.53	1.49	0.00	2.44	0.00	2234.49	3767.12
22	PESTICIDES	1.81			5.82	0.00	0.00		0.00	30.74	1018.94
23	PAINTS	45470.43	490.60	100.04	1198.24	13411.75	7301.08	457.83	329.69	967.47	1988.47
24	DRUGS & OTHER CHEMICAL	16723.11	194.04	2656.74	21341.01	13724.21	8472.65	67215.70	2870.38	6021.80	9987.93
25	NON METALLIC MINERALS	2091.53	33.96	105.90	692.60	1081.84	108.49	214.31	74.25	1723.24	1763.16
26	IRON & STEEL	4703.89	50.75	842.42	902.07	1206.75	187.81	947.76	236.73	277.30	561.55
27	MISC. MANUFACTURING	62212.19	1123.70	5456.06	12253.04	31055.73	5652.39	22153.57	5054.62	13710.61	19640.35
28	OTHER INDUSTRIES	17670.57	136.67	140.51	2278.00	2044.86	554.26	1912.33	560.71	2349.05	3037.93

29	CONSTRUCTION	3727.43	53.35	1.00	338.65	575.37	298.12	258.02	229.81	117.92	136.36
30	ELECTRICITY-WATER-GAS SS	163273.55	2062.37	12106.87	28988.43	48847.03	5220.11	13702.93	7832.07	33149.29	45129.23
31	TRANSPORT & COMMUNICATION	141211.43	3378.39	7287.72	14907.42	35651.04	10499.83	14881.98	40560.52	9771.80	15324.24
32	SERVICES	547618.53	16305.43	20587.65	55530.44	115245.40	63289.92	57228.83	92447.73	26450.67	45047.08
	Total Input at Factor Cost	2733930.51	72990.88	118345.88	322858.41	611206.17	259250.55	300008.41	944126.44	170713.79	269882.26
	Net Indirect tax	148518.33	7885.99	5600.03	77109.94	45969.92	21831.09	54443.11	409339.70	24840.94	49516.89
	Total Input(Purchaser Price)	2882448.84	80876.87	123945.91	399968.34	657176.10	281081.65	354451.51	1353466.14	195554.73	319399.14
	Value added	1040311.54	26585.77	50788.61	89554.01	232888.91	83795.17	136956.78	136934.18	41489.54	78121.33
	Gross output	3922760.39	107462.65	174734.52	489522.35	890065.00	364876.82	491408.30	1490400.33	237044.27	397520.47
33	SUSPENDED SOLIDS(SS)	0.00	20.48	0.01	10.43	499.90	56.25	28.25	0.00	0.45	16.77
34	DISSOLVED SOLIDS(DS)	235.43	76.93	0.12	77.46	0.00	258.75	78.12	0.00	58.75	0.00
35	CHLORIDE	0.00	0.00	0.04	20.15	0.00	82.50	0.00	0.00	0.00	0.00
36	SULPHIDE	0.00	0.00	0.00	0.00	0.00	0.45	1.68	11.77	0.00	0.00
37	OIL & GREASE(O/G)	0.00	11.28	0.00	0.00	0.00	0.00	0.00	88.38	0.00	17.82
38	PHENOL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00	5.66
39	ZINC	0.00	0.00	0.00	1.70	0.00	0.00	0.00	0.00	0.00	0.00
40	OTHER POLLUTANTS	1.14	1.58	0.07	749.47	212.77	25.73	3.72	0.00	31.11	2.46

Contd… Table 4.6

	Sectors	21	22	23	24	25	26	27	28	29	30
1	AGRICULTURE	68.04	1.54	1225.35	163859.97	5115.91	765.08	6840.21	89121.92	248682.41	179.25
2	MILK & MILK PRODUCTS				585.23	3.00		0.93	0.00	208.51	0.00
3	LIVESTOCK PRODUCTS	678.99	72.04	99.33	2482.02	395.18	0.45	8441.35	108.29	6607.33	1500.06
4	FISHING	209.83	0.38	20.29	107.87	75.65	0.13	6280.34	52.16	36.96	0.00
5	COAL & LIGNITE	7697.86	81.57	1305.11	6596.36	68643.75	108191.17	30388.56	622.57	953.61	287423.53
6	MINING & QUARRYING	116225.56	395.16	844.11	3151.22	148048.83	50280.84	73232.26	191.84	313147.87	144723.56
7	SUGAR	2.07	0.00	5.09	8405.14	0.00	0.00	1.96	1.18	88.08	0.65
8	EDIBLE OIL & VANASPATI	0.00	0.00	1.26	2334.20	0.00	0.00	2.75	0.77	21.45	0.00
9	BEVERAGES	0.00	0.00	306.09	208.94	0.00	0.00	0.82	8.06	20.16	0.60
10	OTHER FOOD PRODUCTS	0.00	0.00	56.48	5879.38	164.84	52.02	126.53	58.09	48.07	2.09
11	OTHER TEXTILES	169.85	141.65	594.56	13717.02	1502.74	1018.84	12071.28	5817.70	845.07	562.69
12	WOOLEN TEXTILES				24.65	1.13	0.00	100.21	1.32	16.93	3.41
13	JUTE TEXTILES	20550.95	37.25	9.40	2294.44	29300.84	472.17	2014.06	867.02	11643.75	66.52
14	MAN MADE FIBRE	17.96		8107.76	2797.60	579.83	87.67	65115.10	103786.56	570.53	196.45
15	PAPER	702.59	4362.90	3573.41	61606.63	6230.97	1600.77	43404.80	3692.38	10885.96	3774.29
16	LEATHER	0.00	0.00	1.64	161.80	8.07	4.50	1482.66	150.82	95.22	0.62
17	RUBBER PRODUCTS	24.05	7.71	17.73	988.12	84.69	640.47	76993.10	733.59	2991.19	631.44
18	PETROLEUM PRODUCTS	13727.05	2348.03	2563.73	12343.48	63030.58	86143.77	117168.72	2857.79	116239.70	23961.19
19	INORGANIC CHEMICALS	55056.90	3184.80	19522.72	31410.08	6325.06	3404.69	38645.99	1247.82	290.23	1660.68
20	ORGANIC CHEMICALS	64664.82	4835.56	21829.00	83472.22	11225.55	10980.20	43140.58	13211.59	477.63	140.42
21	FERTILIZERS	63714.65	940.47	1.61	21.86	0.00	0.00	499.05	4.07	14136.82	15.56
22	PESTICIDES	2042.16	23772.93	307.10	19.10	0.00	0.75	188.50	0.00	5808.83	0.00
23	PAINTS	26.28	9.04	23165.55	4008.91	1677.27	1317.60	40365.82	3751.42	85764.00	37.29
24	DRUGS & OTHER CHEMICAL	43237.65	6528.59	26572.17	323854.83	1914.09	1727.31	39334.28	7447.39	536.00	489.20
25	NON METALLIC MINERALS	636.20	675.22	864.84	9912.83	64085.58	7364.80	24727.12	1045.00	592123.12	59.62
26	IRON & STEEL	464.46	59.12	862.55	1296.27	20279.13	646572.23	1002625.15	1592.72	650811.19	2766.13
27	MISC. MANUFACTURING	21429.98	8204.79	20550.60	40365.52	49490.32	297855.66	2161601.33	14942.75	317262.97	62445.52

28	OTHER INDUSTRIES	8293.72	2006.32	2372.97	16689.52	7231.25	2763.06	58855.66	36723.39	113201.58	165.08
29	CONSTRUCTION	204.75	78.95	39.20	623.88	10276.33	3108.66	15101.58	296.04	20392.84	60016.59
30	ELECTRICITY-WATER-GAS SS	39083.53	5170.89	10182.03	43085.62	97275.85	126176.85	315120.63	16090.35	25853.47	553780.45
31	TRANSPORT & COMMUNICATION	30410.22	3023.42	10390.68	52025.14	111634.95	155853.86	379243.95	20158.72	294679.96	179700.86
32	SERVICES	90863.09	13741.14	39418.91	193003.54	137959.38	265466.46	1128447.01	67292.31	544174.65	194585.02
	Total Input at Factor Cost	580203.22	79679.47	194811.27	1087333.38	842560.77	1771850.00	5691562.29	391875.61	3378616.09	1518888.79
	Net Indirect tax	59018.41	9349.94	39407.98	149573.22	76211.95	199322.85	842413.81	81848.18	283489.22	142077.83
	Total Input(Purchaser Price)	639221.64	89029.41	234219.25	1236906.60	918772.73	1971172.85	6533976.11	473723.79	3662105.31	1660966.62
	Value added	73311.65	30256.33	31452.75	328827.19	264390.32	372217.51	2978058.45	184615.61	2331394.37	842226.51
	Gross output	712533.28	119285.74	265672.01	1565733.79	1183163.05	2343390.35	9512034.55	658339.40	5993499.68	2503193.12
33	SUSPENDED SOLIDS(SS)	130.55	0.01	0.69	0.00	0.11	0.00	0.00	0.00	0.00	44.21
34	DISSOLVED SOLIDS(DS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	CHLORIDE	0.00	3.04	0.00	0.00	0.00	17.81	0.00	0.00	0.00	0.00
36	SULPHIDE	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
37	OIL & GREASE(O/G)	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	PHENOL	0.00	0.00	0.04	0.00	0.00	3.26	0.00	0.00	0.00	0.00
39	ZINC	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
40	OTHER POLLUTANTS	33.64	1.03	0.00	0.00	0.00	5.91	0.00	0.00	0.00	0.00

Contd.. Table 4.6

	Sectors	31	32	TOTAL	PFCE	GFCE	GFCF	CIS	EXP.	Less	GROSS
											OUTPUT
1	AGRICULTURE	74580.56	342971.14	5034119.12	7685661.16	16738.78	0.00	150644.40	126318.32	120590.38	12892891.39
2	MILK & MILK PRODUCTS	0.00	81243.27	269238.41	2151843.58	56917.05					2477999.05
3	LIVESTOCK PRODUCTS	0.00	70898.45	955636.30	856844.54	342.64	28126.77	17815.00	5479.63	23021.76	1841223.10
4	FISHING	0.00	2004.62	46663.50	401991.83	212.59		523.00	794.16	1904.00	448281.09
5	COAL & LIGNITE	14211.50	24567.12	667863.75	11689.53	119.29		-35118.00	1009.94	54366.00	591198.51
6	MINING & QUARRYING	0.00	40581.64	1656786.78	0.00	430.09	0.00	14842.00	70604.76	910793.73	831869.90
7	SUGAR	0.00	21971.09	100467.26	550734.85	0.00	0.00	18642.00	2825.42	9731.97	662937.55
8	EDIBLE OIL & VANASPATI	130.12	39512.82	153792.27	523422.69	0.00	0.00	6540.00	46738.74	21944.93	708548.77
9	BEVERAGES	1330.81	27292.29	75879.26	296348.08	20.95	0.00	5360.00	86322.61	1104.81	462826.09
10	OTHER FOOD PRODUCTS	1332.59	22350.76	91966.33	1077267.54	597.07	0.00	-261.00	140944.69	18310.48	1292204.16
11	OTHER TEXTILES	3290.68	93537.50	1185907.67	2257723.22	5352.47	2306.84	34745.00	490414.78	53689.59	3922760.39
12	WOOLEN TEXTILES	602.25	1932.55	33295.88	72096.17			2669.00	4225.12	4823.53	107462.65
13	JUTE TEXTILES	291.71	10517.88	148310.42	4424.64	1542.28		-2953.00	23559.12	148.94	174734.52
14	MAN MADE FIBRE	48.29	33384.44	537699.55		43235.70		7908.00	12663.92	111984.82	489522.35
15	PAPER	28341.74	214371.92	738464.03	167282.12	77368.62	0.00	-4607.00	24779.16	113221.92	890065.00
16	LEATHER	687.62	10411.42	101480.27	106682.58	0.00	0.00	1075.00	164017.92	8378.95	364876.82
17	RUBBER PRODUCTS	124155.83	10438.57	238608.20	82321.18	2133.57	154589.36	4886.00	17468.12	8598.13	491408.30
18	PETROLEUM PRODUCTS	553491.17	39128.79	1269094.42	387473.87	58162.96	0.00	8386.00	58682.41	291399.34	1490400.33
19	INORGANIC CHEMICALS	114.32	12966.38	267589.54		1498.61		7242.00	39116.93	78402.80	237044.27
20	ORGANIC CHEMICALS	3.71	26076.90	441241.69		42465.14		9749.00	36552.77	132488.13	397520.47
21	FERTILIZERS	0.00	9769.96	824625.99		1897.79		9388.00	38.31	123416.81	712533.28
22	PESTICIDES	292.55	1118.42	114062.45		36.41		228.00	9130.11	4171.23	119285.74
23	PAINTS	3148.04	11873.70	247579.01				3838.00	30096.44	15841.45	265672.01
24	DRUGS & OTHER CHEMICAL	1721.12	325575.08	976066.68	372623.99	44398.67	0.00	123346.00	132606.23	83307.78	1565733.79
25	NON METALLIC MINERALS	4258.25	13237.96	743830.67	141037.78	6.43	5758.12	4899.00	305074.93	17443.88	1183163.05
26	IRON & STEEL	14132.37	108306.95	2460776.18	0.00	3.12	101796.78	64225.00	44955.47	328366.20	2343390.35
27	MISC. MANUFACTURING	429772.97	406900.97	4294461.69	1051974.83	382632.03	3921890.50	355243.00	625707.78	1119875.28	9512034.55
28	OTHER INDUSTRIES	22202.29	66174.27	396193.13	56394.93	49795.18	17739.42	138061.00	15423.72	15267.98	658339.40

29	CONSTRUCTION	106137.44	384964.57	840811.28		397913.30	4754775.10				5993499.68
30	ELECTRICITY-WATER-GAS SS	98765.72	254765.62	2136683.43	263719.03	101111.09	0.00	387.00	1292.57	0.00	2503193.12
31	TRANSPORT & COMMUNICATION	254117.54	1014463.50	3057523.84	1745797.69	372132.75	115140.92	0.00	332105.96	239066.00	5383635.16
32	SERVICES	563282.45	1592704.70	6977939.81	7497514.03	3729262.89	417946.96	0.00	809591.54	109571.00	19322684.24
	Total Input at Factor Cost	2300443.65	5316015.25	37084658.83							80338939.10
	Net Indirect tax	309153.3271	352257.8612	3264583.012							
	Total Input(Purchaser Price)	2609596.98	5668273.114	40349241.84							
	Value added	2774038.178	13654411.13	39989697.26							
	Gross output	5383635.158	19322684.24	80338939.1							
33	SUSPENDED SOLIDS(SS)	0	0								
34	DISSOLVED SOLIDS(DS)	0	0								
35	CHLORIDE	0	0								
36	SULPHIDE	0	0								
37	OIL & GREASE(O/G)	0	0								
38	PHENOL	0	0								
39	ZINC	0	0								
40	OTHER POLLUTANTS	0	0								

The different water pollution data in thousand tonnes are shown in the rows (33-40) of the table 4.6. In this table we only introduce the pollution flows explicitly in original aggregated input-output table (Table 4.2). The entries in the third column at the rows(33, 37, and 40) in table 4.6 indicate that in the year 1989-90, livestock products sector generated 985.9398, 203.7018, and 2721.92 thousand tonnes of suspended solids (SS), Oil and grease and Other pollutant respectively.

4.7 Cost Analysis: Pollution Abatement Cost

National and global effects of economic activities on the natural environment have increased resulting in environmental pollution. Of various kinds of environmental pollution (air, water, land, noise and radiation) water pollution is the most serious in its implication, water being indispensible and playing a pivotal role in our lives, for the very existence of mankind. Growing industrialization and accompanying urbanization have placed increasingly competitive demand on one hand on water, the nation's common property resource. On the other end water resources are the principal recipients of external diseconomies such as industrial and municipal wastes. This external diseconomies can be minimized by preservation of environmental resources or control of pollution, if pollutors or some other agent of the economy incur some additional costs. However, the particular agent will have no incentive to incur pollution abatement cost since the environment is a public good. Environmental resource may be regarded as public good in the sense that benefits (economic burden) from preserved (degraded) environment accure to a large number of economic agents in the economy or to all users of water resources or society as a whole. It is difficult to define or enforce property rights to the services of these resources, thus cannot be priced. This justifies the various environmental regulations on control of pollution.

The water (Prevention and control of pollution) Act, 1974, amended in 1986; the Water (Prevention and control of pollution) Cess Act, 1977, amended in 1988; the Environment Protection Act, 1986 are the most important laws, pertaining to industrial pollution abatement in India. These laws set national goals for eliminating, the practice of discharging pollutants into water bodies without providing the required treatment and these are specific guidelines for effluent discharges (termed MINAS). Minimal National standard for a particular industry is the effluent standard achievable by the industry by installing pollution control measures which are within the techno-economic capability of the industry. Generally, two main aspects are taken into consideration for development of standards of waste water discharges. One relates to the adverse effects on health and environment and the other achievability of limits of pollutants by incorporation of appropriate pollution control measures.

The latter approach aims at use of best available and economically feasibly technology. Economically feasible technology assures that the cost of pollution control measures will remain within the affordability of the industrial units. Standards developed on these principles are techno-economic standards and these standards are uniform throughout the country.

In order to develop the most economic pollution control solution in terms of investment and operational costs, it is recommended that pollution abaement measures at sources should be introduced prior to installation of treatment systems.

Before designing treatment system the following aspects should be looked into -

i) segregation of waste water based on type and strength

ii) reduction of quantity and strength of waste water by adopting in-process and in-plant control measures

iii) decide the best combination of treatment system

Technical feasibility and economical feasibility of the treatment system should be also looked at. The technology to be used in a particular case is primarily guided by the following considerations;

- Degree of treatment needed based on the characteristics of the waste and the statutory regulation in respect of the quality of the effluent to be discharged on the receiving body.
- Cost-capital and recurring.
- Availability of land to accommodate the treatment plant.
- Availability of the operation and maintenance skills and facilities at the site.

4.7.1 Cost Data

Since most of the industries have no systematic approach towards effluent treatment, any figure obtained from them will not provide any practical idea about the cost involvement. Moreover, applicability of the types of treatment schemes/ alternatives differs for different categories of a particular industry in terms of its production capability. Therefore, industries who have effluent treatment systems and also possess information about financial requirements are selected as listed in table 4.7.

Table 4.7
List of the sectors having Cost Data

SECTORS SERIAL Nos.	SECTORS
3.	Livestocks
4.	Fishing

7.	Sugar
9.	Beverages
10.	Food Products
11.	Cotton Textiles
13.	Jute Textiles
14.	Man made Fibre
16.	Leather Products
17.	Natural Rubber

For the purpose of the present study we would be dealing only with the operational (or running / recurring) cost aspects of the pollution abatement measures. Running cost of the treatment plant will include cost of power, salaries of the staff, chemicals used, maintenance, repairs and depreciation. It is very likely that we should make a point here that our main concern is only BOD removal.

The cost involved in pollution abatement activity of each sectors is analysed and evaluated suitably for clean water valuation of each sectors. It is observed for almost all the sectors, that the details on cost break-up data is available for specific unit whose production capacity in terms of Tonne/ day is given from which annual production is derived, by multiplying it with total number of working days (i.e., considered to be in average 300 days). From this annual production level, total waste water flow is determined simply based on the waste water flow per tonne of product $\times$ annual production. In the next step total BOD (in '000tonne) generated by that specific unit is deduced from the data on BOD generated (mg) per litre of wastewater flow of the sector concerned $\times$ total wastewater flow. Then given the level of treatment i.e., to what extent BOD is removed (90-95%) and the cost data in Lakh Rs. for Energy, Chemicals and Manpower required including operation and maintenance, cost per unit of BOD removed ('000 tonnes) is obtained. From this total cost is arrived at by multiplying cost per unit of BOD removed with the total

amount of BOD removed. Details of the cost data analysed for each of the selected industries are discussed in the Appendix No. 2.

The cost data so derived is incorporated in the input-output framework through introduction of a new sector, the ‘ Clean Water ‘ sector as presented in the row and column 33 of the table 4.8.

Of the running cost items, cost of power and chemicals (inorganic) used has been treated endogenously into the system and the salaries of the staffs, cost of operation and maintenance exogeneously as components of Gross Value Added.

This Section

4.8 LIMITATION OF DATA

This section points out towards the problems being faced in the process of data analysis ,relating to inadequacy of data

1. Detail adequate, appropriate and recent up-date data on different types of water pollutants generated by different industries of the Indian economy were lacking. For e.g., water pollution data on Non Ferrous basic Metals, Machinery ,Electrical and Transport Equipment sectors and Crude Petroleum ,Natural Gas ,Iron Ore, Bauxite, Copper Ore Metallic Minerals extraction were not available.

2. Practical and detail break-up of the total cost data of pollution abatement activities has been available and possible to analyse for only 10 industries, based on estimation being made by these said industries of a presumed ETP.

3. Data on the effluent character of the waste water and solid wastes coming out from any ETP, as required for proper and complete construction of Water Quality Index were not Available.

4. Data on the quality of labor and capital goods required for any pollution activities and capital stock were absent.

These to an extent constraints our efforts towards making a more effective and socially useful applicable experiments.

Table 4.8

Extended Input-output Table
(including the 'Clean Water' sector)

	SECTORS	1	2	3	4	5	6	7	8	9	10	11	12
1	AGRICULTURE	1065818.2	378654.4	773625.9	259.5	4.7	0.0	376979.6	511751.1	144449.0	290603.1	412053.1	95.5
2	MILK & MILK PRODUCTS	3102.6	2661.4	108.4	17.9		0.0	96.7	926.0	1087.3	178717.1	467.0	0.5
3	LIVESTOCK PRODUCTS	704963.7	0.0	427.4	0.0	0.0	0.0	350.1	742.5	375.8	62967.7	43397.7	6501.0
4	FISHING	529.5		18.5	6293.9		0.0	16.5	158.2	187.8	30504.3	6.9	
5	COAL & LIGNITE	1998.6		1.8		6422.1	93.9	1512.1	1425.6	5392.0	3320.0	11859.1	208.2
6	MINING & QUARRYING	71.8	0.0	0.0	0.0	5873.6	522.7	2239.5	10.6	1347.8	1159.1	511.2	1.0
7	SUGAR	1160.5	0.0	35.8	0.0	0.0	0.0	1331.1	314.1	7054.9	59318.9	1.9	0.0
8	EDIBLE OIL & VANASPATI	1099.2	37307.4	53052.1	0.0	0.0	0.0	1.2	18641.3	11.7	1637.4	20.9	0.0
9	BEVERAGES	66.2	0.0	0.7	0.0	0.0	0.0	5.9	6.4	44441.9	1398.9	12.3	0.0
10	OTHER FOOD PRODUCTS	717.3	2565.5	16689.4	1853.3	0.0	0.0	157.1	885.1	7309.0	25532.3	3822.1	4.4
11	OTHER TEXTILES	3862.5	22838.7	1675.4	11882.7	70.3	0.0	1464.2	6063.7	425.8	2620.9	915088.9	29862.0
12	WOOLEN TEXTILES	5.2		0.0			0.0	0.0	18.3	0.0	0.0	23268.6	7304.1
13	JUTE TEXTILES	3690.0		1.7	701.2		0.0	8727.0	718.2	166.3	4057.5	27419.8	205.2
14	MAN MADE FIBRE	11.7		0.0			0.0	0.0	737.1	5.6	764.6	208517.5	3916.9
15	PAPER	3386.9	0.0	12.4	68.0	1188.6	74.9	827.4	1101.6	5368.9	33017.6	16139.5	159.2
16	LEATHER	17.7	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	16.4	530.1	45.3
17	RUBBER PRODUCTS	2013.1		0.0		299.7	10.1	12.8	10.9	50.2	36.9	6701.1	24.8
18	PETROLEUM PRODUCTS	103707.5	0.0	6.7	11555.1	15522.7	16126.0	2907.1	1510.4	1214.9	13655.0	18527.9	296.1
19	INORGANIC CHEMICALS	168.8		0.6	14.7		1123.7	1045.5	1409.9	1646.5	1126.5	13253.3	153.1

20	ORGANIC CHEMICALS	319.0		0.6	4.0		0.0	3757.6	1603.7	1192.1	1413.8	27566.8	383.3
21	FERTILIZERS	724704.4		0.0			0.0	0.0	376.3	0.0	2237.9	60.6	0.8
22	PESTICIDES	78960.6		0.0			0.0	0.0	41.0	0.0	453.3	1.8	
23	PAINTS	17.9		0.0			0.0	31.7	552.7	35.6	80.6	45470.4	490.6
24	DRUGS & OTHER CHEMICAL	202.0	1251.4	4697.5	746.0	20062.2	2184.5	808.7	6980.8	1353.0	9635.2	16723.1	194.0
25	NON METALLIC MINERALS	151.6	0.0	0.9	0.0	0.0	9770.8	2429.2	120.9	2843.2	1634.4	2091.5	34.0
26	IRON & STEEL	320.9	0.0	0.0	244.8	0.0	0.0	175.3	106.7	174.3	68.9	4703.9	50.7
27	MISC. MANUFACTURING	120271.2	401.6	1892.2	15109.7	83628.6	24091.9	6392.8	3365.6	7362.9	22809.6	62212.2	1123.7
28	OTHER INDUSTRIES	1088.9	0.0	5.5	1835.0	2970.5	389.8	375.0	2586.6	8169.3	11408.4	17670.6	136.7
29	CONSTRUCTION	221222.6	1134.9	4258.0		1096.0	3388.2	867.9	378.9	249.0	1238.9	3727.4	53.4
30	ELECTRICITY-WATER-GAS SS	110958.2	0.0	4.3	175.4	37330.1	11586.4	6456.3	8677.9	6925.9	8906.0	163273.6	2062.4
31	TRANSPORT & COMN.	134312.4	10202.1	20712.3	2144.5	15698.1	3730.4	7161.4	11413.3	24175.6	28796.5	141211.4	3378.4
32	SERVICES	436346.2	80126.4	140973.7	10258.0	43169.9	34143.5	101434.4	59150.5	44813.3	156833.6	547618.5	16305.4
33	CLEAN WATER	0.0	0.0	204722.5	747.2	0.0	0.0	2777.2	0.0	527.4	77.2	1535.5	0.0
	Total Input at Factor Cost	3725266.8	537143.6	1018201.9	63163.9	233337.3	107236.9	527564.2	641790.0	317829.8	955971.2	2733930.5	72990.9
	Net Indirect tax	-320224.2	9142.4	13670.6	6744.7	33652.6	18691.4	12660.0	22338.8	21327.5	57398.7	148518.3	7886.0
	Total Input at Purchaser's Price	3405042.6	546286.1	1031872.5	69908.6	266989.9	125928.3	540224.2	664128.9	339157.2	1013369.9	2882448.8	80876.9
	Value added	9487848.8	1931713.0	809350.6	378372.5	324208.6	705941.6	122713.4	44419.9	123668.9	278834.3	1040311.5	26585.8
	Gross output	12892891.4	2477999.0	1841223.1	448281.1	591198.5	831869.9	662937.6	708548.8	462826.1	1292204.2	3922760.4	107462.6

