ENVIRONOMICS

A Financial Estimate of Environmental Pollution Control And Abatement Schemes in Eloor-Edayar Industrial Belt

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under the supervision and guidance of
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Thesis Submitted to Cochin University of Science And Technology for the award of the Degree of Doctor of Philosophy in Economics under the Faculty of Social Sciences

DEPARTMENT OF APPLIED ECONOMICS
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CERTIFICATE

This is to Certify that the Thesis "Environomics - A Financial Estimate of Environmental Pollution Control and Abatement Schemes in Eloor-Edayar Industrial Belt" is a bonafide record of research work done by Shri.C.A. Antony under my supervision and guidance. The thesis is worth submitting for the award of the degree of Doctor of Philosophy in Economics.

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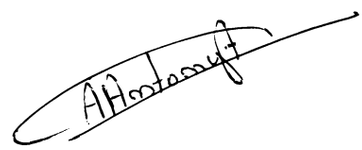
DECLARATION

I declare that this thesis is the record of bonafide research carried out by me under the supervision of Dr. K.C. Sankaranarayanan, Professor and Head of the Department of Applied Economics, Cochin University of Science and Technology. I further declare that this has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar title of recognition.



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C O N T E N T S

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CHAPTER - I

THE APPROACH

Introduction

Economic system is part of a larger ecosystem and man is only one of the species of this system. The laws of nature are common to all species. Man and the systems created by him are not exempt from them. As per the law of conservation of nature matter and energy can neither be created nor be destroyed. The resources drawn in the form of materials and energy from nature by its inhabitants must, therefore, inevitably return to nature as wastes. But the environment has the capacity to regenerate those wastes back to useful inputs. In its capacity as resource supplier, supplier of goods and services, and waste assimilator, environment adopts its own ways and means to maintain earth's regenerative capacity and the ecosystem in balance. The tragedy is that man disrupts the earth's regenerating and balancing capacity through massive resource-use and waste generation in production-consumption activities. When such disruption recklessly continues the resources gradually become extinct or exhausted and the environment gets polluted.

Till the beginning of the 20th century there was little interference by man with nature's regenerative system. He was able to coexist with nature and considered nature as an unlimited source of inputs, materials and energy. With the growth of cities and the advent of industrialization man began to interfere with nature and consequently nature started manifesting signs of deterioration in its cleansing powers. The continuous

boom witnessed after the World War II, with rising energy use and leaping material standards, brought in its trail new problems. Air in big cities began to get pollutted by automobile exhausts and industrial emissions which caused respiratory diseases. Rivers and lakes represented the cynics description: "if you fall, you don't drown, you dissolve"[1]. Landfills leaked poison into nearby aquifers. Certain wastes that existed never before like plastics, radio-active substances, toxic chemicals, etc., were dumped into the environment which neither nature could regenerate, nor could mankind prevent their dangerous impacts on ecosystem and the occupants. The wasteful over-use of resources lead to the disappearance of several species and several others to the verge of extinction. At the present rate of extraction certain vital materials and minerals would be exhausted in the near future. With the low-skill in politico-economic artifacts and less knowledge in technology the amount of wastes per unit of production in developing countries is high. Moreover, poverty got recognized as the worst form of pollution. The pressure that arose, when basic human needs were not met and when man endeavoured to satisfy those needs by any available means, could destroy the resource-base which man depended on for his existence[2]. In short, man's assault on nature became one of the most alarming problems of our time.

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1. Barbara Ward, Progress for a Small Planet, Penguin Books, England, (1979), p.61.

2. Essam El-Hinnawi and Manzur-Ul-Haque Hashmi, (Eds.), Global Environmental Issues, Tycooly International Publishing Ltd., Dublin,(1982), p.4.

Nineteen sixties and seventies witnessed the emergence of a lot of literature on environmental problems. They were largely responsible for creating and propagating environmental awareness among man all over the world. Consequently, a number of international conferences and seminars were conducted and forums met to discuss the dangers of the problems. The historic United Nation's Conference on Human Enviornment held at Stockholm in 1972 could evolve a comprehensive action-plan for the protection of the global environment. This particular conference was remarkably successful in contrast to most of the U.N. Conferences that followed it. It could attract the interests of the developed as well as the developing countries. The Conference highlighted the need for sustainable husbanding of planetary resources and their equitable sharing to foster development in non-industrial countries facing the problem of acute poverty and to prevent environmental degradation in industrialized countries not prudent in the use of technology.[3] The United Nation's Environmental Programme (UNEP) was established immediately after the Stockholm Conference to impart factual information for economic development on a sound ecological basis. Most of the developed and developing countries have enacted comprehensive environmental protection laws and constituted implementation agencies. Guidelines have been drawn and agreements concluded between nations for the protection of the national and the global environment. Various international organizations and agencies are now on alert in this area. Their member countries

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3. Ignacy Saches,"Environment and Development Revisited", in Alternatives - A Journal of World Policy, September 1982, p.383

are required to fulfil certain environmental criteria before receiving development aids. To-date, however, none of those agreements or organziations taken singly or collectively has done more than nibble at the fringe of the larger crisis of planetary resources.[4] The resolutions passed at international levels are quite general in nature as international diplomacy and politics play a major role, and the agreemenents reached are to be ratified by each national government before becoming operative.

India is one of the first countries to recognize the need to protect the environment. The reverence for all things natural is deep rooted in her culture and religion. The great ancient Indian Works of art and literature contain innumerable examples to illustrate human consciousness of the pristine glory and sylvan beauty of nature which provides man food, shelter and recreation. Our great rulers and writers of the past centuries had recognised the need for protected forests and wildlife sancturies. But gradually with the growth of population, environment got neglected in the name of people's basic needs and faster development. Again the ancient environmental spirit got revived with the recent spurt in global environmental awareness, especially after the Stockholm conference. As a result, new and comprehensive environmental protection laws have been enacted. Pollution Control Boards, and Departments and Ministries of Environment have been established at the centre

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4. David W. Orr and Marvin S. Soroos (Eds.), The Global Predicament: Ecological Perspectives on World Order, University of North California Press,(1979), p.7.

and in the States. Variuous environmental protection programmes adopted by them are being progressively implemented. However, the shortage of scientific and technical as well as other infrastructural expertise required to assess and prevent environmental impacts is a serious impediment faced by those agencies.[5] The various programmes taken up during the past few years, more in the form of nucleating activities, would now receive a greater impetus in terms of investment and even more through co-ordinated expeditious implementation during the seventh plan.[6]

A closer observation of the state of Indian Economy reveals that the country's resource base is not properly utilised. Land and water resources are ill-managed. The forests in the country are vanishing at a rapid pace. The relentless deforestation of hillsides and failure to protect land on the plains have accentuated massive floods during the monsoon followed by draught in summer. The country is losing large quantities of organic fertilizers every year due to top soil erosion which is more than that put in artificially. The destruction of the life support system continues along the Himalayas and Western and Eastern Ghats as well as in many other parts of the country. The natural 'genepool' preserves and the flawless beauty of historic monuments are relegated to the second place in the name of development, industrialisation, irrigation

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5. P.K. Sapru," Environment Administration: Structural and Policy Issues in India", Management in Government, January-March 1985, p.490.

6. Government of India (1985), Seventh Plan 1985-90, Planning Commission, New Delhi, p-388.

projects and oil and fertilizer plants. Industrial pollution ever mounts; major rivers are pollution loaded; and the atmosphere in the industrial cities is suffocating. The plantations under the social forestry programme sponsored by the World Bank and the United States Aid for International Development (USAID) are mainly meant for use in polyfibre industries. As such, they cannot meet the shortage of fuelwood and fodder in the country. Further, those plantations (especially eucalyptus) in dryland agriculture drain the soil of its fertility and moisture and are inappropriate for dryland ecosystem where water is a limiting factor for biological productivity.[7] The forest denudation not only has undesirable ecological consequences but deprives the forest dwellers (adivasis) of food, fuel and fibre. The introduction of mechanised boats has badly hit the traditional fisherman of his livelihood along the country's vast coastal areas. The resources of the country have not been nurtured to meet the basic needs of the people, but exploited only for the benefit of certain sections of society. In fact, the current development in India can be described as the process by which the rich and the more powerful reallocate the nation's resources in their favour and modern technology is the tool that subserves this purpose.[8] In that process the state of India's environment continues to deteriorate and the country is slowly becoming a vast wasteland.

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7. K.S. Dakshina Murthy," Politics of Environment", Economic and Political Weekly, May 3, 1986, p.774.

8. Darryl D'Monte, Temples or Tombs? Industry Versus Environment: Three Contraversies, Centre for Science and Environment, New Delhi,(1985), p.26.

In this context, it is timely and demanding to have undertaken a study of this nature in the area of economics and environmental protection.

Subject Matter

In a study of environment and economics the relationship between ecology and economics has to be considered. When economics deals with the well-being of the human household, ecology discusses that of the society of all living beings in their surroundings. The ecosystem as well as the economic system draws life-requirements or resources from the earthly environment, i.e., nature. Economic system, being the part of a larger ecosystem, should not undermine the ecosystem balance in its attempts to increase human welfare. Economic growth must aim at development in a protected environment improving the quality of life.

Environmental pollution and resource depletion are the two major offshoots of economic development. Pollution occurs when waste generation exceeds the assimilative capacity of the environment. When the resource-use rate exceeds nature's reproductive rate, renewable resources become extinct. With exploitation, rather than rational utilization, non renewable sources are exhausted. There is yet another offshoot of development, i.e., societal deterioration and this is accentuated by industrialization, urbanisation and population growth. Though the general framework, the ideas and the theories differ, both free market and Marxian economics in the past have

considered earth as a bottomless reservoir of resources and have practised a reckless exploitation instead of a rational and optimal use of the limited resources. Under the existing framework, the application of most of the prevailing theories in economics would often lead to the squandering of resources. The present study is on the subject and scope of the emerging branch in economics, namely environmental economics or 'environomics'. An attempt is also made to highlight the need to redefine certain principles of the science of economics in the environmental context.

Many of the undercurrents in the 'economic and environmental' issues can be gleaned through the case studies of specific projects or problem areas. As they are limited in scope such studies lend themselves to documentation and analysis. By contrast, problems of larger magnitude and general nature involving a very vast area, are far too diffuse, varied and complex to be easily studied and generalizations arrived at.[9] Keeping this in mind environmental protection of Eloor-Edayar industrial belt, the largest and the most polluted in the State of Kerala is selected for a comprehensive study and generalization. This study analyses the financial, economic, social and political implications of the polluted environment in the project area and various impacts of pollution and its control and abatement measures aimed at protecting the environment. A financial estimate is made accounting for different categories of costs and benefits involved in the abatement and

9. Darryl D'Monte,(1985), Ibid, p.15

control of pollution. And the economic feasibility of protecting the environment of the project area is established through a thorough benefit-cost analysis and preparing a comprehensive benefit-cost analysis table.

The objectives of the study are:

1 To define environomics and discuss important issues and problematics of this new branch of economics.

2. To conduct an 'environmental impact assessment' of Eloor-Edayar industrial belt considering the economic, social and other aspects of the problem.

3. To judge the economic feasibility of protecting the environment of the project area by making a financial estimate taking into account the various costs and benefits involved in the process - and

4. To make available relevant data to the appropriate authorities for decision making and implementing various environmental protection measures in problem areas, there and elsewhere.

Methodology

The present study is based on the premise that environmental problem is essentially economic. At the same time it is multi-disciplinary. Source materials are drawn from various branches of economics and other disciplines like physical and biological

sciences, social sciences, engineering, medicine and law. For the purpose some of the centres of higher learning in the country have been visited; a large number of books and articles dealing with environmental literature have been surveyed; and some of the scientists and experts in the field have been consulted. There are a few studies conducted earlier in the project area on some aspects of the problem. They have been consulted and the methodology adopted by them are improved upon in the present study. The financial estimation of environmental protection of the industrial belt is made in the study involving six stages. They are:

1. Identification of the harmful solid, liquid and gaseous pollutants emitted or present in the project area;

2. Assessment of possible and probable impacts of those pollutants with the help of relevant literature.

3. Identification of the specific impacts of those pollutants on the living (men, animals, vegetation, etc.) and on the non-living (materials, structures, aesthetics, etc.) in the area.

4. Prescription of measures for the control and abatement of environmental degradation in the area.

5. Estimation of incremental costs and benefits of protecting the environment from disturbances or degradation; and

6. Presentation of a comprehensive 'benefit-cost analysis table' accounting for the protection of environment of the area.

The data for the study were collected in the following manner:

1. The primary data were collected with the help of four survey schedules.

   i) Factory survey: to identify pollutants in the wastes, effluents and emissions thrown out of the factories.
   ii) Household survey: to evaluate the impacts of pollutants on the well-being of men and animals in the area and on the vegetation, materials, structures and aesthetics.
   iii) Employee Survey: to identify occupational health hazards and other related matters, and
   iv) Hospital Survey: to assess the health impacts of pollutants on the people and animals.

   These surveys were conducted with the help of appropriate schedules (given in annexures I through IV). The survey schedules were prepared in an interlocking manner to check the validity of certain data as they were obtained from more than one source.

2. The secondary data were collected from some of the earlier studies conducted in the project area. In addition, certain reports and seminar papers on the subject that appeared during recent years have been gone through. An extensive

survey of literature on the subject helped in assembling and analysing the ideas and information thus collected;

3. Suggestions and expert opinion were obtained from the officials of National Environmental Engineering and Research Institute and the Kerala State Pollution Control Board and from some of the leading environmentalists in the country; and

4. The benfit-cost analysis was made and 'table' presented of environmental protection of the project area after a financial estimate of incremental benefits and costs involved in the process.

Limitations of the study

1. The non-quantifiability of most of the environmental aspects has led to approximations;

2. Non availability of certain information on account of gaps in knowledge, especially with respect to the impacts of some of the pollutants;

3. Lack of cooperation from the side of the factory managements in giving some of the details of their polluting activities; and

4. The inability to obtain certain information even from official environment protection agencies which are eager to conceal rather than reveal the information.

However, every possible attempt has been made to make the study successful. The officls and experts in the Kerala State Pollution Control Board (KSPCB) and the National Environmental Engineering and Research Institute (NEERI) have been consulted at every stage. Besides, the affected people of the locality and the activists of some of the major voluntary environmental protection organisations and movements in the area and in the state have been frequently contacted.

Scheme of the Study

The present study consists of nine chapters including the introductory chapter.

Chapter II makes a brief review of environmental literature and examines various measures adopted at the global level to protect the environment. The environmental problems often transgress national sovereignity and geographical boundaries. Therefore, attempts must be made at the national and international levels to protect the environment, the resources of which are the common property of mankind. The protection of the national environment from the ancient till the present forms the content of Chapter III. These chapters together provide a background to understand the issues analysed in the subsequent chapters.

Carefully worked out theoretical framework is a pre-requisite for the successful study of a complex subject. Some of the theoretical issues of 'environomics' are examined in Chapter IV.

The theoretical issues involved in estimating the costs and benefits of environmental protection constitute the theme of Chapter V.

The state of environment in Eloor-Edayar Industrial belt and the impact analysis of pollution of the area are discussed in Chapter VI and VII respectively. Chapter VIII makes the financial estimate of environmental protection of the project area.

And finally, Chapter IX presents the findings of the study.

CHAPTER - II

GLOBAL ENVIRONMENTAL AWARENESS

Global Awareness

Earth, according to the present knowledge is the only habitat for all life-forms including man. The photographs of earth taken from spacecrafts present the vast dark void of space against which the earth is merely a small, green and blue oasis. The earth has neither boundaries nor rivers, only oceans, deserts, polar-caps, mountains, forests and drifting clouds blended in a unique mosaic of life. There could be no clearer demonstration of 'spaceship earth' and no more stark evidence that earth is the only possible habitat for man.[1] In other words, ecological crisis transcends the relatively fixed boundaries between nations. The air spreads over nations. The water bodies are often multinational assets in the sense that rivers flow through more than one country and the oceans, the seas and the lakes surround several countries. The pollution of land resources is a concern for the countries affected and the entire world. The problems of oceanic pollution, international river management, climatic disruption, protection of atmospheric ozone levels, resource depletion, impending dangers of mounting build-up of lethal weapons etc., demand the emergence of new forms of institutions and radical changes in the prevailing concept of national sovereignity. The global awareness of environmental problems was increasingly created by the large

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1. David W. Orr and Marvin S. Soroos (Eds.), The Global Predicament: Ecological Perspectives on World Order, University of North Carolina Press,(1979), p-4.

number of environmental literature that has appeared in the recent past. It was eventually legitimized and quickly propagated by various international conferences and organizations. Various international agreements and treaties concluded between nations, legislative enactments, and further follow-up actions were important moves in the right direction towards the protection of global environment.

Environmental Literature

Apart from a few classic papers from earlier generations of economists (Gray, 1912; Hottelling, 1931) with the static view of natural resources complex (Ely and Wehrwein, 1940) any identifiable literature on resource-economics did not really make appearance until the 1950s (Allen, 1955; Scott, 1955; Ciriacy-Wantrup, 1956; Gordon, 1957) and much of this was concerned with conservation as a national target in an institutional setting rather than with the more general economic principles.[2] Rachel Carson's (1962) 'Silent Spring' is the first notable scientific work which created cumulative insights in our understanding of environmental problems. It reveals that nature is not an infinitely expandable 'spring cleaner' for any degree of waste in human societies, that waste disposal is not cost-free and that in order to maintain environmental standards some would have to pay.[3] In the last two decades the writings in this area have become many and varied with

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2. John A. Butlin (Ed.), Economics and Resources Policy, Longman, London,(1981) p.33

3. Barbara Ward, Progress for a Small Planet, Penguin Books, England,(1977), p.62.

increasing focus on global concerns with attention directed to the key issues of pollution as a central feature of contemporary resource-use patterns (Jarret, 1966) and the seemingly unavoidable paradoxes of resource-ownership and access (Hardin, 1968; Dales, 1968). Barbara Ward and Rene Dubos (1972) perceived environmental problems from a global perspective within their social, political and economic dimensions and touched upon the problems in its totality. According to them, man requires to develop a global state of mind as he has citizenship to two countries, his own and the planet in the global phase of human evolution. Barry Commoner (1972) finds social origins in the crisis, and advocates a national ecological policy in a 'democratic society' for every country with adhering importance to ecological criterion rather than to profit maximization. Meadows et.al. (1972) are concerned with the finiteness of the resource supplies, Ehrlich et. al (1973) with population growth and Daly (1973) with intertemporal equity in resource-use. Mihajlo Mesarovic and Edward Pestel (1974) reject the pessimistic forecasts of Meadows and others and describe them as prophecies of a 'doomsday'. They advocate organic development rather than 'limited growth' through developing a sense of identity with future generations. As opposed to writers like Meadows, Ehrlich and their associates who hold pessimistic view of environmental future by advocating zero population and zero economic growth, some others have argued that through technological advancement, within a century or two, mankind would be, everywhere, rich and in control of the forces of

nature (Herman Kahn, William Brown and Leon Martel, 1976).[4] But in the foreseeable future, it seems, there are no technological fixes that can quickly erase the ecological crisis. Katherine Montague and Peter Montague (1976) demand restraint in economic activities by moving into a stage characterized by a dynamic equilibrium between human civilization and natural environment.[5] E.F. Schumacher (1973) advocates moderation in all activities, especially in the use of technology, industrialization and economic growth and highlights the need for intragenerational equity referring to the Gandhian saying that 'earth provides enough to satisfy every man's need but not for every man's greed.'[6] Larry Korn (1978) in his 'One Straw Revolution', while describing Mazanobu Fukuoka's natural farming in Japan, maintains that by preserving the ecosystem balance based on nature's dictum of mutual coexistence and survival of all living things, peace and order on earth is preserved. Ashok S. Guha (1981) maintains an evolutionary view of economic growth and rejects the stage theories which visualize development in terms of uniform sequence of stages in different countries ignoring the diversity of natural environments in which growth occurs and the diversity of adaptation it induces.[7] According to him, the 'rhythm' of economic growth is essentially identical

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4. Kahn Herman, Brown William and Martel Leon, The Next 2000 Years, William Morrow, New York,(1976), p.1.

5. Frolov I., Global Problems and the Future of Mankind, Progress Publishers, Moscow,(1982), p.127.

6. Schumacher E.F., Small is Beautiful, Blond and Briggs Ltd., Great Britain,(1973), p.26.

7. Ashok S. Guha, An Evolutionary View of Economic Growth, Oxford University Press, New York,(1981), p.17.

to the rhythm of evolution of species.[8] Besides those mentioned above, there is a plethora of literature designated as 'environmental' attracting the interests of the human society and cautioning against man's reckless exploitation of global environment.

International Conferences

Various international conferences were held during the past few decades to express the seriousness and the global concern with environmental problems. But the environmental issues were more pronounced in the Stockholm Conference (1972) [See Appendix 2.1 on Stockholm Confernece (1972)] than in many of the others. The U.N. Conferences which focussed attention on the global ecological crisis date back to the 1948 conference on Conservation and Utilization of Resources held at Lake Success. The year 1957-58 was declared by the United Nations as the Geophysical Year. The conference on Biosphere was held at Paris in 1968 and on Environment and Development at Founnex in 1971.[9] The Stockholm Conference was closely followed by the Bucharest Conference on Population (1974) and the Rome Conference on Food (1974) which recognized development as a multidimensional concept encompassing not only economic and social aspects of national activity, but also those related to population, the use of natural resources and the management of environment.[10]

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8. Ashok S. Guha (1981), op. cit., p.16.
9. David Orr and Marvin S. Soroos (1979), op. cit.,pp.6-7.
10. Essam El. Hinnavi and Manzur Ul-Haque Hashmi (Eds.), Global Environmental Issues, Published for UNEP, by Tycooly International Publishing Ltd., Dublin, (1982), pp.1-10.

Environmental issues were implicit in the Conference of the Law of the Sea which began in 1974 and at the special sessions of the General Assembly on Raw Materials in the spring of 1974 and the Fall of 1975. Lima Conference on Industrialization (1975), Geneva Conference on Employment (1976), Vancouver Conference on Human Settlement (1976), Buenos Aires Conference on Water (1977), Nairobi Conference on Desertification (1977) and Alma Atta Conference on Primary Health Care (1978) were all sponsored by the United Nations and had the underlying ecological perspecitives.[11]

The U.N. Law of the Sea Conference held in April 1982, ten years after the Stockholm Conference produced contrasting results.[12] The law of the Sea Conference was a negation of the spirit of Stockholm and consensus failed to emerge. Delegates from U.S.A. voted against the treaty while the delegates from U.K., FRG, and the Soviet Union abstained. In their assertive arrogance a handfull of industrialized nations decided to go ahead with plans of appropriating sea-bed resources. The more recent conferences on New International Economic Order and North-South Dialogues too manifested a reversal of the Stockholm spirit as developed countries were not willing to share the global resources with the developing countries.

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11. Ibid

12. Ignacy Sachs, "Environment and Development Revisited", Alternatives - A Journal of World Policy, Sept. 1982, p.383.

Legislative Enactments

The development of international response to environmental affairs can be traced through several legislative measures enacted by different countries of the world. The United States passed a comprehensive Environmental Protection Act and set up the Environmental Protection Agency in 1969 followed by the Resources Recovery Act, 1970 and more recently the Resources Conservation and Recovery Act.[13] In 1971, the Federal Republic of Germany formulated an Environmental Programme and followed it up with a Waste Disposal Law to co-ordinate the collection and reuse of waste materials. In 1974, the British Government passed a new and enlarged Control of Pollution Bill on the same lines and then set up a Waste Management Advisory Council. The French, in 1975, introduced a law on waste-disposal and the recovery of materials. Japan has not only decided to devote more than two per cent of GNP to the elimination of pollution, but is concentrating more and more on its new "Keep Japan Clean Centre" and latest techniques of waste management and recycling. In the Tenth Five Year Plan for the economic and social development of USSR a special section has been introduced with comprehensive measures to protect the environment and to use the resources rationally. About half of more than 350 million Roubles allocated for the purpose goes towards the protection and rational use of water resources.[14]

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13. Barbara Ward (1979), op. cit., p.63.

14. Yusuf J. Ahmed and Frank G. Miller (Eds.), Integrated Physical, Socio-economic and Environmental Planning, UNEP, Tycooly International Publishing Ltd., (1982), p.153.

Though they lag behind developed countries to a large extent in this respect, most of the developing countries are presently at their right earnest in enacting various environmental protection laws and adopting resource conservation measures.

International Agencies[15]

Global concern to environmental issues can also be traced through the formation of international organizations including the Food and Agricultural Organization (1945), the International Meteorological Organization (1951), the United Nations Committee on the Effects of Radiation (1955), the Inter Governmental Maritime Consultative Organization (1958) and the United Nations Environmental Programme (UNEP) (1972). The UNEP was established immediately after the Stockholm Conference to impart factual informtion for economic development on a sound ecological basis. The concept of 'ecodevelopment' gained larger currency through the UNEP. It was further refined and publicised through the Cocoyoc Declaration of 1974 after the U.N. sponsored symposium jointly organised by the UNEP and the UNCTAD. The UNEP organised, in collaboration with its regional commissions, an important series of seminars in 1979-80 on the alternate resource-use pattern. "The World Conservation Strategy" published in 1980 by the International Union for Conservation of Nature (IUCN), UNEP and the World Wildlife Fund

15. (i) Richard A. Carpenter, Balancing Economic and Environmental Objectives: The Question is Still How?, East-West Centre, Honolulu, Hawaii (1981), pp.175-180; (ii) World Bank/August 1978, Environmental Considerations for the Industrial Development Sector, Washington D.C., pp.12-13. (iii) David Orr and Marvin S. Soroos (1979), Op.cit., pp.5-10.

is yet to be translated into specific national plans. The focus of this document is on "living-resource conservation" for sustainable development. The World Health Organisation (WHO) established guidelines for ambient air and water quality conducive to health. The public awareness of the vulnerability of ecosystems and the limits to natural resources was increased continuously through the reports of UNEP, the UNESCO, the Man and Biosphere Programme, the IUCN, the Dag Hammerskjold Foundation, the Club of Rome and other similar international organizations.