Contd…Table4.8

	SECTORS	13	14	15	16	17	18	19	20	21	22	23	24
1	AGRICULTURE	48790.7	5785.7	35040.1	2868.5	43467.4	103.9	5024.4	5332.9	68.0	1.5	1225.4	163860.0
2	MILK & MILK PRODUCTS			0.7	7.3		0.0	0.6	3.9				585.2
3	LIVESTOCK PRODUCTS	0.4	794.1	216.4	43330.3	120.7	0.0	83.3	81.9	679.0	72.0	99.3	2482.0
4	FISHING		7.0	22.4	5.7	30.7	0.0	50.6	43.3	209.8	0.4	20.3	107.9
5	COAL & LIGNITE	982.0	787.6	14993.6	233.3	3370.7	52664.1	4905.6	7010.7	7697.9	81.6	1305.1	6596.4
6	MINING & QUARRYING	0.4	20349.1	543.8	4.5	1027.4	714075.5	7367.7	10858.0	116225.6	395.2	844.1	3151.2
7	SUGAR	0.0	23.6	0.0	0.0	0.0	0.0	94.6	656.6	2.1	0.0	5.1	8405.1
8	EDIBLE OIL & VANASPATI	0.0	1.2	0.0	0.0	0.0	0.0	6.6	9.9	0.0	0.0	1.3	2334.2
9	BEVERAGES	0.0	568.6	0.0	96.6	0.0	0.0	43.5	70.7	0.0	0.0	306.1	208.9
10	OTHER FOOD PRODUCTS	10.8	76.3	1981.7	71.7	0.0	0.9	120.5	98.1	0.0	0.0	56.5	5879.4
11	OTHER TEXTILES	2282.9	13784.7	5959.6	8081.6	25454.3	480.5	320.6	418.8	169.9	141.7	594.6	13717.0
12	WOOLEN TEXTILES	1.4	6.3	0.0	3.0	3.9	2.7						24.7
13	JUTE TEXTILES	15312.3	1636.3	3655.1	595.6	225.3	571.0	1070.2	1491.6	20550.9	37.2	9.4	2294.4
14	MAN MADE FIBRE	90.4	67209.0	3774.8	1251.8	26711.1	559.6	3583.1	5874.3	18.0		8107.8	2797.6
15	PAPER	188.8	21978.6	256502.7	894.9	1524.0	1329.9	2759.4	9392.3	702.6	4362.9	3573.4	61606.6
16	LEATHER	0.0	3.3	1.7	84467.1	3384.3	0.0	3.7	2.1	0.0	0.0	1.6	161.8
17	RUBBER PRODUCTS	27.6	286.4	103.5	7724.8	3428.5	70.4	24.3	76.4	24.1	7.7	17.7	988.1
18	PETROLEUM PRODUCTS	1057.3	3405.6	4502.3	2230.9	3192.7	23405.9	4083.1	9183.3	13727.0	2348.0	2563.7	12343.5
19	INORGANIC CHEMICALS	107.1	7865.5	14913.5	2070.1	3292.1	329.2	20251.4	24988.2	55056.9	3184.8	19522.7	31410.1
20	ORGANIC CHEMICALS	209.0	37717.2	6148.8	3728.2	5799.7	336.4	24116.4	46886.8	64664.8	4835.6	21829.0	83472.2
21	FERTILIZERS		2136.5	1.5	0.0	2.4	0.0	2234.5	3767.1	63714.7	940.5	1.6	21.9
22	PESTICIDES		5.8	0.0	0.0		0.0	30.7	1018.9	2042.2	23772.9	307.1	19.1
23	PAINTS	100.0	1198.2	13411.7	7301.1	457.8	329.7	967.5	1988.5	26.3	9.0	23165.6	4008.9
24	DRUGS & OTHER	2656.7	21341.0	13724.2	8472.7	67215.7	2870.4	6021.8	9987.9	43237.7	6528.6	26572.2	323854.8

	CHEMICAL												
25	NON METALLIC MINERALS	105.9	692.6	1081.8	108.5	214.3	74.3	1723.2	1763.2	636.2	675.2	864.8	9912.8
26	IRON & STEEL	842.4	902.1	1206.7	187.8	947.8	236.7	277.3	561.5	464.5	59.1	862.6	1296.3
27	MISC. MANUFACTURING	5456.1	12253.0	31055.7	5652.4	22153.6	5054.6	13710.6	19640.3	21430.0	8204.8	20550.6	40365.5
28	OTHER INDUSTRIES	140.5	2278.0	2044.9	554.3	1912.3	560.7	2349.1	3037.9	8293.7	2006.3	2373.0	16689.5
29	CONSTRUCTION	1.0	338.6	575.4	298.1	258.0	229.8	117.9	136.4	204.7	79.0	39.2	623.9
30	ELECTRICITY-WATER-GAS SS	12106.9	28988.4	48847.0	5220.1	13702.9	7832.1	33149.3	45129.2	39083.5	5170.9	10182.0	43085.6
31	TRANSPORT & COMN.	7287.7	14907.4	35651.0	10499.8	14882.0	40560.5	9771.8	15324.2	30410.2	3023.4	10390.7	52025.1
32	SERVICES	20587.6	55530.4	115245.4	63289.9	57228.8	92447.7	26450.7	45047.1	90863.1	13741.1	39418.9	193003.5
33	CLEAN WATER	51.3	3564.2	0.0	342.4	96.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Input at Factor Cost	118345.9	322858.4	611206.2	259250.6	300008.4	944126.4	170713.8	269882.3	580203.2	79679.5	194811.3	1087333.4
	Net Indirect tax	5600.0	77109.9	45969.9	21831.1	54443.1	409339.7	24840.9	49516.9	59018.4	9349.9	39408.0	149573.2
	Total Input at Purchaser's Price	123945.9	399968.3	657176.1	281081.6	354451.5	1353466.1	195554.7	319399.1	639221.6	89029.4	234219.3	1236906.6
	Value added	50788.6	89554.0	232888.9	83795.2	136956.8	136934.2	41489.5	78121.3	73311.6	30256.3	31452.8	328827.2
	Gross output	174734.5	489522.4	890065.0	364876.8	491408.3	1490400.3	237044.3	397520.5	712533.3	119285.7	265672.0	1565733.8

Contd… Table 4.8

	SECTORS	25	26	27	28	29	30	31	32	33	TOTAL	PFCE	GFCE

1	AGRICULTURE	5115.9	765.1	6840.2	89121.9	248682.4	179.2	74580.6	342971.1		3954294.2	7685661.2	16738.8
2	MILK & MILK PRODUCTS	3.0		0.9	0.0	208.5	0.0	0.0	81243.3		187185.0	2151843.6	56917.1
3	LIVESTOCK PRODUCTS	395.2	0.5	8441.4	108.3	6607.3	1500.1	0.0	70898.4		819725.8	856844.5	342.6
4	FISHING	75.7	0.1	6280.3	52.2	37.0	0.0	0.0	2004.6		37715.6	401991.8	212.6
5	COAL & LIGNITE	68643.7	108191.2	30388.6	622.6	953.6	287423.5	14211.5	24567.1		32233.4	11689.5	119.3
6	MINING & QUARRYING	148048.8	50280.8	73232.3	191.8	313147.9	144723.6	0.0	40581.6		11737.5	0.0	430.1
7	SUGAR	0.0	0.0	2.0	1.2	88.1	0.6	0.0	21971.1		69217.3	550734.8	0.0
8	EDIBLE OIL & VANASPATI	0.0	0.0	2.8	0.8	21.5	0.0	130.1	39512.8		111771.1	523422.7	0.0
9	BEVERAGES	0.0	0.0	0.8	8.1	20.2	0.6	1330.8	27292.3		45932.1	296348.1	20.9
10	OTHER FOOD PRODUCTS	164.8	52.0	126.5	58.1	48.1	2.1	1332.6	22350.8		59535.4	1077267.5	597.1
11	OTHER TEXTILES	1502.7	1018.8	12071.3	5817.7	845.1	562.7	3290.7	93537.5		995855.2	2257723.2	5352.5
12	WOOLEN TEXTILES	1.1	0.0	100.2	1.3	16.9	3.4	602.3	1932.5		30596.2	72096.2	
13	JUTE TEXTILES	29300.8	472.2	2014.1	867.0	11643.8	66.5	291.7	10517.9		45687.1	4424.6	1542.3
14	MAN MADE FIBRE	579.8	87.7	65115.1	103786.6	570.5	196.5	48.3	33384.4		213953.4		43235.7
15	PAPER	6231.0	1600.8	43404.8	3692.4	10886.0	3774.3	28341.7	214371.9		61345.0	167282.1	77368.6
16	LEATHER	8.1	4.5	1482.7	150.8	95.2	0.6	687.6	10411.4		613.8	106682.6	0.0
17	RUBBER PRODUCTS	84.7	640.5	76993.1	733.6	2991.2	631.4	124155.8	10438.6		9159.8	82321.2	2133.6
18	PETROLEUM PRODUCTS	63030.6	86143.8	117168.7	2857.8	116239.7	23961.2	553491.2	39128.8		185029.2	387473.9	58163.0
19	INORGANIC CHEMICALS	6325.1	3404.7	38646.0	1247.8	290.2	1660.7	114.3	12966.4	27922.5	19942.8		1498.6
20	ORGANIC CHEMICALS	11225.6	10980.2	43140.6	13211.6	477.6	140.4	3.7	26076.9		36241.1		42465.1
21	FERTILIZERS	0.0	0.0	499.0	4.1	14136.8	15.6	0.0	9770.0		727379.9		1897.8
22	PESTICIDES	0.0	0.7	188.5	0.0	5808.8	0.0	292.5	1118.4		79456.6		36.4
23	PAINTS	1677.3	1317.6	40365.8	3751.4	85764.0	37.3	3148.0	11873.7		46679.5		
24	DRUGS & OTHER	1914.1	1727.3	39334.3	7447.4	536.0	489.2	1721.1	325575.1		64838.5	372624.0	44398.7

	CHEMICAL												
25	NON METALLIC MINERALS	64085.6	7364.8	24727.1	1045.0	592123.1	59.6	4258.3	13238.0		19076.4	141037.8	6.4
26	IRON & STEEL	20279.1	646572.2	1002625.1	1592.7	650811.2	2766.1	14132.4	108306.9		5845.5	0.0	3.1
27	MISC. MANUFACTURING	49490.3	297855.7	2161601.3	14942.7	317263.0	62445.5	429773.0	406901.0		348661.9	1051974.8	382632.0
28	OTHER INDUSTRIES	7231.2	2763.1	58855.7	36723.4	113201.6	165.1	22202.3	66174.3		46636.4	56394.9	49795.2
29	CONSTRUCTION	10276.3	3108.7	15101.6	296.0	20392.8	60016.6	106137.4	384964.6		237615.2		397913.3
30	ELECTRICITY-WATER-GAS SS	97275.9	126176.9	315120.6	16090.4	25853.5	553780.4	98765.7	254765.6	186518.9	356356.4	263719.0	101111.1
31	TRANSPORT & COMN.	111635.0	155853.9	379243.9	20158.7	294680.0	179700.9	254117.5	1014463.5		402936.5	1745797.7	372132.7
32	SERVICES	137959.4	265466.5	1128447.0	67292.3	544174.7	194585.0	563282.4	1592704.7		1671173.4	7497514.0	3729262.9
33	CLEAN WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		210386.9		
	Total Input at Factor Cost	842560.8	1771850.0	5691562.3	391875.6	3378616.1	1518888.8	2300443.7	5316015.3	214441.4	10934427.1	27762869.9	5386327.5
	Net Indirect tax	76212.0	199322.8	842413.8	81848.2	283489.2	142077.8	309153.3	352257.9		31806.8		
	Total Input at Purchaser's Price	918772.7	1971172.8	6533976.1	473723.8	3662105.3	1660966.6	2609597.0	5668273.1	214441.4	10966233.9		
	Value added	264390.3	372217.5	2978058.4	184615.6	2331394.4	842226.5	2774038.2	13654411.1	65131.2	15273968.7		
	Gross output	1183163.0	2343390.4	9512034.6	658339.4	5993499.7	2503193.1	5383635.2	19322684.2	279572.5	26240202.7		

Contd… Table 4.8

	SECTORS	GFCF	CIS	EXP.	Less	TOTAL	GROSS
						F.DD	OUTPUT
1	AGRICULTURE	0.0	150644.4	126318.3	120590.4	7858772.3	11813066.5
2	MILK & MILK PRODUCTS					2208760.6	2395945.6
3	LIVESTOCK PRODUCTS	28126.8	17815.0	5479.6	23021.8	885586.8	1705312.6
4	FISHING		523.0	794.2	1904.0	401617.6	439333.2
5	COAL & LIGNITE		-35118.0	1009.9	54366.0	-76665.2	-44431.8
6	MINING & QUARRYING	0.0	14842.0	70604.8	910793.7	-824916.9	-813179.4
7	SUGAR	0.0	18642.0	2825.4	9732.0	562470.3	631687.6
8	EDIBLE OIL & VANASPATI	0.0	6540.0	46738.7	21944.9	554756.5	666527.6
9	BEVERAGES	0.0	5360.0	86322.6	1104.8	386946.8	432879.0
10	OTHER FOOD PRODUCTS	0.0	-261.0	140944.7	18310.5	1200237.8	1259773.2
11	OTHER TEXTILES	2306.8	34745.0	490414.8	53689.6	2736852.7	3732707.9
12	WOOLEN TEXTILES		2669.0	4225.1	4823.5	74166.8	104763.0
13	JUTE TEXTILES		-2953.0	23559.1	148.9	26424.1	72111.2
14	MAN MADE FIBRE		7908.0	12663.9	111984.8	-48177.2	165776.2
15	PAPER	0.0	-4607.0	24779.2	113221.9	151601.0	212946.0
16	LEATHER	0.0	1075.0	164017.9	8379.0	263396.6	264010.4
17	RUBBER PRODUCTS	154589.4	4886.0	17468.1	8598.1	252800.1	261959.9
18	PETROLEUM PRODUCTS	0.0	8386.0	58682.4	291399.3	221305.9	406335.1
19	INORGANIC CHEMICALS		7242.0	39116.9	78402.8	-30545.3	-10602.5
20	ORGANIC CHEMICALS		9749.0	36552.8	132488.1	-43721.2	-7480.1
21	FERTILIZERS		9388.0	38.3	123416.8	-112092.7	615287.2
22	PESTICIDES		228.0	9130.1	4171.2	5223.3	84679.9
23	PAINTS		3838.0	30096.4	15841.5	18093.0	64772.5
24	DRUGS & OTHER CHEMICAL	0.0	123346.0	132606.2	83307.8	589667.1	654505.7
25	NON METALLIC MINERALS	5758.1	4899.0	305074.9	17443.9	439332.4	458408.7
26	IRON & STEEL	101796.8	64225.0	44955.5	328366.2	-117385.8	-111540.3
27	MISC. MANUFACTURING	3921890.5	355243.0	625707.8	1119875.3	5217572.9	5566234.8
28	OTHER INDUSTRIES	17739.4	138061.0	15423.7	15268.0	262146.3	308782.6
29	CONSTRUCTION	4754775.1				5152688.4	5390303.6
30	ELECTRICITY-WATER-GAS SS	0.0	387.0	1292.6	0.0	366509.7	722866.1
31	TRANSPORT & COMN.	115140.9	0.0	332106.0	239066.0	2326111.3	2729047.8
32	SERVICES	417947.0	0.0	809591.5	109571.0	12344744.4	14015917.9
33	CLEAN WATER					69185.6	279572.5
	Total Input at Factor Cost	9520070.8	947702.4	3658541.6	4021231.8	43254280.3	54188707.4
	Net Indirect tax						3264583.0
	Total Input at Purchaser's Price						40563683.2
	Value added						40054828.4
	Gross output						80618511.6

Chapter 5

Water Quality Indices

The availability of water in terms of both quantity and quality is essential to the very existence of mankind. Water though indispensable and playing a pivotal role in our lives is one of the most badly abused resources. Earlier people used to recognise the importance of water from quantity view point. Recognition of the importance of water quality developed more slowly, only in recent years. It is the result of alarming degradation in water quality caused due to domestic, industrial or agricultural discharges. Polluting substances include organic elements, metals, minerals, solid wastes, suspended solids, toxic chemicals, acids and alkali. Pollutants like ammonia, chloride, sulphide, zinc, phenol, sulphate, phosphate, arsenic, cyanide, etc., are also found in the waste water generated by the different industries of the Indian economy, agriculture or domestic spheres. Consequently, the number of physical and chemical parameters (which defines the water quality) such as pH, DO, total solids, inorganic and organic trace elements, that need to be monitored for proper assessment of water quality is quite large. Thus it will be more convenient to integrate the data pool in some way to produce a single number, to reflect the water quality status. Water quality index (WQI) achieves that result. The WQI considered in our case is of the form

$$WQI = \sum_{i=1}^{n} w_i q_i$$

where,

q_I = the quality of ith parameter a number between 0 and 100,

w_i = the weight of ith parameter a number between 0 and 1 and n = the total number of parameters.

The development and formulation of WQI involves four stages :

1) Parameter selection

2) Transformation of parameter estimates to a common scale.

3) Assignment of weightages to all the parameters

4) Aggregation of individual parameter scores to produce a final index score.

In the development of water quality indices experts (in the concerned field of water quality management) like – Horton, Robert K.; Robert M. Brown; Welsh Parker; David G. Smith; Ved Prakash; Nguyen Trung Viet etc (as referred to by Prof. S.A. Abbasi (1999) differ from each other with respect to either one or both of the following key factors :

i) Methods of assigning importance to individual water quality parameters

ii) Methods used to aggregate individual parameters into a single index score.

Here, we shall consider the systematic opinion research technique, as attempted by Robert M. Brown (as mentioned by Abbasi, 1999) . It has been utilised to incorporate the judgement of a large and diverse panel of experts. A panel of 142 persons with expertise in water quality management was selected for the study conducted by him. They were asked to rank the water quality parameters according to their significance as contributor to overall quality. The rating was done on a scale of 1 (highest) to 5 (lowest), based on the polluting effect of the parameter relative to other parameters. Each of the parameter represents only a part of the overall quality, thus parameters of lower importance even cannot be discarded, since they are still part of the overall quality.

In the next step, arithmetic mean was calculated on the rating scores of the experts, to arrive at the “mean of all significance rating” for each individual parameters..

Then to convert the rating into weights, a temporary weight of 1.0 was assigned to the parameter which received the highest significance rating. All other temporary weights were obtained by dividing the highest rating by the corresponding individual mean rating of the parameters. Each temporary weight was then divided by the sum of all temporary weights to deduce the final weights, which must sum upto one. A total weight of l is thus distributed among the parameters to reflect the relative importance of the parameters. The weightage hence assigned to a parameter is an indication of the degree to which water quality may be affected by that particular parameter.

The step coming next to the above is transformation of parameter to a common quality scale referred commonly as quality rating score. The quality rating score is assigned to a particular parameter depending on an individual judgement or a consensus opinion of experts based on the water quality standards. It reflects the magnitude of violation of set of standards. The quality rating is done on a scale of 0 to 100 (ie., highest to lowest polluting). .

Finally, an overall quality rating is derived, simply by multiplying the final weights (w_i) of each individual parameters with the corresponding quality rating (q_i). The sum of which gives the required single number WQI.

Taking these steps as the base our data has been analysed for assessing the water quality status of the waste water generated by the different industries of the Indian Economy. Details of which is presented in the table (1-23) of the Appendix 3.

Now, to evaluate the water quality status of the waste water generated by

the different industries of the Indian Economy using the WQI value so derived, water resource has been classified in the following way.

Table 5.1

Water Resource Classification

WQI vALuE	CLASS	DESCRIPTION
63-100	A	Good to Excellent
50-63	B	Medium to Good
38-50	C	Bad
Below 38	D,E	Bad to Very Bad

Based on this classification each sector has been designated a class along with its corresponding description, as illustrated in the tables (1-23) given in the Appendix 3.

Accordingly, theses sectors could be categorised (as depicted in table 5.2) under three broad headings namely – Good / Excellent ; Bad and Very bad – depending on the water resource classification as evident from table 5.1, to give a clear picture of water quality status of different industries. The last classification of table 5.1 (ie., D and E – Bad to Very bad) has been decomposed to class D with WQI values above 20 and described as Bad and those below 20 as Very bad under class E.

Table 5.2

Industry Classification (Based On Water Quality Index)

WQI VALUES	DESCRIPTION	CLASS	SECTORS
63-100	Good	A	Thermal Plant(66.39)
38-50 & 20-38	Bad	C D	Coal & lignite(46.67), Jute Textile(47.27), Ceramic(44.15), Fishing (23.26), Sugar(25.22), Food Products(23.79), Viscose Rayon(30.57), Paper(21.24), Petroleum Products(20.20), Pesticides(20.69)
Below 20	Very bad	E	Milk & Milk Products(17.45), Livestocks(15.72), Edible oil & Vanaspati(4.34), Beverages(4.385), Other Textiles(18.93), Woolen Textiles(17.215), Leathers(15.26), Rubber(10.57), Organic Chemicals(5.88), Paints(15.71), Drugs(9.26), Iron & Steel(10.675)

Corresponding to the above table the sectors of the economy could be further ranked, based on the WQI values, showing the highest to lowest polluting sectors of the Indian economy in descending order in the following table 5.3.

TABLE 5.3

RANKING OF SECTORS

(Based on pollution generation)

RANK	SECTORS
1.	**Edible Oil & Vanaspati**
2.	**(4.34)**
3.	**Beverages (4.385)**
4.	Organic Chemicals (5.88)

5.	Drugs & Other Chemicals (9.26)
6.	Rubber (10.57)
7.	Iron & Steel (10.675)
8.	Leather Products (15.26)
9.	Paints (15.71)
10.	Livestock (15.72)
11.	Woolen Textile (17.215)
12.	Milk & Milk Products (17.45)
13.	Cotton Textile (18.93)
14.	Petroleum Products (20.20)
15.	Pesticides (20.69)
16.	Paper (21.24)
17.	Fishing (23.26)
18.	Food Products (23.79)
19.	Sugar (25.22)
20.	Man made Fibre (30.57)
21.	Non Metallic Mineral (44.15)
22.	Coal & Lignite (46.67)
23.	Jute Textile (47.27)
	Thermal Plant[1] (66.39)

1. In Thermal Power Plant the water consumed are usually recycled for further utilisation. Thus pollution generation accounted for is very marginal.

N.B. The Chapter has been prepared under the guidance of Professor Sidhartha Dutta, Professor of Chemical Engineering Department, Jadavpur University, Calcutta.

Chapter 6

Experiment With Model I: The Results And Discussion

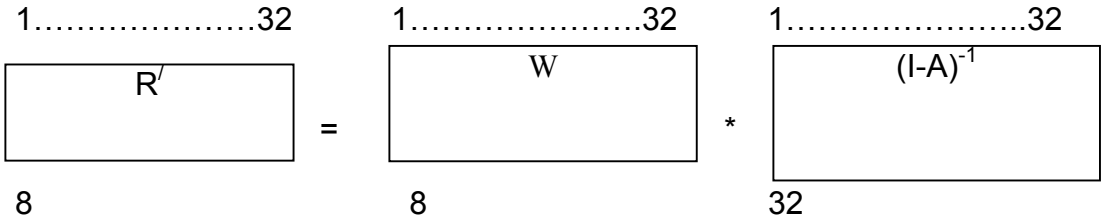
This Chapter attempts towards making a discussion on the results derived at through application of the methodology (Model I) described in Chapter 3 based on the data analysed in Chapter 4.

6.1 Direct And Indirect Pollution Output Coefficient

Tables 6.1, 6.2, 6.3 show us the direct, total (direct and indirect) and indirect water pollution generation coefficients of different sectors respectively. In some cases matrices are transposed for the sake of conveniences. The eight sets of pollution output coefficient that make up matrix W used in the computation are shown in table 6.1. As it is well known, the inverse $(I-A)^{-1}$, where A represents structural (input coefficients) matrix of a given economy describes the total i.e. direct and indirect, effect of " one Lakh Rupees " worth increase in the final demand for the products of any given industry on the total output of this and every other industry. The amounts of each one of the eight different kinds of water pollutants generated in connection with the increase in level of all output contributing directly or indirectly to deliver to final uses of one “Lakh Rupees" worth of each particular kind of good are represented accordingly by the matrix product,

$W * (I-A)^{-1}$.

In other words, direct and indirect water pollution coefficients of the Indian industries are given by the matrix product



Here

$R^{/}$ is the direct and indirect water pollution coefficient matrix of different sectors (8 X 32)

W is the direct water pollution coefficient matrix of different sectors (8 X 32)

$(I - A)^{-1}$ is the Leontief matrix multiplier of different sectors (32 X 32)

The results of such computations are shown in table 6.2. Every entry in table 6.2 (total coefficient) is significantly higher compared to the corresponding figure in table 6.1 (direct coefficient only). Every null entry in table 6.1 signifies that the sector is non polluting, however, the corresponding non-zero entry in table 6.2 stresses that though the sector is non polluting, it indirectly participates in the over all pollution generating machinery. As for example , due to lack of data some sectors such as [other industries (28) , Construction (29),Transport and communication (31) and Services] are assumed to be non- polluting in these exercises (table 6.1). But however the table 6.2 stresses that though the above sectors are assumed non-polluting, they indirectly participate in the overall pollution generating machinery (through the inputs it uses). For example , direct total pollution generation in transport and communication is assumed to be absent (table6.1) but indirectly (through the inputs it uses) it generates pollution indirectly at the rate of 0.000012, 0.000007, 0.000008, 0.000029 thousand tonnes of suspended solids(SS), Dissoved Solids (DS), Oil and Grease, Other

pollutants respectively per Lakh Rupees of the products of these sectors.

Table 6.1 and 6.2 show that among the sectors direct pollution generation coefficient is found to be highest in Paper and Livestock products sector . Livestock sector directly generates (0.000535, 0.000110, 0.001478 thousand tonnes of suspended solids, Oil and Grease , and other pollutant respectively) per Lakh Rs. of the products of these sectors. Whereas total (direct and indirect) generation is highest for the Paper industry. This sector generates directly and indirectly 0.000805, 0.000013, 0.000001, 0.000004, 0.000384 thousand tonnes of suspended solids, dissolved solids, chloride, oil & grease and other pollutants respectively. Indirect pollution generation coefficient (table 6.3) has been constructed by deducting direct pollution generation coefficients (table 6.1) from total pollution generation coefficients (table 6.2).

It appears from the table 6.3 that the indirect pollution coefficients in almost all the sectors are significantly higher except livestock industries. In case of Livestock industries indirect pollution generation is found to be insignificant. Similar comparison between indirect and direct pollution coefficient has been shown in other industries (Sugar, Beverages, Other textiles, Woolen Textiles, Paper, Fertilizers, Milk & Milk products, Coal & Lignite, Edible Oil & Vanaspati, Food Products, Man made fibre, Leather, Petroleum product, Inorganic Chemicals) using bar diagrams (Fig.1-6).