Environmental Impact Assessment (EIA) is a condition for obtaining development grants or loans from the World Bank and the United States Agency for International Development (USAID). The World Bank now insists on environmental assessment for all major projects financed through the Office of Environment and Health Affairs (OEHA). Questions about pollution, erosion, wildlife and health effects are to be answered before sanctioning major projects such as power plants, road construction and large dams. The emphasis is on disease, water supply, sanitation and industrial pollution. Besides UNEP, WHO, World Bank and other organizations mentioned above, the International Atomic Energy Agency (IAEA), and the Organization for European Cooperation and Development (OECD) are also engaged in activities relating to environmental protection. All these international agencies are currently associated with environmental protection either as their principal function or as an important part of their principal missions. The matters considered by

those organizations are usually quite general in nature. Some degree of international response is also evident in the growing number of treaties that directly or indirectly affect the environment including the Test Ban of 1963, Prohibition on Ocean Dumping in 1972 and 1975 as well as agreements to control pollution in the Baltic and the Mediterranean.[16]

Follow-up Action

Environmental awareness and the introduction of strict environmental control measures in some countries have encouraged the development of eco-technologies, for example, "recycling and low-waste and non-waste technologies".[17] From an environmental point of view such technologies could lead to substantial savings. In Norway, strict measures to control atmospheric pollution have led to innovation in the production of ferro-silicon which have reduced production costs by 8 to 12 per cent. In Sweden changes in the pulp industry from sulphite to sulphate process and recycling of waste water have led to reductions in water consumption, production costs and wastes discharged.

Despite the leading roles played by developed countries in various international forums, conferences, committees and organizations in the field of environmental protection, they are unwilling to share the global resources with developing

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16. David Orr and Marvin S. Soroos (1979), op. cit., p.7

17. Essam El Hinnavi and Manzur Ul-Haque Hashmi (Eds.), (1982), op. cit.,pp.8-10.

countries. They all go ahead with plans of appropriating raw materials, energy, seabed resources, etc. for more than their due share. The developed countries use international forums to exert their economic and political power and to perpetuate their neo-imperialist domination over the less developed countries. It is not surprising to find that the first manifestations of concern over global ecological degradation arose in the advanced countries and within the ruling class as they began to feel the impact of actually and potentially decreasing availability of natural resources.[18] While mounting environmental pressures from popular movements in the west have resulted in a slowing down of environmental degradation there, the resource squeeze has led to an intensification of ecological damage in the third world countries. For instance, several recent studies have shown that while depletion of forest cover in the US and Europe has declined sharply in the last decade, the very reverse is occuring in the third world.[19] Similarly, while inshore trawling has been banned in most western countries it is pursued directly or encouraged for export in the third world.[20]

The scientific and technological revolution has brought in a new form of international division of labour. Earlier the 'centre' or 'metropolis' specialised in manufacturing while the 'periphery' specialised in raw materials. Now the developed

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18 Raghunandan D., "Ecology and Consciousness", Economic and Political Weekly, Vol. XXII, No.13, March 28, 1987,p.548

19. Ibid

20. Ibid

countries (centres) are transferring some manufacturing units to the less developed countries on account of environmental regulations and the ban on production and marketing of some of the harmful products in the former.[21] For example, there is a trend to locate new capacities of the Japanese aluminium industries abroad due to environmental considerations together with the availability of raw materials and cheap electric power in the host developing countries. Difficulties in finding environmentally sound refinery sites have forced the petroleum industry to look abroad as well, particularly to Indonesia. In the USA, a trend is emerging towards the relocation of industries producing asbestoes, mercury, pesticides and other environmentally hazardous substances. For example, asbestoes factories have been installed in Mexico and Brazil. The plants in ferrous and non-ferrous metallurgy, primary oil refinery, toxic chemicals, etc. that have been built or are under construction in the less developed countries not only enable the imperialist powers to obtain the products produced by cheap labour, raw material and energy but also to save a lot of money on environmental protection by pushing those polluting entreprises outside their national borders. The people of the developing countries have to shoulder all the after effects produced by the operation of such polluting industries.[22] This new form of imperialist exploitation reveals that the white

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21. Details of relocation of hazardous industries in LDCs are given in Essam El-Hinnavi and Manzur Ul-Haque Hashmi (Eds.), (1982), op. cit., p.10.

22. Uma Devi S., International Economics, Institute of Correspondence Course, Kerala University, p.17.

man has always considered the coloured race lesser humans. The less developed countries have also to pay a high price for technology transfer in terms of payments made to foreign specialists, etc. The creation of artificial conflicts between developing countries and then the sale of army and military hardware are special features of the present strategy of neo-colonialism.

Even the direct environmental programmes of the international organisations are framed with ulterior motives. For instance, the afforestations is encouraged with generous World Bank support, provided the trees are eucalyptus for poly-fibre industry and not fodder or fuel yielding ones. Mono-cultures of high yielding exotics are promoted while concern is expressed at the depletion of native genetic stocks. Gene banks are maintained in the US and borrowers are discouraged while programmes are initiated covertly or overtly to destroy the native genepool. In this age of biological warfare of using food as weapon, control over seeds can even be used as a means of destroying a nation's or region's crops and compelling it into submission.[23] But even without going into this aspect of the question, it may be said that economic profits which the seeds trade can bring constitute by itself an important enough motivating force for efforts to be made to manipulate its control and related information.[24] Germ plasm of plant varieties

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23 Bharat Dogra, "Genetic Erosion of Plant Wealth", Yojana, 30October 16-31, 1986.

24 Ibid.

are being taken out of the developing countries and later when the indegenous varieties have become extinct, these countries have to pay for seeds in a commercial purchase. Several third world countries are now discovering to their dismay that the germ plasm of new extinct plants can be obtained only from the gene banks of the developed countries.[25]

Similarly, international aiding agencies prescribe the purchase of equipment, gadgets and the know-how from specified multinational corporations or developed countries with the intension of helping them to find market for their products in less developed countries. They encourage consumerism which is the worst and the latest menace to environmental protection and prudential resource use. Rulers of the third world countries are told that the adoption of development pattern of developed countries in toto would help to increase income and employment in their countries and that they shut their eyes against the political and economic domination of the developed countries over their countries. They are persuaded and if resisted they are bribed. Not only the political leaders, but many scientists, bureaucrats and technocrats of most third world countries occupying crucial positions have been so much corrupted by the high salaries and other carieerist opportunities provided by various organisations of the developed countries, that it is possible for vested interests to get away with amazing acts of manipulations and cheating. The ruling class of the capitalist system are thus not unaware of the

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25. Ibid

ecological problems, but their response is geographically select and designed to perpetuate their dominance over the globe.[26]

The developed countries, in fact, behave on a life-boat ethics according to which they are in the life-boats of prosperity. They are not only unwilling to stretch a helping hand to the less developed countries perishing in the vast ocean of poverty, but are also pushing them down when they show signs of possible or better survival. If the developing countries are rescued from drowning in poverty - i.e., if they too adopt the rate of resource use, consumption and waste generation of developed countries - they believe, all are doomed. The same logic is more or less in a similar manner extended to the national scene where the minority elites and the well-to-do consider others as less human having right only to serve the former. Similarly, it may be observed at the national scene that the propertied and dominant classes exercising control over the political and economic domains have ecological awareness of a kind that relates to their interests in appropriating and protecting the surplus generated.[27]

Having reviewed briefly the level of environmental consciousness and environmental protection efforts globally, the same must be examined at the national level.

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26. Raghunandan D., "Ecology and Consciousness", Economic and Political Weekly, March 28, 1987, p.548.

27. Ibid.

CHAPTER - III

ENVIRONMENTAL PROTECTION IN INDIA

During Ancient Times

The ancient concept of 'pancha bhooda' (earth, water, fire, space and air) as essential constituents of life might have evolved as the result of human consciousness on the inter-relatationship between the biotic and abiotic things in nature.[1] In Vedas, Epics and other works of art and literature, there are innumerable examples to illustrate man's realization of the need to protect the environment. Apprehensions on the consequences of irrational approach to nature had risen in Vedic times as reflected in the following passage:-

"Let what I dig from thee
O Earth, rapidly spring and grow again,
O purifier, let me not pierce
Through thy vitals or thy heart"

(Griffith's translation of Adharva Veda, 12:1:35)

The epic event of 'palazhi madhana' for 'amrutha' and other valuables from the sea by a prolonged churning of the 'milk ocean' produces 'Kalakoda visha', a catastrophic form of pollution. This depicts the lust for over exploitation of nature and its after effects. In the ancient days of Aryan history, Aryans used to worship with simple or complex rites,

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1. U.K. Gopalan,"Environmental Consciousness", Paper presented at the World Environmental Day Seminar on Development and Environment, Cochin, June 5, 1982.

2. Raja Ramanna, Inagural Address, at the Environmental Day Seminar, Cochin, June 5, 1982.

Mitra (the sun), Varuna (the god of night or blue sky), Dyn (the day), Prithvi (the earth) and Agni (the fire). All of them are prevedic deities.

Manu, the ancient law giver who prescribed punishment for cutting trees, had pointed out possible salvation for those who had planted trees. Kautilya's 'Arthasastra' (300 B.C.) recognizes types of superintendents and refers to the protected forests 'abhayarnaya' where the wildlife is conserved. Recognizing the importance of the balance of nature as well as the aesthetic and cultural values, Ashoka (242 B.C.) declared that wildlife should be preserved. He insisted that certain species of animals, birds, fishes and insects should not be killed at all. Akbar (1256 A.D.) and other Mughal rulers had introduced exotic trees into this country to organize parks, gardens and avenues.[3]

Our identification with nature is central to our culture. This can be seen in the so called forms of worship prevailing in the country elevating mountains, rivers, oceans, wind, trees, and animals to the status of gods and goddesses. Some plants such as peepal, tulsi, bergard, oak, dhatara, kamal, etc., are related to gods and goddesses and their environment inculcates moral, spiritual and aesthetic values in the minds of people.[4]

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3. U.K. Gopalan, op.cit.

4. K.B. Gupta and S.B. Malik, "Environment and its Relation to Spiritual Education", in the First National Environmental Congress, New Delhi, Dec. 28-30, 1982.

The Chipko Movement

However, the traditionally fostered environmental consciousness in India began to decline with the increase in population and its congenial problems of food, housing and raw materials. Air, water and land began to be considered something to be conquered and exploited for the benefit of man. The British colonialization was primarily interested in the exploitation of nature and hence encouraged farmers to encroach upon forest land for agricultural purposes. As a consequence of their policy vast areas of our forests were cleared and subsequently became arid. This necessitated the establishment of conservancies, a conscious effort to improve the environment. However, the conservators proved to be inefficient in improving the terrestrial environment even though plantations and such other programmes were initiated. Resources were over-exploited and environment denuded by the more powerful in the society.[5]

One of the glaring events relating to environmental consciousness and representing the spirit of ancient tradition took place in a bisnoi village, Khejadali near Jodhpur in Rajastan, once a luxuriant forest where the desertification is relentlessly marching ahead at present.[6] It was in the year 1730 that a noble lady by name 'Amrithadevi' who believed that felling of trees was against the tenets of her faith stiffly

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5. Some of the major India's environmental Problems are described in The State of India's Environment 1984-85: The Second Citizens' Report, Centre for Science and Environment, New Delhi,(1985).

6. The event given here is described in U.K. Gopalan,(1982), op.cit.

resisted Jodhpur Maharaja's agents who came to her village to cut down the trees for fuel and wood. Saying that a tree saved at the cost of one's life is a good bargain, Amrithadevi clung to a tree prepared to be cut down by the wood cutters. She was mercilessly axed to bits. The news began to spread and the people of Khejadali and neighbouring villages flocked to the place to protect the trees. In all, 363 people laid down their lives on that fateful day. This spirit of sacrifice for the noble cause of environment is reflected in the present 'Chipko Movement' (tree hugging) started in the remote Chamoli District of U.P. in 1970. The movement encourages the people of the Himalayan hillsides to hug the trees and dares the contractors' axes to protect a fragile and vitally important ecosystem. It is the moving spirit of Amrithadevi which is behind the numerous conservation movements and hundreds of voluntary organizations functioning for the protection of national environment in different parts of the country at present. There are more than 200 non governmental voluntary organizations functioning in this field as noted in the Seventh Plan document.[7]

Environmental Protection in the Constitution

Environmental protection is no longer a controversial issue in India. The Constitution of India has placed as one of the primary responsibilities of the state, and the duty of every citizen, the protection of the national environment. Article 48A of Part IV of the Constitution which deals with the Directive Principles of State Policy reads:-

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7. Government of India, Seventh Five Year 1985-90, Planning Commission, New Delhi, 1985, p-308

"Protection and improvement of environment and safeguarding the forests and wildlife:- the state shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country".

Similarly, Article 51A of Part IVA deals with Fundamental Duties. Clause 'g' of the article reads:-

"It shall be the duty of every citizen .... to protect and to improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures". These laudable articles of the constitution indicate the importance of protecting the national environment.[8]

Legislative Measures

The overriding concern for ecological security and the Constitutional directives have provided a strong base for environmental protection. There have been several laws enacted from time to time which are directly or indirectly related to the protection of various aspects of the environment. (See the List of Acts in Appendix 3.1)[9] Among them, the more recent ones are the Insecticides Act (1968), Wildlife Protection Act (1972), Water (Prevention and Control of Pollution) Act (1974), Water (Prevention and Control of Pollution) Cess Act (1977), Forest Conservation Act (1980) and the Air (Prevention and

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8. From the address delivered by Justice K. Sukumaran (High Court of Kerala) at the Environmental Day Seminar on June 5, 1982, at Cochin.

9. Nag Chaudhari, Introduction to Environmental Management, Interprint, Naraina, New Delhi,(1983),pp.7-8.

Control of Pollution Act (1981). The Merchant Shipping (Amendment) Act (1982) amends the Merchant Shipping Act (1958) and aims at protecting the territorial waters of the country from various kinds of sea pollution. All these legislative enactments are meant to correct people from abberations. The Environment (Protection) Act, 1986 is the most recent piece of legislation which is more comprehensive and propose to remove lacunae in the earlier Acts. It deals with environmental protection by the control and abatement of all kinds pollution and proposes to prohibit all kinds of environmentally dangerous activities in the country.

Enforcement Bodies

The Government of India established a Central Board for the Prevention and Control of Water Pollution after the enactment of the Water Act, 1974. Most of the State Boards came into being immediately after. After the passing of the Air Act, 1981, Kerala State Board for the Prevention and Control of Water Pollution was renamed as the Kerala State Pollution Control Board (KSPCB) and assumed the responsibility for preventing all kinds of pollution in the state. The basic tasks before the Central Board and its counterparts in the states are: assessment and control of water and air pollution; assessment and control of coastal pollution; development of professional expertise and trained manpower, development of cost effective technologies for air and water pollution control and strengthening the institutional R & D support for pollution monitoring and control.[10]

10. Government of India, Sixth Five Year Plan 1980-85, Planning Commission, New Delhi, 1980, pp-343-351.

The execution of the provisions of various environmental Acts is the responsibility of the concerned ministries at the Centre and the States. The responsibility for coordinating various enviromental protection activities of different ministries, boards, departments and organizations is placed on the Central Minister of State for Environmental Protection. The performance of National Environmental Engineering and Research Institute (NEERI) with its headquarters at Nagpur and regional centres in different parts of the country in the field of pollution monitoring and research has always been commendable. The role played earlier by the National Committee on Environmental Planning and Co-ordination (NCEPC) and presently by the Department of Environment (DOEn) needs special mention in this context.

The NCEPC and DOEn[11]

The NCEPC was established by the Government of India in 1972 with the major objectives of promoting research in the field of environment and serving as a "think-tank" on environmental policy matters. The research programmes of NCEPC had been implemented through the Indian National Man and Biosphere (MAB) Committee and the Environmental Research Committee (ERC). About 120 projects undertaken were spread over 14 major areas including tropical and subtropical forest ecosystems, ecological impact of land use and management, impact of overgrazing on ecology, water uses and ecological impacts, impact of fertilizers and insecticides on health, conservation of natural and

11. Ibid.

genetic materials etc. Investigations were conducted on the long term ecological impacts of river valley Schemes in Idukki (Kerala) and Beas-sutlej link (Punjab) and fertilizer projects at Nhava Sheva (Bombay) and Rewas (Maharashtra). Other areas of involvement by NCEPC include 500 TPA-DDT plant at Rasayani (Bombay), Nhava Sheva Port, ONGC's offshore drilling platform at Nhava, and the Thal Vaishat fertilizer township. Studies conducted on the environmental aspects of the proposed link between Old and New Bombay, the Doon Valley, and the watersheds of the rivers Ganga and Yamuna are particularly noted. Studies were also made by NCEPC on the impact of Mathura Refinery on Taj Mahal, setting up of the Naval Base Training School on the shores of Chilk Lake and establishing biosphere reserves in Western Ghats spreading over to the States of Kerala, Karnataka and Tamil Nadu.

On the advice of the NCEPC, a National Fellowship Award on Environmental Science was instituted by the Central Government. The Pitamber Pant Award, named after the first Chairman of NCEPC is aimed at promoting excellence in environmental research. A source-book could be brought out with specific information on matters relating to the environment and a map prepared on important wetlands and wildlife in various regions of the country. The NCEPC initiated from time to time various programmes to create environmental awareness and to educate people through formal and informal means.

In recognition of the need for a fresh and comprehensive look at the administrative and legislative aspects of environmental protection, the Government of India constituted a "high powered committee" in 1979 headed by the deputy chairman of the Planning Commission. According to the recommendations of the committee (its report was submitted in September 1980) the DOEn was established and the 26 member NCEPC was reconstituted and renamed as the National Committee on Environmental Planning (NCEP) on April 1, 1981 with an extended life of two more years. As the area of activities of DOEn increased, there was overlapping in the functioning of NCEP and DOEn prompting the Government to wind up the former on 31st March 1983.[12] The main functions of DOEn identified are:-

1. to work as a nodal agency for environmental protection and economic development in the country,

2. to carry out environmental appraisal of developmental projects through other agencies/ministries as well as directly,

3. to take up the administrative responsibility for pollution monitoring and regulation,

4. to conserve critical ecosytstems designated as biosphere reserves, and -

5. to conserve marine ecosystems

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12. Indian Express , April 1, 1983.

Other Cooperating Agencies

ERC and the Indian National MAB Committee have been consistently co-operating with the activities of NCEP(C) and DOEn from the time of their inception. Earlier NCEP(C) and now DOEn have been in constant contact with the Planning Commission for evolving the mechanism of assessing environmental implications of various development projects. Several other agencies such as the University Grants Commission (UGC), the Council for Scientific and Industrial Research (CSIR) and the Department of Science and Technology (DST) have been aiding a number of research projects in different sectors of the economy. Besides, there are hundreds of voluntary agencies, specialized institutions and university centres conducting research. They are in action for the cause of environment in various parts of the country.

Under the bilateral and multilateral environmental programmes involving joint projects, training, and transfer of information, India has benefited greatly from international co-operation. The DOEn is the nodal agency for co-operation with a number of international organizations such as the UNEP, International Union for Conservation of Nature (IUCN), South Asia Cooperative Environment Programme (SACEP) and International Centre for Integrated Mountain Development (ICIMOD) and also participates in the environmental programmes of other international bodies such as ESCAP, WHO, ILO, FAO, UNIDO, IPU, UNESCO, and World Bank. India has been a beneficiary of technical and financial assistance from those international agencies in the field of environmental protection.

The use of earth observation satellites orbiting geosynchronous for land, atmosphere and ocean application is praiseworthy.[13] Since the launching of Bhaskara I and II, future plans of remote sensing technology for environmental monitoring have become highly prospective. One of the main objectives of INSAT series of satellites is to conduct studies on national environment. Indian Remote Sensing Satellite (IRS) is an approved project of the Department of space with launch schedule for 1985-86.(Schedule delayed). The data from IRS together with foreign satellites (LANDSAT, ERR-I, SPOT, MOS-I etc.) will be of significant use for application in the areas related to the country's environment.

Under the Five Year Plans[14]

In India, some aspects of environmental protection have always been included in the development programmes right from the initiation of the Five Year Plans. Water supply and sanitation, soil and water conservation, energy, and forestry were the areas of particular consideration. However, the concern for the integration of environmental considerations in the process of planning for development was for the first time explicitly articulated in the Fourth Plan. But the idea of ecodevelopment obtained full recognition only in the Sixth Plan. Major activities in the area of environment on which work

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13. For details, V.R. Rao,"Remote Sensing for Environment Monitoring, Present and Future Opportunities", paper presented in the National Environmmental Congress Dec. 28-30, 1982, New Delhi.

14. See details in the Fourth, Fifth, Sixth and Seventh Five Year Plans.

has been initiated or stepped up during the Sixth Plan included: water and air pollution monitoring and control, environmental impact assessment, natural living resource conservation, special projects on wildlife, ecological studies by the Botanical and Zoological Surveys of India (BSI & ZSI), ecodevelopment programmes, environmental reserach promotion, and environmental education, training and awareness. The DOEn was set up at the Centre, and in the States; various instituions and ministries were constituted; and important environemtnal laws were enacted during the period.

Minimum national standards for polluting discharges from specified industries were formulated and control measures implemented in a progressively stringent manner. A network of about 120 monitoring stations to check water pollution has been created. Zoning and classification of all the major rivers have been completed to provide a basis for water quality management. A river basin-wise inventory for Yamuna and Ganga has been prepared to assess pollution load. A 12-point strategy adopted for wildlife protection and development in October 1983, successful implementation of 'project tiger' and the establishment of the Wildlife Institute of India are particularly noted. Preparatory work has been done for setting up Biosphere Reserves in a few carefully selected and identified areas which have enormous pristine genetic diversities, for example, Nilgiri, Namdapha, Nanda Devi and Uttarkhand. In order to promote environmental research nearly 400 research projects have been sanctioned to the Universities, R&D institutions and non governmental

agencies. Research relevant to the integrated development of the Western Ghats, Himalayan region and the Ganga basin has been initiated. One 'Centre of Excellence' has been set up at IISc, Bangalore to conduct studies on Western Ghats' problems.

A computerized Environmental Information System (ENVIS) with a network of distributed information centres all over the country has been started. A variety of 'information products' have been prepared including a directory of non governmental organizations active in the field of environmental protection. The first National Environmental Congress and the first National Conference of Legislators on Environment were held as part of the awareness building programmes. Various programmes on environmental education, training and awareness are launched, workshops conducted, and nationwide celebrations organized on the World Environment Day (June 5) and during the Wildlife week.

Seventh Plan Proposals[15]

Environmental programmes taken up during the Sixth Five Year Plan will receive a greater impetus during the Seventh Plan. A major programme on the 'Prevention of Pollution of Ganga' is undertaken in the Seventh Plan. A Central Ganga Authroity has already been set up under the chairmanship of the Prime Minister. A special programme is initiated for the control of hazardous substances used in the country or imported for various agricultural and industrial purposes. Efforts are under way to develop ecotechnologies to make cost-effective waste recycling and to procure useful inputs from effluents and emmissions.

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15. Government of India, Seventh Five Year Plan 1985-90, Planning Commission New Delhi, 1985, pp-385-394.

Technical Cells for Environmental Assessment will be set up, attached to various ministries and departments. A National Environmental Monitoring Organization (NEMO) is proposed to be set up to synthesize environment-related information from every sector into a supporting framework for environemntal impact assessment. The actual data storage and dissemination would be carried out under the ENVIS. The NEMO would have to use professional expertise and infrastructure within the IITs, Universities, the Surveys and other governmental and non governmental organizations.

During the Seventh Plan, work would be initiated on taxonomic investigations and publication of Flora and Fauna of India. The BSI and ZSI will take up joint programmes for the Survey of Living Resources and Ecological Mapping in collaboration with NRSA and related agencies. The BSI would organize at least four seed banks of Non-Agricultural Economic Plants, at preset collected from the wild and under threat, as also, Tissue Banks of Endangered/ Threatened Species of Plants. Those Banks would be backed by All India Co-oridinated Projects (AICP) on Seed Biology and Tissue Culture with conservation techniques. The ZSI will take up a major project'on Butterfly Farming. Preparation of Red Data Books of Threatened/Endangered Plants and Animlas will be an important programme of the BSI & ZSI. Works related to identification and inventorization of Less Known Economic Plants and Animal Species as also Species-Oriented Ecological Studies and identification of Pollution Resistant Plants will receive priority.

Eco-task Forces of ex-servicemen will deal with critically degraded, inaccessible and difficult areas in the country. The Eco-Development Camps will sensitise youngsters on the importance of environmental conservation. The on-going Action-Oriented Research & the Development and Extension Programme in the Himlayan and Western Ghats regions would be extended to the Eastern Ghats and Cauvery Basin. The Himalayan Institute of Environment & Development will become fully operational. A centre for Environmental Education at Ahmedabad and the one for Mines' Environmental Studies at Dhanbad are being set up. The ENVIS' Documentation Centre will be strengthened to serve as a Regional Documentation Centre for South Asia. Through the International information systems such as INFOTERRA, the Centre would be linked to the global netwrok of enviromental information systems. A major programme for the publication of environmental status reports, research and policy papers and journals and news letters for the widespread dissemination of environmental information is envisaged.

For those and many other programmes, the Seventh Plan envisages an outlay of Rs.427.91 crores in the 'environment and ecology' sector.