TABLE 6.1

DIRECT WATER POLLUTION OUTPUT COEFFICIENTS

('000 tonnes discharged per Lakh Rs. of output at 1989/90 price)

	SECTORS	SS	DS	CHLORIDE	SULPHIDE	O/G	PHENOL	ZINC	OTHER
1	AGRICULTURE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000122
2	MILK & MILK PRODUCTS	0.000139	0.000193	0.000019	0.000000	0.000053	0.000000	0.000000	0.000127
3	LIVESTOCK PRODUCTS	0.000535	0.000000	0.000000	0.000000	0.000111	0.000000	0.000000	0.001478
4	FISHING	0.000002	0.000000	0.000000	0.000000	0.000001	0.000000	0.000000	0.000001
5	COAL & LIGNITE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6	MINING & QUARRYING	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
7	SUGAR	0.000456	0.001010	0.000000	0.000000	0.000007	0.000000	0.000000	0.000023
8	EDIBLE OIL & VANASPATI	0.000010	0.000000	0.000000	0.000000	0.000007	0.000000	0.000000	0.000000
9	BEVERAGES	0.000089	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000012
10	OTHER FOOD PRODUCTS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
11	OTHER TEXTILES	0.000000	0.000060	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
12	WOOLEN TEXTILES	0.000191	0.000716	0.000000	0.000000	0.000105	0.000000	0.000000	0.000015
13	JUTE TEXTILES	0.000000	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
14	MAN MADE FIBRE	0.000021	0.000158	0.000041	0.000000	0.000000	0.000000	0.000003	0.001531
15	PAPER	0.000562	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000239
16	LEATHER	0.000154	0.000709	0.000226	0.000001	0.000000	0.000000	0.000000	0.000071
17	RUBBER PRODUCTS	0.000057	0.000159	0.000000	0.000003	0.000000	0.000000	0.000000	0.000008
18	PETROLEUM PRODUCTS	0.000000	0.000000	0.000000	0.000008	0.000059	0.000001	0.000000	0.000000
19	INORGANIC CHEMICALS	0.000002	0.000248	0.000000	0.000000	0.000000	0.000000	0.000000	0.000131
20	ORGANIC CHEMICALS	0.000042	0.000000	0.000000	0.000000	0.000045	0.000014	0.000000	0.000006
21	FERTILIZERS	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000047
22	PESTICIDES	0.000000	0.000000	0.000025	0.000000	0.000000	0.000000	0.000000	0.000009
23	PAINTS	0.000003	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
24	DRUGS & OTHER CHEMICAL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25	NON METALLIC MINERALS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
26	IRON & STEEL	0.000000	0.000000	0.000008	0.000000	0.000000	0.000001	0.000000	0.000003
27	MISC. MANUFACTURING	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
28	OTHER INDUSTRIES	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
29	CONSTRUCTION	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
30	ELECTRICITY-WATER-GAS SS	0.000018	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
31	TRANSPORT & COMMUNICATION	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
32	SERVICES	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

TABLE 6.2

DIRECT & INDIRECT WATER POLLUTION OUTPUT COEFFICIENTS

('000 tonnes of pollutants directly & indirectly discharged per Lakh Rs.

(1989/90 price) worth of each industries sales to final dd)

	SECTORS	SS	DS	CHLORIDE	SULPHIDE	O/G	PHENOL	ZINC	OTHER
1	AGRICULTURE	0.000050	0.000003	0.000000	0.000000	0.000008	0.000000	0.000000	0.000237
2	MILK & MILK PRODUCTS	0.000148	0.000196	0.000019	0.000000	0.000055	0.000000	0.000000	0.000169
3	LIVESTOCK PRODUCTS	0.000561	0.000003	0.000000	0.000000	0.000115	0.000000	0.000000	0.001588
4	FISHING	0.000005	0.000004	0.000000	0.000000	0.000003	0.000000	0.000000	0.000011
5	COAL & LIGNITE	0.000010	0.000003	0.000001	0.000000	0.000003	0.000000	0.000000	0.000015
6	MINING & QUARRYING	0.000002	0.000001	0.000000	0.000000	0.000002	0.000000	0.000000	0.000004
7	SUGAR	0.000492	0.001016	0.000000	0.000000	0.000013	0.000000	0.000000	0.000167
8	EDIBLE OIL & VANASPATI	0.000054	0.000006	0.000001	0.000000	0.000015	0.000000	0.000000	0.000188
9	BEVERAGES	0.000142	0.000278	0.000001	0.000000	0.000005	0.000000	0.000000	0.000122
10	OTHER FOOD PRODUCTS	0.000110	0.000079	0.000003	0.000000	0.000018	0.000000	0.000000	0.000187
11	OTHER TEXTILES	0.000036	0.000104	0.000004	0.000000	0.000007	0.000000	0.000000	0.000202
12	WOOLEN TEXTILES	0.000262	0.000810	0.000003	0.000000	0.000124	0.000000	0.000000	0.000260
13	JUTE TEXTILES	0.000024	0.000006	0.000001	0.000000	0.000004	0.000000	0.000000	0.000086
14	MAN MADE FIBRE	0.000089	0.000199	0.000048	0.000000	0.000008	0.000002	0.000004	0.001834
15	PAPER	0.000805	0.000013	0.000001	0.000000	0.000004	0.000000	0.000000	0.000384
16	LEATHER	0.000305	0.000939	0.000295	0.000002	0.000021	0.000000	0.000000	0.000377
17	RUBBER PRODUCTS	0.000089	0.000190	0.000005	0.000004	0.000005	0.000001	0.000000	0.000166
18	PETROLEUM PRODUCTS	0.000004	0.000002	0.000000	0.000008	0.000062	0.000001	0.000000	0.000006
19	INORGANIC CHEMICALS	0.000039	0.000282	0.000001	0.000000	0.000010	0.000002	0.000000	0.000212
20	ORGANIC CHEMICALS	0.000089	0.000030	0.000002	0.000000	0.000055	0.000017	0.000000	0.000085
21	FERTILIZERS	0.000227	0.000031	0.000001	0.000000	0.000010	0.000002	0.000000	0.000102
22	PESTICIDES	0.000057	0.000016	0.000033	0.000000	0.000007	0.000001	0.000000	0.000065
23	PAINTS	0.000044	0.000038	0.000003	0.000000	0.000009	0.000002	0.000000	0.000117
24	DRUGS & OTHER CHEMICAL	0.000065	0.000022	0.000001	0.000000	0.000007	0.000001	0.000000	0.000086
25	NON METALLIC MINERALS	0.000016	0.000005	0.000001	0.000001	0.000006	0.000000	0.000000	0.000023
26	IRON & STEEL	0.000012	0.000005	0.000011	0.000001	0.000006	0.000002	0.000000	0.000021
27	MISC. MANUFACTURING	0.000016	0.000009	0.000002	0.000000	0.000003	0.000001	0.000000	0.000037
28	OTHER INDUSTRIES	0.000034	0.000038	0.000009	0.000000	0.000005	0.000001	0.000001	0.000354
29	CONSTRUCTION	0.000012	0.000004	0.000002	0.000000	0.000004	0.000000	0.000000	0.000032
30	ELECTRICITY-WATER-GAS SS	0.000030	0.000003	0.000000	0.000000	0.000003	0.000000	0.000000	0.000012
31	TRANSPORT & COMMUNICATION	0.000012	0.000007	0.000001	0.000001	0.000008	0.000000	0.000000	0.000020
32	SERVICES	0.000019	0.000006	0.000001	0.000000	0.000002	0.000000	0.000000	0.000029

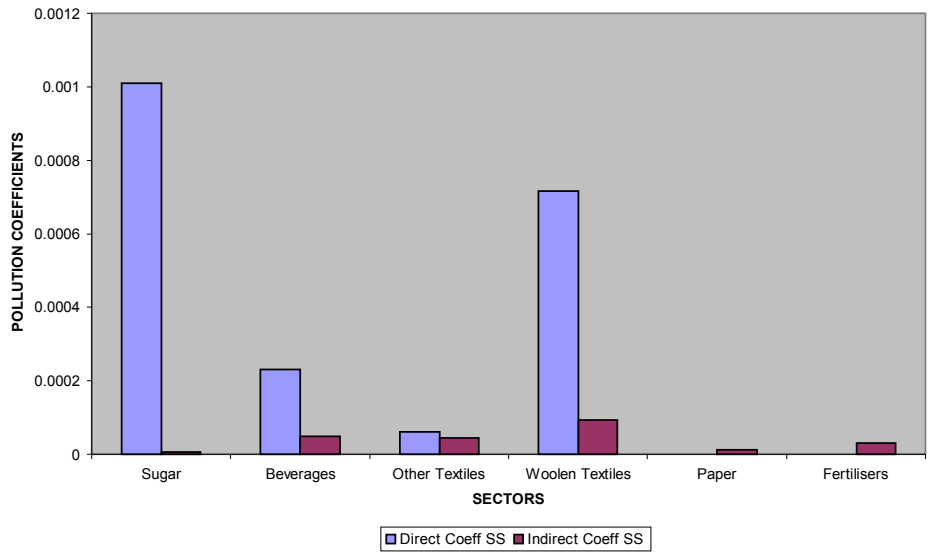
TABLE 6.3

INDIRECT WATER POLLUTION OUTPUT COEFFICIENTS

(‘000 tonnes of pollutants indirectly discharged per Lakh Rs. of output at 1989/90 price)

	SECTORS	SS	DS	CHLORIDE	SULPHIDE	O/G	PHENOL	ZINC	OTHER
1	AGRICULTURE	0.000050	0.000003	0.000000	0.000000	0.000008	0.000000	0.000000	0.000115
2	MILK & MILK PRODUCTS	0.000010	0.000002	0.000000	0.000000	0.000002	0.000000	0.000000	0.000042
3	LIVESTOCK PRODUCTS	0.000025	0.000003	0.000000	0.000000	0.000004	0.000000	0.000000	0.000110
4	FISHING	0.000003	0.000004	0.000000	0.000000	0.000002	0.000000	0.000000	0.000010
5	COAL & LIGNITE	0.000010	0.000003	0.000001	0.000000	0.000003	0.000000	0.000000	0.000015
6	MINING & QUARRYING	0.000002	0.000001	0.000000	0.000000	0.000002	0.000000	0.000000	0.000004
7	SUGAR	0.000035	0.000006	0.000000	0.000000	0.000006	0.000000	0.000000	0.000144
8	EDIBLE OIL & VANASPATI	0.000044	0.000006	0.000001	0.000000	0.000007	0.000000	0.000000	0.000188
9	BEVERAGES	0.000053	0.000048	0.000001	0.000000	0.000005	0.000000	0.000000	0.000110
10	OTHER FOOD PRODUCTS	0.000109	0.000079	0.000003	0.000000	0.000018	0.000000	0.000000	0.000187
11	OTHER TEXTILES	0.000036	0.000044	0.000004	0.000000	0.000007	0.000000	0.000000	0.000202
12	WOOLEN TEXTILES	0.000071	0.000094	0.000003	0.000000	0.000019	0.000000	0.000000	0.000245
13	JUTE TEXTILES	0.000024	0.000005	0.000001	0.000000	0.000004	0.000000	0.000000	0.000086
14	MAN MADE FIBRE	0.000068	0.000041	0.000007	0.000000	0.000008	0.000002	0.000001	0.000302
15	PAPER	0.000244	0.000013	0.000001	0.000000	0.000004	0.000000	0.000000	0.000145
16	LEATHER	0.000151	0.000230	0.000069	0.000001	0.000021	0.000000	0.000000	0.000307
17	RUBBER PRODUCTS	0.000031	0.000031	0.000005	0.000000	0.000005	0.000001	0.000000	0.000158
18	PETROLEUM PRODUCTS	0.000004	0.000002	0.000000	0.000000	0.000002	0.000000	0.000000	0.000006
19	INORGANIC CHEMICALS	0.000037	0.000034	0.000001	0.000000	0.000010	0.000002	0.000000	0.000081
20	ORGANIC CHEMICALS	0.000047	0.000030	0.000002	0.000000	0.000010	0.000002	0.000000	0.000078
21	FERTILIZERS	0.000044	0.000031	0.000001	0.000000	0.000010	0.000002	0.000000	0.000054
22	PESTICIDES	0.000057	0.000016	0.000007	0.000000	0.000007	0.000001	0.000000	0.000056
23	PAINTS	0.000041	0.000038	0.000003	0.000000	0.000009	0.000002	0.000000	0.000117
24	DRUGS & OTHER CHEMICAL	0.000065	0.000022	0.000001	0.000000	0.000007	0.000001	0.000000	0.000086
25	NON METALLIC MINERALS	0.000016	0.000005	0.000001	0.000001	0.000006	0.000000	0.000000	0.000023
26	IRON & STEEL	0.000012	0.000005	0.000004	0.000001	0.000006	0.000001	0.000000	0.000019
27	MISC. MANUFACTURING	0.000016	0.000009	0.000002	0.000000	0.000003	0.000001	0.000000	0.000037
28	OTHER INDUSTRIES	0.000034	0.000038	0.000009	0.000000	0.000005	0.000001	0.000001	0.000354
29	CONSTRUCTION	0.000012	0.000004	0.000002	0.000000	0.000004	0.000000	0.000000	0.000032
30	ELECTRICITY-WATER-GAS SS	0.000013	0.000003	0.000000	0.000000	0.000003	0.000000	0.000000	0.000012
31	TRANSPORT & COMMUNICATION	0.000012	0.000007	0.000001	0.000001	0.000008	0.000000	0.000000	0.000020
32	SERVICES	0.000019	0.000006	0.000001	0.000000	0.000002	0.000000	0.000000	0.000029

FIG. 3 : COMPARISION BETWEEN DIRECT & INDIRECT COEFF (SS)



6.2 Total Amount Of Pollution In Total Final Demand And Its Component

In this Section we would find out the total amount of different types of pollution in total final demand and different components of final demand of different industries. In matrix notations the complete set of such multiplication can be described as follows

$$\underset{8}{\boxed{\bar{R}}} = \underset{8}{\boxed{R^{/}}} * \underset{32}{\boxed{\bar{Y}^{-1}}}$$

(1……32 over the first matrix, 1……32 over the second, 1……32 over the third)

$\bar{R}$ is the amount of each one of the eight different kinds of pollutants (SS, DS, Chloride, Sulphide, Oil and Grease, Phenol, Zinc and Others) generated directly and indirectly to meet total final demand of different sectors (8 x 32) of the year 1989-90.

$R^{/}$ is the direct and indirect water pollution coefficient matrix of different sectors (8 X 32)

$\bar{Y}^{-1}$ is the diagonal matrix of total final demand (32 X 32)

Table 6.4 shows us the results of such computations. In this sections matrices are transposed for the sake of conveniences. Rows of the table (table 6.4) shows the total amount of different types of pollutant generated in the year 1989-90 by total final demand of different sectors. Some figures in table 6.4 show negative entries as the total final demand of those particular industries (sector 5, 6, 14, 19, 20 etc.) are negative. Examining the entries in column 2 table 6.4, we see for example, that the additional output of SS generated under the given technical conditions by all industries contributing to the delivery to final users of one additional Lakh Rupees worth of sugar product (sector 7) amounts to 30.8 tonnes of SS. Multiplying 0.46 with 562470.2 (value of total final demand of sugar sector for the year 1989-90), we find that in that year particular industry was responsible for the generation of 276.59 thousand tonnes of SS. Similar calculation has been done for each of the eight pollutants and six components of Final Demand (Private final Consumption Expenditure, Government Final Consumption Expenditure, Gross Fixed Capital Formation, Change in stock, Export and Import) Results of such computations are shown in table 6.5, 6.6, 6.7, 6.8, 6.9, 6.10 respectively.

Share of total amount of different types of water pollution in total final demand of all the sectors taken together and its components are shown in table 6.11. It appears form table 6.11 that in that particular year 2489.900, 2041.218, 171.0338, 13.9743, 462.2062, 10.286,1.77, 5645.02 thousand tonnes of Suspended Solids, Dissolved Solids, Chloride, Sulphide, Oil & Grease, Phenol, Zinc and other pollutants are generated by total final demand of all the sectors. Total amount of each kind of pollutant (say phenol) present in any particular components of final demand (say private final consumption expenditure) in all the sectors is calculated following the same methodology. 2nd to 6th row of table 6.11 show the results of such computations.

TABLE 6.4

Total Water Pollution Content Of The Total Final Demand Of Different Sectors Of India (for the year 1989-90)

1	AGRICULTURE	390.0989	23.1341	3.0496	1.0712	65.7396	1.3110	0.0408	1860.6739
2	MILK & MILK PRODUCTS	327.8657	431.8767	42.6671	0.0754	120.7744	0.0848	0.0100	373.9901
3	LIVESTOCK PRODUCTS	496.6942	2.5537	0.2461	0.0772	101.8837	0.0836	0.0043	1406.5281
4	FISHING	2.0784	1.5545	0.1068	0.0976	1.2222	0.0263	0.0055	4.4175
5	COAL & LIGNITE	-0.7785	-0.2526	-0.0396	-0.0274	-0.2277	-0.0131	-0.0012	-1.1265
6	MINING & QUARRYING	-1.9293	-0.9466	-0.1073	-0.1605	-1.3020	-0.0443	-0.0035	-3.0990
7	SUGAR	276.4952	571.7080	0.2280	0.0912	7.0703	0.1306	0.0050	94.0237
8	EDIBLE OIL & VANASPATI	29.8518	3.3278	0.3029	0.0901	8.0781	0.1179	0.0093	104.5702
9	BEVERAGES	54.9265	107.4264	0.2369	0.0710	1.9616	0.0730	0.0087	47.2734
10	OTHER FOOD PRODUCTS	131.4944	94.9744	3.8003	0.2464	21.0793	0.1878	0.0214	224.1160
11	OTHER TEXTILES	99.5353	284.3783	10.6010	0.5814	17.8843	1.1296	0.8192	553.3800
12	WOOLEN TEXTILES	19.4228	60.0601	0.2527	0.0131	9.1643	0.0235	0.0189	19.2860
13	JUTE TEXTILES	0.6362	0.1499	0.0201	0.0056	0.1138	0.0046	0.0004	2.2840
14	MAN MADE FIBRE	-4.2897	-9.5990	-2.3316	-0.0120	-0.3752	-0.0818	-0.1956	-88.3338
15	PAPER	122.0613	2.0083	0.1280	0.0351	0.5378	0.0594	0.0069	58.2574
16	LEATHER	80.2541	247.2395	77.7321	0.5005	5.5087	0.1162	0.0131	99.3034
17	RUBBER PRODUCTS	22.4093	48.0706	1.3530	0.9270	1.1707	0.1483	0.0644	41.9362
18	PETROLEUM PRODUCTS	0.9361	0.3498	0.0396	1.8085	13.6190	0.2133	0.0015	1.4332
19	INORGANIC CHEMICALS	-1.2009	-8.6244	-0.0457	-0.0116	-0.2924	-0.0627	-0.0030	-6.4855
20	ORGANIC CHEMICALS	-3.8901	-1.2987	-0.0657	-0.0180	-2.4165	-0.7221	-0.0041	-3.6967
21	FERTILIZERS	-25.4290	-3.4854	-0.0933	-0.0461	-1.0902	-0.2253	-0.0041	-11.3930
22	PESTICIDES	0.2973	0.0857	0.1703	0.0020	0.0347	0.0060	0.0002	0.3371
23	PAINTS	0.7892	0.6869	0.0454	0.0057	0.1658	0.0382	0.0031	2.1116
24	DRUGS & OTHER CHEMICAL	38.4793	12.8829	0.4826	0.1502	4.3858	0.7645	0.0241	50.7858
25	NON METALLIC MINERALS	6.8859	2.3727	0.3062	0.3086	2.7661	0.1670	0.0359	9.9258
26	IRON & STEEL	-1.3824	-0.5555	-1.3127	-0.0814	-0.6628	-0.2626	-0.0022	-2.4967
27	MISC. MANUFACTURING	81.2306	45.2145	12.2382	1.9270	17.9916	2.6853	0.2837	195.4815
28	OTHER INDUSTRIES	8.9516	9.9923	2.2295	0.0495	1.2853	0.1951	0.1809	92.8039
29	CONSTRUCTION	64.3787	21.8170	9.1567	2.1432	20.8396	2.1249	0.1677	164.8933
30	ELECTRICITY-WATER-GASSS	11.1559	0.9786	0.1341	0.1112	0.9490	0.0399	0.0036	4.3743
31	TRANSPORT & COMMUNICATION	28.9173	16.3962	1.3704	2.4143	17.7704	0.4707	0.0420	45.4454
32	SERVICES	232.9546	76.7418	8.1321	1.5282	26.5768	1.4964	0.2132	354.0194

All figures are in ‘000tonnes per lakh Rupees of final demand.

Table 6.5
Total Water Pollution Content Of Private Final Consumption Expenditure Component (Pfce) Of Final Demand Of Different Sectors Of India (For The Year 1989-90)

1	AGRICULTURE	381.5059	22.6245	2.9825	1.0476	64.2915	1.2821	0.0399	1819.6875
2	MILK & MILK PRODUCTS	319.4170	420.7477	41.5677	0.0735	117.6622	0.0826	0.0097	364.3529
3	LIVESTOCK PRODUCTS	480.5737	2.4709	0.2381	0.0747	98.5770	0.0809	0.0042	1360.8784
4	FISHING	2.0803	1.5559	0.1069	0.0977	1.2233	0.0264	0.0055	4.4217
5	COAL & LIGNITE	0.1187	0.0385	0.0060	0.0042	0.0347	0.0020	0.0002	0.1718
6	MINING & QUARRYING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	SUGAR	270.7264	559.7798	0.2232	0.0893	6.9228	0.1279	0.0049	92.0620
8	EDIBLE OIL & VANASPATI	28.1657	3.1398	0.2858	0.0850	7.6218	0.1113	0.0088	98.6639
9	BEVERAGES	42.0661	82.2738	0.1814	0.0544	1.5023	0.0559	0.0066	36.2049
10	OTHER FOOD PRODUCTS	118.0222	85.2438	3.4110	0.2211	18.9196	0.1686	0.0192	201.1542
11	OTHER TEXTILES	82.1101	234.5933	8.7451	0.4797	14.7534	0.9319	0.6758	456.5021
12	WOOLEN TEXTILES	18.8806	58.3833	0.2456	0.0128	8.9085	0.0228	0.0184	18.7475
13	JUTE TEXTILES	0.1065	0.0251	0.0034	0.0009	0.0191	0.0008	0.0001	0.3824
14	MAN MADE FIBRE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	PAPER	134.6870	2.2160	0.1412	0.0387	0.5934	0.0656	0.0076	64.2833
16	LEATHER	32.5050	100.1385	31.4836	0.2027	2.2312	0.0471	0.0053	40.2205
17	RUBBER PRODUCTS	7.2973	15.6536	0.4406	0.3019	0.3812	0.0483	0.0210	13.6560
18	PETROLEUM PRODUCTS	1.6390	0.6124	0.0694	3.1663	23.8449	0.3734	0.0026	2.5093
19	INORGANIC CHEMICALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	ORGANIC CHEMICALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	FERTILIZERS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	PESTICIDES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23	PAINTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	DRUGS & OTHER CHEMICAL	24.3159	8.1410	0.3050	0.0949	2.7715	0.4831	0.0152	32.0927
25	NON METALLIC MINERALS	2.2106	0.7617	0.0983	0.0991	0.8880	0.0536	0.0115	3.1864
26	IRON & STEEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	MISC. MANUFACTURING	16.3778	9.1162	2.4675	0.3885	3.6275	0.5414	0.0572	39.4133
28	OTHER INDUSTRIES	1.9257	2.1496	0.4796	0.0107	0.2765	0.0420	0.0389	19.9647
29	CONSTRUCTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	ELECTRICITY-WATER-GAS SS	8.0272	0.7042	0.0965	0.0800	0.6828	0.0287	0.0026	3.1475
31	TRANSPORT & COMMUNICATION	21.7030	12.3057	1.0285	1.8120	13.3371	0.3533	0.0316	34.1078
32	SERVICES	141.4837	46.6087	4.9390	0.9281	16.1413	0.9088	0.1295	215.0118

All figures are in ‘000tonnes per lakh Rupees of final demand (PFCE).

Table 6.6

Total Water Pollution Content Of Govt. Final Consumption Expenditure Component (Gfce) Of Final Demand Of Different Sectors Of India (For The Year 1989-90)

1	AGRICULTURE	0.8309	0.0493	0.0065	0.0023	0.1400	0.0028	0.0001	3.9631
2	MILK & MILK PRODUCTS	8.4487	11.1289	1.0995	0.0019	3.1122	0.0022	0.0003	9.6373
3	LIVESTOCK PRODUCTS	0.1922	0.0010	0.0001	0.0000	0.0394	0.0000	0.0000	0.5442
4	FISHING	0.0011	0.0008	0.0001	0.0001	0.0006	0.0000	0.0000	0.0023
5	COAL & LIGNITE	0.0012	0.0004	0.0001	0.0000	0.0004	0.0000	0.0000	0.0018
6	MINING & QUARRYING	0.0010	0.0005	0.0001	0.0001	0.0007	0.0000	0.0000	0.0016
7	SUGAR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	EDIBLE OIL & VANASPATI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	BEVERAGES	0.0030	0.0058	0.0000	0.0000	0.0001	0.0000	0.0000	0.0026
10	OTHER FOOD PRODUCTS	0.0654	0.0472	0.0019	0.0001	0.0105	0.0001	0.0000	0.1115
11	OTHER TEXTILES	0.1947	0.5562	0.0207	0.0011	0.0350	0.0022	0.0016	1.0822
12	WOOLEN TEXTILES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13	JUTE TEXTILES	0.0371	0.0087	0.0012	0.0003	0.0066	0.0003	0.0000	0.1333
14	MAN MADE FIBRE	3.8497	8.6145	2.0925	0.0107	0.3367	0.0734	0.1755	79.2735
15	PAPER	62.2933	1.0249	0.0653	0.0179	0.2745	0.0303	0.0035	29.7313
16	LEATHER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	RUBBER PRODUCTS	0.1891	0.4057	0.0114	0.0078	0.0099	0.0013	0.0005	0.3539
18	PETROLEUM PRODUCTS	0.2460	0.0919	0.0104	0.4753	3.5793	0.0561	0.0004	0.3767
19	INORGANIC CHEMICALS	0.0589	0.4231	0.0022	0.0006	0.0143	0.0031	0.0001	0.3182
20	ORGANIC CHEMICALS	3.7784	1.2614	0.0639	0.0175	2.3471	0.7013	0.0040	3.5905
21	FERTILIZERS	0.4305	0.0590	0.0016	0.0008	0.0185	0.0038	0.0001	0.1929
22	PESTICIDES	0.0021	0.0006	0.0012	0.0000	0.0002	0.0000	0.0000	0.0023
23	PAINTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	DRUGS & OTHER CHEMICAL	2.8973	0.9700	0.0363	0.0113	0.3302	0.0576	0.0018	3.8239
25	NON METALLIC MINERALS	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
26	IRON & STEEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
27	MISC. MANUFACTURING	5.9571	3.3158	0.8975	0.1413	1.3194	0.1969	0.0208	14.3357
28	OTHER INDUSTRIES	1.7004	1.8981	0.4235	0.0094	0.2442	0.0371	0.0344	17.6283
29	CONSTRUCTION	4.9716	1.6848	0.7071	0.1655	1.6093	0.1641	0.0130	12.7338
30	ELECTRICITY-WATER-GAS SS	3.0777	0.2700	0.0370	0.0307	0.2618	0.0110	0.0010	1.2068
31	TRANSPORT & COMMUNICATION	4.6262	2.6231	0.2192	0.3862	2.8429	0.0753	0.0067	7.2704
32	SERVICES	70.3740	23.1832	2.4567	0.4617	8.0287	0.4521	0.0644	106.9468

All figures are in ‘000 tonnes per lakh Rupees of final demand (GFCE).

Table 6.7

Total Water Pollution Content Of Gross Fixed Capital Formation (Gfcf) Of Final Demand Of Different Sectors Of India (For The Year 1989-90)

1	AGRICULTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	MILK & MILK PRODUCTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	LIVESTOCK PRODUCTS	15.7753	0.0811	0.0078	0.0025	3.2359	0.0027	0.0001	44.6722
4	FISHING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	COAL & LIGNITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	MINING & QUARRYING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	SUGAR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	EDIBLE OIL & VANASPATI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	BEVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	OTHER FOOD PRODUCTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	OTHER TEXTILES	0.0839	0.2397	0.0089	0.0005	0.0151	0.0010	0.0007	0.4664
12	WOOLEN TEXTILES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13	JUTE TEXTILES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	MAN MADE FIBRE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	PAPER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	LEATHER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	RUBBER PRODUCTS	13.7034	29.3956	0.8274	0.5669	0.7159	0.0907	0.0394	25.6443
18	PETROLEUM PRODUCTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	INORGANIC CHEMICALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	ORGANIC CHEMICALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	FERTILIZERS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	PESTICIDES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23	PAINTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	DRUGS & OTHER CHEMICAL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25	NON METALLIC MINERALS	0.0902	0.0311	0.0040	0.0040	0.0363	0.0022	0.0005	0.1301
26	IRON & STEEL	1.1988	0.4818	1.1384	0.0706	0.5747	0.2278	0.0019	2.1651
27	MISC. MANUFACTURING	61.0586	33.9864	9.1991	1.4485	13.5238	2.0185	0.2132	146.9375
28	OTHER INDUSTRIES	0.6058	0.6762	0.1509	0.0034	0.0870	0.0132	0.0122	6.2800
29	CONSTRUCTION	59.4071	20.1322	8.4496	1.9777	19.2303	1.9608	0.1548	152.1595
30	ELECTRICITY-WATER-GAS SS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	TRANSPORT & COMMUNICATION	1.4314	0.8116	0.0678	0.1195	0.8796	0.0233	0.0021	2.2495
32	SERVICES	7.8870	2.5982	0.2753	0.0517	0.8998	0.0507	0.0072	11.9858

All figures are in ‘000 tonnes per lakh Rupees of final demand (GFCF) .