Effectiveness of Implementation

It is necessary to focus upon the role of reasearch agencies in the country who are the major source of information. At present, the funds for environmental research in our contry are mainly concentrated in the official agencies like the pollution

control boards, NEERI, Central Labour Institute, the National Institue for Occupational Health etc. In theory, all these agencies are autonomous, but their anotonomy is relative. They, supported by grants from the government cannot be expected to behave differently, especially when the party to be confronted is also a government undertaking. The ministries of agriculture and industry which are the main supporting bases of polluting enterprises are more powerful than these boards and agencies and the ministry of environment. A common complaint about pollution control practice is the nature of secrecy surrounding the relationship between the regulator and the regulated.[16] The pollution control officers believe in 'family like' cooperation with the polluting enterprises since they believe that they can handle the violator without resorting to confrontation.[17]

The rules issued under various acts focus on procedural matters. For example, the rules associated with the water and air acts illustrate the forms to be filled out by the pollution control boards for their annual reports, list the fees for particular pollution tests, and give sample application forms for concerned orders without describing how to make use of the information thus provided.[18] Minimum National Standards (MINAS) for water and air quality relating to industrial

16. Timothy O'Riordan and Ralph C d'Agre, Progess in Resource Management and Environmental Planning, John Wiley and Sons, New York, 1979, p-240.

17. Ibid, p-242

18. Susan G. Hadden, "Statutes and Standards for Pollution Control In India", Economic and Political Weekly Vol. XXII, No.16, April 18, 1987, p.710

operations are more often laid down after a bargaining between the staff of the pollution control boards and the representatives of the industries. This process of fixing standards often makes them unscientific and unfit for fulfilling the objectives of pollution control. To cite an example, a representative of the fertilizer industry succeeded, after more than fifteen meetings with the board staff, in getting a proposed standard of 100 ppm ammonia in effluent raised to 150 ppm by suggesting that the industry would really like a standard of 200 ppm.[19] The industries usually make attempts to win concessions on effluent standards at the central and state levels and if the authorities do not yeild, they try to win more time for compliance and remain without compliance for several years. Further, the enforcement of whatever standards are decided upon is inhibited by a severe lack of resources. Perhaps, in the absence of a policy guidance on the proper balance between economic growth and environmental protection, those negotiations take place in a vacuum and the results cannot be assessed because there is no yardstick against which to measure them.[20]

The government simply does not have the machinery to play the aribitrator in an environmental controversy. The DOEn is hopelessly over burdened and understaffed. Ideally, it should have an officer in each ministry with whom it can liaise.[21]

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19. Ibid

20. Ibid.

21. Darryl D'Monte , Temples or Tombs? Industry versus Environment: Three contraversies, centre for science and Environment, New Delhi (1985), p-219

In the absence of such Coordination each ministry thinks that it is interfering in its affairs, and that environment is a new flanged notion which means everything to everybody and has no clear-cut goals and objectives.[22] The DOEn cannot and will not initiate any enquiry on its own and is content with passing out judgement whenever it is called upon to do so. In this respect NCEP was better able to play the role of a watchdog and enlist the services of outside experts.[23]

Similary, the pollution control boards are hampered by lack of real authority. While it is authorised, for example, to compel the production of information about the environmental impact of any proposed activity, public or private, the board is not empowered to issue regulations establishing a routine requirement for the submission of required data. The board's effectiveness, therefore, is wholly a function of the extent to which it is able to elicit voluntary cooperation from other agencies.[24]

It should be emphasised at the outset, however, that traditional penal code provisions against creating nuisance, disposing of refuse in a prohibited manner, and the like do not constitute the sort of pollution control system which is

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22. Ibid; Also see, Digvijay Sing, The Eco-Vote, Printice Hall of India Private Ltd; New Delhi, 1985, p-47.

23. Darryl D'Monte (1985), op.cit., p-219

24. Colin MacAndrews and Chia Lin Sien, Developing Economies and the Environment: The South-East Asian Experience, McGraw Hill International Book Company, Singapore, 1979, p-19

essential to any genuine environmental management effort.[25] Society must somehow dispose off unwanted residual products of domestic, agricultural and industrial activities. It is the business of the government to find economically feasible ways of accommodating this need while ensuring that productive resources are not wasted and public health is not jeopardised.[26]

Further, it must be remembered that legislative efforts cannot be fully confined to environmental agencies, but must include all the offices of the government whose activities bear or might be brought to bear on the implementation of environmental policy.[27] A variety of non environmental legislations, if properly used, might be of environmental importance. For example, it will be useful to examine the statutory means by which the government can create non penal economic incentives to meet environmental objectives like waiving duty requirement in connection with the import of pollution control equipment, allowing depreciation on capital investments in the development of eco-techniques, and encouraging the domestic production of related equipment through approrpirate investment promotion process etc.[28]

The pattern of resource use and management aspects of environmental protection issues have so far received a low profile in the economic and political affairs of the state. Those

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25. Ibid., p.24
26. Ibid
27 Ibid, pp.38-39
28. Ibid

aspects are to be considered in a wider framework of economic policies pursued by the government. Definitely, economics and ecology, and economics and environment are closely interrelated. This relationship has to be brought into focus in a study on environmental protection. There is the need to integrate economic development, planning and resource management with environmental protection.

CHAPTER - IV

ENVIRONOMICS

Genesis of Environmental Problem

The genetic cause of environmental pollution and resource depletion must be located in the violation of the 'law of conservation'. According to this law, the resources used by the living organisms in the ecosystem must return to nature. Some of them reach the environment as wastes through the excreta of organisms, and the remaining when they die and decay. Similarly the amount of waste residuals generated in the economic system from the production-consumption processes is essentially equal in physical weight to the amount of resources entering into the production consumption processes over a period of time.[1] The wastes thus created are then rejected into the environmental media-land, water or air - respectively as solid (wastes), liquid (effluents) or gaseous (emissions) wastes. Had the waste generation been continued uninhibited, our planet would by now have became a huge heap of wastes with all the resources exhausted but for the regenerative capacity of the earth.

The Regenerative Capacity of Earth

The regenerative capacity of the earth refers to the waste-assimilating activity of the environment. The waste-assimilation and then the regeneration into useful inputs take place through certain natural mechanisms inherent in the environment during 'material circulation' and 'energy flow'. Economic system being the part of a larger ecosystem the basic flows in

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1. Seneca and Taussig, Environmental Economics, Prentice Hall Inc., New Jersy, 1979, p.76.

nature- material circulation and energy flow - are common to both the systems.[2] In both systems, material flow is circular and energy flow is unidirectional.

The material inputs flow in a circle during which they are transformed into outputs and wastes which are again converted into useful inputs and that circulation continues. The bacteria and the organisms like blue-green algae, lichen etc., capable of converting the solid wastes into useful inputs are known as degrader populations. Those degrader populations are the principal agents in the environment enabling it to act as the 'waste assimilator'. The highly specialised bacteria present in the ecosystem are able to "fix" the nitrogen present in the atmosphere and convert it into nitrogeneous compounds essential for the survival of living species. Once fixed in this way and used by plants and animals, denitrifying bacteria then release the nitrogen back into the atmosphere. This circular flow of nitrogen through an ecosystem is only an example of a bio-chemical cycle. Others equally as vital occur for sulphur, carbon and so on.[3] The substitution of carbondioxide for oxygen during photosynthesis is only one of the environmental mechanisms regenerating gaseous pollutants. Similarly, during hydrologic cycle the liquid wastes get purified. These are only some of the instances of numerous ways and means known to us through which the regenerative capacity of the earth is manifested. It may be noted that in economic systems a part of

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2. D.W. Pearce, Environmental Economics, Longman, London , 1976, p.38.

3. Ibid, p.34.

the wastes may be recycled during production and consumption before allowing nature's regenerative capacity to become operative.

As said earlier, energy flow is unidirectional. Energy once used is not re-usable and is released as waste-heat and noise. But continued supply of energy is ensured as sun is the ultimate and infinite source of energy. In ecosystems solar energy is tapped by plants and converted into glucose through photosynthesis. Some of this glucose in turn is used up by plants during the process of respiration as the plants grow. The plants or the primary producers, as they are called, become food for the next category of living beings, herbivores,who again are food for the next category, carnivores,including man in the 'food chain'. The energy thus flows from primary producers to other living things, but this flow is never completed in a circle back to the primary producers. In economic systems, apart from this energy 'inventoried solar energy' such as coal, oil, gas, etc. are also sources of energy as long as their supply exists. In any case energy once used is not reusable.

The Declining Assimilative Capacity of the Environment

Just as the environment can assimilate the wastes generated in the system, the receptors of wastes like plants and animals can asbsorb a considerable amount of it. "A positive correlation with their adaptive organs - sematal structure of fossil plants (Laurophyllum bournse), sunken stoma of Indian fossil plants (Nipaneophyllus), aricular hair of grasses, passage of

higher animals, structure of nose and nasal channel of hair and nasal angle of man - and intensive selection pressure of pollutants has been established."[4] But the environment as the assimilator, and organisms, plants and animals as receptors of wastes have limited capacity to withstand the wastes generated. The biodegrader populations and various purifying mechanisms in the environmental media can remove only a limited quantity of wastes. They have their natural limits. Similarly it is important to note that the receptors of wastes have some definite threshold limit. For instance, "mammalian lungs can clear themselves of a surprising amount of debris; but gradually the ability to do so is cumulatively choked by the persistant intake of ash, soot, and acid; and at some degree of accumulation the self cleansing powers are exhausted."[5] In other words, the regenerative capacity of the earth is limited by the amount of wastes generated which should not exceed the assimilative capacity of the environment. In fact, the problem of environmental pollution arises because "we are overburdening the environment through our activities by adding wastes into air, water and land media in such quantities as to render the resources unsuitable for specific or established uses."[6] The rate of waste generation exceeding nature's regneration rate causes a further decline in the assimilative capacity of the environment. This is because,

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4. T.M. Das,"Programme of Environmental Science", Paper presented in the First National Environmental Congress, New Delhi, Dec. 28-30, 1982

5. Ibid.

6. World Bank, Environmental Consideration for the Industrial Development Sector, Washington D.C., August 1978, p.1.

1. the existing degrader population become less in number and other purifying mechanisms become incapable relative to the increased wastes added to the environment;

2. the assimilative capacity of the existing degrader poupla-tions gets reduced and the regenerating mechanisms get exhausted; and

3. some of the existing degrader populations are chocked and destroyed and purifying mechanisms disrupted due to the excess of wastes.

There is, therefore, the need for practising moderation in the use of resources and waste creation. If the level of output is not adjusted in the economy, the level of assimilative capacity of environment will be shifted further downwards.

The Economic Problem

Various types of wastes discharged into the environment are either non-biodegradable or biodegradable. The non-biodegrad-able wastes are not amenable to biological decomposition and the degrader populations present in the environment cannot degrade and regenerate them into useful inputs. The biodegradable wastes have just the opposite features. Nevertheless, all sorts of pollutants have biological and/or economic impacts particularly when the amount of wastes exceeds the assimilative capacity of the environment. The problem is economic only when the act of pollution involves economic effects in the form of

external costs. External costs are unintended costs passed on to the society through polluting activities. In other words, the physical or biological pollution unaccompanied by economic effects may not give economic dimension to the problem. The amount of wastes surpassing the assimilative capacity of the environment is the necessary condition of the economic problem of pollution, but not the sufficient condition. The aversion for the wastes and people's willingness to pay towards the cost of alleviating the problem constitute the sufficient condition. The necessary condition being fulfilled, the sufficient one often follows eventually.

Besides waste-generation and environmental pollution with every increase in population and production-consumption activities accompanied by economic growth, there arises the problem of resource depletion. Adopting everywhere the resource use-rate of a handful of developed countries, most of the renewable resources would become extinct and non-renewable resources become exhausted in the near future. For instance, if the entire world consumed at the U.S. rate of 30 barrels per person per year, the global petroleum reserves would be exhausted in five years.[7] Similarly, in 1975 every adult and child in the U.S. consumed 40,000 pounds of mineral matter alone quite apart from agricultural products and water.[8] In fact,the root cause of poverty in less developed countries must be traced not as much in population growth as in the cornering of a major share of world's resources by the West. Their poverty is caused at

7. Darryl D' Monte (1985), op.cit p.7
8. Ibid

least in part by the economic domination of the rich countries and continues to be overtly or covertly, under neo-imperialistic policies. No doubt, there is resource depletion with every increase in population, but the best contraceptive is development with a reordering of priorities accounting for intragenerational and intergenerational equity. Economic and social justice too demand that the global resources be reallocated and wealth and income redistributed between individuals/communities/countries and that the same be allowed between generations to maintain the "maximum sustainable yield" of the earth's resource-base on a continuous basis.

Environomics

Environment defined as 'a complex web of nature and the relatedness of its various components and structures'[9] is the subject extensively treated in the science of ecology. The relationship between ecology and economics has to be considered in a study of environmental economics or environomics. Both these disciplines have the same Greek root oikos meaning 'house' or 'household'. The household in ecology is the society of all living beings. In economics the household is the society of humans. The Greek nemein in economics means 'to manage' and logos in ecology refers to 'science'. The management of society for the enhanced welfare of human beings with respect to their wealth creating and wealth consuming activities is the subject matter of economics. The well-being of all living organisms in their environment is the main theme in the science of

9. Kurt Dopfer, Economics in the Future, The Mac Millian Press Ltd., Lodon, 1976, p.9.

ecology[10] which makes an economic system the part of a larger ecostystem, and man only one of the species in the ecosystem. This new branch, 'environomics' is based on this truthful dictum and condemns all activities in human society which violate the natural laws governing the well-being of all creatures in the universe. When man is engaged in activities for enhancing his prosperity, in total disregard for the ecosystem and environment, the net impact, in the long-run will boomerang against his own welfare.

Earth has in the past been commonly considered as a bottomless reservoir of resources and mankind has so far worked out a 'cow-boy economy involving a reckless exploitation of resources rather than a space-ship economy' effecting the preservation and optimal utilization of limited resources. In a cow-boy economy success is measured in terms of the amount of production. But in a space-ship economy the criterion for success is the maintenance in good order of the existing capital stocks - earth's inhabitants and the life support system. In a space-ship economy, the 'economics of scarcity' is followed underlying the principle, "to conserve, to maintain and to use and use again"[11] the natural resources. Most of the prevailing concepts and theories of economics put into practice often lead to the squandering of resources. Revision in a number of concepts of long established acceptance is required. For

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10. Eugene Odum, Fundamentals of Ecology, W.B. Saunders, Philadelphia, 1971, p.3.

11. Allen Cottrel, Environmental Economics, Edward Arnold Publications Ltd., London, 1970, p.8.

example, 'development' needs to be redefined as an era of scarcity; 'conflict' and 'peace' should be interpreted more broadly to take into account the impact of present generations on the welfare of future generations; definitions of 'crisis' and 'catastrophe' normally applied to social interactions need to be supplemented with the idea of man/nature interactions; and new ideas of 'dependence' and 'interdependence' are needed to describe relations on the planet where resources are unevenly distributed.[12] Like-wise most of the general economic theories need recasting in the new mould of spaceship economy.

For instance, until recently most of the economists considered the concept of 'externalities' as an interesting intellectual footnote to the main body of economics. The external diseconomies or social costs of production-consumption processes by way of pollution incurred on society were not included in their cost analyses. They believed that the equality of marginal cost and price (MC = P) under perfect competition was the ideal condition for optimal allocation of resources and optimal production ensuring Pareto's optimum welfare for everybody. But when social marginal costs are added to MC, the total marginal cost price equality (TMC=P) can be obtained only at a lower level of optimum production for a firm, and at higher price and lower production in the case of industry. Under non competititve conditions like monopoly TMC=P is obtained at much lower level of production and at much higher price than the case

12. David W.Orr and Marvin Soroos, The Global Predicament: Ecological Perspectives on World Order, The University of North Carolina Press, U.S.A., 1979, pp.9-10.

may be under perfect competition. Here, one can observe that not only monopoly, but also the neglect of social costs make the market economy unsuitable for optimum allocation of resources and optimum production.

Similarly, environmental resources are considered as common property shared by everyone but not cared for by anybody. It is often held that if private property rights would be granted to them, their possession by individuals would have prevented most of the environmental problems. But as Seneca and Taussing have pointed out the appropriate social response to the common property resource problem is not to convert common property into private property.[13] Considerations of justice and income distribution demand that environmental resources and their services be transformed into public property or public goods. Moreover, ideally,the government is more suited to own the resources of nature to provide socially optimal level of resource use and environmental quality through various control measures implying drastic changes in the politico-economic systems in that eventuality. In the same way, many more instances in the general framework of economic theories can be pointed out as demanding redefinition. Environmental economics is a new branch in economics attempting to redefine economics in the environmental context.

Environmental economics, for brevity, may be denoted as

'environomics' which deals with the different economic aspects of conservation of resources and the protection of quality environment aimed at enhancing the quality of life and the well-being of mankind. The quality of human life greatly depends on environmental quality which ensures the well-being of all life-forms. Environmics is the economics of scarcity based on the principle to maintain in good order the earthly ecosystem, its inhabitants, and their life-support systems. Different aspects of environmental quality such as pure air, fresh and clean water and uncontaminated land resources are all economic goods or, in other words, they are items of scarcity. If any of those environmental resources is used for a particular purpose and contaminated at any locality, that resource then is not available for any other use. This involves a choice that has to be made between alternative uses of environmental resources. Environomics is also the study of society's choices in the intertemporal allocation of resources. Intertemporal or intergenerational allocation of resources refers to deciding how much of the existing stock of resources should be designed for now and how much should be left '<u>in situ</u>' for the future.[14] Besides, this branch also deals with intratemporal or intra-generational equity in resource allocation and distribution of income and wealth. Since this new branch studies environmental damages, protection and conservation as economic problems, it draws sources from nearly all areas of specialization within economics as well as contributions from different intellectual

14. John A.Butlin (Ed.), <u>Economics and Resources Policy</u>, Longman, London, 1981, p.31.

disciplines.[15] "Since environment with its components of living and non-living resources represents the most fundamental building blocks for national development and social well-being, environmental considerations should form an important element in the criteria for setting developmental targets and assessing plan performance in all sectors. Further, environmental management should be integral to all development activities."[16]

Ecodevelopment and Environomic Planning

Ecodevelopment means economic growth for enhanced human welfare in a protected environment. To advocate growth without any regard for environment is madness just as to forsake economic growth for the cause of environment is unreasonable. Continued economic growth is possible even if ecologically dangerous activities are prohibited. In ecodevelopment, economic as well as ecological factors get equal consideration. Consequently an effective ecodevelopment policy results in greater production and quality environment. From the environmental point of view development should be regarded as synonymous with improvement in environmental quality, as both improve the quality of living.

Economic progress demands resources of the environment. When the environment is altered in our favour we have ecodevelopment and when such alteration results in upsetting the

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15. Savage et.al., Economics of Environmental Improvement, Hugton Miflin Company, Boston, 1974, p.4; Also see, Seneca & Taussing (1979), op.cit, p.6.

16. Government of India , Seventh Five Year Plan 1985-90, Planning Commission, New Delhi, 1985,p.387.

ecological balance we have environmental deterioration. One crucial characteristic of ecodevelopment is a beneficial alteration of environmental resources. The other important characteristic of ecodevelopment is increased access of common man to vital resources. These two characteristics have to go hand in hand.[17] Further ecodevelopment does not follow any stage theories of growth 'which visualise development in terms of uniform sequence of stages in different countries and ignore the diversity of natural environments in which growth occurs,and the diversity of adaptation that it induces.[18]

When a vast majority of world population is living in utter poverty and destitution the proposal for zero economic growth canot be recommended. Advocating for the adoption of zero economic growth even in rich countries may result in reducing their demand for import from less developed countries and the availability of foreign capital funds for the development of poorer countries. Therefore raising the standard of living in less developed countries must come from the growth of total world output so that the developed and the developing countries achieve economic advancement simultaneously. Moreover, it would be easier to meet the demand for redistributive justice globally through economic growth everywhere since no one's income has to

17. M.Taghi Farver,"The Interaction of Ecological and Socal Systems", in William H. Mathews (Ed.), Outer Limits and Human Needs, The Dag Hummarskjold Foundation, Uppasala, 1976, p.67.

18. Ashok. S. Guha, An Evolutionary View of Economic Growth, Oxford University Press, New York, 1981, p.17.

be reduced in order to increase the income of others.[19] As John A Butlin has pointed out, though quality of environment is a luxury which the rich can well afford, development is a necessity which the poor cannot do without.[20]

The interaction of man with nature requires proper direction to avoid the spill-over and over exploitation of natural resources. Activities left to individuals to meet their interests often do not reconcile. The reconciliation in this sphere can be brought about only by the state. For this the state should engage herself in environomic planning. Environomic planning may be defined as the planning process adopted by a country with the objectives of enhancing her citizens well-being and improving and protecting the quality of environment on which human well-being depends. It is a kind of intergrated planning comprising the economic, social, technological, physical and such other aspects of improving the quality of life. Thoroughly worked out environmic planning programmes enable to maintain the ecosystem and economic system in balance, to control environmental pollution and resource utilization, to provide the basic physical and social needs of human development and to promote economic growth with equitable distribution of income and wealth - all of them are the requisites for ecodevelopment.

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19. Edward Shapiro, Macroeconomic Analysis,(3rd Edn.),Hocurt Brarcea Invsnoich Inc., New York, 1974, p.375.

20. John A Butlin,(1981),op.cit. p.28

Environmental Management

Environmental management, a term encompassing environmental planning, protection, monitoring, assessment, research, education, conservation and sustainable use of resources,is now accepted as a guiding factor for national development.[21] The main objective of environmental management is to minimize the impact of man's activities on the physical and biological environment through a perspective of the ecosystem.[22] The adoption of effective environmental management policies and programmes makes continuous growth possible by restraining ecologically dangerous activities and through optimal utilization of resources. Since technology has brought faster economic growth and environmental problems along with it, many people maintain a hostile attitude towards advanced technology. But we require a technology far superior to the one which created the problems. Technology yet, is not developed enough to abate and control the hazardous impacts of radio-active wastes, insecticides, pesticides and many other toxic chemicals. Besides, 'ecotechniques' must be developed in future to create output with less scarce resource embodiment. Moreover, exhaustible and renewable resources augmenting technological progress enable per capita consumption of natural resources to remain constant.[23] Meanwhile there is need for laying down

21. Government of India Seventh Five Year Plan 1985-90, Planning Commission, New Delhi,1985,p.385.
22. Yusuf J. Ahmad and Frank G. Muller (Eds.), Integrated Physical, Socio-economic and Environmental Planning, Published for UNEP by Tycooly International Publishing Ltd., Dublin, 1982, p.17.
23. V.Kerry Smith, Scarcity and Growth Reconsidered: Resources for the Future, The John Hopkins University Press, Baltimore and London, 1979, p.43.

appropriate criteria and standards on pollutants emitted from industrial production and processing. The volume of pollutants in the wastes, emissions and effluents should not exceed the prescribed standards and criteria. Appropriate legal measures are to be adopted and implemented to arrest the criminal irresponsibility of the polluters for causing environmental damages. The environmental monitoring agencies may keep a constant vigil on the fall-out of various economic activities on a continuous basis and initiate appropriate legal measures against defaulters. Various social pressure groups and non-governmental organizations (NGO) engaged in environmental protection activities are to be promoted and their demands conceded. Measures are to be initiated to create environmental awareness and to impart environmental education to the masses. Environmental education must be made an essential part of the academic curriculum starting at school level to continue through out higher learning.

A very strict adherence to the standards and criteria in the beginning might obstruct industrialization and economic growth in underdeveloped countries. What is advisable then would be the application of 'best practicable means' (bpm), according to which preventive measures adopted are made progressively stringent as technology advances and the economy develops. A system of accounting social costs (i.e., costs to the society due to environmental damages, etc.) in the actual cost-price calculations of the producers must be adopted. They may be given incentives by the environmental law enforcing bodies and

the governments to comply themselves with the laws framed for the purpose. The recycling of wastes would help to withhold the wastes from entering the environmental media as long as possible and to increase the regenerating capacity of the environment. Through recycling useful inputs are isolated from wastes for further production-consumption purposes and the remaining residues are further crushed to make themselves amenable to degeneration by the degrader populations. A benefit-cost estimation and analysis may be made before setting up every developmental enterprise in order to strike a happy balance between the objectives of economic development and environmental protection. Understanding at international levels must be reached under appropriate forums, and guidelines evolved on the rational utilization of several renewable and non-renewable resources on a global basis. This is vital for the optimum use of resources that maintains nature's 'maximum sustainable yield'. The issue of international disarmament is also relevent here. It is not merely that nuclear, chemical and biological weapons of war would, if used,represent the ultimate pollution of environment, but the very production of armaments makes a heavy demand on materials and environmental resources.[24] If the vast resources used in the development of weapons are directed to the cause of environment and economic development there would be tremendous increase in the welfare of the human race. Adhering to these major guidelines, environmental management achieves economic development and prosperity without obstructing ecological balance.

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24. John A Butlin (1981), op.cit, p.29.

CHAPTER - V

COST ESTIMATION OF ENVIRONMENTAL PROTECTION

Environmental amenities like pollution-free air, fresh and pure water etc., are no more free goods. Society has to pay for such amenities in terms of economic or social costs. Economic costs due to environmental pollution impacts on the society are generally measurable in terms of money, but social costs are not. But both are real costs. We all know that every form of human activity causes some form of contamination of the environment. But the problem attracts the economist only when some cost is involved and/or when the people affected are willing to pay for environmental protection. But there are several difficulties in estimating the cost of environmental protection. This is owing to the involvement of both tangible and intangible factors. Many of the costs are not fully quantifiable. For instance, how can one estimate the cost of deteriorating health of the people in a locality caused by the radioactive wastes let out from a nearby factory? Or, how can one estimate the costs implied in the mental tension and psychological depression of a person working under conditions of sound of very high decibels? Attempts to estimate the health effects of pollution by adding the medical bills and value of the production loss due to illness, will not give the true picture. This is because some of the affected might be ill due to genetic and hereditary reasons and also due to pollution. Thus an estimate of costs on account of pollution alone may be extremely difficult, if not impossible.