TABLE 6.8

TOTAL WATER POLLUTION CONTENT OF CHANGE IN STOCK COMPONENT (CIS) OF FINAL DEMAND OF DIFFERENT SECTORS OF INDIA (for the year 1989-90)

1	AGRICULTURE	7.4778	0.4435	0.0585	0.0205	1.2602	0.0251	0.0008	35.6672
2	MILK & MILK PRODUCTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	LIVESTOCK PRODUCTS	9.9918	0.0514	0.0050	0.0016	2.0496	0.0017	0.0001	28.2946
4	FISHING	0.0027	0.0020	0.0001	0.0001	0.0016	0.0000	0.0000	0.0058
5	COAL & LIGNITE	-0.3566	-0.1157	-0.0181	-0.0125	-0.1043	-0.0060	-0.0005	-0.5160
6	MINING & QUARRYING	0.0347	0.0170	0.0019	0.0029	0.0234	0.0008	0.0001	0.0558
7	SUGAR	9.1639	18.9482	0.0076	0.0030	0.2343	0.0043	0.0002	3.1162
8	EDIBLE OIL & VANASPATI	0.3519	0.0392	0.0036	0.0011	0.0952	0.0014	0.0001	1.2328
9	BEVERAGES	0.7608	1.4881	0.0033	0.0010	0.0272	0.0010	0.0001	0.6548
10	OTHER FOOD PRODUCTS	-0.0286	-0.0207	-0.0008	-0.0001	-0.0046	0.0000	0.0000	-0.0487
11	OTHER TEXTILES	1.2636	3.6103	0.1346	0.0074	0.2270	0.0143	0.0104	7.0253
12	WOOLEN TEXTILES	0.6990	2.1614	0.0091	0.0005	0.3298	0.0008	0.0007	0.6940
13	JUTE TEXTILES	-0.0711	-0.0167	-0.0022	-0.0006	-0.0127	-0.0005	0.0000	-0.2552
14	MAN MADE FIBRE	0.7041	1.5756	0.3827	0.0020	0.0616	0.0134	0.0321	14.4995
15	PAPER	-3.7093	-0.0610	-0.0039	-0.0011	-0.0163	-0.0018	-0.0002	-1.7704
16	LEATHER	0.3275	1.0091	0.3172	0.0020	0.0225	0.0005	0.0001	0.4053
17	RUBBER PRODUCTS	0.4331	0.9291	0.0261	0.0179	0.0226	0.0029	0.0012	0.8105
18	PETROLEUM PRODUCTS	0.0355	0.0133	0.0015	0.0685	0.5161	0.0081	0.0001	0.0543
19	INORGANIC CHEMICALS	0.2847	2.0448	0.0108	0.0028	0.0693	0.0149	0.0007	1.5376
20	ORGANIC CHEMICALS	0.8674	0.2896	0.0147	0.0040	0.5388	0.1610	0.0009	0.8243
21	FERTILIZERS	2.1297	0.2919	0.0078	0.0039	0.0913	0.0189	0.0003	0.9542
22	PESTICIDES	0.0130	0.0037	0.0074	0.0001	0.0015	0.0003	0.0000	0.0147
23	PAINTS	0.1674	0.1457	0.0096	0.0012	0.0352	0.0081	0.0007	0.4479
24	DRUGS & OTHER CHEMICAL	8.0491	2.6948	0.1009	0.0314	0.9174	0.1599	0.0050	10.6233
25	NON METALLIC MINERALS	0.0768	0.0265	0.0034	0.0034	0.0308	0.0019	0.0004	0.1107
26	IRON & STEEL	0.7563	0.3040	0.7182	0.0446	0.3626	0.1437	0.0012	1.3660
27	MISC. MANUFACTURING	5.5307	3.0785	0.8333	0.1312	1.2250	0.1828	0.0193	13.3095
28	OTHER INDUSTRIES	4.7144	5.2625	1.1742	0.0261	0.6769	0.1028	0.0953	48.8757
29	CONSTRUCTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	ELECTRICITY-WATER-GAS SS	0.0118	0.0010	0.0001	0.0001	0.0010	0.0000	0.0000	0.0046
31	TRANSPORT & COMMUNICATION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	SERVICES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

All figures are in ‘000 tonnes per lakh Rupees of final demand (CIS).

Table 6.9

Total Water Pollution Content Of Export Component (Exp.) Of Final Demand Of Different Sectors Of India (For The Year 1989-90)

1	AGRICULTURE	6.2703	0.3718	0.0490	0.0172	1.0567	0.0211	0.0007	29.9076
2	MILK & MILK PRODUCTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	LIVESTOCK PRODUCTS	3.0733	0.0158	0.0015	0.0005	0.6304	0.0005	0.0000	8.7030
4	FISHING	0.0041	0.0031	0.0002	0.0002	0.0024	0.0001	0.0000	0.0087
5	COAL & LIGNITE	0.0103	0.0033	0.0005	0.0004	0.0030	0.0002	0.0000	0.0148
6	MINING & QUARRYING	0.1651	0.0810	0.0092	0.0137	0.1114	0.0038	0.0003	0.2652
7	SUGAR	1.3889	2.8718	0.0011	0.0005	0.0355	0.0007	0.0000	0.4723
8	EDIBLE OIL & VANASPATI	2.5150	0.2804	0.0255	0.0076	0.6806	0.0099	0.0008	8.8101
9	BEVERAGES	12.2534	23.9654	0.0528	0.0158	0.4376	0.0163	0.0019	10.5461
10	OTHER FOOD PRODUCTS	15.4415	11.1529	0.4463	0.0289	2.4754	0.0221	0.0025	26.3181
11	OTHER TEXTILES	17.8357	50.9576	1.8996	0.1042	3.2047	0.2024	0.1468	99.1598
12	WOOLEN TEXTILES	1.1065	3.4215	0.0144	0.0007	0.5221	0.0013	0.0011	1.0987
13	JUTE TEXTILES	0.5672	0.1336	0.0179	0.0050	0.1015	0.0041	0.0004	2.0363
14	MAN MADE FIBRE	1.1276	2.5232	0.6129	0.0031	0.0986	0.0215	0.0514	23.2195
15	PAPER	19.9509	0.3283	0.0209	0.0057	0.0879	0.0097	0.0011	9.5222
16	LEATHER	49.9745	153.9569	48.4041	0.3117	3.4303	0.0724	0.0082	61.8366
17	RUBBER PRODUCTS	1.5484	3.3216	0.0935	0.0641	0.0809	0.0102	0.0044	2.8977
18	PETROLEUM PRODUCTS	0.2482	0.0927	0.0105	0.4795	3.6113	0.0566	0.0004	0.3800
19	INORGANIC CHEMICALS	1.5379	11.0446	0.0585	0.0149	0.3744	0.0803	0.0038	8.3054
20	ORGANIC CHEMICALS	3.2523	1.0858	0.0550	0.0150	2.0203	0.6037	0.0034	3.0906
21	FERTILIZERS	0.0087	0.0012	0.0000	0.0000	0.0004	0.0001	0.0000	0.0039
22	PESTICIDES	0.5197	0.1497	0.2976	0.0034	0.0607	0.0105	0.0003	0.5892
23	PAINTS	1.3127	1.1426	0.0755	0.0095	0.2757	0.0636	0.0052	3.5126
24	DRUGS & OTHER CHEMICAL	8.6533	2.8972	0.1085	0.0338	0.9863	0.1719	0.0054	11.4209
25	NON METALLIC MINERALS	4.7816	1.6476	0.2126	0.2143	1.9208	0.1160	0.0249	6.8925
26	IRON & STEEL	0.5294	0.2128	0.5027	0.0312	0.2538	0.1006	0.0009	0.9562
27	MISC. MANUFACTURING	9.7414	5.4223	1.4676	0.2311	2.1576	0.3220	0.0340	23.4428
28	OTHER INDUSTRIES	0.5267	0.5879	0.1312	0.0029	0.0756	0.0115	0.0106	5.4602
29	CONSTRUCTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	ELECTRICITY-WATER-GAS SS	0.0393	0.0035	0.0005	0.0004	0.0033	0.0001	0.0000	0.0154
31	TRANSPORT & COMMUNICATION	4.1286	2.3409	0.1956	0.3447	2.5371	0.0672	0.0060	6.4884
32	SERVICES	15.2776	5.0329	0.5333	0.1002	1.7430	0.0981	0.0140	23.2173

All figures are in ‘000 tonnes per lakh Rupees of final demand (EXP.).

Table 6.10

Total Water Pollution Content Of Import Component (Imp.)

Of Final Demand Of Different Sectors Of India (For The Year 1989-90)

1	AGRICULTURE	5.9859	0.3550	0.0468	0.0164	1.0088	0.0201	0.0006	28.5515
2	MILK & MILK PRODUCTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	LIVESTOCK PRODUCTS	12.9121	0.0664	0.0064	0.0020	2.6486	0.0022	0.0001	36.5642
4	FISHING	0.0099	0.0074	0.0005	0.0005	0.0058	0.0001	0.0000	0.0209
5	COAL & LIGNITE	0.5521	0.1791	0.0281	0.0194	0.1615	0.0093	0.0008	0.7989
6	MINING & QUARRYING	2.1301	1.0451	0.1184	0.1772	1.4376	0.0490	0.0039	3.4216
7	SUGAR	4.7840	9.8918	0.0039	0.0016	0.1223	0.0023	0.0001	1.6268
8	EDIBLE OIL & VANASPATI	1.1809	0.1316	0.0120	0.0036	0.3196	0.0047	0.0004	4.1366
9	BEVERAGES	0.1568	0.3067	0.0007	0.0002	0.0056	0.0002	0.0000	0.1350
10	OTHER FOOD PRODUCTS	2.0060	1.4489	0.0580	0.0038	0.3216	0.0029	0.0003	3.4190
11	OTHER TEXTILES	1.9526	5.5787	0.2080	0.0114	0.3508	0.0222	0.0161	10.8558
12	WOOLEN TEXTILES	1.2632	3.9061	0.0164	0.0009	0.5960	0.0015	0.0012	1.2543
13	JUTE TEXTILES	0.0036	0.0008	0.0001	0.0000	0.0006	0.0000	0.0000	0.0129
14	MAN MADE FIBRE	9.9712	22.3123	5.4197	0.0278	0.8721	0.1902	0.4547	205.3263
15	PAPER	91.1605	1.4999	0.0956	0.0262	0.4017	0.0444	0.0052	43.5090
16	LEATHER	2.5530	7.8650	2.4727	0.0159	0.1752	0.0037	0.0004	3.1590
17	RUBBER PRODUCTS	0.7622	1.6350	0.0460	0.0315	0.0398	0.0050	0.0022	1.4263
18	PETROLEUM PRODUCTS	1.2326	0.4605	0.0522	2.3812	17.9325	0.2808	0.0019	1.8871
19	INORGANIC CHEMICALS	3.0824	22.1369	0.1172	0.0298	0.7505	0.1610	0.0077	16.6467
20	ORGANIC CHEMICALS	11.7883	3.9355	0.1992	0.0545	7.3228	2.1881	0.0124	11.2021
21	FERTILIZERS	27.9980	3.8375	0.1027	0.0507	1.2004	0.2481	0.0046	12.5440
22	PESTICIDES	0.2374	0.0684	0.1360	0.0016	0.0277	0.0048	0.0002	0.2692
23	PAINTS	0.6910	0.6014	0.0398	0.0050	0.1451	0.0335	0.0028	1.8489
24	DRUGS & OTHER CHEMICAL	5.4363	1.8201	0.0682	0.0212	0.6196	0.1080	0.0034	7.1750
25	NON METALLIC MINERALS	0.2734	0.0942	0.0122	0.0123	0.1098	0.0066	0.0014	0.3941
26	IRON & STEEL	3.8670	1.5540	3.6720	0.2278	1.8540	0.7347	0.0063	6.9841
27	MISC. MANUFACTURING	17.4350	9.7046	2.6268	0.4136	3.8616	0.5764	0.0609	41.9572
28	OTHER INDUSTRIES	0.5214	0.5820	0.1299	0.0029	0.0749	0.0114	0.0105	5.4051
29	CONSTRUCTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	ELECTRICITY-WATER-GAS SS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	TRANSPORT & COMMUNICATION	2.9720	1.6851	0.1408	0.2481	1.8263	0.0484	0.0043	4.6707
32	SERVICES	2.0677	0.6812	0.0722	0.0136	0.2359	0.0133	0.0019	3.1422

All figures are in ‘000tonnes per lakh Rupees of final demand (IMP.).

Table 6.11

Share Of Total Amount Of Different Water Pollution In Final Demand & Its Component Of India (For The Tear 1989-90)

(Figures In '000 Tonnes Per Lakh Rupees Of Final Demand**)**

1	F-DD	2489.9009	2041.2184	171.0338	13.9743	462.2062	10.2860	1.7700	5695.0200
2	PFCF	2135.9456	1669.2843	99.5458	9.3637	405.2116	5.8383	1.1162	4920.8224
3	GFCE	174.2276	57.6250	8.1559	1.7427	24.5626	1.8710	0.3282	293.2650
4	GFCF	161.2415	88.4338	20.1292	4.2452	39.1983	4.3907	0.4322	392.6905
5	CIS	49.6822	44.2168	3.8066	0.3629	8.6830	0.8603	0.1690	167.9943
6	EXPORT	183.7902	285.0497	55.2987	2.0602	28.9794	2.0985	0.3288	378.5921
7	IMPORT	214.9863	103.3912	15.9024	3.8005	44.4287	4.7728	0.6043	458.3443

Chapter 7

Results And Discussion Of Model II

Conducting experiment with these set of analysed pollution abatement cost data (based on the extended input - output model as described in earlier chapter) would result in a new set of outputs and prices as formally illustrated through tables 7.1 and 7.2.

Table 7.1

Effects Of Pollution Control Cost On Output Of Different Goods & Services (Figures Are In Lakh Rs)

	SECTORS	GROSS OUTPUT	NEW OUTPUT	% CHANGE
1	AGRICULTURE	12892891.3927	12906343.8713	0.1043
2	MILK & MILK PRODUCTS	2477999.0487	2478211.8232	0.0086
3	LIVESTOCK PRODUCTS	1841223.1037	1842421.5653	0.0651
4	FISHING	448281.0916	448320.7261	0.0088
5	COAL & LIGNITE	591198.5134	597473.7886	1.0614
6	MINING & QUARRYING	831869.8969	853099.3511	2.5520
7	SUGAR	662937.5538	663040.7753	0.0156
8	EDIBLE OIL & VANASPATI	708548.7711	708688.9925	0.0198
9	BEVERAGES	462826.0931	462917.0045	0.0196
10	OTHER FOOD PRODUCTS	1292204.1604	1292322.7664	0.0092
11	OTHER TEXTILES	3922760.3859	3923588.1289	0.0211
12	WOOLEN TEXTILES	107462.6477	107476.4033	0.0128
13	JUTE TEXTILES	174734.5185	176029.4312	0.7411
14	MAN MADE FIBRE	489522.3549	491706.4022	0.4462
15	PAPER	890065.0042	893040.8746	0.3343
16	LEATHER	364876.8222	364932.5751	0.0153
17	RUBBER PRODUCTS	491408.2965	492325.7271	0.1867
18	PETROLEUM PRODUCTS	1490400.3269	1501035.9144	0.7136
19	INORGANIC CHEMICALS	237044.2735	268997.8584	13.4800
20	ORGANIC CHEMICALS	397520.4714	402950.9576	1.3661
21	FERTILIZERS	712533.2827	714282.4408	0.2455
22	PESTICIDES	119285.7373	119657.5872	0.3117
23	PAINTS	265672.0053	269165.1378	1.3148
24	DRUGS & OTHER CHEMICAL	1565733.7892	1569532.6223	0.2426
25	NON METALLIC MINERALS	1183163.0494	1203808.5202	1.7449
26	IRON & STEEL	2343390.3539	2377206.1263	1.4430
27	MISC. MANUFACTURING	9512034.5529	9541703.1434	0.3119
28	OTHER INDUSTRIES	658339.3988	663323.3810	0.7571
29	CONSTRUCTION	5993499.6823	6183114.8258	3.1637
30	ELECTRICITY-WATER-GAS SS	2503193.1217	2520110.7530	0.6758
31	TRANSPORT & COMN.	5383635.1583	5405946.5906	0.4144
32	SERVICES	19322684.2395	19366474.3490	0.2266
33	CLEAN WATER	279572.5100	279723.2128	0.0539

Table –7.2

Effects Of Pollution Control Cost On Prices

Of Different Goods & Services (Figures Are In Lakh Rs.)

Sl.No.	Old Price	New Price	% CHANGE
1. AGRICULTURE	1	1.006929	0.692994
2. MILK & MILK PRODUCTS	1	1.001217	0.121708
3. LIVESTOCK	1	1.114492	11.44928
4. FISHING	1	1.001900	0.190009
5. COAL & LIGNITE	1	1.000238	0.023813
6. MINING & QUARRYING	1	1.000069	0.006983
7. SUGAR	1	1.008403	0.840374
8. EDIBLE OIL & VANASPATI	1	1.005443	0.544367
9. BEVERAGES	1	1.004252	0.425282
10. FOOD PRODUCTS	1	1.008172	0.817245
11. OTHER TEXTILES	1	1.004116	0.411632
12. WOOLEN TEXTILES	1	1.009215	0.921554
13. JUTE TEXTILES	1	1.002703	0.270329
14. MAN MADE FIBER	1	1.009291	0.929164
15. PAPER	1	1.000867	0.086771
16. LEATHER PRODUCTS	1	1.019520	1.952071
17. RUBBER PRODUCTS	1	1.002097	0.209745
18. PETROLEUM PRODUCTS	1	1.000118	0.011802
19. INORGANIC CHEMICALS	1	1.000764	0.076483
20. ORGANIC CHEMICALS	1	1.000682	0.068288
21. FERTILIZERS	1	1.000669	0.066988
22. PESTICIDES	1	1.000563	0.056314
23. PAINTS	1	1.000959	0.095992
24.DRUGS & OTHER CHEMICALS	1	1.001646	0.164661
25. NON-METALLIC-MINERALS	1	1.000415	0.041577
26. IRON & STEEL	1	1.000314	0.031486
27. MISC. MANUFACTURING	1	1.000507	0.050710
28. OTHER INDUSTRIES	1	1.002781	0.278197
29. CONSTRUCTION	1	1.000693	0.069347
30. ELECTRICITY-WATER-GAS SS	1	1.000285	0.028598
31. TRANSPORT & COMMUNICATION	1	1.000344	0.034416
32. SERVICES	1	1.000798	0.079879

7.1 Effects Of Pollution Abatement Cost On Output

It gets reflected from table – 7.1, that, augmentation of the original input - output system with incorporation of a clear water sector results in output increase for all the sectors of the economy. For clear understanding the sectors could be grouped (as presented in table 7.3) under three broad headings, depending on percentage effect on its output (namely – above 10%, above 1% and below 1%).

Table 7.3

List Of Sectors Categorised Based On Percentage Effects On Output

Category	Sectors
Above 10%	Inorganic Chemicals
Above 1%	Organic Chemicals, Paints, Non-Metallic-Mineral, Iron & Steel, Construction
Below 1%	Agriculture, Milk & Milk Products, Livestocks, Fishing, Sugar, Edible oil & Vanaspati, Beverages, Other Food Products, Other Textiles, Woolen Textiles, Jute Textiles, Man made Fibre, Paper, Leather Products, Rubber Products, Petroleum Products, Fertilizers, Pesticides, Drugs & Other Chemicals, Misc. Manufacturing, Other Industries, Electricity-water-gas Supply, Transport, Services

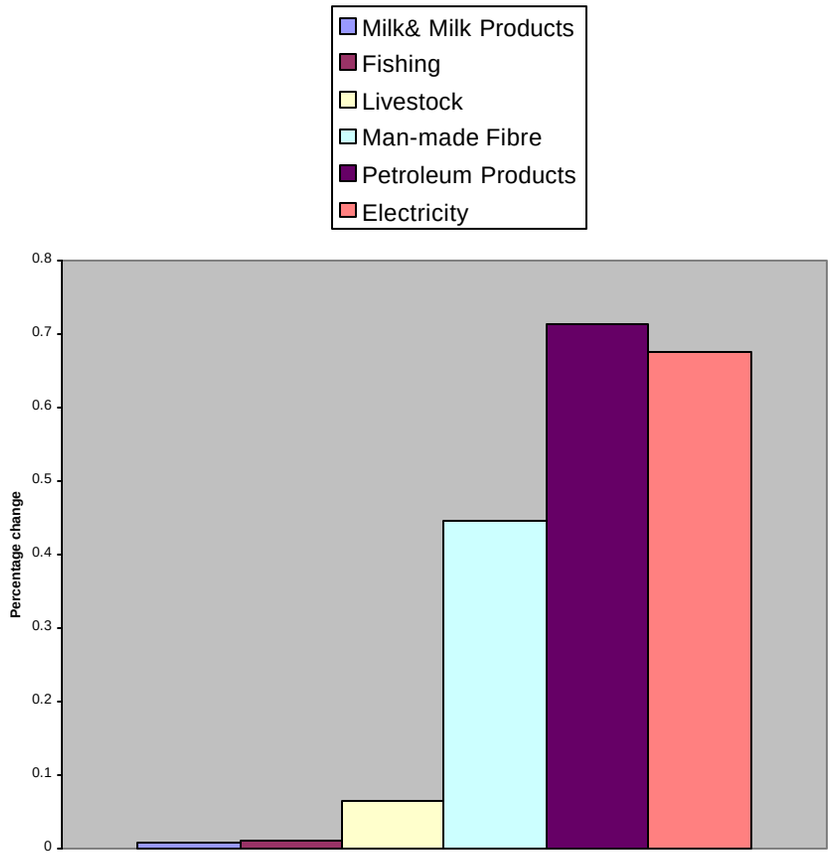
It is seen that Inorganic Chemicals experiences a massive output increase at an rate of 13.5% from Lakh Rs. 237044.2 to Lakh Rs. 268997.8. Percentage output increase for sectors like., Organic Chemicals, Paints, Non-Metallic-Minerals, Iron & Steel, Coal & Lignite, Construction and Minning & Quarrying is noted to be marginal i.e., around 1.366%, 1.31%, 1.74%, 1.44%, 1.06%, 3.16% and 2.55% respectively. For rest of the sectors of the Indian Economy the percentage effect on output of abatement cost is negligible, specifically Milk & Milk Products, Fishing, Livestocks, Other Food Products etc, shows very negligible increase

compared to Man made Fiber, Jute Textiles, Petroleum Products, Other Industries and Electricity-water-gas supply sectors which shows almost 1% increase in output.

Interpretation of it being, resting on the fact that as the clean water sector make use of power and chemical inputs, the demand for these increases, thus calling for its increased production. This in turn increases the demand for products - like, coal and lignite, Mining minerals, Drug and other chemicals - used as inputs in the production of power and chemicals, which further increases the demand for or production of goods used in producing them (involving again power, chemicals and others). It is due to the working of this acceleration principle, which states that changes in the demand for or production of goods tends to give rise to amplified changes in the demand for or production of goods used in producing them, that the output increases for all the sectors of the economy. This is so because the sectors are all interlinked with or interdependent on each other directly or indirectly. The percentage increase (as depicted from column 3) being higher for Inorganic Chemicals, Electricity - water - gas supply, Coal and lignite and Mining sectors consequtively since these may be sectors with extensive linkage and for which the amplitudes of cyclical fluctuations are wider, in the present demand or production situation. Figures 1 and 2 in this regards provides a further clear picture of the mentioned scenario.

Figure – 1

EFFECTS OF POLLUTION ABATEMENT COST ON OUTPUT
(above 1%)



With the inclusion of an additional sector, named, ‘clean water’ sector, a new column vector of output is derived, as evident from table 7.1. Based on these new set of gross outputs, corresponding to the same technology, i.e., [aij] matrix and same amount of final demand, a new matrix of intermediate flows of goods and services could be arrived at as illustrated through table 7.4, depending on the formulation.

$$a_{ij} X_j = X_{ij}$$

aij is the new technical coefficient matrix

Xj is the new gross output (diagonal matrix)

Xij is the intermediate flow matrix

It is noted that intermediate consumption flow for all sectors increase, which is because of the gross output increase. To fulfill the new gross output, production activities must be paced up by all the sectors, inturn calling for more inputs, thus resulting in increased intermediate flows.

TABLE 7.4
NEW EXTENDED INPUT-OUTPUT TABLE OF INDIA *for the year 1989-90*
(showing new intermediate flow of goods & services)
(Figures are in Lakh Rs.)

	SECTORS	1	2	3	4	5	6	7	8	9	10	11	12
1	AGRICULTURE	1066930.3	378686.9	774129.4	259.5	4.8	0.0	377038.3	511852.4	144477.4	290629.8	412140.1	95.5
2	MILK & MILK PRODUCTS	3105.8	2661.6	108.5	17.9	0.0	0.0	96.7	926.2	1087.6	178733.5	467.1	0.5
3	LIVESTOCK PRODUCTS	705699.2	0.0	427.7	0.0	0.0	0.0	350.2	742.7	375.8	62973.4	43406.8	6501.9
4	FISHING	530.1	0.0	18.5	6294.5	0.0	0.0	16.5	158.3	187.8	30507.1	6.9	0.0
5	COAL & LIGNITE	2000.7	0.0	1.8	0.0	6490.3	96.3	1512.4	1425.9	5393.1	3320.3	11861.6	208.2
6	MINING & QUARRYING	71.9	0.0	0.0	0.0	5936.0	536.1	2239.8	10.6	1348.1	1159.2	511.3	1.0
7	SUGAR	1161.7	0.0	35.9	0.0	0.0	0.0	1331.4	314.2	7056.3	59324.3	1.9	0.0
8	EDIBLE OIL & VANASPATI	1100.4	37310.6	53086.6	0.0	0.0	0.0	1.2	18644.9	11.7	1637.6	20.9	0.0
9	BEVERAGES	66.3	0.0	0.7	0.0	0.0	0.0	5.9	6.4	44450.6	1399.0	12.3	0.0
10	OTHER FOOD PRODUCTS	718.1	2565.7	16700.2	1853.5	0.0	0.0	157.1	885.2	7310.4	25534.7	3822.9	4.4
11	OTHER TEXTILES	3866.5	22840.6	1676.5	11883.8	71.1	0.0	1464.5	6064.9	425.9	2621.1	915282.0	29865.8
12	WOOLEN TEXTILES	5.2	0.0	0.0	0.0	0.0	0.0	0.0	18.3	0.0	0.0	23273.5	7305.1
13	JUTE TEXTILES	3693.9	0.0	1.7	701.3	0.0	0.0	8728.4	718.3	166.4	4057.9	27425.6	205.2
14	MAN MADE FIBRE	11.7	0.0	0.0	0.0	0.0	0.0	0.0	737.2	5.6	764.7	208561.5	3917.4
15	PAPER	3390.5	0.0	12.4	68.1	1201.2	76.8	827.5	1101.8	5369.9	33020.6	16142.9	159.2
16	LEATHER	17.7	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	16.4	530.2	45.3
17	RUBBER PRTS	2015.2	0.0	0.0	0.0	302.9	10.4	12.8	10.9	50.2	36.9	6702.5	24.8
18	PETROLEUM PRODUCTS	103815.7	0.0	6.7	11556.1	15687.5	16537.5	2907.5	1510.7	1215.1	13656.2	18531.8	296.1
19	INORGANIC CHEMICALS	169.0	0.0	0.6	14.7	0.0	1152.3	1045.7	1410.2	1646.9	1126.6	13256.1	153.1

20	ORGANIC CHEMICALS	319.4	0.0	0.6	4.0	0.0	0.0	3758.2	1604.0	1192.4	1414.0	27572.6	383.4
21	FERTILIZERS	725460.5	0.0	0.0	0.0	0.0	0.0	0.0	376.3	0.0	2238.1	60.6	0.8
22	PESTICIDES	79043.0	0.0	0.0	0.0	0.0	0.0	0.0	41.0	0.0	453.3	1.8	0.0
23	PAINTS	17.9	0.0	0.0	0.0	0.0	0.0	31.7	552.8	35.6	80.6	45480.0	490.7
24	DRUGS & OTHER CHEMICAL	202.2	1251.5	4700.6	746.0	20275.1	2240.3	808.9	6982.2	1353.3	9636.1	16726.6	194.1
25	NON METALLIC MINERALS	151.7	0.0	0.9	0.0	0.0	10020.1	2429.6	120.9	2843.8	1634.5	2092.0	34.0
26	IRON & STEEL	321.2	0.0	0.0	244.8	0.0	0.0	175.3	106.8	174.3	68.9	4704.9	50.8
27	MISC. MANUFACTURING	120396.7	401.6	1893.4	15111.0	84516.3	24706.7	6393.8	3366.3	7364.3	22811.7	62225.3	1123.8
28	OTHER INDUSTRIES	1090.0	0.0	5.5	1835.2	3002.1	399.8	375.0	2587.1	8170.9	11409.5	17674.3	136.7
29	CONSTRUCTION	221453.4	1135.0	4260.8	0.0	1107.7	3474.7	868.0	379.0	249.0	1239.1	3728.2	53.4
30	ELECTRICITY-WATER-GAS SS	111074.0	0.0	4.3	175.4	37726.3	11882.1	6457.3	8679.6	6927.3	8906.8	163308.0	2062.6
31	TRANSPORT & COMN.	134452.5	10202.9	20725.8	2144.7	15864.8	3825.6	7162.5	11415.6	24180.3	28799.2	141241.2	3378.8
32	SERVICES	436801.5	80133.3	141065.4	10258.9	43628.1	35014.9	101450.2	59162.2	44822.1	156848.0	547734.1	16307.5
33	CLEAN WATER	0.0	0.0	204855.7	747.2	0.0	0.0	2777.7	0.0	527.5	77.2	1535.8	0.0
	Total Input at Factor Cost	3729153.8	537189.8	1018864.7	63169.5	235814.1	109973.6	527646.3	641917.1	317892.2	956058.9	2734507.4	73000.2
	Net Indirect tax	-320224.2	9142.4	13670.6	6744.7	33652.6	18691.4	12660.0	22338.8	21327.5	57398.7	148518.3	7886.0
	Total Input at Purchaser's Price	3408929.6	546332.2	1032535.3	69914.2	269466.7	128665.0	540306.3	664255.9	339219.7	1013457.6	2883025.7	80886.2
	Value added	9497414.3	1931879.6	809886.3	378406.5	328007.1	724434.3	122734.5	44433.1	123697.3	278865.2	1040562.4	26590.2
	Gross output	12906343.9	2478211.8	1842421.6	448320.7	597473.8	853099.4	663040.8	708689.0	462917.0	1292322.8	3923588.1	107476.4

Contd…..Table 7.4

	SECTORS	13	14	15	16	17	18	19	20	21	22	23	24
1	AGRICULTURE	49152.2	5811.5	35157.2	2869.0	43548.5	104.6	5701.7	5405.7	68.2	1.5	1241.5	164257.5
2	MILK & MILK PRODUCTS	0.0	0.0	0.7	7.3	0.0	0.0	0.6	4.0	0.0	0.0	0.0	586.7
3	LIVESTOCK PRODUCTS	0.4	797.6	217.1	43337.0	120.9	0.0	94.5	83.0	680.7	72.3	100.6	2488.0
4	FISHING	0.0	7.0	22.5	5.7	30.7	0.0	57.4	43.9	210.3	0.4	20.6	108.1
5	COAL & LIGNITE	989.3	791.1	15043.7	233.3	3377.0	53040.0	5566.9	7106.5	7716.8	81.8	1322.3	6612.4
6	MINING & QUARRYING	0.4	20439.9	545.6	4.5	1029.3	719171.2	8360.8	11006.3	116510.9	396.4	855.2	3158.9
7	SUGAR	0.0	23.7	0.0	0.0	0.0	0.0	107.3	665.6	2.1	0.0	5.2	8425.5
8	EDIBLE OIL & VANASPATI	0.0	1.3	0.0	0.0	0.0	0.0	7.5	10.1	0.0	0.0	1.3	2339.9
9	BEVERAGES	0.0	571.1	0.0	96.6	0.0	0.0	49.3	71.7	0.0	0.0	310.1	209.4
10	OTHER FOOD PRODUCTS	10.9	76.6	1988.3	71.8	0.0	0.9	136.7	99.5	0.0	0.0	57.2	5893.6
11	OTHER TEXTILES	2299.8	13846.2	5979.5	8082.8	25501.8	483.9	363.8	424.5	170.3	142.1	602.4	13750.3
12	WOOLEN TEXTILES	1.4	6.3	0.0	3.0	3.9	2.7	0.0	0.0	0.0	0.0	0.0	24.7
13	JUTE TEXTILES	15425.7	1643.6	3667.3	595.7	225.8	575.1	1214.4	1512.0	20601.4	37.4	9.5	2300.0
14	MAN MADE FIBRE	91.0	67508.9	3787.4	1252.0	26760.9	563.6	4066.1	5954.6	18.0	0.0	8214.4	2804.4
15	PAPER	190.2	22076.7	257360.3	895.0	1526.8	1339.4	3131.4	9520.6	704.3	4376.5	3620.4	61756.1
16	LEATHER	0.0	3.3	1.7	84480.0	3390.6	0.0	4.2	2.1	0.0	0.0	1.7	162.2
17	RUBBER PRODUCTS	27.8	287.7	103.9	7726.0	3434.9	70.9	27.5	77.5	24.1	7.7	18.0	990.5
18	PETROLEUM PRODUCTS	1065.1	3420.8	4517.4	2231.3	3198.6	23573.0	4633.5	9308.8	13760.7	2355.3	2597.4	12373.4
19	INORGANIC CHEMICALS	107.9	7900.6	14963.4	2070.4	3298.3	331.6	22981.3	25329.6	55192.1	3194.7	19779.4	31486.3
20	ORGANIC CHEMICALS	210.6	37885.5	6169.3	3728.7	5810.6	338.8	27367.3	47527.3	64823.6	4850.6	22116.0	83674.7
21	FERTILIZERS	0.0	2146.1	1.5	0.0	2.4	0.0	2535.7	3818.6	63871.1	943.4	1.6	21.9

22	PESTICIDES	0.0	5.8	0.0	0.0	0.0	0.0	34.9	1032.9	2047.2	23847.0	311.1	19.1
23	PAINTS	100.8	1203.6	13456.6	7302.2	458.7	332.0	1097.9	2015.6	26.3	9.1	23470.1	4018.6
24	DRUGS & OTHER CHEMICAL	2676.4	21436.2	13770.1	8473.9	67341.2	2890.9	6833.5	10124.4	43343.8	6548.9	26921.5	324640.6
25	NON METALLIC MINERALS	106.7	695.7	1085.5	108.5	214.7	74.8	1955.5	1787.2	637.8	677.3	876.2	9936.9
26	IRON & STEEL	848.7	906.1	1210.8	187.8	949.5	238.4	314.7	569.2	465.6	59.3	873.9	1299.4
27	MISC. MANUFACTURING	5496.5	12307.7	31159.6	5653.3	22194.9	5090.7	15558.8	19908.7	21482.6	8230.4	20820.8	40463.5
28	OTHER INDUSTRIES	141.6	2288.2	2051.7	554.3	1915.9	564.7	2665.7	3079.4	8314.1	2012.6	2404.2	16730.0
29	CONSTRUCTION	1.0	340.2	577.3	298.2	258.5	231.4	133.8	138.2	205.3	79.2	39.7	625.4
30	ELECTRICITY-WATER-GAS SS	12196.6	29117.8	49010.3	5220.9	13728.5	7888.0	37617.8	45745.7	39179.5	5187.0	10315.9	43190.2
31	TRANSPORT & COMN.	7341.7	14973.9	35770.2	10501.4	14909.8	40850.0	11089.0	15533.6	30484.9	3032.8	10527.3	52151.4
32	SERVICES	20740.2	55778.2	115630.7	63299.6	57335.7	93107.4	30016.2	45662.5	91086.1	13784.0	39937.2	193471.8
33	CLEAN WATER	51.7	3580.1	0.0	342.5	96.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Input at Factor Cost	119222.9	324298.9	613249.7	259290.2	300568.5	950863.8	193726.0	273569.1	581627.5	79927.9	197372.7	1089971.5
	Net Indirect tax	5600.0	77109.9	45969.9	21831.1	54443.1	409339.7	24840.9	49516.9	59018.4	9349.9	39408.0	149573.2
	Total Input at Purchaser's Price	124822.9	401408.8	659219.6	281121.3	355011.6	1360203.5	218567.0	323086.0	640645.9	89277.8	236780.7	1239544.7
	Value added	51206.5	90297.6	233821.3	83811.3	137314.1	140832.4	50430.9	79865.0	73636.5	30379.8	32384.4	329987.9
	Gross output	176029.4	491706.4	893040.9	364932.6	492325.7	1501035.9	268997.9	402951.0	714282.4	119657.6	269165.1	1569532.6

Contd…Table7.4

	SECTORS	25	26	27	28	29	30	31	32	33	TOTAL	PFCE	GFCE

1	AGRICULTURE	5205.2	776.1	6861.5	89796.6	256549.9	180.5	74889.6	343748.4	0.0	3956244.4	7685661.2	16738.8
2	MILK & MILK PRODUCTS	3.1	0.0	0.9	0.0	215.1	0.0	0.0	81427.4	0.0	187205.5	2151843.6	56917.1
3	LIVESTOCK PRODUCTS	402.1	0.5	8467.7	109.1	6816.4	1510.2	0.0	71059.1	0.0	820477.7	856844.5	342.6
4	FISHING	77.0	0.1	6299.9	52.6	38.1	0.0	0.0	2009.2	0.0	37719.6	401991.8	212.6
5	COAL & LIGNITE	69841.5	109752.4	30483.3	627.3	983.8	289366.1	14270.4	24622.8	0.0	32310.5	11689.5	119.3
6	MINING & QUARRYING	150632.2	51006.4	73460.7	193.3	323054.9	145701.7	0.0	40673.6	0.0	11814.0	0.0	430.1
7	SUGAR	0.0	0.0	2.0	1.2	90.9	0.7	0.0	22020.9	0.0	69225.6	550734.8	0.0
8	EDIBLE OIL & VANASPATI	0.0	0.0	2.8	0.8	22.1	0.0	130.7	39602.4	0.0	111813.8	523422.7	0.0
9	BEVERAGES	0.0	0.0	0.8	8.1	20.8	0.6	1336.3	27354.1	0.0	45941.1	296348.1	20.9
10	OTHER FOOD PRODUCTS	167.7	52.8	126.9	58.5	49.6	2.1	1338.1	22401.4	0.0	59552.2	1077267.5	597.1
11	OTHER TEXTILES	1529.0	1033.5	12108.9	5861.7	871.8	566.5	3304.3	93749.5	0.0	996062.7	2257723.2	5352.5
12	WOOLEN TEXTILES	1.2	0.0	100.5	1.3	17.5	3.4	604.8	1936.9	0.0	30602.1	72096.2	
13	JUTE TEXTILES	29812.1	479.0	2020.3	873.6	12012.1	67.0	292.9	10541.7	0.0	45698.7	4424.6	1542.3
14	MAN MADE FIBRE	590.0	88.9	65318.2	104572.3	588.6	197.8	48.5	33460.1	0.0	213998.1		43235.7
15	PAPER	6339.7	1623.9	43540.2	3720.3	11230.4	3799.8	28459.2	214857.7	0.0	61371.0	167282.1	77368.6
16	LEATHER	8.2	4.6	1487.3	152.0	98.2	0.6	690.5	10435.0	0.0	613.9	106682.6	0.0
17	RUBBER PRODUCTS	86.2	649.7	77233.3	739.1	3085.8	635.7	124670.4	10462.2	0.0	9166.7	82321.2	2133.6
18	PETROLEUM PRODUCTS	64130.4	87386.8	117534.2	2879.4	119917.2	24123.1	555785.0	39217.5	0.0	185720.9	387473.9	58163.0
19	INORGANIC CHEMICALS	6435.4	3453.8	38766.5	1257.3	299.4	1671.9	114.8	12995.8	27937.5	19975.3		1498.6
20	ORGANIC CHEMICALS	11421.4	11138.7	43275.1	13311.6	492.7	141.4	3.7	26136.0	0.0	36248.5		42465.1
21	FERTILIZERS	0.0	0.0	500.6	4.1	14584.1	15.7	0.0	9792.1	0.0	728136.3		1897.8
22	PESTICIDES	0.0	0.8	189.1	0.0	5992.6	0.0	293.8	1120.9	0.0	79539.1		36.4
23	PAINTS	1706.5	1336.6	40491.7	3779.8	88477.3	37.5	3161.1	11900.6	0.0	46689.3		

24	DRUGS & OTHER CHEMICAL	1947.5	1752.2	39457.0	7503.8	553.0	492.5	1728.3	326312.9	0.0	65116.9	372624.0	44398.7
25	NON METALLIC MINERALS	65203.8	7471.1	24804.2	1052.9	610856.0	60.0	4275.9	13268.0	0.0	19327.4	141037.8	6.4
26	IRON & STEEL	20633.0	655902.4	1005752.4	1604.8	671400.8	2784.8	14190.9	108552.4	0.0	5847.0	0.0	3.1
27	MISC. MANUFACTURING	50353.9	302153.8	2168343.5	15055.9	327300.2	62867.6	431554.1	407823.1	0.0	350311.0	1051974.8	382632.0
28	OTHER INDUSTRIES	7357.4	2802.9	59039.2	37001.4	116782.9	166.2	22294.3	66324.2	0.0	46686.1	56394.9	49795.2
29	CONSTRUCTION	10455.6	3153.5	15148.7	298.3	21038.0	60422.2	106577.3	385837.0	186619.4	237948.2		397913.3
30	ELECTRICITY-WATER-GAS SS	98973.3	127997.6	316103.5	16212.2	26671.4	557523.1	99175.0	255343.0	0.0	357203.8	263719.0	101111.1
31	TRANSPORT & COMN.	113582.9	158102.9	380426.8	20311.3	304002.7	180915.4	255170.7	1016762.5	0.0	403394.0	1745797.7	372132.7
32	SERVICES	140366.7	269297.2	1131966.7	67801.7	561390.6	195900.1	565616.9	1596314.2	0.0	1673226.2	7497514.0	3729262.9
33	CLEAN WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	210521.1		
	Total Input at Factor Cost	857262.9	1797418.3	5709314.6	394842.3	3485504.7	1529154.1	2309977.4	5328062.7	214556.9	10945187.6		
	Net Indirect tax	76212.0	199322.8	842413.8	81848.2	283489.2	142077.8	309153.3	352257.9		31806.8		
	Total Input at Purchaser's Price	933474.9	1996741.1	6551728.4	476690.5	3768993.9	1671231.9	2619130.7	5680320.6	214556.9	10976994.4		
	Value added	270333.6	380465.0	2989974.7	186632.9	2414120.9	848878.8	2786815.9	13686153.8	65166.3	15306910.8		
	Gross output	1203808.5	2377206.1	9541703.1	663323.4	6183114.8	2520110.8	5405946.6	19366474.3	279723.2	26283905.2		

Contd… Table7.4

	SECTORS	GFCF	CIS	EXP.	Less	TOTAL	GROSS
1	AGRICULTURE	0.0	150644.4	126318.3	120590.4	7858772.3	11815016.7
2	MILK & MILK PRODUCTS					2208760.6	2395966.1
3	LIVESTOCK PRODUCTS	28126.8	17815.0	5479.6	23021.8	885586.8	1706064.5
4	FISHING		523.0	794.2	1904.0	401617.6	439337.2
5	COAL & LIGNITE		-35118.0	1009.9	54366.0	-76665.2	-44354.8
6	MINING & QUARRYING	0.0	14842.0	70604.8	910793.7	-824916.9	-813102.8
7	SUGAR	0.0	18642.0	2825.4	9732.0	562470.3	631695.9
8	EDIBLE OIL & VANASPATI	0.0	6540.0	46738.7	21944.9	554756.5	666570.3
9	BEVERAGES	0.0	5360.0	86322.6	1104.8	386946.8	432887.9
10	OTHER FOOD PRODUCTS	0.0	-261.0	140944.7	18310.5	1200237.8	1259790.0
11	OTHER TEXTILES	2306.8	34745.0	490414.8	53689.6	2736852.7	3732915.4
12	WOOLEN TEXTILES		2669.0	4225.1	4823.5	74166.8	104768.8
13	JUTE TEXTILES		-2953.0	23559.1	148.9	26424.1	72122.8
14	MAN MADE FIBRE		7908.0	12663.9	111984.8	-48177.2	165820.9
15	PAPER	0.0	-4607.0	24779.2	113221.9	151601.0	212971.9
16	LEATHER	0.0	1075.0	164017.9	8379.0	263396.6	264010.5
17	RUBBER PRODUCTS	154589.4	4886.0	17468.1	8598.1	252800.1	261966.8
18	PETROLEUM PRODUCTS	0.0	8386.0	58682.4	291399.3	221305.9	407026.9
19	INORGANIC CHEMICALS		7242.0	39116.9	78402.8	-30545.3	-10569.9
20	ORGANIC CHEMICALS		9749.0	36552.8	132488.1	-43721.2	-7472.7
21	FERTILIZERS		9388.0	38.3	123416.8	-112092.7	616043.6
22	PESTICIDES		228.0	9130.1	4171.2	5223.3	84762.4
23	PAINTS		3838.0	30096.4	15841.5	18093.0	64782.3
24	DRUGS & OTHER CHEMICAL	0.0	123346.0	132606.2	83307.8	589667.1	654784.0
25	NON METALLIC MINERALS	5758.1	4899.0	305074.9	17443.9	439332.4	458659.8
26	IRON & STEEL	101796.8	64225.0	44955.5	328366.2	-117385.8	-111538.9
27	MISC.	3921890.5	355243.0	625707.8	1119875.3	5217572.9	5567883.9

	MANUFACTURING						
28	OTHER INDUSTRIES	17739.4	138061.0	15423.7	15268.0	262146.3	308832.4
29	CONSTRUCTION	4754775.1				5152688.4	5390636.6
30	ELECTRICITY-WATER-GAS SS	0.0	387.0	1292.6	0.0	366509.7	723713.5
31	TRANSPORT & COMN.	115140.9	0.0	332106.0	239066.0	2326111.3	2729505.3
32	SERVICES	417947.0	0.0	809591.5	109571.0	12344744.4	14017970.6
33	CLEAN WATER					69202.1	279723.2
	Total Input at Factor Cost						
	Net Indirect tax						3264583.0
	Total Input at Purchaser's Price						
	Value added						40269420.5
	Gross output						81088973.6

7.2 Effects Of Pollution Control Cost On Prices

Considering that treatment activity is undertaken we have a value added vector with a non zero element (v_2) and non zero matrix element A_{12}, A_{21}, A_{22}. whereas when treatment is not undertaken all of these terms vanish. So prices for all products will be different and higher in the former case than in the later case.

The added cost will of course be included in the price of the marketed products. Any shift in cost will tend to have an effect on prices. The direct cost of clean water production is not the whole story. Since many industries are effected the cost of purchased intermediate goods and services will also rise unevenly across the economy. So almost all the sectors will be effected more or less.

Herein, also the whole economy could be categorised under four heads depending on the percentage effect on its prices (namely – above 10%, above 1%, around 1% and negligible) as depicted through table 7.5

Table 7.5
List Of Sectors Classified Based On Percentage Effects On Prices

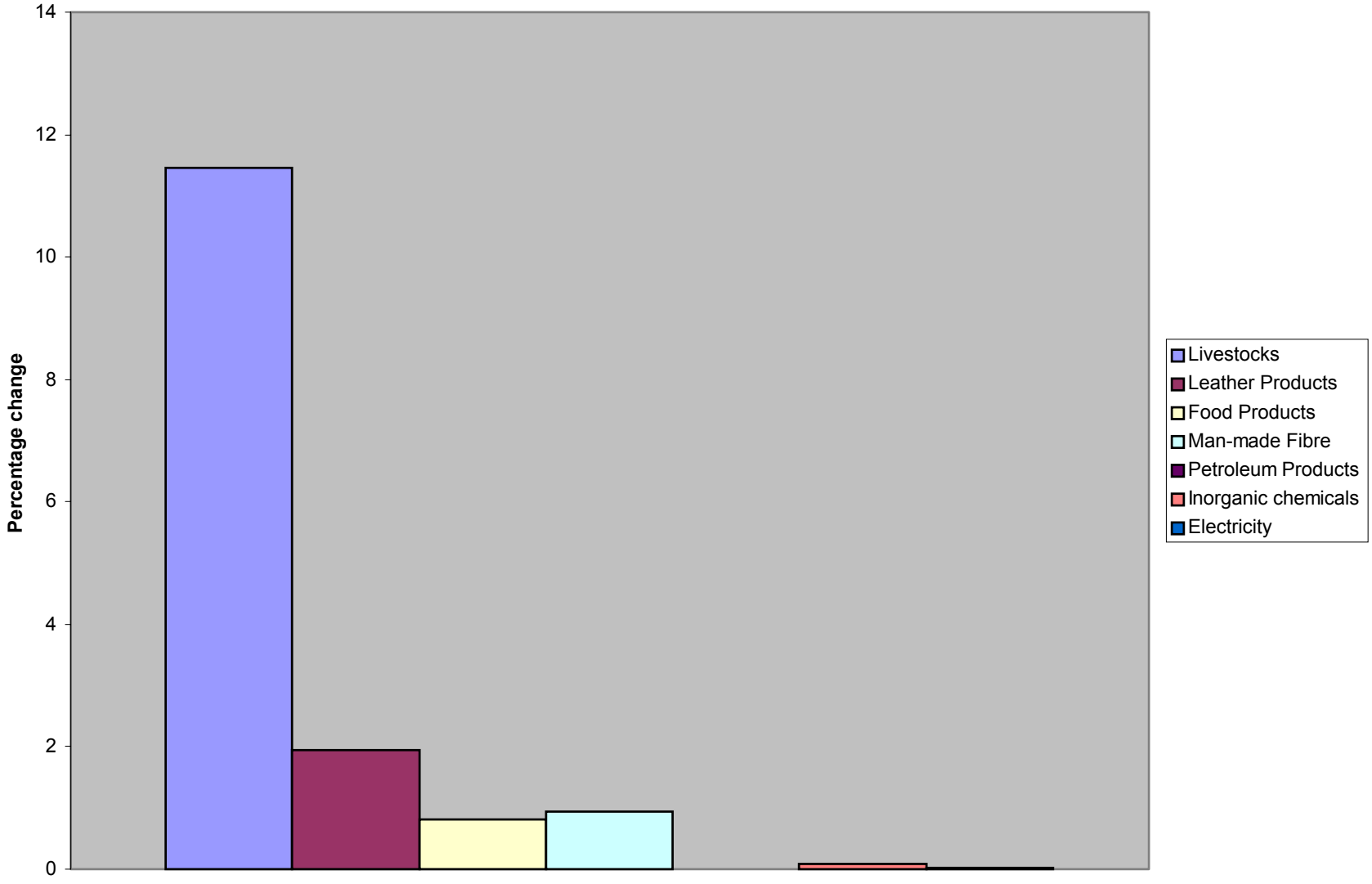
Category	Sectors
Above 10%	Livestocks
Above 1%	Leather Products
Around 1%	Agriculture, Sugar, Edible oil & Vanaspati, Other Food Products, Woolen Textiles, Man made Fiber
Negligible	Milk & Milk Products, Fishing, Coal & Lignite, Mining & Quarrying, Beverages, Other Textiles, Paper, Rubber Products, Petroleum Products, Inorganic Chemicals, Organic Chemicals, Fertilizers, Pesticides, Paints, Non-Metallic-Minerals, Iron & Steel, Misc. Manufacturing, Other Industries, Construction, Electricity-water-gas supply, Transport, Services

As noticed from table 7.2 Livestocks shows a greater percentage effect on prices (i.e., its price increases by 11.45%). Leather Products experiences a

marginal price increase of around 1.95%. Sectors like., Agriculture, Sugar, Edible oil Vanaspati, Other Food Products, Woolen Textiles, Man made Fiber also depicts a marginal increase in price around 1% (.69%, 0.84%, 0.54%, 0.82%, 0.92%, 0.93% respectively). Of the rest of the sectors showing negligible increase in price, Mining & Quarrying and Petroleum Products experiences very negligible effect.

It is evident from table 7.2 that price too increases for all the sectors of the economy. The explanation behind it being the same as in the case of output increase. With the difference, resting on the fact that the increase in price is the outcome of new Gross Value Added derived from the addition of salaries to the staff and cost of operation and maintenance include because of the incorporation of an additional sector, the clean water. As a result of which price increase is not high for the sectors for which demand for or production percentage increase is high, but for sectors for which pollution abatement cost have been available. The reason being that such, additional cost (in form of salaries of the staff and cost of operation + maintenance) by convention influences the economic decision (of price fixing) of the sectors. Moreover, direct as well as indirect effect of the increased demand for or production of goods used as inputs by the clean water sector, (as reflected through the extended $[I - A]^{-1}$ matrix) also influence the price increase to an extent. The percentage increase in price is marginal for sector which doesn't incur additional cost relating to pollution control measures, with exceptions to Agriculture, Milk and Milk product, Drugs & other chemicals, Other industries. These exceptions show quite an increase in price, which may be due to the increased demand for production of these products corresponding to the clean water sector's input requirements. In this direction Figure 3 would provide a clear picture.

Figure – 3
Effects Of Population Abatement Cost On Prices



7.3 Effects On Consumers

It is clear from earlier discussion that the price system would be different if through voluntary action or to obey a special law each industry undertakes to eliminate at its own expense a portion of pollution generated by it , say 90% - 95%. They may either engage in pollution abatement operation (alternatively clean water production) on their own account or may be complied to pay an appropiate proposed tax for pollution generation above MINAS.

The added cost would of course be included in the price of marketable products. On the other hand the product will be more costly if Govt. imposes heavy tax because of generation of pollution above some specified limits. In that case the producer will voluntarily take necessary steps to keep the pollution within the specified limits. In this two process price of the product is bound to increase. If the Govt. is not serious enough regarding pollution control the producer will be much reluctant to control the pollution generation to maximise his profits. In that case the public health will deteriorate and health treatment will go up.