The costs of environmental protection can be widely classified into two categories, viz.

1. direct costs and
2. indirect costs.

The direct costs are those incurred on account of the after-effects of polluting activities, whereas, indirect costs are the spill-over costs on the economy when the protection measures are implemented.

Direct Costs of Environmental Protection

There are five broad categories of direct costs as given below.[1] A brief explanation of each of the categories is necessary to reveal the nature of the direct costs of environmental protection.

1. The Pollution Damage Costs
2. The Damage Avoidance Costs
3. The Pollution Control and Abatement Costs
4. The Pollution Prevention Costs, and
5. The Transaction Costs.

Pollution Damage Costs

They are costs due to damages already caused by pollution such as blighted crops, ill-health, corrosion of materials and structures etc. The blighted or damaged crops would mean loss

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1. Descriptions of some of the direct costs may be referred to in:
   (i) World Bank/August, 1978, Environmental Considerations for the Industrial Development Sector, Washington D.C., 1978, pp.69-80.
   (ii) Seneca and Taussig, Environmental Economics, Prentice Hall Inc., New Jersy, 1979, pp.11-16.

of income to farmers and higher food prices to consumers. This may result in the shortage of foodstuffs and raw materials which may have adverse impacts on the external balance of payments of a country. The pollution-caused illness may erode productivity, reduce workers earnings and raise the costs of medical care for all. The health-effects of pollution on domestic animals are manifested by reduced longivity, increased death rate, decreased productivity and yield. In the case of wild animals this can lead to the extinction of species and the depletion of forests. This, in turn, may cause serious and hazardous ecological changes. The accelerated deterioration of property owing to pollution increases the maintenance and cleaning costs. For example, air pollution may cause paints to peel and thus to impose additional painting costs on the owners of commercial and residential structures. Pollution of the atmosphere is likely to increase everybody's cleaning bills as everybody attempts to maintain standards of cleanliness established in a less polluted age. Even the value of landed property may decrease in a heavily-polluted area.

But much of the costs implied in a variety of damages are not quantifiable at all. Such costs cannot be by any means fully compensated, nor the damages completely repaired. In many instances we will never know how much welfare damages have been caused by pollution and how many people are willing to restore quality environment. Also we cannot measure the entire welfare damages the same way as we can measure damage avoidance and pollution-prevention costs.

Damage Avoidance Costs

When the damages have already been created by the polluting activities, they are required to be repaired or avoided to the maximum possible extent by incurring private or public expenditure. Private expenditure usually takes the form of monetary or non-monetary compensation paid to the people affected by the polluting activities in the private sector. Money payments made for the medical treatment, employment given to the heirs of the deceased etc., would come under this type of costs. The public expenditure takes the form of various types of clean-up programmes, compensation for damages to society, importing of unpolluted drinking water from a nearby or a faraway place, resettling of the people of the affected locality to a pollution-free area etc. On failure of individuals or the government to accept such costs,society can choose to avoid the damages by undertaking some defensive or remedial actions. The people of the affected area may sell off their property and shift their residence to a pollution-free area or make frequent vacations away from such areas. All those and similar costs incurred on pollution damage avoidance are grouped under this category.

Pollution Control and Abatement Costs

Immediate prohibition of environmental pollution resulting from economic activities like production and consumption is an impossible and highly impracticable proposition. Moreover, our technology has not been developed to that extent so as to combat with some of the pollutants to result in zero toxicity.

Therefore, the best practicable means (bpm) suggest that measures be adopted and devices be installed to control and to reduce the intensity of pollution to the possible minimum levels without retarding production and economic growth. As and when the technology advances, gradual reduction of pollution may be possible for the achievement of the desired aim of no pollution at the end. Till then we cannot wait doing nothing to solve the present problem.

The control and abatement costs of environmental protection are the costs of resources devoted to reducing the amount of pollution. The costs incurred for air pollution removal by adsorption, absorption, scrubbing, sedimentation etc.; for waste water treatment by chemical coagulation, precipitation, carbon adsorption, reverse osmosis and lagooning; and for the solid wastes treatment and disposal by sanitary land fill, leachate control, grinding, and incineration are examples of such costs.[2] Installations of such devices aim at reaching a desired level of pollution intensity suggested by experts or reaching a safety standard specified by a law-enforcing authority. The pollution control and abatement costs may also include the costs of adverse effects of environmental protection (indirect costs) on economic growth, employment and production.

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2. Various pollution control and abatement methods are discussed in world Bank/August, 1978, op.cit., pp.36-68.

Pollution Prevention Costs

This category of costs include all those incurred for the purpose of executing the non-pollution policy. The costs incurred by any private or public agency to prohibit and to prevent pollution in toto at the source are included in this type of costs. For instance, the costs incurred by a local government to treat fully its sewage before dumping it into a river are pollution prevention costs. Expenditures for installing air filteration system to contain fully the air pollutants from a particular process is another example of this type of costs.

It may be noted here that we lack the technical know-how to prevent certain kinds of pollution. For example, the wastes, having long lasting adverse impacts on organisms, such as radioactive and nuclear wastes, pesticides etc., are beyond the reach of the known technology. The prevention of activities resulting in such wastes implies costs which are equal to the products foregone. Similarly, in some other cases we have the know-how to prevent pollution. But the costs involved are so high that no agency - private or public - can afford to bear the costs of the required installations. An example of such cases is the prevention of thermal pollution which is a form of water pollution caused by heat. We have the technology to prevent thermal pollution. But as Peter F.Drucker points out: "the heat produced while generating electricity might be used

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3. Peter F. Drucker, Toward Next Economics and Other Essays, Allied Publishers Pvt. Ltd., New Delhi, 1981, p.28.

in greenhouse and fishfarming or to punch 'heat holes' into a layer of cold air over such places as Los Angeles creating an updraft to draw off smog. But they are long range projects. The increased costs are here and now".[3] However, the ultimate target of any policy measure adopted for environmental protection is the total prevention of environmental pollution.

Transaction Costs

They are the costs of the resources used in the research, planning, administration and monitoring for the control of pollution. It is necessary to find out the extent of pollution of the air, water and land resources before taking up measures to control them. A body of experts from different disciplines is required to be appointed to conduct the monitoring work with respect to specific projects in a locality, a state or the country. Much research studies including laboratory and in-field-outdoor experiments are to be made before establishing accurately the extent of their contaminating impacts on the living and the non-living. Considerable expenditure is involved in monitoring and research by way of the costs of laboratory and other equipment. Payments as salary to the experts and their assistants and for extensive travel from place to place to determine the spatial spread of pollution and its impacts etc., are the types of costs included in the category of transaction costs. The process of monitoring and research involves not just hit and run type of costs, but must constantly be incurred for ever-further research and

investigation. Once the safety standards of pollution levels are fixed (for example, those of the Indian Standards Institute- ISI) laws are to be enacted and implemented and a set of machinery for law enactment, adjudication and execution etc., is to be created. All of them involve considerable costs. Many a time, the polluters can be prompted to confine to the standards only through legal measures for which lot of administrative expenses are implied. It is required that a high powered law-enforcing body for every locality, region and state be established and made functional on a permanent basis. Since a happy trade-off between the objectives of rapid economic growth and environmental protection is required all along, it is necessary that an integrated economic planning comprising an environmental planning be adopted. The cost estimate of environmental planning need not be separately made as there may be difficulties in doing so.

For the success of all these and similar measures, it is imperative that an awareness of the problem be created among the public, so that they can be always alert and become the custodians of quality environment. Since we had neglected the environment for so long in the past, the existing educational system, social and ethical values etc., should be changed to adapt themseleves to the quality aspects of life that can be enhanced through the protection of environment. An appropriate educational curriculum involves considerable costs. For all these purposes it is inevitable that a constant flow of expenditure be allowed to safeguard environment from

contamination and to effect control over the pollution already caused.

Indirect Costs of Environmental Protection

People are now more aware of the adverse impacts of environmental pollution on the economy and the various categories of direct costs involved. But it seems that they are not as much bothered about the economic reprecussions or the spillover costs resulting from the execution of environmental protection measures. Even when they know about the possibility of such adverse impacts and the indirect costs, either they ignore them or overlook and bypass them. A brief explanation of each of the main types of indirect costs is required to evaluate the success of various protection measures adopted for solving the problem. The indirect costs of environmental protection occur on account of:[4]

1. the impacts on consumption and production
2. the impacts on employment
3. the impacts on capital supply
4. the impacts on the fiscal and economic bases of municipal and regional governments; and
5. the impacts on international trade and the balance of payments etc.

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4. For details see: (i) Ismail Shariff,"Economic Repercussions and Limitations of Pollution",(ii) Martin Pfaff,"Inter Regional Transfer Through Environmental Policy", in Mishra, Urs and Natraj (Eds,). Regional Planning and National Development, Vikas Publishing House Ltd., New Delhi, 1978 pp.290-314, Also see, (iii) Baumol and Oates, Economics, Environmental Policy and Quality of Life, Prentice Hall Inc., N.J. 1979, pp.174-190

Impacts on Consumption and Production

The implementation of pollution control measures is likely to increase the cost of production of the polluting industries. This cost can be passed on to the consumers in the form of higher prices of the products. But the increase in price may cause substantial decrease in demand and production, depending upon the elasticities of demand and supply. The tastes and preferences of the consumers may be shifted in favour of the products of the non-polluting firms, because their prices do not change on account of pollution control. This rearrangement of the purchase of products will affect the structure of production and employment. The production of the polluting firms will be considerably decreased, if not stopped. In the event of close-down, the resources engaged in the production process will lie idle till the factors thus unemployed can be fruitfully shifted to other firms. Thus the adoption of the pollution control measures can affect the structure of production both in the polluting and non-polluting firms leading to an imbalance in the demand and supply of resources and to a shift of resources from one use to another. The increase in costs and decrease in demand and production lead to serious ramifications throughout the regional economy. Its consequences may also be felt outside the region. The changes in the interregional and intraregional structure of consumption and production must be considered when environmental protection measures are adopted and implemented at regional levels.

Impact on Employment

The adoption of environmental protection measures leads to a shifting of resources from one industry to another. It also has important consequences in the factor markets, especially in those of capital and labour. Both high salaried and low salaried workers may find their jobs threatened. Fear of unemployment and loss of income seem to be felt more heavily among lower income groups. When environmental interests halt or slow down the construction of a refinery or an airport, the protests against the lost jobs usually come from blue collar workers or the jobless. A worker who has lost a job in a polluting industry need only remain unemployed for as long as a period as it takes to find a job in another industry. But even the temporary unemployment can have serious financial and psycholgocial effects on a family, particularly, if it has little accumulated savings. Moreover, by the very nature of industrial activity, changing of one job from another overnight is nearly impossible. It is because such changes cannot generally be accomplished without a programme of retraining.

Impacts on Capital Supply

The capital supply is a prerequisite for regional development. When the cost of production increases and the profit decreases the capital may move from polluting industries to non-polluting ones. The shareholders may not be ready for sharing the added costs on account of environmental protection. Further, when the existing productive capital has to be written off faster to give way for environmentally favourable

production equipments, the climate for investment will be worsened and is likely to have serious impacts on the long run capital supply to the region. The repercussions on the capital market will be more severe when one region implements the protection measures, while others do not or when the regions apply different levels of stringency with respect to pollution control. Thus the implementation of the environmental protection measures can have serious consequences on the capital supply and therefore, on the overall economic development objectives of the region.

Impacts on the Fiscal Base of Municipal/ Regional Governments

The region or a municipality which is greatly dependent on a particular industry for its tax revenues encounters significant reduction in their revenue from corporate and other taxes when a cut-down in production or an out-right shutdown of the plants occurs. The curtailment of production and employment is bound to affect the tax base of municipal and regional governments. Therefore, they are likely to resist the implementation of environmental protection programmes or a set of policies may be adopted which will smoothen the transitional process. Before adopting various measures of environmental protection, the fiscal effects of their implementation must be estimated. Such an estimate may also account for changes in the structure of consumption and production and for the derived changes in the employment of capital and labour.

Impacts on International Trade and Balance of Payments etc.

Just as environmental pollution can cross the geographic boundaries, so can the impacts of environmental protection. The higher product prices of the polluting industries on account of pollution control expenses will mean less competitive exports in the world market and more purchases from abroad by the domestic consumers. Under normal conditions, this will result in a deterioration in the country's balance of payments. In this context, the imposition of the pollution control measures within a country which raises costs, is similar in its effects on international trade,to a revaluation of the country's currency or to an imposition of tariff and devaluation of the currency by other countries,or all of them.

The depressed demand for domestically produced commodities will lead to a decline in incomes which is accentuated by the multiplier process of income determination. The net outcome of all the forces involved is difficult to evaluate. But the impacts on income and the balance of payments of a nation that takes up unilateral pollution controls will be clearly manifested.

It is counter-productive to penalise a nation that is trying to control pollution by allowing its industry to suffer in international competition. Yet this is the situation we are confronted with, primarily because of the absence of any meaningful international co-ordination of environmental protection measures. It is very idealistic to believe that all the

industrial centres are going to suddenly converge on a multi-national pollution control policy. However, some significant economic benefits may be realized for the country which takes the initiative in controlling pollution. Its initial technological lead coupled with growing concern over pollution the world over, might lead to substantial receipts in the balance of payments in the form of export of pollution abatement equipment and know-how. But the primary goal would be to upgrade and maintain the quality of the earth's environment.

Who will pay the Costs?

As already pointed out, various types of direct and indirect costs are involved in environmental protection. But who shall bear the burden of payment towards the costs of environmental protection? The answer is: all of those concerned, the polluter, the beneficiary and the government. Since the polluter (either the producer or the consumer) is the accused in creating the problem, it may be argued that he must bear the costs. Once the environmental protection measures are implemented, the benefits of improved environmental amenitities are accrued to the people of a particular locality. Therefore, it may also be held that the beneficiaries must pay for the costs incurred for providing the benefits thus received. At the same time, the government cannot keep aloof as a non-participating observer in this affair as the control measures require developed technology and huge expenditure which neither the polluter nor the beneficiaries are able to undertake.

Accordingly, we have three principal lines of argument with respect to who shall bear the costs of environmental protection. They are:

1. The Polluter-Pay-Principle(PPP)
2. The Beneficiary-Pay-Principle (BPP) and
3. The Government-Pay-Principle (GPP)

Polluter-Pay-Principle (PPP)

PPP states that the economic agent causing environmental deterioration, viz., the polluter, must bear the whole of the external costs arising from his activities. This principle advocates the payment of compensation to the affected people in the deteriorated environment. In its narrower sense, the PPP aims at allocating the costs 'ex-post-facto', that is, after the environmental damages have already taken place. That does not imply a non-polluting-principle. But in its broader sense PPP contains both the rule for the allocation of external costs in case of damages already caused as well as an injunction against environmental damages.[5] But how will the polluters pay the costs?

It is suggested that environmental protection costs can be paid from the business profit of the polluter. But as Peter F. Drucker has pointed out, such costs will be much more than the sum of all profits after taxes are paid. This is particularly

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5. Martin Pfaff,"International Transfers through Environmental Policy",in Mishra, Urs and Natraj (Eds.), Regional Planning and National Development, Vikas Publishing House Ltd., New Delhi 1978, p.298

so when the control devices imply developed technology and the costs become exorbitantly high. He points out the fallacy of this suggestion by citing the American case: "After taxes, the profits of all American business in a good year come to sixty to seventy billion dollars. And mining and manufacturing - the most polluting industries - account for less than half of this. But at the lowest estimate, the clean up bill even for just the most urgent jobs will be three or four times as large as all business profits".[6]

Beneficiary-Pay-Principle (BPP)

The BPP states that the beneficiaries must bear the cost of environmental protection. This means that the polluting firms are to be paid the costs of pollution prevention and control devices installed by them. But the payments are not directly paid to the polluters, but through taxes to the government. Or, the beneficiaries may be indirectly paying the costs by consuming the products of the polluter. But passing the burden of costs from polluters to the consumers through increased prices of the products implies interregional imbalances among the beneficiaries. This is because, first, the consumers of the products may not be the people who are benefiting from the increased environmental amenities. The products may be consumed by the people outside the region, whereas the benefits are accrued to the people of the region only. Second, the consumers and the beneficiaries are the same people; if that is so the above mentioned interregional imbalances may not occur.

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6. Peter F. Drucker, 1981, op. cit., p.26

And third, only some of the consumers are the beneficiaries, while others are not. Due to such discrepancies, as Martin Pfaff suggests, "before policy measures are recommended that would lead to these kinds of interregional imbalances among beneficiaries and those who pay the costs, an estimate of the degree of imbalances would have to be made"[7]

At the same time, BPP does not mean the bearing of the costs of environmental protection by the beneficiaries to the full extent. If the beneficiaries are paying for the costs fully, this would amount to a 'non-prevention-principle' because, even in the absence of any sort of environmental protection, the entire social costs of pollution are borne by them.

Government-Pay-Principle (GPP)

The government can adopt various measures to help in the payment of environmental protection costs. Besides legal impositions, various instruments of explicit and implicit transfer payments can be adopted for this purpose. These transfers can be in cash or in kind. Explicit transfers in cash may be made to the polluting firms as an incentive to implement environmental protection measures. Such transfers may take the form of operation subsidies, research and development subsides, capital grants, general aids and cost sharing between regional authorities and the industrial organisations. Generally, such explicit regional transfers are adopted depending upon the specific situations of the region, its financial resources, the

7. Martin Pfaff, op.cit., p.298.

structure of the industry and so on. The explicit transfers in kind consist of provisions like free waste treatment facilities out of general tax revenues. In this case, the firms would have access to waste treatment facilities without having to pay for it.

The implicit transfer payments are in the form of public grants (indirect subsidies) that are conveyed through nominal market transactions. For example, the government arranges concessional leasing or concessional loans, to a particular firm at prices below the going market rates. The grant element in such a policy consists in the difference between the present value of the actual leasing or payment made and the value of the payment required, if the market leasing or lending terms were applied.

Another method of conferring the implicit public grants is through the regional tax system. For example, a hidden subsidy may be conveyed to tax payers by way of allowing tax deductions and accelerated depreciation to compensate for the costs of environmental protection. The subsidy element in this can be computed as the difference between the tax liability in the absence of deductions or accelerated depreciation and their present values.

The implicit public grants may also be conveyed through regional administrative measures. For example, relaxing pollution standards by the regional public authority, in a way,

conveys an economic benefit. The grant element implicit in such maeasure is simply the difference between the production costs before and after the relaxation of the standards has taken place.

It is suggested that the government may raise the fund required for paying the environmental protection costs through a reduction in defence spending. In this age of competitively-increasing build-up of weaponry with sophisticated weapons that can annihilate the entire humanity, this suggestion seems apparently stronger. But a thorough examination of this possibility would reveal that this proposal is false and highly impracticable. On this,Peter F. Drucker, with reference to U.S.defence spending, writes, "of the six or seven per cent of our national income that now goes for defence, a large part is the cost of past wars, that is veterans pensions and disability benefits. Even when we could or should cut defence spending the peace dividend is going to be one or two per cent of national income at best".[8] In the case of India too, Drucker's statement is true. Our defence expenditure comes to nearly 5% of the GNP in 1987-88. Of this, only less than 50 per cent goes to the actual defence build-up[9] and this forms only a fraction of what is required for environmental protection of the entire nation. But this is no excuse for not reducing arms build up and defense expenditure throughout the world.

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8. Peter F. Drucker, 1981, op.cit. p.35.

9. Arun Ghosh,"The 1987-88 Budget: A Birds-Eye View of Central Expenditures", Economic and Political Weekly vol.xxii, No.15, April 11, 1987, p.663.

Cost and Benefit Optimality

All the costs of environmental protection are the "benefits foregone" in the sense that the resources spent on environmental protection could have been used elsewhere in the absence of the problem. Similarly, the benefits accrued by way of added environmental amenities are the "costs avoided" (for eg.damages averted) in the sense that a reduction in damages is achieved through environmental protection. Therefore, just as we have direct costs due to environmental pollution, we have direct benefits from protecting the environment such as, benefit from damage costs avoided, from damage avoidance costs avoided, from pollution costs avoided and from transaction costs avoided or reduced.

When development projects are undertaken it is necessary to see that benefits accrued from them are not less than the costs involved in the efforts to execute them. If the projects have already been executed, measures to protect the environment must create positive benefits as against the cost of implementing them. In any case, the costs and benefits optimality concept in the context of environmental protection speaks of striking a balance between the incremental costs and incremental benefits from the attempts to protect the environment as to maximize the total benefits of environmental protection against the total costs. It is only at the equality of marginal costs and marginal benefits that the resources will be used in an economically-efficient manner to bring about the optimal level of environmental pollution abatement and control. Various

measures and policy instruments must be implemented to bring about the desirable level of environmental protection (ie. desirable level of pollution) at that equality. And if the charges are set and the standards are fixed to protect the environment at this optimality level, we can expect to achieve the professed goal of creating protected healthy environment.

The objective of a financial estimate of environmental protection is Principally the evaluation of trade offs between costs and benefits involved in that process. There are several stages in the financial estimation of environmental protection in a specified area or locality (Stages are listed in Ch.I, See P.10). The state of environment in Eloor-Edayar Industrial belt is enquired into in the next chapter as it is the first stage in the financial estimate of environmental protection of that area.

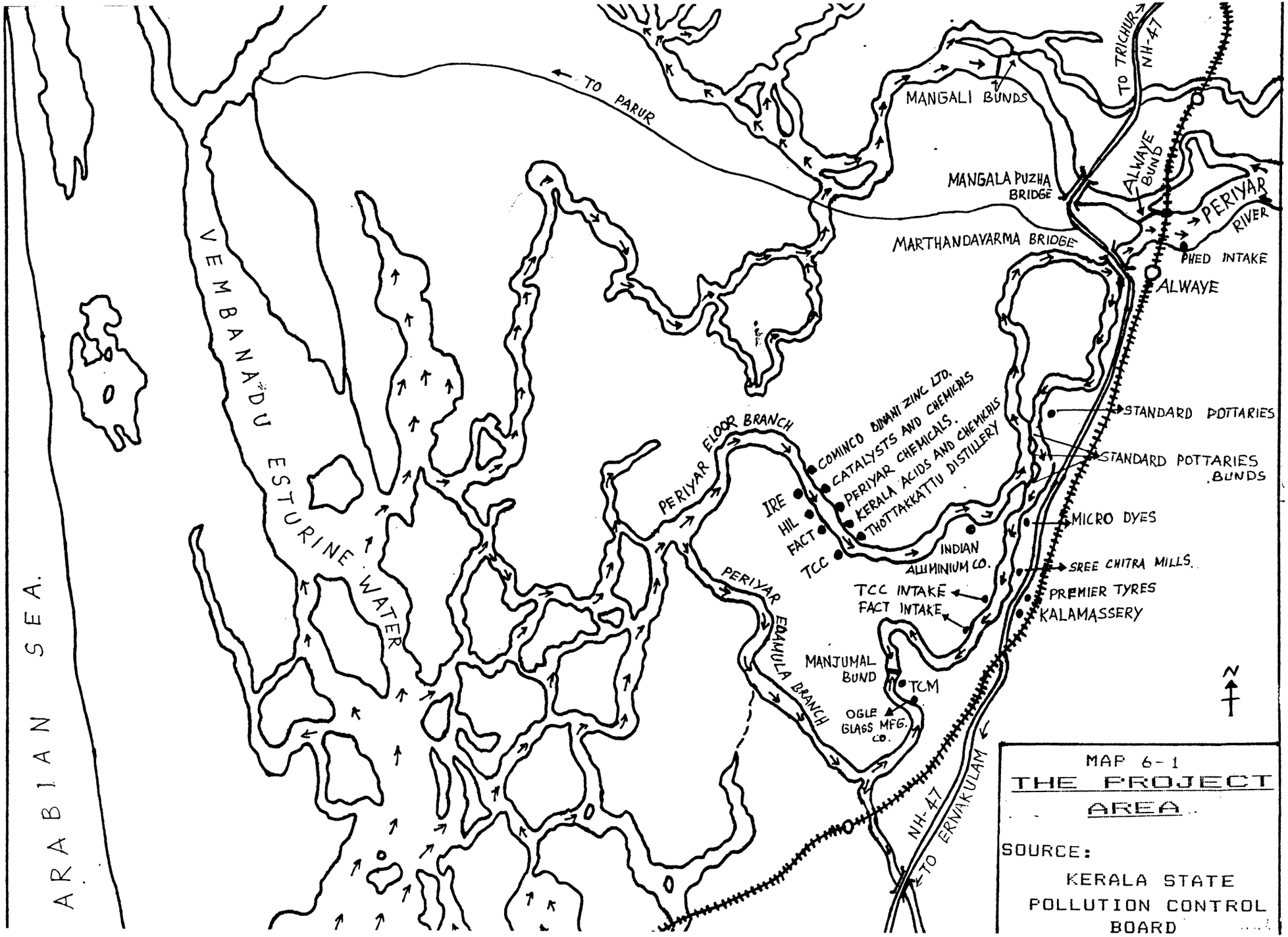
CHAPTER - VI

THE STATE OF ENVIRONMENT IN ELOOR-EDAYAR INDUSTRIAL BELT

The Project Area

The area selected for study is Eloor-Edayar Industrial belt in the State of Kerala. This is located in the middle of the State on the western coast. The area forms part of Ernakulam District and falls under the jurisdiction of the Greater Cochin Development Authority (GCDA). The factories in this belt are situated on the banks of both Eloor and Edamala branches of Periyar River. Both these branches which form the Eloor-Edayar Island empty into the Vembanad Estuary at a distance of about one Kilometre from there. The island has a total area of 11 square kilometres and has the two branches of the longest river of the state on all sides with Vembanad Estuary on the west as shown in Maps 6.1 and 6.2. These branches, especially the Eloor branch, also form a number of small islands as they join the estuary.