So, consumers ultimately bear the burden of pollution generation, either through price increase – due to pollution abatement cost (or clean water production) or taxes imposed by the Govt. on producers – or health treatment cost when pollution is not treated. From the point of view of household i.e., the consumers the relationship between real cost and real benefits remain nevertheless the same, having paid for some abatement activities or tax imposed by Govt. indirectly, he will have to spend less on health treatment cost indirectly.

Chapter 8

Simulation Exercises On Pollution Control Policies

Environmental pollution is often viewed as a negative externality. This external diseconomies of development activities can be minimized by controlling pollution, if polluters or some other agents of the economy incur some additional costs. However, since the environment is a public good, the particular agent will have no incentive to incur the pollution abatement cost. The reason being, it is difficult to define or enforce property rights to the services of such resources, thus cannot be priced. This justifies the governmental regulations and pollution control policies.

Earlier, Government had a tendency of relying on direct regulation or the command and control (CAC) types policies for controlling pollution. India is the first country which had made provision for the protection and improvement of environment in its constitution . In the 42th amendment to the constitution in 1976, provision to its effect was incorporated in the constitution of India with effect from 3rd Jan,1977. The Water (Prevention and Control of Pollution) Act 1974, Amended in 1986; the Water (Prevention and Control of Pollution) Cess Act 1977, amended in 1988; the Environment Protection Act 1986 are the most important laws, pertaining to the industrial pollution abatement in India. Over the years several amendment have been made in the various existing statutes to meet the requirement of the unfolding environmental issues. But such policies or regulations filed to justify itself on the ground that

i) Charges imposed, resulted in price increase which may add to inflation.

ii) This charges may be considered, by the concerned polluter as providing a right to pollute.

iii) There is the difficulty of cost inefficiency in its administration

iv) Regulations in the form of restriction on technical processes of use of inputs would constrain the production possibility.

A consistent application of polluter – pays principle and a more effective use of economic instruments would be the rationale way of internalising pollution related costs. The economic instruments relating to pollution control policies have been classified under the following categories [by Mehta; Mandle and Sankar (1997)]

a) direct economic instruments involving pollution charges / taxes, user charges, tradable permit scheme, deposit refund scheme on used materials and strict liability for potential damages.

b) Indirect economic instruments such as taxes / charges on products which generates pollution, taxes / charges on inputs used in production of goods which generates pollution, taxes / charges on inputs used in production of goods which generates pollution, taxes subsidies) on goods which are complements (substitutes) to goods whose production results in pollution, and fiscal incentives for encouraging clean technologies, abatement technologies and conservation of resources

c) Financial support for development of environment friendly technologies, common effluent treatment plants, recycling operations, enhancing the competence of agencies dealing with environment protection policies,

The present study, however, will be considering only the pollution charges / taxes of the said instruments. Further, experiments would be carried out based on a new set of instruments, developed by us in this context. Those

are; (I) taxes and subsidies on the sectors of the economy, whose certain percentage of industries have Effluent Treatment Plant. (ii) taxes / charges on sectors which make use of pollution generating inputs in their production process, i.e., on sectors which are not operating through pollution free or environmental – friendly production technologies.

Case 1

Pollution Tax

In the present context the tax is imposed based on the quantity of BOD generated by each sector, deviating from the aforementioned conception of equating it with the marginal abatement cost. This modification has been enforced keeping in mind the Constant Return to scale maxim of the Input – Output model.

The rate is determined at Rs. 1000 per ton of BOD generated. The polluting firm as a consequence take the initiative of reducing pollution by itself. The reason being, the tax rate is so fixed that the polluting industry finds it cost effective i.e., to its advantage to take up the Effluent treatment Plant rather than pay the tax amount. Even if the polluters generates pollution beyond standards or does not take abatement measures, the revenues thus collected from taxes would be sufficient (for the authorities) to cover the pollution control administrative costs and the financial assistance / compensation given to the victims of pollution.

Imposition of taxes, affects the concerned sectors through increase in prices, as it incorporates an additional cost for the particular industry. The absolute and percentage increase in prices as a result of taxation in the present study can be noted from the table – 8.1

The first column denotes the old price, ie., the price (unit price) derived under the original input-output framework. The new price deducted as a result of the incorporation of tax is presented in column 3. And finally the last column put forth the percentage (%) increase in price of each sector.

It is evident that price increases for all the sectors even though tax is imposed only on sectors for which we succeeded in collecting the data on pollution generation. The price increase is higher for sectors (Milk and Milk product, livestock, Sugar, Edible oil & Vanaspati, Beverages, Food Products, Woolen Textile, Man-made Fibre, Paper, Leather, Rubber, Organic and Inorganic chemicals, Fertilizer, Pesticides, Paints, Drugs) which has been charged with few exceptions like, Fishing, Cotton and Jute Textile and Electricity-water-gas supply sectors. The reason behind it may be that the BOB generation level for these particular sectors is lower compared to the others. Whereas, sectors which have not been taxed also show sign of marginal price increase as consequence of indirect effect. Hence, emphasing that, the existence of linkages between industries should be accounted for, while adopting pollution control policies (in the nature of tax or charges). Because such added cost would influence the decision (of price fixing) of the sectors of the economy directly as well as indirectly.

TABLE 8.1
EFFECTS OF POLLUTION TAX (RS.1000/TON OF BOD) ON PRICES

SECTORS	OLD PRICE	NEW PRICE	% CHANGE
1. AGRICULTURE	1	1.001038	0.103841
2. MILK & MILK PRODUCTS	1	1.002462	0.246441
3. LIVESTOCK	1	1.015570	1.557028
4. FISHING	1	1.000102	0.010209
5. COAL & LIGNITE	1	1.000130	0.013013
6. MINING & QUARRYING	1	1.000033	0.003396
7. SUGAR	1	1.013783	1.378397
8. EDIBLE OIL & VANASPATI	1	1.001307	0.130797
9. BEVERAGES	1	1.003916	0.391629
10. FOOD PRODUCTS	1	1.002216	0.221683
11. OTHER TEXTILES	1	1.000854	0.085483
12. WOOLEN TEXTILES	1	1.004338	0.433865
13. JUTE TEXTILES	1	1.000435	0.043559
14. MAN MADE FIBER	1	1.001846	0.184616
15. PAPER	1	1.004308	0.430805
16. LEATHER PRODUCTS	1	1.003798	0.379805
17. RUBBER PRODUCTS	1	1.002018	0.201871
18. PETROLEUM PRODUCTS	1	1.000207	0.020760
19. INORGANIC CHEMICALS	1	1.001331	0.133168
20. ORGANIC CHEMICALS	1	1.009528	0.952841
21. FERTILIZERS	1	1.001266	0.126628
22. PESTICIDES	1	1.001094	0.109456
23. PAINTS	1	1.001433	0.143333
24. DRUGS & OTHER CHEMICALS	1	1.001259	0.125967
25. NON-METALLIC-MINERALS	1	1.000260	0.026008
26. IRON & STEEL	1	1.000225	0.022585
27. MISC. MANUFACTURING	1	1.000256	0.025687
28. OTHER INDUSTRIES	1	1.000770	0.077082
29. CONSTRUCTION	1	1.000213	0.021314
30.ELECTRICITY-WATER-GAS SS	1	1.000104	0.010463
31.TRANSPORT & COMMUNICATION	1	1.000175	0.017514
32. SERVICES	1	1.000253	0.025375

CASE 2

The subsidies given and taxes imposed on the sectors of the economy, whose certain percentage of industries have Effluent Treatment Plant (ETP).

The present case considers two options. First, i.e., Case 2a, deals with experiment conducted based on the assumption of giving subsidies to those sectors whose certain percentage of units have undertaken ETP. Secondly, i.e., case 2b experiments with taxes being imposed on sectors who have not yet taken up any ETP scheme, along with the subsidies given as in earlier case (case2a).

CASE 2A

A list of the percentage of industries having Effluent Treatment Plant, for selected each sectors is presented below.

SECTORS	PERCENTAGE OF INDUSTRIES HAVING ETP
Milk and Milk Products	69
Sugar	74
Food products	62
Other Textile	51
Man-made Fibre	75
Leather	62
Rubber	64
Petroleum Products	100
Inorganic Chemical	92
Fertilizer	69
Pesticides	73
Drugs	80
Electricity – water – gas (Thermal)	70

Source : National Inventory of Large and Medium Industry and Status of Effluent Treatment and Emission Control System. CPCB Nov.1997.

In the present context, subsidy at a rate of 10-15% of Net Indirect Taxes of each Sector has been given to the sectors which have ETP. The rate of subsidy (i.e., 10% or 15%) was determined on the basis of the percentage

of industries under each sector, having ETP.

50% - 70% - 10% subsidy

70% - above - 15% subsidy.

It implies that the sectors whose 50% -70% units have undertaken ETP has been given subsidy at a rate of 10%. It appears from the table that 100% of Petroleum Products industries have ETP and Inorganic Chemicals 92% industry have ETP. The sectors whose 70% above units have ETP has been allowed subsidy at a rate of 15%.

It is noticed that the price falls for every sectors of the economy even though subsidy has been allotted to few ETP having selected sectors. With few exceptions to Milk and Milk products and Sugar industries, the percentage fall in price is higher for all the other ETP having sectors, as illustrated in table 8.2.

Table 8.2
Effect Of Subsidy @ 10% - 15% (For Etp Having Sectors On Prices

SECTORS	OLD PRICE	NEW PRICE	% CHANGE
1. AGRICULTURE	1	0.998157	0.184224
2. MILK & MILK PRODUCTS	1	0.999137	0.086216
3. LIVESTOCK	1	0.998849	0.115018
4. FISHING	1	0.998347	0.165237
5. COAL & LIGNITE	1	0.996746	0.325351
6. MINING & QUARRYING	1	0.998697	0.130239
7. SUGAR	1	0.995285	0.471470
8. EDIBLE OIL & VANASPATI	1	0.997720	0.227990
9. BEVERAGES	1	0.997879	0.212063
10. FOOD PRODUCTS	1	0.993257	0.674231
11. OTHER TEXTILES	1	0.990630	0.936944
12. WOOLEN TEXTILES	1	0.994924	0.507511
13. JUTE TEXTILES	1	0.997285	0.271472
14. MAN MADE FIBER	1	0.968310	3.168987
15. PAPER	1	0.996478	0.352116
16. LEATHER PRODUCTS	1	0.988856	1.114346
17. RUBBER PRODUCTS	1	0.982105	1.789469

18. PETROLEUM PRODUCTS	1	0.957006	4.299324
19. INORGANIC CHEMICALS	1	0.977559	2.244196
20. ORGANIC CHEMICALS	1	0.993690	0.630946
21. FERTILIZERS	1	0.984372	1.562730
22. PESTICIDES	1	0.980040	1.995995
23. PAINTS	1	0.992396	0.760342
24. DRUGS & OTHER CHEMICALS	1	0.978748	2.125194
25. NON-METALLIC-MINERALS	1	0.994969	0.503060
26. IRON & STEEL	1	0.995387	0.461206
27. MISC. MANUFACTURING	1	0.996833	0.316683
28. OTHER INDUSTRIES	1	0.992941	0.705802
29. CONSTRUCTION	1	0.997058	0.294143
30. ELECTRICITY-WATER-GAS SS	1	0.990679	0.932093
31. TRANSPORT & COMMUNICATION	1	0.994137	0.586256
32. SERVICES	1	0.998564	0.143544

Sectors Categorised Based On Percentage Of Units Having /Not Having Etp

Sectors having ETP	50% - 70% Subsidy 10%	Milk & Milk Products Food Products Other Textiles Leather Products Rubber Products Fertilizers	0.09%* 0.67% 0.94% 1.11% 1.79% 1.56%	% Price fall, for these sectors is marginal (except for Milk & Milk Prdts) , as subsidy given is lower
	70% -above Subsidy 15%	Sugar Man made Fiber Petroleum Products Inorganic Chemicals Pesticides Drugs & Other Chemicals Electricity-water-gas supply	0.47%* 3.17% 4.3% 2.24% 1.99% 2.12% 0.93%*	% price fall, is higher as subsidy rate is higher for these sectors with exception to Sugar & Electricity-water-gas Supply sectors
Sectors not having ETP	---	Agriculture Livestocks Fishing Coal & Lignite Mining & Quarrying Edible oil & Vanaspati	--- --- --- --- --- --- ---	% price fall for these sectors (not having ETP hence not allowed subsidies) is very negligible with exception to Organic Chemicals, Paints,

		Beverages Woolen Textiles Jute Textiles Paper Organic Chemicals Paints Non-Metallic-Minerals Iron & Steel Misc. Manufacturing Other Industries Construction Transport Services	--- --- --- ---- 0.63% 0.76% --- --- --- --- 0.70% --- 0.59% ----	Other Industries & Transport + Communication. The reason may be the fact that for these sectors the indirect effect / linkage with sectors being subsidised is extensive.

--- Negligible

Of which Petroleum Products, Man made Fiber, Inorganic Chemicals, Drugs & Other Chemicals industries experiences greater fall in price. The possible explanation being lying on the fact that these sectors have been given subsidy at a higher rate. The price fall picture could be made clear by categorising the sectors having / not having ETP and comparing it will the lists of sectors experiencing higher / marginal price fall. In this case also, indirect effect results in the price fall for every other sectors of the economy.

CASE 2B

Experiments have been conducted in the present case simply by extending that of Case 2a, through introduction of tax concept for sectors which has not installed ETP yet. The rate of taxation being determined at 10% of Net Indirect Taxes. The results reflected through table 8.3 point out that the price increases (% increase is depicted through negative sign) for the sectors which are taxed, whereas it falls for the sectors which have being given subsidies. But the percentage fall in price is much lower

compared to the case in 2a. The logically interpretation being that the indirect effect of price increase set in motion due to the taxes charged.

Table 8.3: Effect Of Subsidy & Tax On Prices

SECTORS	OLD PRICE	NEW PRICE	% CHANGE
1. AGRICULTURE	1	1.001359	-0.13592
2. MILK & MILK PRODUCTS	1	0.999759	0.024089
3. LIVESTOCK	1	1.001195	-0.11955
4. FISHING	1	1.000098	-0.00985
5. COAL & LIGNITE	1	1.003203	-0.32031
6. MINING & QUARRYING	1	1.001225	-0.12258
7. SUGAR	1	0.997502	0.249730
8. EDIBLE OIL & VANASPATI	1	1.003587	-0.35872
9. BEVERAGES	1	1.004710	-0.47101
10. FOOD PRODUCTS	1	0.994870	0.512974
11. OTHER TEXTILES	1	0.992277	0.772284
12. WOOLEN TEXTILES	1	1.003956	-0.39561
13. JUTE TEXTILES	1	1.002331	-0.23312
14. MAN MADE FIBER	1	0.971040	2.895926
15. PAPER	1	1.005266	-0.52669
16. LEATHER PRODUCTS	1	0.990479	0.952063
17. RUBBER PRODUCTS	1	0.983591	1.640833
18. PETROLEUM PRODUCTS	1	0.958574	4.142538
19. INORGANIC CHEMICALS	1	0.980618	1.938104
20. ORGANIC CHEMICALS	1	1.009384	-0.93849
21. FERTILIZERS	1	0.987445	1.255491
22. PESTICIDES	1	0.982119	1.788024
23. PAINTS	1	1.011399	-1.13996
24. DRUGS & OTHER CHEMICALS	1	0.981299	1.870030
25. NON-METALLIC-MINERALS	1	1.003677	-0.36778
26. IRON & STEEL	1	1.008594	-0.85949
27. MISC. MANUFACTURING	1	0.999289	0.071037
28. OTHER INDUSTRIES	1	0.994673	0.532655
29. CONSTRUCTION	1	1.000235	-0.02352
30. ELECTRICITY-WATER-GAS SS	1	0.992190	0.780978
31. TRANSPORT & COMMUNICATION	1	0.994892	0.510716
32. SERVICES	1	0.999182	0.081798

CASE 3

Taxes / charges on sectors which make use of pollution generating inputs in their production process i.e., on sectors which are not operating through pollution free or environmental – friendly production technologies.

This case experiments with a tax that is imposed on sectors which uses such inputs that generates high level of pollution. A rate of tax ranging from 5-15% has been considered for the present experiment. The tax rate varies depending on the extent of the polluting input used in the technology engaged by the particular sector. Such a classification has been formulated and designed as reported in the table.

SECTORS	INPUT USED	TAX %
Agriculture	Paper, Rubber, livestock Dairy, Fertilizer*, pesticide*	5
Milk and milk products	Drugs, Dairy products	-
Livestock	Drugs, Livestock	5
Fishing	Fishing, Paper, Drugs	5
Coal & lignite	Paper, Rubber, Drugs*	0
Mining	Drugs	-
Sugar	Paper, petrochemicals*, Drugs, dairy, livestock	10
Edible Oil + Vanaspati	Fish, man – made fibre ,Paper, petrochemicals, Drugs*, paints.	10
Beverages	Fishing, livestock, beverages*, Paper*, Rubber, Petrochemicals Drugs.	15
Food products	Dairy, livestock*, fish*, paper*, drugs, beverages,	15
Other Textile	Livestock*, Wool, Man-made*, Paper, leather, Rubber, Petrochemicals, Paints*, Drugs	15
Woolen textile	Livestock*, Woolen*, man-made*, paper, leather, Rubber, Petrochemicals, Paints, drugs	15
Jute Textile	Man-made, paper, Rubber, Petrochemical, Paints, Drugs*	10
Man-made Fibre	Livestock, Beverages, Man-made*, Paper*, Rubber, organic Chemicals*, Fertilizer, Paints, Drugs	15

Paper	Livestock, Man-made, paper*, Rubber, Organic, Chemicals, Paints, Drugs*.	15
Leather	Livestock*, Beverages, Man-made, Paper, leather*, rubber*, organic-chemicals, paints, Drugs*.	15
Rubber	Livestock, man*-made, paper, leather, rubber*, organic* chemicals Paints, Drugs*	15
Petroleum Products	Man-made, Paper, Organic chemical Paints, Drugs	5
Inorganic Chemicals	Beverages, Man-made*, Paper*, Rubber, Inorganic *chemicals Fertilizers, Paints, Drugs*	15
Organic chemicals	Beverages, Man*-made, Paper*, Rubber, organic *chemicals, Fertilizers, paints, Drugs*	15
Fertilizer	Livestock, Fish, Paper, organic* chemical, Fertilizer*, Drugs*	15
Pesticides	Livestock, Paper*, organic* Chemicals, Fertilizers, Drugs*, Pesticides*	15
Paints	Livestock, Beverages, Man-made*, Paper*, organic *chemicals, Paints, Drugs*.	15
Drugs	Dairy, livestock, Beverages, Paper*, leather, Rubber, organic* chemical, Paints, Drugs*	15
Non-metallic Minerals	Livestock, Man-made, Paper, organic chemicals*, Paints, Drugs.	10
Iron + steel	Paper, Rubber, organic Chemicals, Paints, Drugs	5
Other industries	Man-made, Paper*, leather Rubber, Organic chemicals*, Paints*, Drugs*.	15
Construction	Livestock, Paper, Rubber, Fertilizer, Paints*.	10
Electricity, Gas, Water	Livestock, Paper, Rubber	5
Transport & Communication	Beverages, wool, Paper, leather, Rubber*, Paints, Drugs	10
Services	All	5

* - per unit input used higher in such cases.

Corresponding to this table the observation made is that the price increases for all the sectors, as depicted in table 8.4. But the percentage increase is higher for sectors on which tax is imposed of higher rate. Of which Man made Fiber(3.58%), Rubber(2.61%), Inorganic

Chemicals(2.7%), Organic Chemicals(2.95%), Fertilizers(2.4%), Pesticides(2.37%), Paints(3.69%), Drugs & Chemicals(2.52%), Other Industries(2.93%) indicate comparability higher increase. The reason behind it may be that for these sectors the extent of polluting input used in its production process is noticeably higher. There are few exceptions Like, that in Iron and steel and Electricity- water – Gas supply sector, which show higher percentage price increase despite of being charged at a lower rate. It is so because these sectors are generally extensively linked with the other sectors of the economy.

Table 8. 4 Effect Of Tax On Prices (Based On Polluting Input Used)

	SECTORS	OLD PRICE	NEW PRICE	% CHANGE
1	AGRICULTURE	1.000000	1.004037	0.403681
2	MILK & MILK PRODUCTS	1.000000	1.001063	0.106262
3	LIVESTOCK PRODUCTS	1.000000	1.002916	0.291584
4	FISHING	1.000000	1.002508	0.250815
5	COAL & LIGNITE	1.000000	1.010731	1.073124
6	MINING & QUARRYING	1.000000	1.001418	0.141814
7	SUGAR	1.000000	1.005724	0.572448
8	EDIBLE OIL & VANASPATI	1.000000	1.007734	0.773365
9	BEVERAGES	1.000000	1.012161	1.216117
10	OTHER FOOD PRODUCTS	1.000000	1.010749	1.074929
11	OTHER TEXTILES	1.000000	1.014282	1.428243
12	WOOLEN TEXTILES	1.000000	1.019554	1.955386
13	JUTE TEXTILES	1.000000	1.007922	0.792220
14	MAN MADE FIBRE	1.000000	1.035835	3.583543
15	PAPER	1.000000	1.017024	1.702446
16	LEATHER	1.000000	1.017801	1.780148
17	RUBBER PRODUCTS	1.000000	1.026101	2.610128
18	PETROLEUM PRODUCTS	1.000000	1.015788	1.578789
19	INORGANIC CHEMICALS	1.000000	1.026967	2.696705
20	ORGANIC CHEMICALS	1.000000	1.029473	2.947327
21	FERTILIZERS	1.000000	1.024080	2.407972
22	PESTICIDES	1.000000	1.023714	2.371362
23	PAINTS	1.000000	1.036946	3.694563
24	DRUGS & OTHER CHEMICAL	1.000000	1.025201	2.520106
25	NON METALLIC MINERALS	1.000000	1.012955	1.295492
26	IRON & STEEL	1.000000	1.012969	1.296921
27	MISC. MANUFACTURING	1.000000	1.016698	1.669833
28	OTHER INDUSTRIES	1.000000	1.029307	2.930706
29	CONSTRUCTION	1.000000	1.011035	1.103482
30	ELECTRICITY-WATER-GAS SS	1.000000	1.007886	0.788606
31	TRANSPORT & COMMUNICATION	1.000000	1.010958	1.095816
32	SERVICES	1.000000	1.003706	0.370593

Chapter 9

Environmentally Adjusted National Income Accounting Of India For The Year 1989-90 And Its Implications

So, far we have studied the aspects concerning water resources, water pollution generation directly and indirectly, abatement cost and its effect on output, prices as well as on consumers. Ultimate results of these are deterioration in the water qualities and its depletion. Such environmental deterioration has adverse effect on human welfare. However, as conventional GDP measure fails to account for such welfare losses, an attempt has been made in this Chapter to measure the Environmentally Adjusted Domestic Product (EDP) as well as welfare loss.

Natural Resource Accounting (NRA) is a necessary step to measure sustainability of development. It provides indicators of loss of natural resources, changes in environmental quality and their consequence for long term economic development.

Environmental accounting is an early stage of development and there is considerable debate and controversy over its direction (Perman ,Ma and McGILVRAY, 1998) . The debate on environmental accounting is largely centered on the in corporation of environmental costs and benefits in National accounts.

The need to account for the environment and the economy in an integrated way arises because of the crucial functions of the environment in economic performance and in the generation of human welfare.

Conventional national accounts have only partly accounted for these functions, focusing on market transactions and indicators that reflect important factors in welfare generation but they do not measure welfare itself. However new scarcities of natural resources now threaten the sustained productivity of the economy, and economic production and

consumption activities may impair environmental quality by overloading natural sinks with wastes and pollutants. By not accounting for the private and social costs of the use of natural resources and the degradation of the environment, conventional accounts may send wrong signals of progress to decision makers who may then set society on a non-sustainable development path.

Degradation of natural resource or loss in the quality of environment imposes a burden on future generations. Degradation implies that the present generation borrows from the future generation. If degradation goes beyond a limit then natural regeneration may not be possible. So, we needs to know how much of resource we have used up and how much of a burden we leave behind.

Accounting of natural resource use does not normally take place in the process of economic activities because, the costs of environmental degradation and resource depletion are not borne by the economic actors who cause them but other members of the society surely do.

Thus as a nation we should keep track of our resource base and the state of our natural environment.

The treatment of environmental issues in the accounting framework was initiated by Nordhares and Tobin (IGIDR, 1992) in the United states and the work on developing a natural resource accounting frame work began in Norway in 1974 (Pearce, 1989). Physical accounting of resources was later followed by French (beginning 1978) and Canadian government also.

'World Resource Institute' (WRI) developed a methodology for natural resource account (Repetto et. Al, 1989) an initiated a few country studies using their methodology.

The 'System of Integrated Environmental and Economic Accounting' (SEEA) was tested in Canada, Colombia, Ghana, Indonesia, Japan,

Mexico, Papua, New Guinea, the Philippines, the republic of Korea, Thailand and the USA. Only parts of the SEEA were actually compiled in these studies. The reasons behind these are lack of data and the controveriality to certain valuations of nature services and their welfare effects.

A framework for NRA of India has been prepared by IGIDR in 1992. The frame work given by IGIDR takes off from the Guide lines given by the United Nations through their documents for 'Integrated Economic and Environmental Accounting' [(IEEA),1993].

Growing pressures on the environment and increasing environmental awareness have generated the need to account for the manifold interactions between all sectors of the economy and the environment. Conventional National Accounts focus on the measurement of economic performance and growth as reflected in market activity. For a more comprehensive assessment of the sustainability of growth and development the scope and coverage of economic accounting needs to include the use of non-marketed natural assets and losses in income generation resulting from the depletion and degradation of natural capital.

9.1 Different Categories Of Adjustments To The National Accounts

There is now a wide measure of agreement that the conventional system of National Accounts, in most countries based upon the System of National Account (SNA) , designed by the United Nations Statistical Office , is not adequate as a means of measuring the impact of environmental changes on income and welfare (Perman , Ma and McGILVRAY ,1998). It is so because there was less awareness about the impact of human economic and social development on the environment. The conceptual basis of the National Account are governed by definition of income and

wealth which did not make any allowance for depletion of natural capital or the cost of environmental damage such as pollution.

This view is no longer tenable as it is apparent that production and consumption activities has environmental side effects which imposed considerable cost, some of which will be borne by future generation. Criticism of the conventional system of National Accounts centres on three main issues

1. National Accounts measure a nation's wealth. They record only man-made capital consumption and ignore natural capital consumption which must be accounted for too.

2. although the National Account make allowance for depletion of man made capital in arriving at an estimate of NNP or NNI but they make no allowance for depletion of natural resources. Thus the National accounts overstate "true" national income, particularly in the case of developing countries like India which rely heavily on the exploitation of natural resources.

3. the costs of environmental protection or renovation (so called defensive expenditure) are included in national income but no allowance is made for the corresponding environmental damage in calculating net income. This can be regarded as environmental degradation, to be treated in a manner similar to depletion of natural resource stock and deducted from GDP or NDP.

So there are three categories of adjustments to the national accounts, which have been proposed to reflect the cost and benefits of human activity on the environment. These are the

a) depletion of natural capital

b) environmental degradation, and

c) defensive expenditure.

9.2 Environmental Degradation

A significant number of industries (Livestock, Oil refineries, Coal, Chemical industries, distilleries, Man Made fibre, Dye, Leather, textiles etc.) in India are producing pollution above Mines by several times. These industries are discharging waste waters on to land and water in a alarming proportion thus degrading land and water resources. This degradation of resources are hazardous to health, fertility of land, aquatic life etc.

9.2.1 Health Hazards

In India about 67% of all diseases are water borne which includes typhoid, Jaundice, Cholera and dysentery. Research by Jodhpur University chemistry department (CSE, 1985) has identified several Carcinogenic Compounds in the effluents. A Gandhi Peace Foundations (GPF) identified various forms of Cancer, among other diseases in the area.

In India, one study (IGIDR,1992) has estimated that in terms of health hazards, water borne communicable diseases affect a large number of people and about 73 million work days are loss annually due to water related diseases. The total loss due to medical care expenses and loss in production is estimated about Rs. 799400 Lakhs (IGIDR,1992).

9.2.2 Damages To Crops

The crops irrigated with polluted waters of rivers, reservoirs and Lakes have high probability of damages of various forms. Excessive acidity or alkalinity (Ph below 4 and above 9) are not suitable for crop growth.

In India the loss of agricultural output due to soil degradation is about Rs. 271880 Lakhs as stated by IGIDR.

9.2.3 Defensive Expenditure

Expenditures which are incurred to protect environment and to prevent degradation is called defensive expenditure. Some environmentalists (Leipert, Olson , Tobin) argue that such defensive expenditure should be excluded from or at least deducted from GDP. If defensive expenditure is not undertaken, there is degradation and hence depletion of natural capital. The defensive expenditure is nothing but the cost of Waste water treatment.

The cost of waste water treatment includes

(a) Capital Cost : The capital cost of the treatment includes cost of the civil engineering required for construction of treatment units cost and installing charges for mechanical equipment and electrical works includes general lighting and supplying power to the various units (IGIDR,1992).

(b) Running Cost : The running cost of the treatment plan includes cost of power, salaries of the staff, chemical cost, maintenance, repairs and depreciation.

In this study we have only considered the operation and maintenance cost of treatment. It is so because valuation of any product (clean water) depends upon the running expenditure including depreciation. In this study the total cost involved for treating the waste water treatment has been calculated to be about Rs. 279574.5 Lakhs, based on the discussion as in Chapter 4 and regarding pollution abatement cost.

9.3 Environmentally Adjusted National Accounting

Like other accounting system environmental account should link opening stocks, flows to and from that stocks, and closing stocks. Opening and closing stocks represent the state of the environment at the beginning and at the end of the accounting period. While flows records the impact of the actions of the economic agents on environment.

However, as in our case we are dealing with water resource that is, renewable implies that its stock is infinite in the present period of time but its future holds a finite state being depleted gradually over time[1]. So for the present study only opening stock will be accounted.

Environmentally accounting seeks to track environmental resource use, including both resource depletion and environmental degradation over a given period of time, the reporting period which is usually a year.

Gross income or products as conventionally measured, do not indicate an economically sustainable level until they have been pruned for capital consumption. Regarding the costs of depletion and pollution as consumption of natural capital suggests that they may be subtracted, along with the consumption of produced capital from GDP and GNI (gross national income) to arrive at Environmentally adjusted net Domestic Product (EDP) and National Income.

Such adjustment will give a more realistic indication of wealth creation and consumption of goods and , services and , of course ,where environmental costs are growing faster than GDP, EDP growth rates will be below those of GDP.

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[1] In discussion with Prof. Balaram Bose , Professor of Water Resources, Jadavpur University , Calcutta.

Table 9.1

Seea Flow And Stock Accounts With Environmental Assets

		DOMESTIC PRODUCTION	FINAL CONSUMPTION (HOUSEHOLD, JOINT)	CAPITAL FORMATION	REST OF THE WORLD
1.	Supply of products (O)	1) Other sectors output			Imports (M)
		2)Environmental sectors output			
2.	Use of products (Intermediate consumption) IC	1) Other sectors output	1) Other sectors final consumption	1) Gross capital formation of other sectors (GCF)	Exports(X)
		2) Environmental sectors Output	2) Environmental final consumption	2) Gross capital formation of Environmental sector (GCF_2)	
3.	Use of Fixed capital	Fixed capital consumption of other sectors (CC)		Capital consumption (CC)	
4.	Value added (VA/NDP)	NVA = O – IC – CC NDP = $\sum$NVA			
5.	Use of Natural Assets (depletion and degradation and defensive expenditure)	Environmental cost of Industries Defensive Expenditure(EC_1)+ Loss of Production ($EC_{2)}$	Environmental cost of Household (EC_h)	Natural capital consumption (EC) ,EC = EC_1 + EC_2	
Environmental adjusted indicators		EVA = NVA-EC EDP= $\sum$EVA – EC_h)		ECF = (CF – CC) – EC	

Table 9.2

Environmentally–Adjusted National Accounting Of India

For The Year 1989-90. (Figures Are In Lakh Rs.)

		DOMESTIC PRODUCTION	FINAL CONSUMPTION	CAPITAL FORMATION	REST OF THE WORLD
1.	Supply of products				
	(1) Others sectors	(1) 79816925.19			(1) 4021232
	(2) Water resources	(2) 522013.9			(2) -
2.	Use of production	(1) 36678813.74	(1) 33033028.54	(1) 10467773.17	3658542
		(2) 405845.08	(2) 116168.8	(2) -	
3.	Use of fixed capital	(1) 4526835		(1) 4526835	
4.	Value added (VA/NDP)	NDP or NVA =38357895.7			
5.	Defensive expenditure	279574.51	799400.00 Health cost		
	Loss due to soil degradation	271880.00		Natural capital consumption 1350854.5	
	Total EC = Total EVA= Total EDP =	1350854.5 37806441.22 37007041.22		ECF = (CF – CC) –EC = 4220534.143	
	% Loss in terms of NDP	3.52%			

Source : 1) Input-Output Transaction Table 1989-90, CSO
2) IGIDR(1992), Bombay
3) Centre for Science and Environment (1982)

Accounting for the costs of consumption of natural capital obtains not only an EDP but also an aggregate of Environmentally adjusted (net) Capital Formation [(ECF), table 9.2..

The expansion of the asset boundary of conventional accounts for the inclusion and valuation of natural assets and asset changes permits the

calculation of a range of aggregates. In this analysis the whole economy has been broken up into two sectors, one is water resource sector (natural resource) and other sectors are aggregated into one sector.

The aggregates can be presented as the sum total and elements of conventional accounting identities. These accounting identities are maintained in the SEEA in the following way :

(a) Supply – use identity :

$$O + M = IC + C + CF + X \quad \ldots\ldots\ldots \quad (1)$$

Where O is the supply of goods and services produced by different sectors;

M is the supply of goods and services imported by sectors;

IC is the goods and services used in intermediate; and C is the final consumption;

CF and X is the capital formation and export;

(b) Value-added (environmentally adjusted) identity for different sectors.

$$EVA = O - IC - CC - EC = NVA - EC \quad \ldots\ldots\ldots \quad (2)$$

Where EVA is the environmentally – adjusted value added of industries;

CC is the fixed capital consumption;

EC is the environmental depletion and degradation costs;

NVA is the net value added of industries;

(c) Domestic-product identity (environmentally – adjusted) for the whole economy :

$$EDP = \sum EVA - EC_n = NDP - EC = C + CF - CC - EC + X - M \quad \ldots(3)$$

Where EDP is the environmentally – adjusted net domestic product;

EC_n is the environmental costs generated by household;

Table 9.1 shows the draft of SEEA : Flow and stock account with environmental assets;

Table 9.2 shows the environmentally adjusted National Income accounting for the year 1989-90 which has been constructed based on the draft presented in table 9.1. EDP calculation in detail has been presented in table 9.2. Here, as evident from the table 9.2 the total domestic production of goods and services (O) , given by the sum of intermediate consumption's (IC), final consumption (C), capital formation (CF) and net export (Export - Import) of all the sectors , is Rs. 80338939.099 (Lakhs). EVA, derived from NVA by subtracting EC (Environmental Depletion and Degradation Cost) account to Rs.37806441.22 (Lakhs). Finally EDP which is Environmentally Adjusted Value Added (EVA) - Household Environmental Cost (EC_h) as depicted in equation 3 comes down to Rs. 37007041.22 (Lakhs). Consequently percentage of loss in terms of NDP is 3.52%. Further here, ECF

(Environmentally Adjusted Capital Formation) is Rs.4220534.143 (Lakhs).

9.4 The Contribution Of The Environment To Economic Performance And Welfare Generation

The quality of life or welfare of an individual or of a society cannot be precisely defined, but it is common (at least for Social Scientist) to

associate welfare with levels of income. However, higher income levels permit higher levels of consumption , and consumption is a measure - though by no mean the only determinant - of welfare. It follows that when we assert that a particular environmental change has reduced welfare it is similar to saying that the income of those affected by the change have fallen and there has been a reduction in the aggregate income of the society.

The need to account for the environment and the economy in an integrated way arises because of the crucial functions of the environment in economic performance and in the generation of human welfare.

The purpose of production is to meet human wants and to ultimately increase human welfare. GDP is a measure of production, a significant contributor to welfare, but it is not a welfare measure itself. One reason is that the goods and services may affect human well-being in many ways that are not reflected in their market value.

The environment is an important contribution to both production and human welfare, through three broad sets of environmental function such as

(a) resource functions : the provision of resource, including space for human activity

(b) Waste absorption functions : the neutralization, dispersion or recycling of wastes from human activity;

(c) Environmental service functions; the protection of environment from different deterioration.

These above three sets of functions can each contribute to human well-being in a variety of ways, including :

(a) indirectly, via the economic production system;

(b) directly, through the maintenance of human health.

Environmental deterioration clearly has an adverse impact on human welfare. In the context of GDP measurement, national accounts are not meant to measure welfare. However, they can give insights into welfare generation. For instance, accounting indicators of the depletion or deterioration of stocks of environmental assets, in physical or money terms, provide signals about possible losses of our long-term capability to maintain environmental functions and hence their welfare contributions. Defensive expenditures even though increase GDP in terms of additional investment, it is deducted from GDP to arrive at EDP. The reason behind it being that this kind of investment are made to compensate for the welfare loss resulting from environmental degradation and depletion. The very same indicators may spur policy action, resulting in both the betterment of the environment and an increase in welfare.

In our case whereas NDP is Rs. 38357895.73 (Lakhs), we arrived at EDP of Rs. 37007041.21 (Lakhs) accounting for loss in terms of NDP to be around 3.52%. Apart from welfare loss view point one must also consider the positive side (Schafer, Stahmer ,1989)of incurring defensive expenditure too. That is, this kind of investment made for pollution abatement provides a upsurge for employment generation through acceleration principle , thereby raising income and output level.

9.5 Environmentally Adjusted Domestic Product With Respect To Pollution Control Policies

We have already discussed that Gross Income or products as conventionally measured, do not indicate an economically sustainable level until they have been pruned for capital consumption. Regarding the costs of depletion and pollution as consumption of natural capital suggests

that they may be subtracted, along with the consumption of produced capital from NDP and NNI to arrive at Environmentally adjusted NET Domestic Product (EDP) and National Income Based on the experiment carried out in the Chapter 8 with different pollution control policies (in terms of tax and subsidies) , it is inevitable that a new set of EDP would arise as EDP is derived from GDP or NDP. Calculation of these new set of EDP is illustrated here in. Corresponding to every cases (case 1,2a, 2b , 3) we would be arriving at the new set of EDPs.

CASE 1

In this case the tax is imposed based on the quality of BOD generated by each sector. As a result of the taxation our NDP/NVA increases from Rs. 38357895.73 (Lakhs) to Rs. 38871158.61 (Lakhs) expressing a increase of 1.33 %. Hence new EDP will be Rs. 37520304.22 (lakhs) from Rs. 37007041.22 (lakhs). So in this case loss in terms of new NDP is 3.47% , which is marginally less (.05%) than that of original EDP (3.52% , Table 9.2).

CASE 2a

In this case subsidy at a rate of 10 -15 % of Net Indirect Taxes of each sectors has been given to the sectors which have ETP (Effluent Treatment Plant). In this present context NVA decreases to Rs. 38206221.78 (Lakhs) from Rs. 38357895.7 (lakhs) showing a percentage decrease of 0.39%. In this case new EDP will be Rs. 36855367 (lakhs). So loss in terms of NDP will be 3.54% which is marginally higher than that of original EDP (3.52%).

CASE 2b

Experiments have been conducted in the present case simply by extending the above case, through introduction of the tax concept for sectors which has not installed ETP. As in this present case tax and

subsidy works in the opposite direction , that is, NDP increases due to taxation and decreases because of subsidy given , the new NVA deviates very marginally. From Rs. 38357895.7 (lakhs) to Rs. 38334880.96 (lakhs). In this case new EDP will be Rs. 36698402.6 (lakhs). So, loss in terms of new NDP is 3.52% which is same as that of original loss.

CASE 3

This case experiments with a tax that is imposed on sectors which uses such inputs that generates high level of pollution. In this case NDP has increased from Rs. 38357895.7 (lakhs) to Rs. 38718459.92 (lakhs) and the new EDP will arrive at Rs. 37367505.92 (lakhs). Here loss in terms of new NDP and EDP is very marginally decrease (.03%).

Conclusion can be drawn from this analysis that along with the defensive expenditure , pollution control policies also affect the whole process of EDP calculation. It is evident from above experiment that the effect is not uniform. As in case 2 and 3 loss percentages remain same as in the original loss(9.2) . But in case 1 and 3 ,it is noticed that percentage loss in terms of NDP falls.

Chapter 10

Summary And Recommendations

Almost all the countries of the world are becoming concerned with the environmental problems and environmental considerations are becoming a part of the overall development policy of every nation.

India, being a developing country, has to resolve massive environmental problems which include industrial pollution (i.e. pollution of air, water and soil due to industrial production), vehicular emissions, hospital waste and domestic sewage disposal, etc.

Industrial pollution in the form of air, water, solid, thermal pollution, etc., is assuming alarming proportions with each passing day and this category of problems needs immediate attention and calls for appropriate measures. The Indian industries have been producing pollution at much higher rates than the Minimal National Standard (MINAS) approved by the Pollution Control Board of India.

An economy consists of a large number of industries. These industries do not exist in isolation from each other , rather , are interrelated . The interdependence arise from the fact that the output of a sector is generally required as input by another sector. Though some sectors do not produce pollution directly but these sectors produce pollution indirectly in a very significant way, depending on the methodology of interdependence among sectors of the economy under the framework of Input-output technique of Leontief . There have been several studies . But a quantitative analysis involving interdependence between water pollution and economic activities is only few. Maiti(1994), Maiti and Chakraborty (1989,1993a ,1993b ,1999) have made a modest contribution in this respect. With detailed and recent data an in-depth quantitative study linking the economy and water pollution by different sectors of the Indian

economy has been done. The purpose of the present study is to contribute to this area.

Water though indispensable and playing a pivotal role in our lives is one of the most badly abused resources. Water resources is a renewable resource. It implies that its stock is infinite in the present period of time, but its future holds a finite state, being getting depleted gradually over time. Hence , calling for immediate attention. Water resources can be classified into two broad categories namely., 'Ground Water resource' and Surface Water resource'. Total availability of water is 400 mham, and the losses of water in different way is about 154.05 mham. While total utilisable amount of surface water is 70 mham, the utilisable amount of ground water is 42 mham. So total utilisable amount of water from both the sources is 112 mham. From this amount only 53 mham of water is used by different sectors of India in the year 1989-90. It appears from the study that the main demand for water is for irrigation (accounting for 86.8%). As noticeable the wastage of water is very large. Besides it water also gets polluted by different ways. An attempt has been made in this direction in our present work through studies on different aspects of water pollution .

Water pollution is any physical or chemical change in water that can adversely affect organisms. Water pollution is caused due to variety of factors - e.g., industrial effluent generation, household sewage disposal, agricultural activities. These factors are a major cause of water quality degradation. There are a quite large number of physical and chemical parameters of waste water such as Ph, Dissolved Solids (DO) , Total Solids, Inorganic , Organic trace elements that needs to be monitored for proper assessment of water quality. Hence quality Index has been prepared to integrate the data pool to produce a single number to reflect water quality status (Chapter 5).

The present study has made a detailed quantitative analyses of the link between water pollution generated by different industries and the various economic activities of the Indian economy for the year 1989-90. The study has computed the total amount of water pollution generation directly and indirectly in different industries of India using input-output technique. In Chapter 3 the methodology has been presented. A pollution output coefficient matrix has to be constructed. Then using Leontief inverse matrix, the total pollution generation is to be computed for all the sectors of an economy.

The data required for the study are discussed in Chapter 4. The input-output table (115 X115) of India for the year 1989-90 has been used and the table has been aggregated to 32 sectors.

From the publications of the Central Pollution Control Board and Bureau of Indian Standard 10 types of water pollutant are identified which are being discharged by the different industries. However ,due to data limitation data for these 10 types (BOd,COD, Suspended Solids , Dissolved Solids , Chlorides, Sulphides, Oil & Grease, Zinc, Phenol and Others) of pollution have only available only for 26 sectors. Pollution matrix has been constructed and presented in table 4.4 of Chapter 4.

Detail analysis of cost data concerning pollution abatement activities by different industries of the Indian economy has been illustrated in Chapter 4. As most of the industries do not conduct systematic effluent treatment, data on total cost and its break-up is not available. With the few selected industries for which cost data was available has been analysed in Chapter 4.

The experiment with the model and the results are discussed in Chapter 6. The direct water pollution coefficients counts the direct effect of pollution generation within a sector and the total (direct plus indirect)

counts the indirect effect of pollution generation among other related sectors.

The results show that the amount of total pollution generation per unit of the product (Table 6.2) is significantly higher for all industries compared to direct pollution generation coefficient (Table 6.1) . For example ,direct pollution generation of Leather industries is found to be 0.00015, 0.00071, 0.00023, and 0.00007 of SS ,DS ,Chloride , and Others respectively per Lac Rupees of output. Whereas the total pollution coefficient of this industry is 0.00030, 0.00094, 0.00030, 0.00002, 0.00038 for SS, DS, Chloride, Oil & Grease and Others respectively , which is much higher compared to direct coefficients . Thus one cannot simply look at the size of the direct water pollution coefficients, he must also consider the size of the total coefficients (direct plus indirect). In case of Livestock industries indirect pollution generation is found to be insignificant.

A significant numbers of industries (Livestock's, Oil Refineries, Coal, Chemical industries, Distilleries, Man made fibre, Dye, Leather, Textiles, Paper, Fertilizers, Dairy) in India are producing water pollution above MINAS by several times. India is among less developing countries ,identifying key areas of environmental pollution and Indian industries are becoming increasingly conscious since , 1980, regarding water pollution. A study by CPCB (1997) shows that a significant number of industries are controlling water pollution .The pollution abatement activities involve cost, which in turn, will affect the price and output of different industries. The analysis shows that the demand for all the output of different sectors have changed and the price of all the sectors have increased . It is evident from the study that the inorganic Chemicals experiences a higher percentage increase in output (13.5%) followed by Construction (3.2%) and Mining and Quarrying (2.6%) .

Any shift in cost has an effect on prices. The direct cost of clean water production is not the whole story . Since many industries are affected the cost of purchased intermediate goods of service have also risen unevenly across the economy. The pattern of final consumption have also affected . This study points out that the percentage price increase is higher for Livestock's (11.4%) followed by Leather Products (1.9%).

Final consumers that is the households ultimately bear the burden of pollution generation, either through price increase- due to production of clean water or tax imposed by the government on producers - or health treatment cost when pollution is not treated. From the point of household the relationship between the real cost and real benefits remain nevertheless the same, having paid for clean water production or tax imposed by government indirectly , he will have to spend less on health treatment cost directly.

Further , there is now a wide measure of agreement that the conventional system of National Accounts is no longer adequate as a means of measuring the impact of environmental changes on income and welfare. In the context of GDP measurement , national accounts are not meant to measure welfare . However ,they can give insights into welfare generation. Defensive expenditures even though increases GDP in terms of additional investment , it is deducted from GDP to arrive at EDP. The reason behind it being that this kind of investment is made to compensate for the welfare loss resulting from environmental degradation and depletion. The very same indicators may spur policy action, resulting in both the betterment of the environment and increase in welfare. In this study whereas NDP is Rs. 38357896.73 [(lakhs) chap9] , we arrive at EDP of Rs. 37007041.21 (Lakhs) . So Loss in terms of NDP is 3.52 %.

Recommendations

In the process of conducting all the experiments with the methodologies mentioned in Chapter3 certain problems relating to inadequacy of data were being faced, which made us think about the following recommendations.

Firstly, lack of appropriate and required data on different types of water pollutants generated by different industries of the Indian economy, points out towards the need for detail, adequate and recent up-date data on water pollutants generated. Like for e.g., data on water pollution generation of Metal industry were not available, inspite of it being a sector having extensive linkage with the other sectors of the economy. Availability of data on this sector would have given a better results, through indirect pollution generation by other sector of the economy which are dependent on it.

Secondly, since most of the industries uptill now have no systematic approach towards effluent treatment, they fail to provide any practical data on the pollution abatement costs. It may be noticed that the detail break-up, of the total cost of pollution abatement activity has been available and possible to analyse for only 10 industries of the whole economy, that too for only one or two units of a particular industry such set of data has been calculated (by CPCB) based on estimation of a presumed ETP. Experiments in this study, showing the effect of pollution control cost on output and prices of different goods and services, has been attempted based on the available set of data but for more effective and socially useful results, the study calls for a detail, complete and recent data set on cost of abatement of all the industries of the economy.

Thirdly, in this connection point should also be made regarding non-availability of the effluent character of the waste water and solids wastes coming out from any ETP, as required for proper and complete

construction of Water Quality Index, which involves derivation of WQI before and after treatment activity has been conducted.

Fourthly, due to no-availability of data on the quality of labour and capital; stocks for any pollution abatement activities constrained our effort towards making a study on the direct and indirect increase in demand for labour,i.e, primary inputs.

These are some of the areas of which institutions like CPCB should keep in mind and take steps in the direction of collecting data called, for and by, more socially applicable experiments. Besides, University and Research Institutions should be entrusted to make some detail micro survey on this issues to provide detail data.

The total coefficients as derived in Chapter 6, provide policy makers with one way of assuming the impact of alternative environmental management strategies on pollution generation. Policy of developing penal measure (in form of tax) on the industries generating high level of pollution may be adopted. And industries producing less pollution may be encouraged by giving subsidy. However ,to find appropriate penal tax law and amount of subsidy for different product of different industries Policy makers should take into account these facts of the study conducted by us.

It is observed from the study that the whole economy will be effected due to pollution control. Government can use a variety of regulatory and economic instruments to reduce water pollution. Some contributions have been made in form of policy suggestion in this study from which it is evident that the price system would also differ if instead of voluntary action or to obey a special law ,each industry under takes to eliminate pollution at its expense ,it pays off an appropriate proposed tax for pollution generation. The present study has considered (1) the pollution taxes charged per ton of BOD generation, (2)taxes imposed (on those

sectors who have no ETP and subsidies given on the sectors who have Effluent Treatment Plant (ETP) and (3) taxes on those sectors which make use of pollution generating inputs in their production process. From the study it is apparent that the price of the product will be more costly if sectors are taxed than provided the pollution control schemes have been undertaken. Further the price of the product will be cheaper if subsidies are given on those sectors who have ETP .

Pollution control schemes should be imposed on all the sectors producing water pollution other wise a penal measures must be taken on the industries not implementing pollution control schemes. The quantum of panel measures in form of tax on an sector should be proportional to the amount of pollution generated by that industry above MINAS. Sectors producing less pollution by taking different measures of clean water production may be encouraged to implement pollution control scheme by giving subsidy to keep its price under control (as suggested by us).

It is observed from this study that it is very difficult to prepare an accurate national picture of India's water resources because accurate field data are almost non-existent. Till now we have no arrangements in this country to compile and publish on an annual basis , comprehensive data regarding various aspects of water which are important for policy analysis and programme formulation. Attention should be given in this direction.

Conventional national accounts have only being focusing on market transaction and indicators that reflect important factors in welfare generation but they do not measure welfare itself. However new scarcities of natural resources now threaten the sustained productivity of the economy, and economic production and consumption activities may impair environmental quality by overloading natural sinks with wastes and pollutants. By not accounting for the private and social costs of the use of

natural resources (water resources) and the degradation of the environment , conventional accounts may send wrong signals of progress to decision makers who may then set society on a non-sustainable development path. So, EDP must be done along with NDP annually. Such adjustments will give a more realistic indication of wealth creation and consumption of goods and services . And ,of course, where environmental costs are growing faster than GDP , EDP growth rates will be below that of GDP. So, data on depletion , degradation, defensive expenditure should be available annually to do work in this direction along with GDP or NDP calculation. Based on our study considering only “water resources” we have seen that in India (1989-90) EDP falls back by 3.52% of GDP . If other natural resources could be accounted for then the situation would have been much worser. Hence calling for further research in this field.