The Eloor branch is broader and straighter. It is into this branch that most of the industries discharge their effluents. The Edamala branch is narrower and curved and it is in this that the water intake points of most of the industries are located. The intake points are protected from saline intrusion by a bund at Manjummal. Tidal effect is comparatively pronounced in the Eloor branch as it is broader and straighter. The thrust of the tidal effect obstructs the flow of Periyar river in this branch and the fresh water flow is mostly directed



MAP 6-1

THE PROJECT AREA

SOURCE:

KERALA STATE POLLUTION CONTROL BOARD

through the Edamala branch at the branching point below the Marthandavarma Bridge.

Geographical Features

The project area is situated adjacent to Cochin city at an elevation of three metres above sea level with longitude 76°20'E and latitude 9°45'N.[1] Being a coastal area, it has moderate climate. The prevalance of peculiar meteorological conditions such as heavy rains and longer duration of sunshine in this tropical region contributes to an effective natural dispersal of air pollutants. The average annual rainfall is 3235 mm. varying between 2157 mm and 4525mm[2].

The strong south westerly sea winds during the monsoon months of June, July and August and the north westerly sea winds during October and November also play an effective role in the dispersal of the pollutants. Perhaps, the dominant winds directed to the east save the dwellers of Cochin city from much of the hazards of air pollution by spreading the air pollutants away from the city. The humidity in the area varies between 50 and 95[3] and the temperature between 20°C and 36°C[4]

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1. The Kerala State Pollution Control Board, Environmental status Report on Greater Cochin-Kerala, Trivandrum,(1982), p.26.

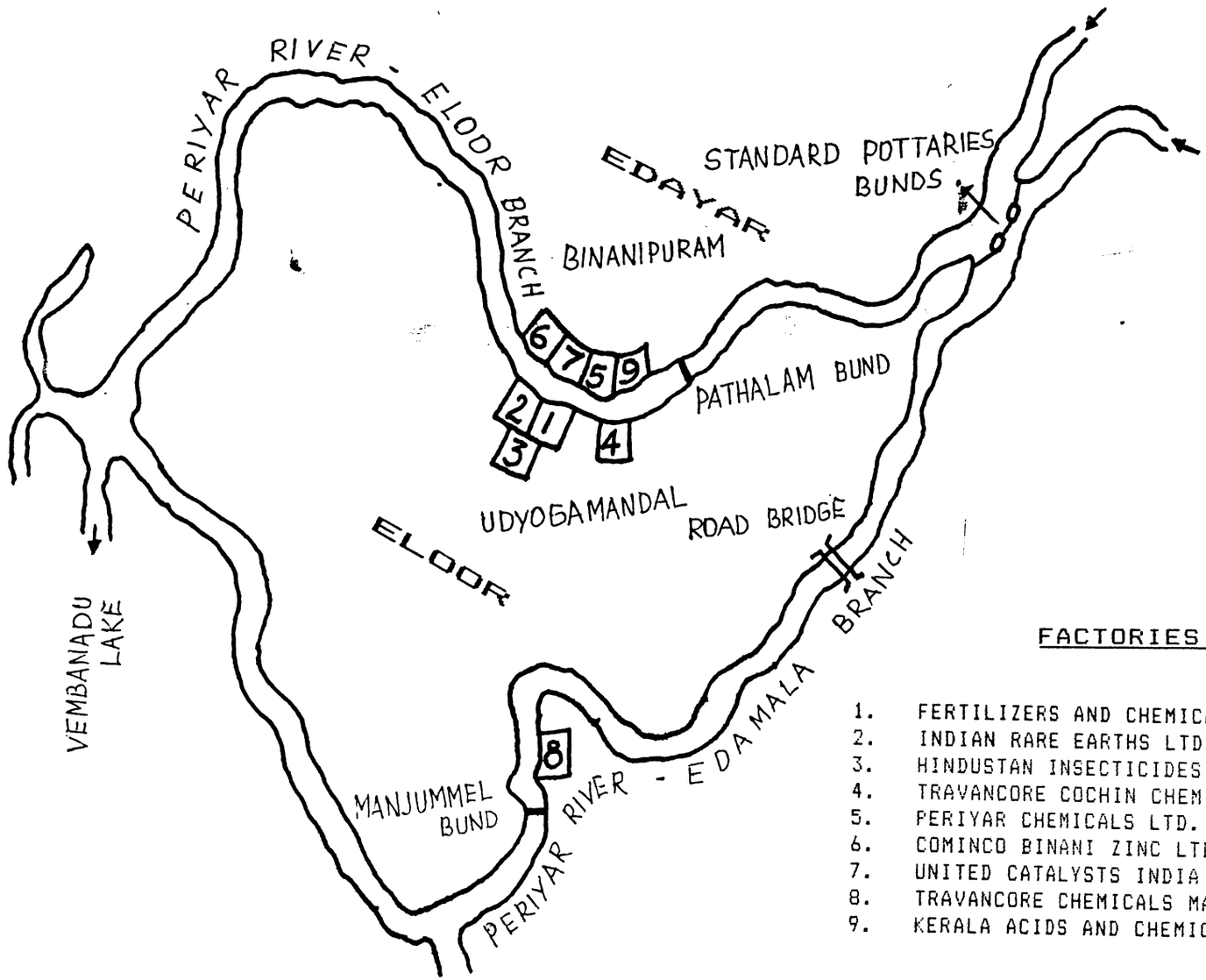
2. Ibid, p.4.

3. George Mathai Tharakan, Comparative Study of Air Pollution in Eloor-Edayar Industrial Belt, School of Management Studies, University of Cochin,(1976), p.36.

4. Kerala State Pollution Control Board,Environmental Status Report on Greater Cochin, Kerala,(1982). p.4.

MAP 6-2

ELOOR-EDAYAR ISLAND



FACTORIES SURVEYED

1. FERTILIZERS AND CHEMICALS TRAVANCORE LTD. (FACT)
2. INDIAN RARE EARTHS LTD. (IRE)
3. HINDUSTAN INSECTICIDES LTD. (HIL)
4. TRAVANCORE COCHIN CHEMICALS LTD. (TCC)
5. PERIYAR CHEMICALS LTD. (PCL)
6. COMINCO BINANI ZINC LTD. (CBZ)
7. UNITED CATALYSTS INDIA LTD. (UCIL)
8. TRAVANCORE CHEMICALS MANUFACTURING COMPANY LTD. (TCM)
9. KERALA ACIDS AND CHEMICALS LTD. (KACL)

Generally soil is disturbed in the low lying areas on the banks along both the branches of the periyar river. Frequent flooding during the monsoons was common in this area prior to the construction of Idukki Dam in 1975. Even now, during the peak of the monsoons, deposition of salt and clay along the banks is not uncommon.

The Paathalam Bund

Periyar, as the very name suggests, is the longest among the 44 major rivers in the state with a running course of 244 kilometres. It has its origin in the Western Ghats and enters the project area at Alwaye below the Marthandavarma Bridge. The river is perennial and the flow diminishes considerably during the dry months, February to May. However, the water discharge is sufficient to maintain the normal flow characteristics even during the dry months.[5]

But unfortunately, during March 1982, there was a total disruption of the normal flow pattern due to very low water levels in Periyar because of the drought conditions. Reverse flow in the Eloor branch during uptides carried the saline water along with the pollutants discharged from the factories, up to the Marthandavarma Bridge and sometimes even beyond. It was then emptied into the estuary through the Edamala branch. This could virtually contaminate the water intake points of the

5. Jolly Joseph, A survey of Ground Water in Eloor-Edayar Industrial Belt, Dept. of Applied Chemistry, University of Cochin,(1982), p.51

factories in the area. The industrial pollution load was thus circulating the island creating a lot of environmental problems and posing a threat to the industrial water supply.

To protect the water intake points from further contamination by the saline upward flow a temporary earthen bund was constructed at Paathalam near Udyogamandal in the year 1982. It could prevent the saline intrusion, but precipitated a lot of serious ecological, economic and political issues. The consequences were collectively termed as the Paathalam Bund Episode. The surface water quality during the period of the episode was monitored by the Kerala State Pollution Control Board (KSPCB). The Board has found an alarming increase in pollution load with respect to all the selected quality indicators.[6] Though, it was considered an episodic issue then, it continued to be a recurring issue, since the water level could not be regulated by the trailrace waters from the Edamalayar Project as expected.

Factories Surveyed

Altogether 9 factories were surveyed in the area for the purpose of the present study. The schedule used for interviewing the executives of those factories for collecting relevant information is given in Annexure--1. The factories are listed in table 6.1 with specifications such as years of establishment and commencement of production, nature of ownership, type of industry, and their location. Their geographical locations are marked in Map 6.2.

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6. For details, see, KSPCB, Episodal Pollution Caused by a Bund Across Periyar, A case Study, Trivandrum,(1982).

The first three factories in the list, namely Fertilizers and Chemicals Travancore Limited (FACT), Indian Rare Earths Limited (IRE) and Hindustan Insecticides Limited (HIL) are central government-owned industrial units. The fourth, Travancore Cochin Chemicals Limited (TCC) is owned by the Kerala State and the ninth, Kerala Acids and Chemicals Limited (KACL) is a Public Limited Company. The remaining four, namely, Periyar Chemicals Limited (PCL), Cominco Binani Zinc Limited (CBZ), United Catalysts India Limited (UCIL) and Travancore Chemicals Manufacturing Company Limited (TCM) are major private limited Companies. The last in the list (KACL) has only recently become fully operational and therefore could not be subjected to a detailed study except for finding out the potential pollutants from the nature of the raw materials used in the production process. A major industry located in the project area, viz. Indian Aluminium Company (INDAL) is excluded from the study as this is a non polluting industry unlike others. This industrial unit only cools water and causes no appreciable water pollution.[7] Though INDAL emits air pollutants such as flourine, CO2, Carbon dust, arsenic particles, their magnitude is considered to be insignificant.

The factories, FACT, IRE, HIL and TCC are situated at Udyogamandal in Eloor on the southern bank of the Eloor branch of the river. The PCL, CBZ, UCIL and KACL are located at Binanipuram in Edayar on the northern bank of the Eloor branch.

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7. Kerala State Planning Board, Economic Review-1982 Trivandrum, Section 9.47.

TCM is at Manjummal, on the eastern bank of the Edamala branch. The FACT is a fertilizer unit; HIL is an insecticides unit; IRE and CBZ are ore processing industrial units; and all others are chemical industrial units.

The study covers about one third of all major industries in Kerala (i.e., 9 out of 31) which include 60 per cent (6 out of 10) of all major chemical industrial units in the State.[8]

Potential Pollutants

Table 6.2 shows the potential pollutants let out by each of the factories by way of effluents, emissions and solid wastes. These pollutants from the respective factories are noted down after consulting the experts in the State Pollution Control Board and the National Environmental Engineering and Research Institute (NEERI). They are harmful in many ways to life and property and to vegetation and animals, if not controlled.

Free ammonia, ammoniacal nitrogen, phosphate (P205), P204, Flourides, PH, suspended solids, COD, Hexavalent Chromium and Zinc are the pollutants contained in the effluents from FACT. The effluents from IRE contain flourides, phosphates, P204, PH, radio-activity,[9] COD and suspended solids. The insecti-cides such as DDTand BHC, PH, suspended solids, and COD are the major polluting elements in the effluents flowed from HIL.

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8. Ibid

9. Storage and disposal of radiactive substances at IRE in the project area are discussed separately in this Chapter.

Water pollutants such as mercury, free chloride, sulphides solids, zinc, PH and COD from TCC; BOD, COD, PH, suspended solids, oil and grease and sulphides from PCL; Zinc,acidic chemicals, PH, and suspended solids from CBZ and hexavalent chromium, PH, suspended solids, copper, iron and zinc from UCIL also contribute to the contamination of water bodies in the area. The effluents from TCM contain copper, salt (NACL), hexavalent chromium and zinc.

Some of the above said pollutants exist in effluents only in traces (eg.copper, chromium etc.). Other pollutants exist in considerable amounts of which a few exceed the desirable and permissible limits, even after treatment. For a few of the polluting elements such as DDT, BHC, mercury and radio-active wastes there does not exist treatment technology and methods of control,and even an insignificant amount of such pollutants can cause hazardous and long lasting effects on living organisms.

Neither the public agencies and their reports, nor the factories themselves do reveal exactly the extent of pollutants contained in the effluents and their intensities. The public agencies like the Pollution Control Board and NEERI are reluctant to make known the intensities of pollutants presumably on reasons such as the confidential nature of the subject and the upkeep of their good relation with the factories, which is perhaps necessary for them to function smoothly with the cooperation of the factory management. On the other hand, the factories are unwilling to impart such information because such

revelations may hamper their interests and obstruct the smooth running of the factories in due course. Anyhow this is a delicate area. The reluctance in the part of the different agencies, viz., KSPCB, NEERI and the factory managements makes it difficult to expose the true nature of the polluting activities of the factories.

The intensities of the pollutants in the effluents before and after treatment as per the information supplied by the factory managements are shown in table 6.3. It shows that the values of most of the parameters conform to the standards prescribed by the Indian Standards Institute (ISI) and/or by the Pollution Control Board. (Standards are the legally permissible maximum content of pollutants in the effluents). But the visible and felt impacts of those pollutants on life, materials and vegetation in the area from the use of the polluted water reveal that many of the pollutants far exceed the legal limits.

The annual report of the KSPCB for the period 1979-80 speaks of the seriousness of some of the water pollutants from the factories in the area. But the report does not give the intensity of the pollutants. According to the report, the major industrial units contributing to water pollution in the area are TCC, FACT, IRE, HIL and CBZ. "The discharge of wastes from major chloroalkaline industry, Viz. TCC, contains mercury. The discharge of effluents from IRE shows the presence of radioactive materials. The wastes thrown into the river from HIL contain DDT, BHC and other insecticides. All these make the

pollution in this river (Periyar) more serious. The reasons for the contamination of this river with ammonia, flouride, phosphate, etc., are due to the effluents from FACT. The zinc containing effluent discharged from the CBZ further aggrevates the pollution problem.[10]

Suspended particulates, oxides of nitrogen, sulphur and carbon, chlorine, hydrogen chloride, acid fumes,ammonia, flourine and other flue gases are the major air pollutants emitted by the factories in the area. Eventhough, the Air (control and Prevention of Pollution) Act, 1981 has been enacted, the Board is yet to take up and execute measures to control air pollution. Therefore no factory in the area has adopted effective measures to restrain air pollutants on a regular basis. Since there was not any compulsion to control air pollution, some of these factories were converting their water pollutants into gaseous form to escape from the clutches of laws regarding the control of water pollution. However, this may not be possible when the Air Act, 1981 is fully enforced.

Solid wastes disposed from these factories are not of considerable quantities. The harmful effects from the solid wastes discharged are less significant compared to those from water and air pollutants in the area.

In India we do not have any legal enactment to control sound resulting from industrial processing and related activities.

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10. KSPCB,Annual Report 1979-1980, Trivandrum, p.12.

Therefore no attempt has so far been made by any of these factories nor by any other agency to monitor and to assess the extent and the impact of sound produced by these factories around the locality. The sound levels in the factory premises and in their respective surroundings are observed to be of alarmingly high decibels, especially in the case of FACT and TCC.

Water Pollution in the Area

Due to the heavy load of various pollutants from the factories, the ground water in the area is polluted. In the river Periyar, especially at its lower reaches the pollution of water is serious. The condition of the Vembanad backwaters is none the better. It may be noted that none of the factories presently studied let out their effluents directly into the sea, or into any lake, or into any public sewage system; but only to the river Periyar.

Ground Water Quality of the Area

The uncontaminated natural water contains fixed range of mineral concentrations as shown in table 6.4. Some of the studies conducted on the quality of ground water in the area show that the values of the parameters exceed not only in their natural contents but also the legal limits prescribed by ISI and/or KSPCB. For example, a study conducted by the Department of Applied Chemistry, Cochin University in 1982[11] revealed

11. Jolly Joseph, A Survey of Ground Water in Eloor-Edayar Industrial Belt, Dept of Chemistry, Cochin University (1982), pp.50-55,

that the quality of the ground water in the Eloor-Edayar island is poor. The study altogether covered 11 wells spread over the island and values obtained for the parameters show that the mineral contents exceed those present in natural water. Also, the values of some of the parameters cross the permissible limits prescribed by KSPCB for the surface uncontaminated water for drinking purpose. Values of the parameters obtained and the permissible limits are shown in table 6.5.

Similarly, the findings of yet another study made by KSPCB and the Department of Science and Technology in co-operation with the Global Environmental Monitoring Programme (GEMS) of the World Bank reveal that the values of most of the parameters such as PH, total coliform, faceal coliform, Dissolved oxygen (DO) Biological Oxygen Demand (BOD), Chloride, hardness, and alkalinity exceed the permissible limits. The monitoring results of open wells at Eloor (in 1981) are shown in table 6.6.

In short, the ground water in the area is highly polluted. The presence of excess minerals and other elements which determine the quality of water reveals this fact. The ground water towards the low reaches of Eloor and Edamala branches and towards the estuary is affected by salinity, as well as industrial discharges. But, near the industrial water intake points and towards the main land, the ground water is less affected and do not often reach this level of contamination.

Polluted Periyar River

In the state there are about 150 large and medium scale industries discharging their trade effluents. It is estimated that about 5000 lakh litres of trade effluents are being dumped into the State's water bodies such as rivers, lakes and tidal waters every day. Of this, 48.5% of the wastes are from chemical industrial units containing chemical pollutants and40.3% from industries letting out organic pollutants. More than 11% (11.2%) represent wastes from engineering industries.[12] The Periyar river alone receives the maximum quantity of industrial effluents, i.e., about 2425 lakh litres[13] per day and almost half of this originate from the industries situated in the Eloor-Edayar industrial belt. That is, the industrial effluents from these industries alone constitute more than 30 per cent of all such effluents created in the state in a day.

Periyar being the only river in the region a major portion of the industrial pollution load of the region is borne by that river. During the year 1982-83, all the industries in the area together discharged more than 1028 lakh litres of effluents per day into the river.[14] The details of waste water generated and the percentage of treatment in the case of each of the industries are shown in table 6.7. The levels of treatment of the pollutants from these factories vary from 50 per cent to 90

12. KSPCB, Annual Report, 1979-80-,Trivandrum, p.11.

13. Ibid.

14. The State Planning Board, Economic Review, 1982, pp.238-239.

per cent. It is true that in 1974-75 (when the state board for pollution control became operational) waste water was not treated by any of these factories, whereas at present it is treated at least partially before being discharged into the river.

Since the effluents are not fully treated, several tonnes of pollutants reach the river every year.[15] Details of the amount of various pollutants reaching the river is given in table 6.8. The 26185.96 lakh litres of waste water from these industries reaching the river contains about 1757 tonnes of suspended solids, 13.838 tonnes of BOD and 900.425 tonnes of COD per year. Periyar river also receives from the effluents toxic, biomagnifiable and biochemical substances such as 2000 Kg. of mercury, 1476 Kg of hexavalent chromium, 10095.46 Kg. of zinc, 327 Kg of copper, 250 tonnes of flourides and 30,000 Kg of iron per year. The pollution load of phosphates, free ammonia and ammoniacal nitrogen from these industries amount to 809 tonnes, 685 tonnes and 2512 tonnes respectively during a year.

Due to this heavy load of pollutants, Periyar river in the area is considrably polluted. The State Pollution Board has been thoroughly monitoring the river under a project funded by the Department of Science and Technology. The monitoring results at eight stations in the river in the area and the adjacent localities during the year 1980 are shown in table

15. The quantity of various pollutants reaching Periyar River during a year is obtained from, Environmental Status Report on Greater Cochin,(1982), pp.30-31.

6.9. As can be seen, the values of all parameters in the upper reaches of the river are normal. The quality of water in the portion of the river flowing through the project area is very poor due to the wastes discharged into it from the industries situated in the Eloor-Edayar belt. The worst pH record was as low as 2.8 (highly acidic) and the Dissolved Oxygen content, was 0.93 mg/l. The B.O.D of the river water went upto 16.2 mg/l. Concentration of pollutants like ammoniacal nitrogen was as high as 46 mg/l. and phosphate was 15.8 mg/l.[16]

In addition to the industrial pollutants another grave danger posed to the river is the bilogical pollution due to urbanisation of the Greater Cochin Area and the rapid growth of Municipalities like Alwaye, Perumbavoor etc. on the banks of the river upstream above the industrial belt.[17] Raw sewages from these municipalities containing the released storm water, effluents from markets and hospitals, blood and carcasses from slaughter houses etc. are directly let out into the river without any treatment as these municipalities do not have any plant for sewage treatment at all. One of the main outlets for sewage from Alwaye is just 250 metres away from the pumping station for drinking water supply to Greater Cochin. With local bodies polluting the river in this manner the social conciousness of the general public has deteriorated to the extent that the people living along the river dump their garbage into the

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16. Ibid., pp.6-7

17. P. Venugopal, "Polluted Flows the Periyar", Indian Express, Dec.6, 1986. Also see, Seminar Papers, National Seminar on "Save Periyar" conducted at Alwaye on 7th Dec. 1986.

river. Almost every day there are press reports indicating the presence of live thread like worms in the drinking water supplied to the millions of the Greater Cochin area. Besides, the agricultural wastes from farms all along the river and soil containing residues of fertilisers and insecticides of various types must be flowing into the river in considerable amounts.

While chemical and bilogical pollution of the river is growing day by day, the problem is aggravated by two more factors. (1) large scale lowering of the river bed by the removal of sand for filling low lying areas and building construction and the reduced flow of water by the construction of dams upstream. With the lowering of the bed level of the river and reduced flow from upstream, the reverse flow from the sea at the high tides, as mentioned earlier, carries all the chemical and biological pollutants upto or even above the main water supply pumping station at Alwaye.[18] During summer, the water is so polluted that people are afraid to take bath in the river. Still, people have to drink this water in Cochin and the surrounding towns.

Condition of the Vembanad Backwaters

The Vembanad backwaters into which the river Periyar empties itself lies at the west of the project area and covers a significant area of the western part of Greater Cochin. The backwaters are connected to the sea at two places in Greater cochin,

18. P. Venugopal, "Pollution Seeping into Drinking Water Too" Indian Express, Dec. 12, 1986.

at Cochin and Crangannore. The entire backwater stretch is saline during summer. But with the onset of the monsoons, the salinity decreases drastically. The total dissolved oxygen in the backwaters comes down to 160 mg/l. during the monsoon season from values as high as 53750 mg/l during the summer season.[19] Thus normally, during the monsoons the entrie stretch of the backwater becomes a fresh water lake.

But, the above mentioned and similar pollution load reaching the backwaters through the river together with that from other 78 million litres of effluents per day flowed directly from various other industrial units causes serious pollution of the backwaters.[20] Besides, pollution of the backwaters is also caused by husk - retting and agricultural wastes. Consequently, during recent times fish kills in Vembanad backwaters are reported several times during a year. The life and health of all living organisms in it are affected.

Air Pollution

The atmosphere of the area and of the surrounding places is polluted due to industrial emissions. Every factory in the area causes pollution of air in varying magnitudes. Table 6.10 shows the major air pollutants emitted by the factories, the average height of the stacks and the volume of such pollutants discharged during a year. The volume of sulphur and ammonium compounds

19. KSPCB, Environmental Status Report on Greater Cochin, 1982, p.5

20. Ibid.

discharged is very high. A large amount of carbon dioxide is also let out. The extent of chlorine disposed off into the air by certain factories in the area also causes serious problems of air pollution in and around the project area.

The concentration of some of the air pollutants in the project area have been studied by George Mathai Tharakan in 1976. The monitoring results of sulphur dioxide, sulphuric acid mist, ammonia and ammonium compounds and suspended particulate matter obtained when the experiment was conducted for each of them at three stations in the premises of CBZ for a month are given in table 6.11. The average range of values obtained in the case of all these parameters exceeded the permissible limits. (The permissible limits are shown in tables 6.12 and 6.13)

Similarly, the study conducted by NEERI[21] on the condition of atmosphere over Cochin city included Udyogamandal (Eloor) as one of its monitoring stations. The values obtained for parameters like sulphur dioxide, nitrogen dioxide and suspended particulate matter (summarily given in table 6.14) exceed the desirable limits of pollution of the atmosphere around the Eloor-Edayar belt. Yet another set of data obtained from NEERI[22] gives the monitoring results (during January-March

21. National Environmental Engineering and Reasearch Institute, National Air Quality Monitoring Net work, Air Quality in Selected cities in India, Nagpur(1978-79), pp.78-81

22. V.T. Padmanabhan,"The Number Game: A sutdy of Occupational Health Hazards at IRE, Alwaye", Economic and Political Weekly, March 8-15, 1986.

1980) of the average concentration of SO_2 and suspended particulate matter at Eloor. One of the sampling stations was located at half a kilometre north of FACT. The average concentration of SO_2 reached a four-hourly maximum of 423 ug/m^3 and a day's maximum of 150 ug/m^3. Similarly the average for suspended particulate matter had reached 186 ug/m^3 of maximum and as high as the arithmetic mean (AM) of 173 ug/m^3 (See table 6.15) during the period.

Another study by P.V.S. Namboodiripad on the concentration of sulphur dioxide in the area obtained certain alarming results (see table 6.16). "It can be seen that the value of SO_2 has gone as high as 700 ug/m^3 in this area which is perhaps the highest in the world. It can be said that only rarely or occasionally does the level reach such a high measure. The average comes to more than 300 or 400 ug/m^3. Even this would be one of the highest in the world"[23]

There is a close relation between relative humidity and the concentration of polluting gases. Relative humidity is defined as the partial pressure of water vapour in air divided by the vapour pressure of water at a given temperature.[24] When the humidity is low in the atmosphere, the gases can immediately go high and get dispersed to far off places. The concentration of

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23. P.V.S. Namboodiripad,"The Air We Breathe",paper presented in World Environmental Day Seminar, at the School of Environmental Studies, University of Cochin, Cochin, June 5, 1982.

24. George Mathai Tharakan,(1976), op.cit p.36

the gases becomes very high in highly humid periods of the year. Therefore the difference in humidity will help us to understand the severity of the problem during the rainy months in Kerala. The humidity range during the different months are given in table 6.17. The high concentration of polluting gases in high humidity has its serious effects in the immediate locality around the Eloor-Edayar industrial belt.

Similarly, fog formation is a regular feature during the rainy season in this area. The smog (smoke and fog) often covers the atmosphere of an area with a radius of 3 to 5 kilometres from the Eloor-Edayar belt and sometimes goes even beyond (Vypin, Parur, Alwaye, Thrikkakara, Palarivattom, etc. are affected places). This can cause serious health hazards on humans and animals and damage to crops and materials.

Solid Wastes and Sound Pollution

Solid wastes disposed off from the factories in the area are not of considerable quantities except in the case of FACT where chalk and gypsum are the major items. (The case of IRE is discussed separately). These wastes are careied to a distant wharf area and used for filling the low lying lands there. Other wastes from the factories such as saw dust, floor moppings, gunny bags, packing materials, suspended solids, Calcium Carbonate, barium sulphate, silica, iron dust, mud etc., are disposed off mostly into the factories' own land to fill the low lying lands and in the case of some of the factories they are flowed into the effluent streams. The problem of solid

waste disposal in this area is less serious compared to that of water and air pollutants.

Noise is a purely disfunctional consequence of our technology. Above a certain level sound can be harmful even when it is not consciously being heard and directly affects our physical and emotional well being.[25] As mentioned earlier, there has not so far been made any attempt by any of the factories nor by any other agency to monitor and assess the extent and the impact of sound produced by the factories in the locality.

Storage and Disposal of Radioactive Substances in the Area

The Udyogamandal unit of the IRE is the single and major producer of radioactive substances in the project area. IRE, an undertaking of the Department of Atomic Energy (DAE) is engaged in the processing of monazite sand found in abundance in Kerala and Tamilnadu coasts. The plant has a processing capacity of 4200 tonnes a year. The main products of IRE are Thorium, rare earth chloride (RE Chloride) and Zirconium. Mainly because of the prohibitive provisions of the Atomic Energy Act of 1962, no serious attempt has been made for the repeated measurement of radiation level (concentration level of radio nuclides) with the help of sophisticated gadgets by any researcher, individual or

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25. Joseph Julian, Social Problems, Prentice Hall Inc., New Jersey,(1980), p.540

organization. Recently, studies by V.T. Padmanabhan[26] on the potential threat of serious radioactive pollution of the area from the storage of the factory's main products and the disposal of radioactive wastes within the factory compound are noted by environmentalists and the public at large both in the country and abroad. The main product, thorium oxide, is stored in a silo attached to the factory and the bye-product/wastes in RCC barrels are burried in the factory compound in concrete trenches all of them containing highly radioactive elements, though in varying bacquerels (bq)[27]

An estimated 11,000 tonnes of monazite was processed at IRE during 1953-61 to yield an estimated 12,876 tonnes of RE Cholride, of which 3710 tonnes were exported as per customs

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26. See 1. Padmanabhan, V.T. Duranthathinte Noottandileku (in Malayalam), Pushtaka Prasadhaka Sangham, Pandalam, Kerala, 1985.

2. The Number Game - A study of Occupational-Health Hazards at IRE, Alwaye, Kerala Sasthra Sahithya Parishat, 1986.

3. "The Number Game - A study of Occupational Health Hazards at IRE, Alwaye", in Economic and Political Weekly, March 8-15 (Nos.10 and 11), 1986.

and 4. "All within Limits: Radio active waste Disposal at IRE",in Economic and Political Weekly, Feb. 28 (No.9) and March 7 (No.10), 1987.

27. Radiation is emitted during the transformation (disintegration) of a radioactive substance. The unit of measuring the rate of transformation is becquerel (bq.) which denotes one distintegration per second.

statistics.[28] During the priod of 1962-85 an estimated 75,380 tonnes of monazite were processed to yield a proportionate RE Chloride and radio active wastes at the rate of one barrelful of waste for every ten tonnes of monazite processed.[29] As of now, nearly 5000 barrels of radio active solid wastes are buried near the factory. The solid wastes contain uranium 238, meso-throrium, barium sulphate and sodium chloride.[30]

It is reported that many of the R.C.C. barrels are broken even before being placed in the trench which is said to be built with concrete using poor quality cement.[31] The area surrounding the disposal site has a high population density with an occupancy rate of 20,000 persons per square kilometre because of the presence of the factories and the residential complexes. Less than 30 metres away from the disposal site is a sulphuric acid plant complex of the FACT with an installed capacity of 700 tonnes of sulphuric acid per day. It is an admitted fact that a quarter of a tonne of sulphuric acid is lost as leakage every day. In this way, hundreds of tonnes of acid must have leaked into the ground which can damage the trench and the barrels as the acid was there even before IRE decided on the disposal

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28. Padmanabhan, V.T.,"All within Limits: Radioactive Waste Disposal at IRE", in Economic and Political Weekly, No.9, Feb. 28,1987, pp.380-81.

29. Ibid.

30. Ibid.

31. Padmamabhan, V.T.,"All within Limits: Radioactive waste Disposal at IRE"in Economic and Political Weekly, No.10, March 7, 1987, p.420

site. Further, being close to the perennial river, there is underground water the year round near the trench. Even during the summer , half the concrete trench would be immersed in water which is acidic. The main product, thorium oxide in the form of a fine powder is stored in a silo built with plastered walls and roofed with asbestoes sheets. A crack is found on the wall facing the river (Eloor Branch). The possibilities, like damage of a dam upstream, a flood, a terrorist's bomb, a cyclone or a storm can not be ruled out outright. And, if contaminated, for thousands of years, the river Periyar would have to be totally abandoned.

According to sources inside IRE, earlier the waste was towed away in boats for dumping in the Arabian Sea somewhere near Cochin.[32] Radioactive elements are also released along with liquid effluents directly into the river Periyar. As the flow chart of the IRE shows, there is only one stage in the process when water is used in significant quantity - leaching of slurry containing thorium, uranium and rare earths to remove the phosphate content. But water is also used for floor washing which is done at frequent intervals. The effluent treatment plant was set up only during the year 1980. Even this does not deal with the entire effluents discharged from the shop floor. It seems that KSPCB is not aware of the discharge point of IRE at its Southern boundary which drains off water from the floor washing. It is a fact that the pollution control Board does not

32. V.T. Padmanabhan, "All Within Limits: Radioactive Wastes Disposal at IRE", Economic and Political Weekly, Feb. 28, 1987, p.381

have either gadgets or expertise for measuring radioactivity. It is estimated that the total amount of uranium so far lost to the marine ecosystem from IRE is well over 70 tonnes, an average loss of 1.5 tonnes every year.[33] During 1953-80, an estimated 3,367 tonnes of solid wastes might have escaped into the river. The thorium and uranium content of this quantity works out to 673.4 and 6.74 tonnes respectively.[34] Tables 6.18, 6.19, 6.20 and 6.21 give details of the total quantity of radio activity released from IRE during 1953-80, their radiation potential and Half Life[35] of Uranium and thorium elements.

33. V.T. Padmanabhan, Economic and Political Weekly, March 7, op.cit, p.423

34. V.T. Padmanabhan, Economic and Political Weekly, Feb. 28, op.cit, p.383

35. A half life is the length of time during which half the atoms of an element under consideration have disintegrated or decayed to attain stable form and yet another half life is required to decay the half of the remaining half of atoms and so on.

TABLE - 6.1

Factories Surveyed

Sl. No.	Factories Surveyed	Year of establi-shment	Year of commence-ment of production	Nature of ownership	Type of Industry	Loacation
1.	Fertilizers and Chemical Travancore Ltd. (FACT)	1944	1947	Govt. of India undertaking	Fertilizer	Eloor (Udyogamandal)
2.	Indian Rare Earths Ltd. (IRE)	1952	1953	- do -	Ore proces-sing	- do -
3.	Hindustan Insecticides Ltd.(HIL)	1958	1958	- do -	Chemical	- do -
4.	Travancore-Cochin Chemicals Ltd (TCC)	1950	1954	Govt. of Kerala undertaking	Chemical	- do-
5.	Periyar Chemicals Ltd. (PCL)	1969	1971	Private	Chemical	Edyar (Binanipuram)
6.	Cominco Binani Zinc Ltd. (CBZ)			Private	Ore Proces-sing	- do -
7.	United Catalysts India Ltd.(UCIL)	1969	1970	Private	Chemical	- do -
8.	Travancore Chemicals Manufacturing Co., Ltd. (TCM)	1942	1942	Private	Chemical	Manjummal
9.	Kerala Acids & Chemicals Ltd. (KACL)	Being commissioned		Public Ltd	Chemical	Edayar (Binanipuram)

TABLE - 6.2

Potential Pollutants

Factories	Water Pollutants	Air Pollutants	Solid Wastes
1. FACT	Suspended solids, Dissolved flourides, Dissolved Phosphates, P^H, free ammonia Ammoniacal nitrogen, COD Hexavalent chromium, Zinc etc.	Ammonia SO_2 CO_2 flourine suspended particulates	Gypsm chalk
2. IRE	Fluorides, Phosphates, Radio-active materials P^H, C.O.D., Suspended solids		Radioactive substances
3. HIL	Insecticides, P^H, COD, suspended colids	Acidic fumes	Sow dust, floor moppings, gunny bags, suspended solids insecticieds.
4. TCC	Mercury, Free chloride, Sulphides, P^H, COD, Zinc, Suspended solids	Cl_2, HCL	Calcium carbonate, Barium sulphate and other redeamed residuals.
5. PCL	B.O.D., C.O.D., p^H, Suspended solids, oil and grease, sulphides	CO, CO_2	
6. CBZ	Suspended solids, Zinc, P^H, acidic chemicals		
7. UCIL	Hexavalent Chromium, P^H, suspended solids, Copper, iron, zinc.		
8. TCM	Copper, Salt (NACL), Hexavalent chromiu, zinc		Zilica, Iron-dust, Red mud from Boxite plant etc.

Table - 6.3

Concentration of Pollutants in the Effluents

Factories	Water Pollutants	Before treatment	After treatment	Standard (ISI/KSPCB)
FACT	PH	5 - 9.5	Within limits	5.5 - 9.0
	Free Amonia	700 ppm	"	--
	Ammoniacal Nitrogen	600 ppm	"	50 mg/1
	Dissolved phosphate	4000 ppm	"	2.0 mg/1
	Dissolved flourides	3000 ppm	"	2.0 mg/1
	Suspended solid	20,000 ppm	"	100.0 mg/1
IRE				
HIL	Insecticides	--	1 - 2 ppm	zero
	PH	3.5 to 6.0	7.0 - 8.0	5.5 - 9.0
	Suspended solids	800 ppm	75 ppm.	100 mg/1
TCC	Mercury	0.1 mg/1	0.005 mg/1	0.01 mg/1
	PH	4.5 - 11.0	6.0 - 8.0	5.5 - 9.0
	Suspended solids	600 mg/1	50 mg/1	100 mg/1
PCL	Suspended solids CBZ	150 mg/1	50-80 mg/1	100 mg/1
UCIL	Suspended solids	200 ppm	30-60 ppm	100 mg/1
TCM	Copper	10 ppm.	1 ppm.	3 mg/1.
	Salt (NACL)	negligible	-	

Note: mg/1 = milligrams per litre.

ppm = parts per million.

PH = measure of acidity or alkalinity; PH zero to 7 means the water is acidic and PH 7 to 15 means alkaline.

TABLE - 6.4

Typical Mineral Concentrations for Uncontaminated Water

Chemical Component	Expressed as	Natural Water Types				
		Rain	Soft Surface	Soft Surface	Hard Surface	Hard Surface
Calcium	$CaCO_3$ Equi(mg/1)	16	30	29	80	142
Magnesium	$CaCO_3$ (mg/1)	3	16	32	40	59
Sodium & Pottasium	Na (mg/1)	6	9	26	19	20
Biocarbonate	$CaCO_3$ (mg/1)	12	42	60	106	143
Chloride	C1 (mg/1)	5	7	9	23	23
Sulphate	SO_4 (mg/1)	10	12	17	38	59
Nitrate	N (mg/1)	0.1	1.5	--	0.4	0.06
Iron	Fe (mg/1)	0	1.1	1.8	0	0.18
Silica	$Si0_2$ (mg/1)	0	30	41	184	12
Carbondioxide	$CaCO_3$ (mg/1)	4	4	59	4	14
PH	-	6.8	6.9	6.6	7.8	7.4

Source: World Bank/August 1978, Environmental Consideration for the Industrial Development Sector, Washington, D.C. 1978, p.102.

TABLE - 6.5

Ground Water Quality in Eloor-Edayar Island

Parameters	Values	Permissible limit (KSPCB)
PH	5.5 - 7.5	5.5 - 7.0
Total hardness as $CaCO_3$	17.5 - 127 mg/1	Standard not prescribed
Chloride	10 - 142 mg/1	1.0 mg/1
Sulphate	1.3 - 54 mg/1	2.0 mg/1
Nitrate	3 - 31.4 mg/1	Standard not prescribed
Flouride	0.2 - 2.33 mg/1	2.0 mg/1
Suspended solids	98 - 460 mg/1	30 mg/1

Source: Compiled from Jolly Joseph, "A Survey of Ground Water in Eloor-Edayar Industrial Belt", Project Report, Department of Applied Chemistry, Cochin University, 1982, p-52.

TABLE - 6.6

Ground Water Quality of Open Wells at Eloor (1981)

Parameters	Values Minimum	Maximum	Permissible limits (KSPCB)
PH	6.20	6.85	5.5 - 7.00
Total Coliform (MPN/100 ML)	160	5500	*50
Feacal Coliform (MPN/100 ML)	90	1200	*50
Dissolved Oxygen (mg/1)	2.06	4.2	*prescribed minimum 5.0 mg/1.
Biochemical Oxygen demand (B.O.D.) (mg/1.)	0.216	2.60	30 for 5 days at 20°C maximum.
Chloride (mg/1)	12.6	132.6	1
Hardness (mg/1)	13.2	212	*142
Alkalinity	8.0	13.2	7.00

Source: KSPCB, Environmental status Report of Greater Cochin, op.cit. Kerala 1982.

* New York State Surface Water Standards; See World Bank/August 1978 op.cit. p.99 and p.102.

Permissible limits for parameters against asteric mark have not been prescribed by KSPCB in the case of drinking water.

TABLE - 6.7

Volume of Waste Water Discharged by the Industries Into the River Periyar (in 1982-83)

Name of the Factory	Source of water intake	Waste Wtr generated in 1974-75 (000'ltr/day)	% of treatment in 1974-75	Waste Wtr generated in 1982-83 (000'ltr/day)	% of treatment	Waste Wtr let out into
1. FACT	Edamala branch	61,000	0	61,000	50	Eloor branch
2. IRE	Edamala branch	4,586	0	4,586	90	Eloor branch
3. HIL	Edamala branch	245	0	325	90	A Canal which joins Eloor branch
4. TCC	Edamala branch	10,200	0	10,200 (An extensive treatment plan proposed)	50	Eloor branch
5. PCL	Factory's own well	120	0	120	80 (partially treated)	Eloor branch
6. CBZ	Edamala branch	23,150	0	23,150	60	Eloor branch
7. UCIL	Edamala branch	2,800	0	2,800	--	Eloor branch
8. TCM	Edamala branch	655	0	655	--	Eloor branch
Total volume of effluents discharged		1,02,756		1,02,756		

102756000 litres/day during 1982-83.

Source Government of Kerala, Economic Review 1982, State Planning Board, Trivandrum, 1983, pp.238,239.

TABLE - 6.8

Quantity of Pollutants Discharged into the River Periyar

Name of the Factory	Waster water (1000000 ltrs/year)	Suspended solids (tonnes/yr)	B.O.D. (tonnes/ uear)	C.O.D. (tonnes/ year)	PH (average)	Toxic, biomagnified and bio-accumulable substances and other parameters (kgs/year)
FACT	20658.00	1336.06	--	558.20	5.78-7.62	Hexavalent chromium: 1125 kg/year F:250000 kg/year; P_2O_4: 736000 kg/year Free Ammonia: 685000 kg/year. Ammoniacal Nitrogen: 2512000 kg/year
IRE	705.10	11.97	--	38.67	3.9-12.0	P_2O_4: 73000 kg/year; Zinc = negligible.
HIL	65.60	2.04	--	5.20	4.13	Insecticides, not measured.
TCC	3504.00	327.82	--	220.84	7.4-9.4	Mercury: 2000 kg/year.
PCL	43.20	11.67	10.48	48.65	5.60	- -
CBZ	844.98	7.604	--	--	--	Zinc 7500 kg/year.
UCIL	126.00	57.45	2.27	17.15	7.62	Hexavalent chromium: 316 kg/year Zinc: 2450 kg/year Copper: 327 kg/year, Iron: 30,000 kg/year.
TCM	238.08	1.418	1.088	11.715	6.03-7.05	Hexavalent chromium: 35 kg/year Zinc: 145.46 kg/year
Total	26185.96	1757.032	13.838	900.425	--	Mercury: 2000 kg/year; Zinc: 10095.46 kg/yr Hexavalent Chromium: 1476 kg/year, Copper: 327 kg/year and others as shown above.

Source: KSPCB, Environmental Status Report of Greater Cochin, 1982, op.cit. pp.3031 (combiled)

TABLE - 6.9

Water Quality - Periyar Riverine System - 1980

Monitoring Stations	PH		B.O.D. 5 days (mg/1)		Total dissolved solids (mg/1)		Dissolved Oxygen		Total amonical nitrogen (mg/1)		Chlorides (mg/1)		Phosphate (mg/1)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1. Cheruthoni	7.3	7.85	1.2	1.2	65	140	6.7	7.33	trace	2.3	10	12	--	--
2. Neriyamangalam	6.9	7.5	2.0	2.6	70	70	7.53	8.0	0.1	2.1	7	12	--	--
3. Thottuva	6.7	8.1	0.2	1.3	20	806.6	6.7	8.9	0.15	3.2	6	20	0.8	0.8
4. Chowara	7.1	8.1	0.5	2.6	15	694.8	5.67	8.73	0.1	5.9	4.5	900	--	--
5. Eloor	2.8	7.9	0.8	5.8	665	16,885	2.2	8.7	0.3	46	12	9500	0.60	15.8
6. Edayar	4.8	7.4	10	11.4	75	3,510	4.2	7.6	0.10	28	8	3800	0.1	2.5
7. Kalamassery	7.05	7.45	0.8	9.8	48	524	0.93	8.0	0.01	2.4	8.0	36.0	0.6	1.62
8. Manjummal	5.9	7.9	0.20	16.2	75.5	7,400	4.8	7.8	0.20	16	8.0	5600	0.2	0.8

Source: KSPCB, Environmental Status Report, 1982, op.cit. p.25.

TABLE - 6.10

Major Air Pollutants emitted by the Factories in the Area

Air Pollutants	Number of stacks	Estimated volume/ year in metric tonnes	Average height of the stacks
1. Sulphur dioxide	12)		55'
	)	Above 2500	
2. Sulphuric acid fumes	14)		50'
3. Ammonia	11)		40'
	)	Above 3000	
4. Flourine	8)		40'
5. Carbondioxide	23	50000	35'
6. Chlorine	5	Above 800	35'
7. Hydrochloric acid fumes	8	- - -	60'
8. Flue gases such as N_2,H_2O, etc.	16	- - -	30'

Source: George Mathai Tharakan, Comparative Study on Air Pollution in the Eloor-Edayar Industrial Belt, Project Report, University of Cochin, 1976, Chapter III.

TABLE 6.11

Concentration of Certain Air Pollutants

Major Air Pollutants	Average Concentration During a Month
Sulphur dioxide	00.049 - 0.074 ppm.
Sulphuric acid mists	15.68 - 20.53 ppm.
Ammonia & Ammoniacal compounds	28.8 - 36.00 ppm
Suspended particulate matter	01.15 mg/1 - 1.97 mg/1.

Source: George Mathai Tharakan, (1976) op.cit (adapted).

TABLE - 6.12

U.S. National Ambient Air Quality Standards

Pollutants	Average time	Primary Standards	Secondary Standards
Particulate matter	Annual geometric mean	75 ug/m^3	60 ug/m^3
	24 hours	260 ug/m^3	150 ug/m^3
Sulphur Oxides	Annual arithematc mean	80 ug/m^3 (0.03 ppm)	- -
	24 hours	365 ug/m^3(0.14 ppm)	- -
	3 hours	---	1300 ug/m^3(0.5 ppm)
Carbon monoxides	8 hours	10 mg/m^3 (9 ppm)	10 mg/m^3 (9 ppm)
	1 hour	40 mg/m^3(35 ppm)	40 mg/m^3 (35 ppm)
Nitrogen dioxides	Annual arith-ematic mean	100 ug/m^3 (0.05 ppm)	100 ug/m^3 (0.05 ppm)
Photo chemi-cal oxid-ants	1 hour	160 ug/m^3 (0.08 ppm)	160 ug/m^3 (0.08 ppm)
Hydrocarbons (non-methane)	3 hours (6 to 9 am)	160 ug/m^3 (0.24 ppm)	160 ug/m^3 (0.24 ppm)

Source: World Bank/August 1978 Op.cit. p.16.

TABLE 6.13

Range of Uncontaminated and Hazardous Air Quality Levels

Contaminants	Uncontaminated	Hazardous to humans
CO	0.03 ppm	(50 ppm (90 minutes) (10 ppm (8 hours)
NO_2	4 ppb	0.06 ppm (mean 24 hours)
NO	2 ppb	- - -
$HCCH_4$	1 - 1.5 ppm	500 ppm (aliphatic) (alicyclic)
Other HC	0.1 ppm	(25 ppm (aromatic) (0.06 ppm (HOHC) (0.25 ppm (Adroloin) (50 ppm (Acetaldehyde)
SO_2	0.002 ppm	0.04 ppm
O_3	0.1 - 0.05 ppm	0.3 ppm
Particulates	10 - 60 ug/m^3	80 - 100 ug/m^3

Source: World Bank/August, 1978. Op.cit. p.98.

TABLE - 6.14

Concentration of SO_2, NO_2 and Suspended Particulates at Udyogamandal Area

Month (1979)	Average Concentration of Given Parameters (in ug/m^3)		
	SO_2 (every 10th day, 24 hours	NO_2 (once a month 24 hours)	Suspended Particulates
January	--	--	--
February	190	8	153
March	34	10	112
April	55	28	150
May	53	26	144
June	206	13	194
July	211	13	150
August	94	18	195
September	--	--	--

Source: Government of India 'Air Quality in Selected cities in India 1978-79, NEERI, Nagpur, 1980, pp.78,79 and 81.

TABLE - 6.15

Concentration of SO_2 and Particulates in the Area During January - March 1980

Unit: Ug/m^3

Month/ Year	Total Samples	SO^2 4hrly Max.	Days Max.	Suspended particulate matter AM	Max	AM
Jan 1980	3	423	150	76	186	173
Feb 1980	2	60	38	24	161	145
Mar 1980	3	177	63	39	115	101

Notes: Sampling frequency: every 10th day - 24 hours.
AM = Arithematic Mean.
4 hrs. Max = Maximum recorded in 4 hours. in the month.
Days max = Maximum calculated for 24 hours. in the month.

Source: NEERI, (Data received from WHO vide letter No.1CP, 003 dated October 5, 1984), quoted in V.T. Padmanabhan, the Number Game in Economic and Political Weekly, March 8-15, 1986 op.cit., p.452.

TABLE - 6.16

Concentration of SO_2 in Eloor-Edayar Industrial Belt.

Unit: ug/m^3

Time	3rd September 1978	5th October 1978	20th November 1978	26th December 1978
1st four hours	425	700	191	292
2nd four hours	97.5	177	372	148
3rd four hours	83	21	208	113
4th four hours	51.2	12	20	45
5th four hours	62.1	Spoiled	25	90
6th four hours	557.5	225	12	195

Source: P.V.S. Namboodiripad, "The Air We Breath", Paper Presented in World Environmental Day Seminar, June 5, 1982, Cochin.

TABLE - 6. 17

Humidity Range During Different Months in Kerala

Months	Humidity range
J	50 - 70
F	60 - 72
M	50 - 67
A	60 - 73
M	61 - 85
J	69 - 93
J	78 - 93
A	80 - 95

Source: George Mathai Tharakan, (1976), Op.cit. p.36

TABLE - 6.18

Radio Activity due to Effluents Released From IRE During 1953 - 1980

Element	Quantity tonnes	Radioactivity Giga bq.per mt.	Total activity
Thorium 232	673.4	4.06	673.40x4.06 = 2732.40
Mesothorium I			2732.40
Radiothorium			2732.40
Uranium.238	6.73	12.30	6.73x12.30 = 82.83
Uranium II			82.83
Radium 226			82.83
Radium D			82.83
Total radioactivity in Giga Bq.per metric tonne			5828.40

Giga bq = One billion Becquerel.