APPENDIX NO.1

AGGREGATED SECTOR CLASSIFICATION FOR INPUT-OUTPUT TRANSACTION

Sl. No.	AGGREGATED SECTORS	SECTORS
1.	AGRICULTURE	Paddy(1), Wheat(2), Jowar(3), Bajra(4), Maize(5), Gram(6), Pulses(7), Sugarcane(8), Groundnut(9), Jute(10), Cotton(11),Tea(12),Coffee(13), Rubber(14), Coconut(15), Tobacco(16),Other crops(17), Forestry & Logging(21)
2.	MILK & MILK PRODUCTS	Milk & milk products(18)
3.	LIVESTOCK PRODUCTS	Animal services(19), Other livestocks(20)
4.	FISHING	Fishing(22)
5.	COAL & LIGNITE	Coal & Lignite(23)
6.	MINING & QUARRYING	Crude Petroleum & Natural Gas (24), Iron ore(25), Manganese ore(26),Bauxite(27), Copper ore(28),Other metallic mineral(29), Lime stone(30), Mica(31),Other non Metallic minerals(32)
7.	SUGAR	Sugar(33),Khandsari Boora(34)
8.	EDIBLE OIL & VANASPATI	Hydrogenated oil[vanaspati](35), Other Edible oils(36)
9.	BEVERAGES	Tea & coffee processed(37), Beverages(39)
10.	OTHER FOOD PRODUCT	Miscellaneous foodproducts(38) Tobacco products(40)
11.	OTHER TEXTILES	Khadi(41),Cotton textiles(42), Silk textile(44), Art silk, Synthetic fibre(45), Carpet weaving(47), Readymade Garments(48), Miscellaneous textiles(49)
12.	WOOLEN TEXTILES	Woolen textiles(43)
13.	JUTE TEXTILES	Jute,Hemp,Mesta textiles(46)
14.	MAN-MADE FIBRE	Synthetic fibre, resin(67)
15.	PAPER	Paper, Paper products(52), Printing & Publishing(53)
16.	LEATHER PRODUCTS	Leather footwear(54), Leather & Leather products(55)

17.	RUBBER PRODUCTS	Rubber products(56)
18.	PETROLEUM PRODUCTS	Petroleum products(58), Coal tar products(59)
19.	INORGANIC CHEMICALS	Inorganic heavy chemicals(60)
20.	ORGANIC CHEMICALS	Organic heavy chemicals(61)
21.	FERTILISER	Fertilizers(62)
22.	PAINTS	Paints,Varnishes & Dyes(64)
23.	PESTICIDES	Pesticides(63)
24.	DRUGS AND OTHERS	Drugs & Medicine(65), Soaps, Cosmetics(66), Other chemicals(68)
25.	NON METALLIC MINERALS	Structural clay(69), Cement(70), Other non Metallic mineral(71)
26.	IRON AND STEEL	Iron steel & Ferrous(72), Iron steel casting(73), Iron steel foundries(74)
27.	METAL INDUSTRY	Non ferrous basic metal(75), Hand tools, Hardware(76), Misc.metal products(77), Tractors & agricultural Implements(78), Industrial machinery(79,80), Machinery tools(81), Office computing machine(82), Other non electrical machine(83), Electrical industrial(84), Electrical wire & cables(85), Batteries(86), Electrical appliances(87), Communication equipment(88),Other electrical machinery(89), Electronic equipments(90),Ships & boats (91), Rail equipments(92), Motor vehicles(93), Motor cycles & scooters(94), Bicycles, rickshaw(95), Other transport equipments(96) Watches & Clocks(97), Miscellaneous manufacture(98)
28.	OTHER INDUSTRIES	Furniture & Fixtures(50), Wood & wood products(51), Plastic products(57)
29.	CONSTRUCTION	Construction(99)
30.	ELECTRICITY-GAS WATER SUPPLY	Electricity(100), Gas(101), Water supply(102)
31.	TRANSPORT AND COMMUNICATION	Railway transport services (103), Other transport Services(104), Storages and warehousing(105), communications(106)

32.	SERVICES	Trade(107), Hotel & Restaurants(108),Banking(109), Insurance(110), Owner - ship of Dwelling(111), Education & Research(112), Medical & Health(113), Other Services(114), Public Administration(115)

APPENDIX NO. 2

ANALYSIS OF COST DATA OF DIFFERENT INDUSTRIES

3. Livestock

Waste water = 0.63575 m^3 / TLWK = 635.75 l/TLWK

Production = 1828 1000 MT

Total waste water flow = 1162151 X 10^6 l

	Characteristic (mg/l)	Characteristic ('000T)
Ph	6.9-9	
BOD	2383.77	2770.300689
COD	4412.21	5127.654264
SS	848.375	985.9398546
O/G	175.28	203.7018273
TKN	2309.7	
P	32.44	2721.902343

Cost :-

Capacity 70 TLWK / Day

Annual production = 21000TLWK

Waste water flow = 635.75 l/TLWK

$\Rightarrow$ Total waste water = 13350750 l

Now, BOD = 2383.77 mg/l

$\therefore$ Total BOD = 0.0318 '000 Tonnes

Considering upto 90% is eliminated through treatment $\Rightarrow$ 0.02862 '000 Tonnes

BOD and 10% tolerated $\Rightarrow$ 0.00318 '000 tonnes BOD

Cost structure for abatement of 0.02862 '000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / '000 T BOD
Energy	2.1	73.375
Chemicals	0.25	8.735
Manpower	0.44	15.374
O & M	0.28	9.783

Gross Output 1841223

Total BOD generated = 2770.300689 '000 Tonnes

BOD removed / eliminated = 2493.2709 '00 Tonnes

Total cost :		Lakh Rs.
Energy =	73.375 X 2493.2709	= 182943.75
Chemical =	8.735 X 2493.2709	= 21778.72
Manpower =	15.374 X 2493.2709	= 38331.55
O & M =	9.783 X 2493.2709	= 24391.67
		267445.69

E + C = 204722.47

4. Fishing

Waste water = 2356 l /T

Production = 2.8 MT

Total waste water flow = 6596.8 X 10^6 l

Characteristic : (mg/l)			Characteristic ('000T)
Ph	6.9-7		-
BOD	276.16		1.82
COD	589.68		3.89
SS	142.33		0.94
O/G	61.58		0.41
TKN	39.79		0.26

Cost :-

Capacity =5 T / Day

Annual production = 1500 T

Waste water flow = 2356 l/T

$\Rightarrow$ Total waste water flow = 3534000 l

Now, BOD = 276.16 ' mg/l

$\therefore$ Total BOD = 0.000976 '000 Tonnes

Considering upto 90% is eliminated through treatment $\Rightarrow$ 0.000878 '000 Tonnes

BOD and 10% tolerated $\Rightarrow$ 0.0000976 '000 tonnes BOD

Cost structure for abatement of 0.000878 '000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / '000 T BOD
Energy	0.39	444.19
Chemicals	0.01	11.39
Manpower	0.22	250.57
O & M	0.06	68.34

Gross Output = 448281

Total BOD generated = 1.82 '000 Tonnes

BOD removed / eliminated = 1.64 '00 Tonnes

Total cost :		Lakh Rs.
Energy =	444.19 X 1.64	= 728.47
Chemical =	11.39 X 1.64	= 18.60
Manpower =	250.57 X 1.64	= 410.93
O & M =	68.34 X 1.64	= 112.08
		1270.16

E + C = 747.15

7. Sugar

Waste water = 2830 l/T

Production = 216095 '000 MT

Total waste water flow = 611548850000l

Characteristic : (mg/l)		Characteristic ('000T)
Ph	4.6-7.1	-
DS	1095.4	669.89
SS	494.7	302.53
O/G	7.07	4.32
Nitrogen	24.73	15.12
BOD	1413.43	864.38
COD	2473.50	1512.67

Cost :-

Capacity - water released = 144000 X 10^3 l

Now, Bod = 1413.43 mg /l

$\therefore$ Total BOD $\Rightarrow$ 0.2035 '000 Tonnes

Assuming upto 90% is eliminated through treatment ⇒ 0.18315 '000 Tonnes

BOD and 10% tolerated ⇒ 0.02035 '000 tonnes BOD

Cost structure for abatement of 0.18315 '000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / '000 T BOD
Energy	0.325	1.77
Chemicals	0.329	1.80
Manpower	0.114	0.62
O & M	0.095	0.52

Gross Output = 662937.5

Total BOD generated = 864.38 '000 Tonnes

BOD eliminated = 777.94 '00 Tonnes

Total cost :		Lakh Rs.
Energy =	1.77 X 777.94	= 1376.95
Chemical =	1.8 X 777.94	= 1400.29
Manpower =	0.62 X 777.94	= 482.32
O & M =	0.52 X 777.94	= 404.53
		3664.09

E + C = 2777.24

9. Beverages

Waste water = 9639 l/kl

Production = 516907 kl

Total waste water flow = 4982466573 l

Characteristic : (mg/l)		Characteristic ('000T)
Ph	3.9-4.3	-
BOD	26115	130.117
COD	50450	251.365
SS	8250	41.105
Nitrogen	1135	5.655
Alkalinity	445	2.217
Total solids	21320	106.226

Cost :-

Capacity = 5000 kl

Waste water flow = 9639 l/kl

$\Rightarrow$ Total waste water flow = 48195000 l

Now, BOD = 26115 mg /l

$\therefore$ Total BOD $\Rightarrow$ 1.259 '000 Tonnes

Assuming upto 98% is eliminated through treatment $\Rightarrow$ 1.2338 '000 Tonnes

BOD and 10% tolerated $\Rightarrow$ 0.1259 '000 tonnes BOD

Cost structure for abatement of 1.2338 '000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / '000 T
Energy	2.228	1.806
Chemicals	2.875	2.33
Manpower	1.529	1.239
O & M	1.352	1.096

Gross Output = 462826

Total BOD generated = 130.117 '000 Tonnes

BOD eliminated = 127.51 '000 Tonnes

Total cost :		Lakh Rs.
Energy =	1.806 X 127.51	= 230.28
Chemical =	2.33 X 127.51	= 297.10
Manpower =	1.239 X 127.51	= 157.98
O & M =	1.096 X 127.51	= 139.75
		825.11

E + C = 527.38

10. Food Products

Waste water = 1400 l/ T

Production = 200000 T

Total waste water flow = 2800 X 105 l

Characteristic : (mg/l)		Characteristic (‘000T)
BOD	5070	1.42
COD	9570	2.68
SS	857	0.24
O/G	7	0.002

Cost :-

Capacity = 10 T / day

Annual production = 3000 T

Waste water flow = 1400 l /T

$\therefore$ Total waste water flow = 4200000l

Now, BOD = 5070 mg /l

$\therefore$ Total BOD $\Rightarrow$ 0.021 ‘000 Tonnes

Assuming upto 99% is eliminated through treatment $\Rightarrow$ 0.021 ‘000 Tonnes

BOD :

Cost structure for abatement of 0.021 ‘000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / ‘000 T
Energy	1.0	47.62
Chemicals	0.15	7.14
Manpower	0.18	8.57
O & M	0.08	3.81

Gross Output = 1292204
Total BOD generated = 1.42 ‘000 Tonnes
BOD eliminated = 1.41 ‘000 Tonnes

Total cost :		Lakh Rs.
Energy =	47.62 X 1.41	= 67.14
Chemical =	7.14 X 1.41	= 10.07
Manpower =	8.57 X 1.41	= 12.08
O & M =	3.81 X 1.41	= 5.37
		94.66

E + C = 77.21

11. Cotton Textile

Waste water flow = 38157.894740 l

Characteristic : (mg/l)		Characteristic (‘000T)
Ph	9.8-11.8	-
BOD	760	29
COD	1418	54.11
Total solids	6170	235.43
Alkalinity	17.35	0.66
Chromium	12.5	.48

Cost :-
Capacity - waste water flow = 90 X 10^6 l
Now, BOD = 760 mg /l
$\therefore$ Total BOD = 0.068 ‘000 Tonnes
Assuming upto 90% is eliminated through treatment $\Rightarrow$ 0.0612 ‘000 Tonnes BOD
Cost structure for abatement of 0.0612 ‘000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / ‘000 T
Energy	2.4	39.22
Chemicals	1.2	19.61
Manpower	0.6	9.80
O & M	0.25	4.08

Gross Output = 3922760
Total BOD generated = 29 ‘000 Tonnes
BOD eliminated = 26.1 ‘000 Tonnes

Total cost :		Lakh Rs.
Energy =	39.22 X 26.1	= 1023.64
Chemical =	19.61 X 26.1	= 511.82
Manpower =	9.80 X 26.1	= 255.78
O & M =	4.08 X 26.1	= 106.49
		1897.73

E + C = 1535.46

13. Jute Textile

Waste water = 200 l/T
Production = 1252000 Tonnes
Total waste water flow = 250400000 l

Characteristic : (mg/l)		Characteristic (‘000T)
Ph	6.8-7.8	-
SS	21.25	0.0053
DS	492.75	0.1234
O/G	17.6	0.0044
Chloride	156.4	0.0392
Nitrogen	85.7	
Sodium	157.4	0.0664
Magnesium	22.10	
COD	259	0.0648
BOD	115	0.0288

Cost :-
Capacity = 70 T/day
Annual production = 21000 Tonnes
Waste water = 200 l/T
$\Rightarrow$ Total waste water flow = 42000000 l
Now, BOD = 115 mg /l
$\therefore$ Total BOD $\Rightarrow$ 0.000483 ‘000 Tonnes
Assuming 90% is eliminated through treatment $\Rightarrow$ 0.0004347 ‘000 Tonnes BOD
Cost structure for abatement of 0.0004347 ‘000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / ‘000 T
Energy	0.86	1978.38
Chemicals	-	
Manpower	1.44	3312.63
O & M	0.04	92.02

Gross Output = 174734.5
Total BOD generated = 0.0288
BOD eliminated = 0.02592

Total cost :		Lakh Rs.

Energy =	1978.38 X 0.02592	= 51.28
Chemical =		
Manpower =	3312.63 X 0.02592	= 85.86
O & M =	92.02 X 0.02592	= 2.38
		139.52

E + C = 51.28

14. Man-made

Waste water = 291000 l/T
Production = 584262 T
Total waste water flow = 170020242 l

Characteristic : (mg/l)		Characteristic (‘000T)
Ph	2.8-8.55	-
DS	455.6	77.46
SS	61.36	10.43
BOD	131.17	22.30
COD	294.37	50.05
Chloride	118.5	20.15
Zinc	10	1.7
Others	4408.1	749.47

Cost :-
Capacity = 10 T/day
Annual production = 3000T
Waste water = 291000 l/T
$\Rightarrow$ Total waste water flow = 875 X 10^6 l
Now, BOD = 131.17 mg /l
$\therefore$ Total BOD $\Rightarrow$ 0.1145 ‘000 Tonnes
Assuming upto 90% is eliminated through treatment $\Rightarrow$ 0.10305 ‘000 Tonnes BOD
Cost structure for abatement of 0.10305 ‘000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / ‘000 T
Energy	0.3	2.9
Chemicals	18.0	174.67
Manpower	0.3	2.9
O & M	0.264	2.56

Gross Output = 489522.3
Total BOD generated = 22.302 ‘000 Tonnes

BOD eliminated = 20.072 '000 Tonnes

Total cost :		Lakh Rs.
Energy =	2.9 X 20.072	= 58.21
Chemical =	174.67 X 20.072	= 3505.98
Manpower =	2.9 X 20.072	= 58.21
O & M =	2.56 X 20.072	= 51.38
		3673.78

E + C = 3564.17

16. Tanneries

Waste water = 50 X 10^6 l/day
Total waste water flow = 15 X 10^9 l

Characteristic : (mg/l)		Characteristic ('000T)
Ph	7.5-8.5	-
BOD	1850	27.75
COD	4500	67.5
Chloride	5500	82.5
DS	17250	258.75
SS	3750	56.25
Sulphides	30	0.45
Others	1715	25.725

Cost :-
Capacity = 41.7 X 10^6 l
Now, BOD = 1850 mg /l
$\therefore$ Total BOD $\Rightarrow$ 0.077 '000 Tonnes
Assuming upto 90% is eliminated through treatment $\Rightarrow$ 0.0693Tonnes
Cost structure for abatement of 0.0693 '000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / '000 T
Energy	0.05	0.72
Chemicals	0.9	12.99
Manpower	0.1	1.44
O & M	0.15	2.16

Gross Output = 364876.8
Total BOD generated = 27.75 '000 Tonnes
BOD eliminated = 24.975 '000 Tonnes

Total cost :		Lakh Rs.
Energy =	0.72 X 24.975	= 17.98
Chemical =	12.99 X 24.975	= 324.42
Manpower =	1.44 X 24.975	= 35.96
O & M =	2.16 X 24.975	= 53.95
		432.31

E + C = 342.4

17. Rubber

Waste water = 28.01 m^3 / T
Production = 293441 tonnes
Total waste water flow = 8219282410 l

Characteristic : (mg/l)		Characteristic (‘000T)
Ph	5-8.9	-
BOD	8215.8	67.53
COD	14045	115.44
SS	3436.8	28.25
DS	9504.8	78.12
Sulphides	204.12	1.68
Nitrogen	452.5	3.72

Cost :-
Capacity - waste water flow = 29 m^3 / day
Total waste water = 8.7 X 10^6 l
Now, BOD = 8215.8 mg /l
$\therefore$ Total BOD $\Rightarrow$ 0.715 ‘000 Tonnes
Assuming upto 90% is eliminated through treatment $\Rightarrow$ 0.06435 ‘000T
BOD :
Cost structure for abatement of 0.06435 ‘000 tonnes BOD :

	Lakh Rs.	Lakh Rs. / ‘000 T
Energy	0.0225	0.35
Chemicals	0.08	1.24

Manpower	0.035	0.54
O & M		

Gross Output = 491408.2
Total BOD generated = 66.53 '000 Tonnes
BOD eliminated = 60.78 '000 Tonnes

Total cost :		Lakh Rs.
Energy =	0.35 X 60.78	= 21.27
Chemical =	1.24 X 60.78	= 75.37
Manpower =	0.54 X 60.78	= 32.82
		129.46

E + C = 96.64

APPENDIX NO. 3

WATER QUALITY INDICES

Table - 1

2. Milk + Milk Products

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	2925.0	1.4	1.0	0.15	2	0.30
Ph	8 --10	2.1	0.7	0.10	72	7.20
TDS	1060.0	2.4	0.6	0.09	20	1.80
TSS	760.0	2.9	0.5	0.07	10	0.70
BOD	1240.0	2.3	0.6	0.09	5	0.45
Oil+ grease	290.0	2.1	0.7	0.10	1	0.10
Chloride	105.0	1.7	0.8	0.12	30	3.60
Alkalinity	600.0	2.1	0.7	0.10	15	1.50
Nitrogen	84.0	2.4	0.6	0.09	5	0.45
Phosphorous	11.7	2.4	0.6	0.09	15	1.35
						17.45

Class - E
Very Bad

Table – 2
3. Livestock

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	4412.21	1.4	1	0.21	2	0.42
Ph	6.9 -9	2.1	0.7	0.15	82	12.30
BOD	2383.77	2.3	0.6	0.13	2	0.26
TSS	848.375	2.9	0.5	0.11	8	0.88
Oil+ grease	175.28	2.1	0.7	0.15	2	0.30
TKN	2309.7	2.4	0.6	0.13	2	0.26
Phosphate	32.44	2.4	0.6	0.13	10	1.30
			4.7			**15.72**

Class - E
Very Bad

Tabke – 3

4. Fishing

	Characteristic (mg/l)	Mean of Significance Rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	589.68	1.4	1.0	0.24	10	2.40
Ph	6.9-7.5	2.1	0.7	0.17	90	15.30
BOD	276.16	2.3	0.6	0.15	5	0.75
TSS	142.33	2.9	0.5	0.12	10	1.20
Oil+ grease	61.58	2.1	0.7	0.17	8	1.36
TKN	39.79	2.4	0.6	0.15	15	2.25
			4.1			**23.26**

Class – D
Bad

Table – 4
5. Coal + Lignite

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality Rating	Overall quality rating
COD	23.0	1.4	1.0	0.19	94	17.86
Ph	8.0	2.1	0.7	0.13	92	11.96
TDS	555.0	2.4	0.6	0.12	90	10.80
Cloride	45.5	1.7	0.8	0.15	30	4.50
Sulphide	92.0	1.7	0.8	0.15	2	0.30
Iron	4.2	2.1	0.7	0.13	5	0.65
Phosphate	100.0	2.4	0.6	0.12	5	0.60
			5.2			**46.67**

Class - C
Bad

Table 5
7. Sugar

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	2473.50	1.4	1.0	0.21	3	0.63
Ph	4.6-7.1	2.1	0.7	0.15	15	2.25
TDS	1095.40	2.4	0.6	0.13	30	3.90
TSS	494.70	2.9	0.5	0.11	15	1.65
Oil+ grease	7.07	2.1	0.7	0.15	92	13.80
Nitrogen	24.73	2.4	0.6	0.13	20	2.60
BOD	1413.43	2.3	0.6	0.13	3	0.39
			4.7			**25.22**
					Class - D Bad	

Table 6
8. Edible + Vanaspati

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	9250.0	1.4	1.0	0.29	2	0.58
Ph	5.5-6.1	2.1	0.7	0.20	10	2.00
TSS	1100.0	2.9	0.5	0.14	3	0.42
Oil+ grease	762.5	2.1	0.7	0.20	5	1.00
BOD	4400.0	2.3	0.6	0.17	2	0.34
			3.5			**4.34**

Class - E
Very Bad

Table 7
9. Distilleries

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	50450	1.4	1.0	0.22	0.5	0.110
Ph	3.9-4.3	2.1	0.7	0.16	2.0	0.320
BOD	26115	2.3	0.6	0.13	0.5	0.065
TSS	8250	2.9	0.5	0.11	3.0	0.330
Nitrogen	1135	2.4	0.6	0.13	2.0	0.260
Alkalinity	445	2.1	0.7	0.16	15.0	2.400
Total solids	21320	3.2	0.4	0.09	10.0	0.900
			4.5			**4.385**

Class - E
Very Bad

Table - 8
10. Food Products

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	9570.0	1.4	1.0	0.36	1	0.36
BOD	5070.0	2.3	0.6	0.21	1	0.21
TSS	857.0	2.9	0.5	0.18	4	0.72
Oil+ grease	7.0	2.1	0.7	0.25	90	22.50
			2.8			**23.79**

Class - D
Bad

Table - 9
11. Cotton Textiles

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	1418.00	1.4	1.0	0.28	3	0.84
Ph	9.8-11.8	2.1	0.7	0.21	15	3.15
BOD	760.00	2.3	0.6	0.18	5	0.90
Total solids	6170.00	3.2	0.4	0.12	12	1.44
Alkalinity	17.35	2.1	0.7	0.21	60	12.60
			3.4			**18.93**

Class - E
Very Bad

Table - 10
12. Woolen Textile

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	2314.0	1.4	1.0	0.20	3.0	0.600
Ph	5-8	2.1	0.7	0.15	90.0	13.500
TDS	3547.0	2.4	0.6	0.13	10.0	1.300
TSS	944.5	2.9	0.5	0.11	4.0	0.440
BOD	1333.5	2.3	0.6	0.13	3.0	0.390
Oil + grease	519.9	2.1	0.7	0.15	0.5	0.075
Sodium	73.0	2.4	0.6	0.13	7.0	0.910
			4.7			**17.215**

Class - E
Very Bad

Table - 11
13. Jute Textile

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	259.00	1.4	1.0	0.16	75	12.00
Ph	6.8-7.8	2.1	0.7	0.11	90	9.90
TSS	21.25	2.9	0.5	0.08	94	7.52
TDS	492.75	2.4	0.6	0.10	50	5.00
Oil + grease	17.60	2.1	0.7	0.11	5	0.55
Cloride	156.40	1.7	0.8	0.13	60	7.80
Amm. Nitrogen	85.70	2.4	0.6	0.10	25	2.50
BOD	115.00	2.3	0.6	0.10	15	1.50
Sodium	157.40	2.4	0.6	0.10	5	0.50
			6.1			**47.27**

Class – C
Bad

Table – 12
14. Viscose Rayon

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	245.0	1.4	1.0	0.16	80	12.80
Ph	2.8-7.3	2.1	0.7	0.11	20	2.20
TDS	1150.0	2.4	0.6	0.10	45	4.50
TSS	185.0	2.9	0.5	0.08	25	2.00
BOD	215.0	2.3	0.6	0.10	15	1.50
Chloride	118.5	1.7	0.8	0.13	30	3.90
Zinc	10.0	2.0	0.7	0.11	2	0.22
Sulphate	3695.0	2.4	0.6	0.10	7	0.70
Alkalinity	175.0	2.1	0.7	0.11	25	2.75
			6.2			**30.57**

Class – D
Bad

Table – 13
15. Paper

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	1287.00	1.4	1.0	0.24	5	1.20
Ph	6.6-10	2.1	0.7	0.17	75	12.75
TSS	789.00	2.9	0.5	0.12	7	0.84
BOD	395.00	2.3	0.6	0.15	5	0.75
Alkalinity	312.00	2.1	0.7	0.17	30	5.10
Sodium	9.18	2.4	0.6	0.15	4	0.60
			4.1			**21.24**

Class – D
Bad

Table – 14
16. Tanneries

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	4500.0	1.4	1.0	0.17	2	0.34
Ph	7.5-8.5	2.1	0.7	0.12	90	10.80
BOD	1850.0	2.3	0.6	0.11	3	0.33
Clorides	5500.0	1.7	0.8	0.14	1	0.14
TDS	17250.0	2.4	0.6	0.11	3	0.33
TSS	3750.0	2.9	0.5	0.09	2	0.18
Sulphides	30.0	1.7	0.8	0.14	1	0.14
Alkalinity	1550.0	2.1	0.7	0.12	25	3.00
			5.7			**15.26**

Class – E
Very Bad

Table – 15
17. Rubber

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	14045.00	1.4	1.0	0.210	1	0.210
Ph	5-8.9	2.1	0.7	0.150	60	9.000
BOD	8215.80	2.3	0.6	0.120	2	0.240
TSS	3436.80	2.9	0.5	0.100	2	0.200
TDS	9504.80	2.4	0.6	0.125	5	0.625
Sulphides	204.12	1.7	0.8	0.170	1	0.170
Amm.Nitrogen	452.50	2.4	0.6	0.125	1	0.125
			4.8			**10.570**

Class – E
Very Bad

Table – 16
18. Petroleum Products (Haldia Oil Refinery)

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
Sulphide	80.0	1.7	1.0	0.24	1	0.24
Ph	7.2	2.1	0.8	0.19	94	17.86
BOD	100.0	2.3	0.7	0.17	10	1.70
Oil+grease	600.0	2.1	0.8	0.19	1	0.19
Phenol	15.0	1.8	0.9	0.21	1	0.21
			4.2			**20.20**

Class – E
Bad

Table – 17
20. Organic Chemicals

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	10569.60	1.4	1.0	0.20	1	0.20
Ph	7-12	2.1	0.7	0.14	30	4.20
TSS	258.75	2.9	0.5	0.10	8	0.80
BOD	4918.44	2.3	0.6	0.12	2	0.24
Cynide	38.00	1.8	0.8	0.16	1	0.16
Phenol	87.36	2.0	0.7	0.14	1	0.14
Oil + Grease	275.00	2.1	0.7	0.14	1	0.14
			5			**5.88**

Class – E
Very Bad

Table – 18
22. Pesticides

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	16400.00	1.4	1.0	0.19	0.5	0.095
Ph	6-7	2.1	0.7	0.13	90.0	11.700
TSS	78.00	2.9	0.5	0.09	90.0	8.100
BOD	19000.00	2.3	0.6	0.11	0.5	0.055
Cloride	36528.00	1.7	0.8	0.15	2.0	0.300
Sulphate	2350.00	2.4	0.6	0.11	2.0	0.220
Phosphate	3448.00	2.4	0.6	0.11	1.0	0.110
Sodium	6500	2.4	0.6	0.11	1.0	0.110
			5.4			**20.690**

Class – D
Bad

Table – 19
23. Paints

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	3000.00	1.4	1.0	0.24	2	0.48
Ph	6.5-10.5	2.1	0.7	0.17	80	13.60
TSS	710.00	2.9	0.5	0.12	7	0.84
BOD	2400.00	2.3	0.6	0.14	2	0.28
Oil + grease	80.00	2.1	0.7	0.17	2	0.34
Phenolics	36.50	2.0	0.7	0.17	1	0.17
			4.2			**15.71**

Class – E
Very Bad

Table – 20
24. Drugs

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	1325.00	1.4	1.0	0.14	4	0.56
Ph	4-8	2.1	0.7	0.09	40	3.60
BOD	32625.00	2.3	0.6	0.08	1	0.08
Oil + grease	35.00	2.1	0.7	0.10	10	1.00
TSS	355.00	2.9	0.5	0.07	10	0.70
Chloride	85.00	1.7	0.8	0.11	15	1.65
Sulphide	110.00	1.7	0.8	0.11	1	0.11
Phenol	3.00	2.0	0.7	0.09	8	0.72
Cynide	1.00	1.8	0.8	0.11	10	1.10
Heavy metal	6.75	2.1	0.7	0.10	1	0.10
			7.3			**9.62**

Class – E
Very Bad

Table – 21
25. Ceramic

	Characteristic (mg/l)	**Mean of** significance rating	Temporary weights	Final Weights	Quality rating	Overall quality rating
COD	176.50	1.4	1.0	0.29	92	26.68
Ph	7-9	2.1	0.7	0.20	80	16.00
TSS	461.20	2.9	0.5	0.14	5	0.70
Zinc	282.80	2.0	0.6	0.17	1	0.17
Iron	7.82	2.1	0.7	0.20	3	6.00
			3.5			**44.15**

Class - C
Bad

Table - 22
26. Iron + Steel

	Characteristic (mg/l)	Mean of Significance Rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	1770.00	1.4	1.0	0.22	2.0	0.440
Ph	8.5-9.5	2.1	0.7	0.15	60.0	9.000
BOD	850.00	2.3	0.6	0.13	5.0	0.650
Sulphide	15.00	1.7	0.8	0.17	1.0	0.170
Phenol	750.00	2.0	0.7	0.15	0.5	0.075
Chloride	4100.00	1.7	0.8	0.17	2.0	0.340
			4.6			**10.675**

Class - E
Very Bad

Table - 23
30. Thermal Plant

	Characteristic (mg/l)	Mean of significance rating	Temporary weights	Final weights	Quality rating	Overall quality rating
COD	144.00	1.4	1.0	0.45	82	36.90
Ph	6.5-8.5	2.1	0.7	0.32	90	28.80
TSS	1248.70	2.9	0.5	0.23	3	0.69
			2.2			**66.39**
					Class - A Good	

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