Source: Padmanabhan V.T., "All Within Limits: Radioactive Waste Disposal at IRE", in Economic and Political Weekly, No. 9, Feb 28, 1987 p.382.

TABLE - 6.19

Radioactivity Released from IRE During 1953 - 1980

Nuclide	Half life years	PERIOD 1953-61 Quantity tonnes	1953-61 Activity Giga.bq.	1962-69 Quantity tonnes	1962-69 Activity Giga.bq.	1953-80 Quantity tonnes	1953-80 Activity Giga.bq.
Uranium 238	4.5 billion	15.8	194.34	50.76	624.35	6.73	82.80
Uranium 234	248000	--	194.34	--	624.35	--	82.80
Radium 226	1617	--	194.34	--	624.35	--	82.80
Radium 210	23	--	194.34	--	624.35	--	82.80
Thorium 232	18 billion	--	---	--	--	673.40	2732.40
Mesothorium	6.75	--	6414.80	--	20608.56	--	2732.40
Radiothorium	1.90	--	6414.80	--	20608.56	--	2732.40
Total Activity			12839.60		41217.12		8197.20

Source: V.T.Padmanabhan , in Economic and Political Weekly, Feb.28, 1987, "op.cit", P-382.

TABLE - 6.20

Radioactive Decay Series - Thorium 232

Element	Atomic Number	Half Life	Type of radioactivity
Thorium 232	232	14 billions yrs.	Alpha
Mesothorium I	228	6.75 years	Beta
Mesothorium II	228	6.1 hours	Beta
Radiothorium	228	1.9 years	Alpha
Thorium X	224	3.6 days	Alpha
Thoron (gassions)	220	54 seconds	Alpha
Thorium A	216	0.16 seconds	Alpha
Thorium B	212	10.60 hours	Beta
Thorium C	212	60.50 hours	Alpha
Thorium C^1	212	0.000000 seconds	Beta
Thorium C"	208	3.7 minutes	Beta
Lead	208	Stable	--

Source: V.T. Padmanabhan, in Economic and Political Weekly, Feb. 28, 1987 "op.cit" p-383.

TABLE - 6.21

Radioactive Decay Series: Uranium 238

Element	Automic Number	Half Life	Type of Radioactivity
Uranium I	238	4.56 billion yrs.	Alpha
Uranium X	234	24 days	Beta
Uranium Z	234	6.7 hours	Beta
Uranium II	234	248000 years	Alpha
Ionium	230	80000 years	Alpha
Radium	226	1617 years	Alpha
Radon (Gas)	222	3.8 daus	Alpha
Radium A	218	3 minutes	Alpha
Radium B	214	27 minutes	Beta
Radium C	214	20 minutes	Alpha/Beta
Radium C¹	214	0.0004 seconds	Alpha
Radium C"	210	1.32 minutes	Beta
Radium D	210	23 years	Beta
Radium E	210	5 days	Alpha/Beta
Radium F	210	138 days	Alpha
Radium E"	206	4.2 minutes	Beta
Lead	206	Stable	--

Source: V.T. Padmanabhan, in Economic and Political Weekly, Feb.28, 1987, "op.cit" P.383.

CHAPTER - VII

IMPACT ANALYSIS

The state of environment in Eloor-Edayar industrial belt was the topic of discussion in Chapter six. The major harmful pollutants present in the area, as identified by the factories, the Board and various other agencies, had been pointed out in that chapter. As is made known, pollution in our study area is both natural and man made. Pollution caused by natural forces implies, mainly the salinity intrusion. The salinity intrusion causes hardships and financial losses to the people and the industries in the locality by way of contamination of the river and ground water and the industrial water intake points. Even a bund constructed at Paathalam to protect the industrial water supply points from salinity intrusion, caused further hazards and problems as described earlier. Here is a rare example for, protection or no protection of the environment creating problems associated with it.

The man made pollution in the area through effluents, emissions, solid wastes and sound is caused by industrial production and processing. The categories of contaminants which can have deleterious effects on water quality include acidity or alkalinity (PH), coloured matters, heated liquids, toxic chemicals, suspended and floating materials, biodegradable and non-biodegradable organic matters, mineral salts, algal nutrients, foaming agents and bacteria and viruses. The residues, flowed through the effluents, of mercury, pesticides such as DDT and BHC, and radio-active wastes do not get treated, nor do we have, at present, any feasible treatment technology for the purpose.

The specific air contaminants produced by industrial production and processing are numerous and will depend upon the individual operation or activity involved. The most common air contaminants originating from industrial operations in the locality are ammonia, oxides of sulphur (SO_x) and nitrogen (NO_x), hydrocarbons, carbon monoxide, carbon dioxide, particulate matter of carbon origin, particulate matter of dust origin, fluorides, chlorine and various organic solvents. The solid wastes polluting the environment are the radioactive substances containing Uranium 238, mesothorium, barium sulphate, and sodium chloride, gypsum and chalk; packing materials such as cartons, boxes and plastics; tyre residuals, cans and ash resulting from burning; rubble from demolitions; slag heap from smelting and other operations; partially concentrated organic sludges from various industrial processing; waste oil and grease; and stored or discarded unusable materials such as vehicular junk, parts of machinery, oil drums and similar items. All these pollutants of different categories are present in the environment of the area in varying quantities and differing intensities. Sound is yet another category of contaminants deteriorating the quality of the environment in the immediate vicinity of the factories.

Various Impacts of Major Pollutants

When many types of polluting substances are discharged into the environmental media their quality is degraded to such an extent that their beneficial uses are no longer possible. No one industrial unit discharges all types of pollutants but the

discharges even in small amounts from different units put together can cause irreparable harm. The various impacts of major pollutants are classified as:

1. Impacts on Human Health and Welfare;
2. Impacts on animals, birds and fishes;
3. Impact on vegetation; and
4. Impact on structures, materials and aesthetics.

Each of the above categories of impacts are briefly discussed below:

Impacts on Human Health and Welfare

Polluted water and air, solid wastes and sound, adversely affect human health and welfare. Various diseases are caused in people directly when they drink polluted water, and indirectly, when they consume life forms grown in such water. Human health depends upon the quality of air breathed; and widespread and serious health hazards are associated with poor air quality. Solid wastes produce adverse health impacts by breeding disease carriers such as rats, mosquitoes and flies, or by contaminating the ground and surface waters through leaching and run off during rains, and by polluting the air through noxious gases emanating from the heap of such wastes. Similarly sound above a certain level can cause physical and mental ill health.

The presence of organic pollutants in water poses a hazard to public health. In developing countries water borne diseases like cholera, typhoid, dysentry and gastroenteritis are very

common due to the reckless use of water.[1]

Exposure to extremely low levels of environmental metal contaminants such as cadmium, lead, arsenic, copper and their compounds over long periods can cause permanent ill effects on health.[2] For instance, cadmium is a respiratory poison and contributes to high blood pressure and heart disease. Lead and lead compounds are abortificients and cause a high rate of miscarriages. Lead compounds can also affect skin, gastro intestinal tract, lungs and central nervous system and cause lead encephalopathy and lead neuropathy in children. Similarly, arsenic compounds are believed to cause cancer of skin, lungs and liver and may afflict abnormalities in offsprings. And slightly higher concentrations of copper in drinking water can certainly render the affected more sensitive and this is suspected to be the cause of certain types of diarrhoea.

One reason why the persistent pollutants such as mercury, pesticides and radio-active wastes pose slow but serious and long lasting problems on health is the process known as biological magnification.[3] Biological magnification means

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1. K.C. Sankaranarayanan and V. Karunakaran, "Economic Growth and Environmental Quality", Southern Economist, Vol. 22, No. 4, June 15, 1983, p.11.

2. Pollution impacts of cadmium, lead, arsenic, copper and their compounds are referred to in D. Chakraborti and R. Chakravorty, "Chemicals Pollute Environment", Science Reporter, August 1983, CSIR, New Delhi, pp.445-447.

3. Joseph Julian, Social Problems, Printice Hall Inc., New Jersy, (1980), p.541

that the concentration of a given substance increases as it ascends in the food chain. People who live along the river, inject and store these pollutants with the water they drink and the fish and other local food they eat. Mercury poisoning leads to impairment of vision and muscles, and in many cases causes convulsions, madness, paralysis, coma and death. Exposure to $HgCl_2$ results in the accumulation of mercury into kidney which is the primary target organ.[4] Mercury, which reacts with oxygen-free mud of the lake bottoms, is capable of being converted into a highly toxic form of mythyl mercury and finds its way into man through his consumption of poisoned fish.[5]

The persistent organochlorine pesticides affect the central nervous system, reproduction, cardiac metabolism and extensive mascular degeneration causing cancers, birth defects and sterility. An OXFAM study in a few villages in Karnataka in 1977 revealed that pesticides had been the reason for a mysterious disease with intermittent pains in the limb and knee joints which later became so continuous that some could hardly stand up.[6] Twenty five years ago Rachel Carson published "Silent Spring" and warned us in no uncertain terms: "It is our alarming misfortune that so primitive a science (applied entomology) has armed itself with the most modern and terrible weapons and that in turning them against insects has also turned

4. L.E. Hinde Jr. and W.C. Loring, The Effects of Man Made Environment on Health and Behaviour, Castle House Publications Ltd., Atlanta, USA, (1979), p.8

5. Ibid.

6. N.N. Sachidanand, "The Growing Pesticides Hazards", The Hindu , June 24, 1983.

them against the earth."[7] A large number of pesticides have been found to produce one or more of the following problems in man and animals: cancer, congenital deformities, liver and kidney damages, vomiting, ulcer, cholinesteras inhibition, deleterious effects on the central nervous system, sterility, leukaemia, convulsions, etc.[8] It is reported that there are an estimated 3,75,000 cases of human poisoning by pesticides in developing countries every year with some 10,000 deaths.[9] There has been a callous neglect and disregard of the health of the people of India with regard to policies concerning pesticides import, manufacture and use. Pesticides which are banned or highly restricted in developed countries are being imported to India and also being manufactured locally.[10] It is shocking to notice that HIL produces insecticides which are banned for use or sale (eg. DDT, endosulphan, etc.) in most of the developed countries.

Among the presistent pollutants radio-active substances are most dangerous. The radio-active isotopes retain their potency for many years and even centuries with an increased potential for damages to human health in terms of higher incidence of

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7. Carson Rachel, Silent Spring, Fawcett Publications Inc., Greenwich, Connecticut (1962), p.262.

8. FAO, Pesticides Residues in Food: 1982 Evaluations, Plant production and Protection Paper 49, Rome (1983), pp. 1-427,.

9. Almeida, W.F., "The Dangers and Precautions", World Health, August/September 1984 pp 10-12 referred to in Economic and Policital Weekly, March 28 (No.13) 1987. pp. A23-28.

10. Dinesh Mohan, "Food vs Limbs: Pesticides and Physical Disability in India", Economic and Political Weekly, March 28, (No.13), 1987 pp. A23-28.

cancer and genetic defetcs. Health effects of radiation are classified into two: Stochastic and non-stochastic. Stochastic effects are "those for which the probability of an effect occurring rather than its severity is regarded as a function of dose without threshold. Non stochastic effects are those for which a threshold may therefore occur."[11] According to the International Commission on Radiological protection which recommends the standards for radiation, cancer and genetic disorders are stochasitc effects.[12] Gofman, an authority on radiation and health, considers genetic effects as non-stochastic.[13] Other diseases caused by radiations are impairment of fetility, haematological deficiencies, cataract of lens, non malignant damage to skin etc. There are some medical resarchers who strongly feel that radiation causes heart diseases also. All that is needed to trigger the process of carcinogenesis is damage to a chromosome or gene of a single cell. There are billions of cells in the human body and each cell has 46 chromosomes and 25,000 to 1,00,000 genes (cells in gonads and ovaries have 23 chromosomes). Any alteration of the deoxyriboneucleic acid (DNA) which is the information base for the enormous biochemical capabilities of the cell, including instructions for carrying out the process of cell reproduction can lead to loss of cellular control or cellular regulation. This loss of control results in proliferation of cells leading

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11 ILO, Encyclopaedia of Occupational Health and Safety, Vol.II, Geneva, (1983), p.1867

12. Ibid.

13. Gofman John, W., Radiation of Human Health, Pantheon Books, New York (1983), p.404

to the formation of a tumour.[14] If the insult is directed against a cell in gonad or ovary, the effect is transmitted to the next generation. The cell death through radiation leads also to impairement of fertility. It is also noted that the number of harmful genes carried in the permanent genetic load material of a generation is undoubtedly much larger than would appear from the number of live-born offsprings with visible defects and that increasing the genetic load may not have immediate dramatic results.[15]

Increase of acidity in water with PH values less than 6 and increase in alkalinity with PH values more than 8 are considered as injurious to human health. Oxides of sulphur and nitrogen react with atmospheric oxygen to form their respective acids. They directly or through rain acidify the soil, and surface and ground waters progressively. The acidic water dissolves metals in the soil and moves to the ground water casuing its pollution. Therefore polluted ground water has all health impacts of metal poisoning.

Sulphur dioxide attacks lungs and other parts of the respiratory system and causes pulmonary diseases in man. Nitric oxide reduces the oxygen carrying capacity of blood and nitrogen dioxide damages lungs and causes eye irritation. Carbon

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14 Bertell Roosalie, Handbook for Estimating Health Effects from Exposure to Ionising Radiation, Institute of Concern for Public Health, Toronoto Canada, Ministry of Concern for Public Health, Buffalo, USA and International Radiation Reseeach and Training Institute, Burmingham, U.K. 1984, p.55

15. Ibid.

monoxide affects body metabolism due to its higher affinity to haemoglobin; and inflicts headaches and retards physical and mental activities at higher concentrations. Hydrocarbons are able to unite with the oxides of nitrogen through reaction in sunlight to produce the phenomenon of smog. Visibility problems and breathing difficulties are the two major results of smog. When combined with carbon monoxide emissions it constitutes serious health hazards. Also some hydrocarbons present in the air are suspected to cause cancer.[16]

Air pollutants such as ammonia, chlorine, flourine and their compounds are also well known for their adverse health effects. Even small amounts of ammonia affect the conjunctiva of the eye and cause cough in high concentrations. Similarly, chlorine affects the respiratory tract with symptoms of choking and suffocation. Higher concentration of chlorine causes burning pain and a sense of constriction of the chest aggravated by coughing. Small concentrations cause continuous headache and epigastric pain. In severe cases chlorine causes pulmonary ocdeman and pneumonia along with skin irritation.[17]

Absorption of minute fractions of flourine causes nausea and vomiting, abdominal pain; salivation, puritas and diarrhoea. Being a highly reactive substance fluorine rarely affects directly but through its compounds. Hydrogen flouride even in small concentrations attacks larynx and trachea giving rise to

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16. D. Chakraborty and R. Chakravorty (1983), op. cit, p.446

17. Ibid

cough and haemophysis. High concentrations can cause even respiratory paralysis. The ultimate result is slow ulceration of gums, mucosa, larynx, bronchitis and conjunctivitis.[18] (Major health impacts of some of the air pollutants are given in table 7.1)

Sound, if allowed to be transmitted above 80 decibels, is as harmful as poisonous gases. It can inflict psychological, physical, nutritional, phylogenic, pathological and neurological damages. Sound above 80 decibels can cause permanent deafness and above 150 decibels can be fatal.[19] Employees of the factories become victims of sound induced deafness and suffer greater hearing losses with advancing age. Also, noise above a certain level significantly contributes to the tension level of daily life, sometimes even precipitating stress related illness such as peptic ulcer and hypertension. Noise may also contribute to cardiac and cirulatory diseases and it may culminate with other stresses.[20]

Impacts on Animals, Birds and Fishes

Animals have differing threshold limits to pollutants from man. In all other respects the impacts of various pollutants on animals are similar to that on man. Therefore a lengthy description on such impact is not made to avoid repetition. In

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18. Ibid

19. News Report, Indian Express, July 30, 1983, p.5

20. OECD, The State of Environment in OECD Member Countries, Paris (1979), p.114; Also see, Joseph Julian, 1980, op. cit., p.540

the absence of discretionary selection powers in animals they are more quickly affected by various types of pollutants than man. Further, animals are affected not only through the consumption of polluted water and the breathing of contaminated air, but through food also due to the deposition of contaminants on vegetation and forage.

Pollutants can destabilize an aquatic ecosystem when they contaminate water bodies. Disturbances in aquatic environment in many ways can impair the health of organisms living in water and may lead to large scale fish kills. The effluents discharged from factories are often hot enough to cause temperature changes in the receiving stream. Rapid changes in temperature are extremly dangerous to aquatic life and when the optimum range of temperature in water bodies is violated the organisms move to another location or die; and also, interrupt the regular spawning-migration involved in the biological cycle of many fishes.[21]

Organic matters discharged into the water courses increase the biochemical oxygen demand (BOD) in the process of degrading them and thereby deplete the dissolved oxygen (DO) supply in water. The depletion of dissolved oxygen results in a change in the composition of organisms that inhabit a stream. When the dissovled oxygen level drops below approximately 5 mg/1, the more desirable species of fish such as trout and bass leave the area and coarser types predominate. Below an oxygen demand

21. E. Joe and Middle Brooks, Industrial Pollution, Vo;.I. John Wiley and Sons, New York (1979), pp.1-2

level of approximately 2 mg/1 fishes disappear and the environment shifts towards anaerobic species.[22] Similarly the addition of nutrients such as phosphorous, nitrogen and trace elements can result in excessive algal growth and when this growth dies, it can exert a higher oxygen demand which may cause fish kills as well as produce unpleasant odours and tastes.[23]

Floating solids, grease and scum are unsightly and can affect aquatic characteristics such as oxygen transfer and light penetration. Solid sediments can form sludge blankets which decompose and produce odorous gases and floating mats on the surface of the water body. Blankets of solids also interfere with the natural organisms which live attached to the bottom of the water bodies. Fish hatching is also impeded by solid sediments. Suspended solids can retard the growth of aquatic vegetation necessary for the survival of other life forms in the streams and lakes.[24]

Air pollutants like oxides of sulphur and nitrogen can also harm fishes and other aquatic organisms through acidification of water. Acidified water dissolves toxic metals and causes metallic poisoning of the fishes. Fishes have often been found to have disappeared completely in acidified water bodies. Studies have shown that all normal aquatic life forms are distroyed at

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22. Ibid.,

23. Ibid

24. Ibid

p^H values less than 5 and damages start at p^H less than 6.5.[25]

Birds are affected through polluted water and air, and by feeding on contaminated food. Ordinarily, various impacts of pollutants on birds are of less immediate concern except when domestic birds like fowls and ducks etc. are affected. It is known that feeding on food contaminated by persistent pollutants cause eggs to develop thin shells that constantly break before hatching.[26] But generally, the impacts of pollutants on birds are similar to those on man and animals.

Impacts on Vegetation

Pollution renders water unsuitable for irrigation. The combination of low P^H water in the soil creates a situation in which the trees may absorb much of its nutrition. The consequence is that the tree loses vitality and becomes highly susceptible to injury by other external factors. It is easy to see then, that the tree is sick. First the needles turn brown and fall off at the top of the tree. The tendency to shed needles spreads over the whole tree. Next, branches break away and even the top of the tree may snap off. Trees thus attacked die slowly but surely. Further, through the acidification of the soil and surface waters, important plant nutrients such as potassium, magnesium and calcium are leached out of the ground

25. National Swedish Environmental Protection Board, Swedish Ministry of Agriculture, Acidification: A Bottomless Threat to our Environment, Solna (1983), pp.23-24

26. Joseph Julian (1980) op. cit, p.529

and are thus lost to trees and plants. Similarly, the damages by the acidification of moisture in the atmosphere begin on the fringes of a collection of trees. Scraggy trees and those that soar high above their fellows are the first to be attacked.[27]

Pollutants which are known as photo-toxicants are sulphur dioxide, peroxy acetyle nitrate and ethylene. Of somewhat lesser severity are chlorine, hydrogen chloride, ammonia, mercury and oxides of nitrogen. Sulphur dioxide of the first list and all in the second list are present in the area. Generally, gaseous pollutants enter the plants with air through the stoma in the course of normal respiration. Once in the leaf of the plants, pollutants destroy chlorophyll and disrupt phtosynthesis.[28] Damges can range from a reduction in growth rate to complete death of the plant.

Damages to plants caused by sulphur dioxide occur at levels far smaller than those at which humans are noticeably affected. Some crops such as alfalfa have shown physiological disorders at levels as low as 0.02 to 0.05 ppm. A number of vegetables fruits, nuts, and forest crops are also sensitive to sulphur dioxide at such low levels of intensity. Sulphur dioxide, when it reacts in atmosphere, can gradually change into sulphates which affect several plant functions such as growth, photo-synthesis and respiration.[29] The direct affects of the oxides

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27. National Swedish Environmental Protection Board (1983), op. cit., p.8.

28. George Mathai Tharakan, op. cit. (1976) Chapter IV.

29. Ibid.,

of nitrogen on ecosystems are not as large as those of the oxides of sulphur or phtochemical oxidants at similar concentrations. It is the role of oxides of nitrogen in the formation of photochemical oxidants that present grave concern, and that is considered the most harmful of the air pollutants affecting crops and plants.[30] Adverse impacts of chlorine, hydrogen flouride, ammonia, mercury and sulphuric acid mists are given in table 7.2.

Pesticides and fertilizers damage plants in a severe manner by killing the earth worms, nature's manure manufacturers. Solid wastes kill the valuable and rare vegetation by the dumping of junk, oil, rubble, and similar materials. It can destroy grasses and cause siltation of soil by inundating the land with run off water.

Impacts on Structures, Materials and Aesthetics

The discharge of industrial contaminants to the water medium can produce general effects causing water to appear aesthetically undesirable. Water which appears polluted is never fully used resulting in the general degradation of the area. Polluted water causes or increases corrosion of all types of materials with which water comes into contact. It can lower the land use and monetary values of land surrounding the water. Wastes in the water encourage the growth of undesirable bilogical life, often in excessive quantities, to interfere with the domestic and recreational uses of water for bathing and boating etc.

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30. Ibid.,

Above all, pollution makes water unsuitable for industrial use. Acidification of lakes and water courses can exert an influence on the rate of corrosion suffered by metallic materials; for example, sluice gates, cement dams, and piping in power stations and road culverts made of galvanized steel and cast iron pipes, concrete foundations and lead jacketed cables. They represent a lot of invested capital and any corrosion that occurs is therefore of importance.

The air pollutants can affect materials by soiling or chemical deterioration. High smoke and particulate levels are associated with soiling of clothing and structures. Very small particles in the air have a great ability to scatter visible light. This makes the air hazy. Such haze can affect the climate, most noticeably in the industrial areas. Atmoshperic corrosion of important materials is the very well documented effect of air borne sulphur compounds. In this respect other polluting gases play only a subordinate role. Among the materials that are liable to suffer damges are unprotected carbon, steel, copper materials, nickel and nickel plated steel, aluminium materials, stainless steel, steel painted with rust resistants and sand stone and limestone. They can also do damage to plastics, paper, leather, textiles, plaster and electrical contacts.[31]

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31. Elliott H. Blaustein, Rose T. Blaustein and Peter Greenleaf, Your Environment and You: Understanding the Pollution Problem, Occeana Publications Inc., Dobbs Ferry, New York, (1974), pp. 115-125

Solid wastes also produce adverse-impact on land as the formerly used land has now become a waste land by storing or burning of industrial waste products. Solid wastes can produce the general non-aesthetic effects of bad odours such as the one caused by the decomposition of organic matters from stored sludges or oil. Fires and explosions may also be caused by improperly stored building materials, oils etc.

It is possible to calculate with a fair degree of accuracy what the corrosion of technically important materials and structures cost in term of cash. But a problem of a different kind is the corrosion damge to irreplaceable objects and monuments of cultural value that are made of sandstone or limestone. When such relics of the past are destroyed, it is not only a loss to the country concerned, but it is also something that detracts from the common cultural heritage of all.

Specific impacts Identified in the Project Area

The project area has all sorts of public activities. Residential areas and public places like schools, hospitals, temples, churches and mosques are all situated scattered apart from various industrial and commercial units. The reduction in the quality of environment through contaminated water, polluted atmosphere, pollution by solid wastes and by sound can cause untold adverse consequences on people, domestic animals, fish, agriculture, materials and structures of the area.

Impacts on People

The ground water in the area half a kilometre inland on both sides along the one kilometre stretch of the Eloor branch is polluted. This area measures one and a half square kilometres inhabited by approximately 2100 people and 322 households on 37.5 hectares of land.[32] The well water here is unsuitable for domestic consumption and therefore, the people of the area are required to depend on public water supply. The river water pollution has affected the households of more than 50 fishermen engaged in fishing activities along the river in this area alone. They are now displaced and must find out alternative jobs since the branch does not contain fish in large quantity and the fish has become poisoned. The river water is not suitable for bathing and irrigation. The people of the area have complained of hair-loss and skin diseases when they bathed in the river. They have also revealed that some fishermen are engaged in fishing activities in the river and they sell off their catch at far away places to people who do not know that the fish is poisoned.

The area with a 5 kilometre radius around the industrial belt suffers from serious air pollution. The impact of air pollution on people and resources in the area between 5 and 10 kilometers around the industrial belt is considerable only at

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32. The Density of population in the area is considered as 1396 which is the average of that of Parur Taluk and Alwaye Taluk in which the affected area is spread. Density of Population:
    Parur Taluk = 1674
    Alwaye Taluk = 1119
    Source: Census of India 1981, Government of India, 1982

certain times and beyond this, the problem is insignificant. Therefore the impacts of air pollution on an area (3.14 x 5 x 5) 78.5 square kilometres inhabited by approximately (78.5 x 1396) 109586 people and (109586/6.5) 16859 households on (78.5 x 25) 1962.5 hectares of land are required to be studied.

In the present study, 100 households in the area with 652 people are surveyed under the household survey. Those households have been selected at random from three panchayats over which the affected area is spread. The three panchayats are Eloor, Kalamassery and Kadungallore. Of the households surveyed 35 belonged to low income group (yearly income upto Rs.6000) 30 households belonged to lower middle income group (between Rs.6001 and 12000), 25 households belonged to upper middle income group (between Rs.12001 and 18000) and 10 households belonged to high income group (Rs.18001 and above). The number of people studied are 235 from low income, 192 from lower middle income, 167 from upper middle income and 58 from high income group. Table 7.3 gives the details on the impacts of environmental pollution on the health of the people of the area with information such as various income groups, households surveyed, number of people affected and the percentage of affected people to the total population surveyed. It was found that approximately 47 per cent of the people surveyed are suffering from one or more diseases identified in the area. health impacts on low and middle income groups are considerably higher than that on the high income group of people.

The diesases identified in the area are cough and bronchitis; breathing trouble and asthma; headache; stomach pain, gas trouble, vomiting and loss of appetite; fever, shivering and body pain; eye irritation; children's T.B.; and various skin diseases. The percentage of people affected by these diseases (except for children's T.B. and skin disease) in various income groups are given in table 7.4. Approximately, 7.54%, 13.84%, 11.98% and 10.84% of the people are affected in low, lower middle, upper middle and high income groups respectively. About 44% of the people are suffering from one or more diseases identified and given in the table.

Many complaints have been received by local panchayat authorities, Ernakulam Collectorate and also by some of the companies directly, from the people of the area pointing to the health hazards caused by the careless emission of pollutants. Several asthma and T.B. patients have requested some of the companies at least to have high stacks so that the pollutants may get dispersed more efficiently reducing their harmful effects. Doctors in the area are of the opinion that there is a very high incidence of these diseases in this locality compared to other localities having no environmental pollution. The results of the hospital survey could not be used to arrive at any definite conclusion. A disease-wise classification of cases of illness in the area could not be made scientifically, mainly due to the improper maintenance of hospital records and lack of uniformity in the process. Maintenance of records is perhaps not meant for any further scrutiny by any researcher or anybody

else. However, the interviews and discussions with some of the doctors in the area were very useful in understanding the seriousness of the problem. They expressed with certainty, the view that cases of children's T.B., eye diseases and asthma in the locality can be attributed only to atmospheric pollution. They have advised some of the patients in the locality to shift their residences if they wanted a permanent cure for their illness. During the survey 11 households voluntarily expressed their readiness to move from the locality to any far away place, the moment they can sell off their property at a remunerative price. It was particularly noted that many people in the locality, especially of the low income group, have not undergone any medical check up and they do not know from what all diseases they suffer.

People of the locality have organized'dharna'against the problem, several times during the last few years before the companies, collectorate and panchayat offices to redress their grievances. The result was, so far, not positive. They also wonder why one of the companies which has a high stack does not use it for emitting polluting gases prefering to use low stacks instead.

During the factory survey some of the employees revealed that,in the course of the previous year, they had to run away from their offices more than three times due to the leakage of SO_2 or NH_3 from some of the factories. They suffer from all the diseases mentioned above and they are of the opinion that

the factory workers suffer from hearing problems with advancing age due to sound pollution. In their opinion, the factories hardly go beyond propaganda in their pollution control efforts and they accuse each other for the problem.

Of late, it has been observed that Cochin city is occasionally enveloped by a mist like formation. The School of Environment Studies of Cochin Uninversity has reported that such mist like formations contain ammonia, the concentration of which at times rises above the toxic level. Those who pass through this mist-like formation very often complain of a foul smell, burning sensation in the eyes and breathing difficulties.[33] An experiment conducted by the Department of Physics of Cochin University using laser beams revealed that the concentration of air pollutants in the area is most intense during night between 12 pm and 3 am.[34]

In a letter addressed to the Prime Minister, Prof. K.V. Thomas (M.P. from Ernakulam) alleged that 14 workers of IRE died of cancer between 1970 and 1984 (letter to the Prime Minister dated April 19, 1985). The Prime Minister in his reply promised to examine the issue (Prime Minister's letter dated April 23, 1985). Earlier, in a memorandum addressed to the Prime Minister

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33. K.C. Sankaranarayanan and V. Karunakaran,"Economic Growth & Environmental Quality,"Southern Economist, June 15, 1983, pp.11-12.

34. M.K. Satheeshkumar & C.P.G. Vallabhan, A Photoacoustic set up for Atmospheric Attenuation Studies Using He Ne Lazer Beam, Dept. of Physics, University of Cochin, Kerala, 1983, p.324.

all the recognised trade unions of IRE had pointed out that the high incidence of cancer among workers can be attributed to radioactivity (memorandum to the Prime Minister undated).[35] The study conducted by V.T. Padmanabhan on the incidence of cancer, heart diseases and mortality rate among IRE workers in comparison with T.C.C. workers and employees registered at Employees State Insurance Corporation (ESIC) reveals that incidence of cancer, heart disease and total mortality among IRE workers are respectively 4.62, 2.24 and 2.72 times larger than that among T.C.C workers. The incidence of cancer and heart diseases among IRE workers are respectively 6.77 and 2.72 times more than that among employees registered with ESIC (see Tables 7.5 and 7.6). Further the study points out that the incidence of sterility among IRE workers and genetic disorders among their offsprings are seemingly higher than their spontaneous occurence in the general population.[36]

The employee welfare survey conducted in 125 employee households containing 131 employees of the factories of the area - all residing in the project area - was aimed at finding out the occurrence of various diseases among workers and their family members. The summary results of the survey are given in table 7.7. As the table reveals more than 30 percent of the employees are affected by one or more diseases listed in table 7.8. Of the 812 members of the employee households, more than 30 percent are the victims of those diseases. Children are the

35. V.T. Padmanabhan, Economic and Political Weekly, March 8-15, (1985), pp.449-51

36. Ibid.,

worst hit and they are suffering mainly from respiratory and skin diseases, genetic disorders and primary complex. Thirty eight percent of the children and 27.5 percent of the grown-ups including employees of the households are affected by one or more diseases. Details of occurrence of various diseases among employees, children below 15 years and grown ups other than employees and their respective percentages to the totally affected and to the population of the households etc. are given in table 7.8. Further, during the survey it was noticed that in some households all members were suffering from asthma and in some others all members were suffering from skin diseases like allergic itching and black spots or white patches all over the body. The occurrence of genetic disorders among children reported during the survey are photo-dermatitis, congenital cardiac disease, weakness of limbs, malformation of one side of the face and mental retardation. About 15 cases of abortion were reported from those households during the survey. Some of the incidences particularly noted were:one woman had abortion four times and each time after four months of pregnancy; first pregnancy getting aborted was a usual occurrence in some cases; two women suffered from abortion twice; menstrual irregularities are reported in some; one woman gave still birth thrice; and premature birth was reported in one case.

Impacts on Domestic Animals and Fishes

The 100 households as per the household survey, bring up totally 379 domestic animals including birds. Only three types of domestic animals are found to be maintained in the locality.

Table 7.9 gives particulars on the number of domestic animals brought up by different income groups in the affected area. On the basis of survey results the total livestock population in the affected area in three panchayats is (379 / 100 x 16859) about 63895, including birds. Fowls exceed the cattle and goats in number. The households presently surveyed do not keep buffaloes and ducks as there is no unpolluted water bodies in the locality.

The domestic animals in the area suffer from conjunctivitis, bronchitis, skin diseases and various gastro-intestinal disorders. A high incidence of death of animals has been reported during the survey. Veterinary doctors have pointed out that the main reason for frequent animal deaths in the area is pollution through feed and through the breathing of the polluted air. As was observed during the survey, the high income group of people are more careful about maintaining, and treating their livestock as soon as the symptoms of illness are noticed.

In the immediate locality there is only one Veterninary hospital at Eloor. The doctors there firmly believe that the high rate of abortion and infertility seen in cows is because of the problem of pollution from fluorine and fluorides. According to them the number of cattle attended to during diseases is low partly due to lack of adequate hospital facilities and partly due to carelessness of the people. In their opinion more information could be obtained with a detailed investigation.

In recent years, there has been a number of newspaper reports about fish mortality due to water pollution in the backwater and the Periyar river near Eloor-Edayar industrial belt. In a paper presented at the Seminar on "Status of Environmental studies in India" held in March, 1981, at Trivandrum, the School of Environmental Studies, Cochin University has pointed out that fish mortality in the waters in and around Greater Cochin area is caused by the presence of ammonia as well as mineral acids contained in the effluents discharged from the industrial belt. It has also been pointed out that the quality of fish has deteriorated considerably in these polluted waters.[37]

It is urgently required that strict measures are adopted to keep the level of industrial pollution of the Vembanadu Lake within prescribed standards to save the rich fish fauna of the lake. According to the "Studies on Systematics and Biology of the Fishes in Vembanadu Lake" by Dr. B. Madhusoodana Kurup of the Department of Industrial Fisheries of Cochin University, the Eloor-Varapuzha region of the lake has already been turned into a barren area for fish due to the discharge of industrieal effluents.[38] The study points out that mass mortality of fishes is encountered during the pre-monsoon period and this may be due to the reduction of water discharge from the adjoining rivers with the result that the effluents from the factories do

37. Dr. K.C. Sankaranarayanan & V. Karunakaran, Southern Economist, June 15,1983, op.cit p-12.

38. News Report, "Check Pollution to Save Vembanad Lake", in Indian Express , July 18, 1982, p.3.

not get diluted and washed away as in the monsoon season. High levels of mortality were observed among fish species like anchovies (kozhuva), cat fishes (koori), pearlspot (karimeen), glassy perchlets (nandan), barbs (parel) silver biddies (prachil), sprats (soochi-kozhuva) and half beak (murashu). The pollution of water bodies also interrupted the regular spawning migration involved in the biological cycle of many fishes of fresh water and estuarine species.[39]

Impacts on Agriculture

The impacts of environmental pollution from the industrial belt spreads to an area of (78.5 x 25) 1962.5 hectares of land. The net area sown is 77.61 percent of the total geographic area. Since 30.43 per cent of the total geographic area is sown more than once a year, the total cropped area exceeds the geographic area by 8.04 per cent as per statistics on agricultural land use pattern in Ernakulam District.[40] Accordingly, the total cropped area affected in the locality is (1962.5 x 108.4 / 100) 2120.285 hectares. Land use pattern in agriculture with details of net area sown, area sown more than once a year, total cropped area and their percentages to total geographic area in the district and in the state is given in table 7.10.

In table 7.11 the percentages of areas under food crops and non food crops, net area sown and area sown more than once a

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39. Ibid

40. Government of Kerala Season & Crop Report of Kerala State, 1977-78, Directorate of Economics and Statistics, Trivandrum, (1982), p.38.

year respectively to total cropped area are given. About 65.26 per cent of total cropped area is allocated for food crops and 34.74 percent for non food crops. Net area sown is 71.83 per cent and area sown more than once is 28.17 per cent of the cropped area.[41] Accordingly, in the locality, of the 2120.285 hectares of cropped area, about 1383.7 hectares are used for food crops and 736.585 hectares for non food crops. Net sown area is 1523 hectares and area sown more than once a year is 597.285 hectares.

Major crops cultivated in the area are paddy; coconut; fruit trees like banana, mango and jack; tapioca and vegetables; and pepper and ginger. These crops together occupy 1735.029 hectares which is 81.83 per cent of the total cropped area. Among other crops which occupy 18.17 per cent of the cropped area, arecanut consumes the largest portion of land, specifically 2.14 per cent of the cropped area. Crops like rubber, tea, coffee, betel leaves etc., which are included among other crops occupy only a small portion of land. The area used for major crops in the locality and their respective percentages to total cropped area are also given in table 7.11

We can observe in the area plants of different crops at varying stages of destruction. "The damages range from bleaching of the leaves and turning of the green colour to yellowish brown, to total snapping off and drying off of the trees. The trees that soar high above others are found most

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41. Ibid

affected in the area. The top of such trees have dried off completely. Brown red spots on veins and the surface of the leaves of most of the crops in the area are observed. The paddy gets charred; the leaves of coconut trees dry and fall off frequently; the nuts and fruits on the trees fall before they are ripe; and generally, all types of plants yield less now than in the past as reported by the people of the locality during the survey.

Small plants like vegetables and plantains etc., are frequently destroyed and the impacts of this is felt more by low and middle income groups of people for whom such plants can contribute considerably to their meagre income. People of the locality have pointed out that the grown up trees would remain alive for only a few more years, at the present rate of destruction. They have no hope of bringing up saplings of coconut and arecanut trees for the benefit of the younger generation. They have started showing indifference to applying fertilizers to their crops and treating them when they are infected because they do not believe that the condition of the atmosphere of the locality can change for the better in the near future. Some of the households have reported that during every year, in some part of the three panchayats, a few hectares of paddy are destroyed. In some years the occurrence becomes episodic. For example, in January-February, 1974, approximately 40 acres of crops suddenly showed signs of charring. An investigation initiated by the district collector, on receiving complaints from the people of the locality revealed that SO_2

of FACT and Chlorine of TCC were responsible for the damage.[42] To cite a more recent example, hectares of paddy fields in Eloor Panchayat were suddenly destroyed due to a heavy accidental emission of SO_2 from FACT on September 1, 1983. The collectorate officials supervised a detailed survey for assessing damages caused by this accident. Their rough assessment revealed that damages on crops alone amounted to a huge loss. The official report is yet to be published. In short, agriculture in this locality can be said to be a gambledepending on the success and failure of factory stacks and machinery engaged in industrial production and processing.

Impacts on Materials and Structures

Visibility reduction and fog formation are two serious effects noted in this area. In rainy season visibility in the roads of Eloor is very poor. Most of the motor vehicles have their head lights on even in day time during this season. People cannot recognize each other even at a distance of 20 feet, at times. Similarly, fog formation which is a regular feature during rainy season spreads to a distance in radius from 3 to 4 kilometres. It is known that the number of road accidents is greater in the Ernakulam District than in any other districts in the state. This may also be due to atmospheric pollution of the area.

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42. N.S. Mony, Primary & Interim Report on Paddy Charring in Eloor (1976), in George Mathai Tharakan, op. cit Chapter IV.

Causes of motor vehicle accidents in Kerala are classified as.[43]

1. Fault of driver of motor vehicle.
2. Fault of driver of the other motor vehicle.
3. Fault of cyclists.
4. Fault of pedestrians.
5. Mechanical defects.
6. Defective road surface.
7. Bad weather conditions.
8. Other causes.
9. Causes not known. Atmospheric pollution is not considered as one of the reasons for accidents in official records, as it is not a common cause for accidents in all the districts. Accidents due to polluted atmosphere may be considered under the last three categories of causes listed above; namely, due to bad weather conditions, other causes, and causes not known.

Table 7.12 gives some important information on motor vehicle accidents in the state, Ernakulam district (which reports the greatest number of accidents in the state) and Idukki district (which reports the smallest number of accidents) during 1978. The number of accidents and casualities are the highest for Ernakulam District. The number of accidents and casualities due to causes including environmental pollution is also the highest for this district.

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43. Government of Kerala, Industries and Industrial Labour & Infrastructure, Transport and Industries Division, State Planning Board,Trivandrum, June(1980), p.285.

The problem of corrosion in the area is serious. Residents of more than 70 per cent of the households surveyed reported that they are required to plaster and/or whitewash their houses every year. This requirement in other places is normally only once in three or more years. Their iron gates, window bars, grills and door locks etc., get rusted quickly and they are required to repair and paint them frequently. Some of them showed the worn out electric contacts in their houses which were constructed not even 10 years ago. The cost per household of different income groups incurred on maintenance of structures and materials is considerable.

Table - 7.1

Health Impacts of some of the Major air Pollutants

Sl. No.	Pollutants	Principal Health Effects	U.S. National Ambients standards (in Ug/m^3)
1.	Total suspended particulates (TSP)	Directly toxic effects or aggravation of the effects of gaseous pollutants; aggravation of asthma or other respiratory or cardio-respiratory symptoms; increased cough and chest discomfort; increased mortality.	Primary: Annual = 75 24 hour =260 Secondary: 24 hour =150 Alert: 24 hour =375
2.	Sulphurdioxide SO_2	Aggravation of respiratory diseases including asthma, chronic bronchitis and emphysema, reduced lung function; irritation of eyes and respiratory tract; increased mortality	Primary: Annual = 80 24 hour = 365 Alert: 24 hour = 800
3.	Carbon-Monoxide (CO)	Reduced tolerance for exercise, impairment or mental function impairment of foetal development, aggravation of cardio-vascular diseases.	Primary: 8 hour =10,000 1 hour =40,000 Alert: 8 hour =17,000
4.	Photo-chemical Oxidants (O_x)	Aggravation of respiratory and cardio-vascular illnesses; irritation of eyes and respiratory tract; impairment of cardio pulmonary function.	Primary: 1 hour = 160 Alert: 1 hour = 200
5.	Nitrogen-dioxide (NO_2)	Aggravation of respiratory and cardio vascular illness and chronic nephritis	Primary: Annual = 100 Alert: 24 hour = 282 1 hour =1130
6.	Hydro Carbons (HC)	Suspected contribution to cancer	Primary: 3 hour = 160

Source: World Bank/August 1978, Environmental Considerations for the Industrial Development Sector, Washington D.C. pp.2-5

Table - 7.2

Pollution Effects on Vegetation

Pollutants	Symptoms	Maturity of leaf affected	Injury Threshold		
			Part of leaf affected	Vol. (ppm)	Sustained exposure
Sulphur-Dioxide	Bleached spots, bleached areas between veins, chlorosis, insect injury winter and drought conditions may also show similar markings	Middle aged most sensitive & Oldest leaves sensitive	Missophyll cells	0.03	8 hours
Hydrogen Fluoride	Tip and margin burn, devarfing leaf abscission narrow brown and red band separates necrotic from green tissue	Youngest leaves most sensitive	Epidermis and Misso-phyll cells	0.1 (ppb)	5 weeks
Chlorine	Bleaching between veins, tip and margin burn, leaf abscission	Mature leaf most sensitive	Epidermis and Missophyll cells	0.1	2 hours
Ammonia	Cooked green appearance becoming brown or green drying, overall blackening of some species	Mature leaf most sensitive	Complete tissue	20	4 hours
Hydrogen Chloride	Acid type necrotic lesion, tip burn on fir needles; leaf margin necrotis on broad leaves	Oldest leaves most sensitive	Epdermis and misso-phyll cells	5-10	2 hours
Mercury	Chlorosis and abscission, brown spotting yellowing of veins	Oldest leaves most sensitive	Epidermis	1	--
Sulphuric acid	Necrotic spots on upper surface smilar to caustic or acidic compounds, high humidity need.	All	All	--	--

Source: Sterm, Wohless, Bonbel and Lowry, Fundamentals of Air Pollution, Academic Press (1972), pp. 116-117.

Table - 7.3

Impacts on Human Health

Serial Number	Income Group	No. of households surveyed	No. of people surveyed	People suffering from one or more diseases	Percentage of affected people to the total surveyed
1.	Low (Yearly income less than Rs.6,000/-)	35	235	97	41.28
2.	Lower Middle (between Rs.6001 & 12000)	30	192	108	56.25
3.	Upper Middle (between Rs.12001 & 18000)	25	167	65	38.92
4.	High (Rs.18001 & above)	10	58	32	55.17
Total	-	100	652	302	47% (approximate average)

Table 7.4

Incidence of Diseases on people of Different Income Groups

Sl. No.	Diseases	Number of people affected and their percentage							
		Low income group		Lower Middle income group		Upper Middle income group		High Income group	
		No.of cases iden-tified	%age of aff-ected peope	No.of cases iden-tified	%age of aff-ected peope	No.of cases iden-tified	%age of aff-ected people	No. of cases iden-tified	%age of aff-ected people
1	2	3	4	5	6	7	8	9	10
1.	Cough/ Bronchitis	32	13.62	42	21.88	41	24.55	10	17.24
2.	Breathing trouble/Asthma	36	15.32	45	23.44	20	11.98	11	18.97
3.	Headache	12	5.12	42	21.88	27	16.17	10	18.97
4.	Stomach pain/ Gas trouble/ Vomitting/ loss of appetite	8	3.40	15	7.81	3	1.8	4	6.90
5.	Chest pain	8	3.40	3	1.56	22	13.17	5	8.62
6.	Fever/Shivering body pain	12	5.12	18	9.38	20	11.98	2	3.45
7.	Eye-irritation	16	6.80	21	10.94	7	4.19	2	3.45
Total		112	7.54 Average	186	13.84 Average	140	11.98 Average	44	10.84 Average
		(Grand average of the Columns 4,6,8 and 10 is 44.2%)							

Table - 7.5

Incidence of Cancer, Heart Diseases and Rate of Mortality per 10,000 Population in IRE, TCC and ESIC (All India), 1970-84

Unit	Population	Cancer		Heart disease		Total Mortality	
		Nos.	Rate per 10,000	Nos.	Rate per 10,000	Nos.	Rate per 10,000
IRE	262	11	420	8	305	21	802
TCC	440	4	91	6	136	13	295
ESIC	69.68 lakhs	6.2 per 1000	62	11.12 per 1000	112	NA	NA

Note: ESIC date pertains to 1969-70 to 1983-84.
Mortality date of ESIC not available

Source: V.T. Padmanabhan, Economic and Political Weekly, March 8-15, 1986, op.cit., p-450.

TABLE - 7.6

Relative Risks Between IRE-TCC & IRE-ESIC

Sl. No.	Diseases	Incidence per 10,000			Relative Risks	
		IRE	TCC	ESIC	IRE/TCC	IRE/ESIC
1.	Cancer	420	91	62	4.62	6.77
2.	Heart diseases	305	136	112	2.24	2.72
3.	Total Mortality	802	295	NA	2.72	NA.

Note: Relative risk is the ratio between the incidence among exposed and incidence among non-exposed.

Source: V.T. Padmanabhan, Economic and Political Weekly, March 8-15, 1986, op.cit., p.450.

TABLE - 7.7

Summary Results of the Employee Survey.

Sl. No.	Coverage	Total members	Members affected	Percentage of affected to the total
1.	Employee Households Surveyed	125	58	46.4
2.	Population of the Households	812	246	30.3
3.	Employees of factories in the households	131	42	32.1
4.	Children below 15 years	216	82	38.0
5.	Groups-ups other than employees	465	122	26.2
6.	Grown-ups including the employees	596	164	27.5

Table 7.8

Incidence of Diseases in Employee Households

Sl.	Diseases	Employees		Children below 15 years		Grown-ups other than employees		Total of the affected members	Percentage to the totally affected (1/246 100)	Percentage of affected to total population (/ 812 x 100)
		Affected	Percentage to the totally affected (/ 42 x	Affected	Percentage to the totally affected (/ 82 x 100)	Affected	Percentage to the totally affected (/ 122 x 100)			
1.	Respiratory	17	40.5	31	37.8	25	20.5	73	29.7	9.0
2.	Heart	8	19.1	3	3.7	6	4.9	17	6.9	2.1
3.	Skin	5	11.9	16	19.5	13	10.7	34	13.8	4.2
4.	Intestinal	4	9.5	-	-	5	4.1	9	3.7	1.1
5.	Genetic	3	7.1	9	11.0	31	25.4	43	17.5	5.2
6.	Primary Complex	-	-	7	8.5	-	-	7	2.8	0.9
7.	Others	5	11.9	16	19.5	42	34.4	63	25.6	7.8
Total		42	100%	82	100%	122	100%	246	100%	30.3% of the total population (812)
Percentage of affected to total population (/ 812 x 100)		5.2	+	10.1	+	15.0	=	30.3% of the total population (812)		

Note: An affected member may be suffering from more than one illness. But only one dominant disease in the affected member is counted in this classification.

TABLE - 7.9

Domestic Animals Brought up by 100 Households in the locality

Sl. No.	Income Group of Households	Fowls	Cattle	Goats	Total
1.	Low	80	10	25	115
2.	Lower Middle	108	21	9	138
3.	Upper Middle	40	20	15	75
4.	High	43	4	4	51
Total		271	55	53	379

TABLE - 7.10

Land use Pattern in Agriculture in Ernakulam District and the State (1977-78)

Sl. No.	Details	Ernakulam District		Kerala State	
		Area (hectares)	Percent-age	Area (hectares)	Percent-age
1.	Total Geographic Area	235319	100	3885497	100
2.	Net Area Sawn	182622	77.61	2201269	56.65
3.	Area Sawn more than once a year	71607	30.43	722535	18.60
4.	Total cropped area	254229	108.04	2923804	75.25

Source: Government of Kerala, Season and crop report of Kerala State 1977-78, Directorate of Econonmics and statistics, Trivandrum, 1982, pp. 37-38.

TABLE - 7.11

Percentage of Area Under Major Crops to Total Cropped Area in the Locality

Details	Area (hectares)	Percentage to total cropped area.
Under food crops	1385.7	65.26
Under non-food crops	736.585	34.74
Total cropped area	2120.285	100
Net Sown	1523.00	71.83
Sown more than once a year	597.285	28.17
Total cropped area	2120.285	100
Under major crops in the locality	1735.029	81.83
Such as:		
1. Paddy	827.759	39.04
2. Coconut	477.912	22.54
3. Fruit trees like banana, mango, and jack	194.642	9.18
4. Tapioca & Vegitables	155.841	7.35
5. Pepper & Ginger	78.875	3.72
6. Others	385.256	18.17

Source: Percentage given in the last column refer to Ernakulam District; compiled from Season and Crop Report of Kerala State, 1977-78; Directorate of Economics and Statistics, Trivandrum, 1982, pp.38-42.

TABLE - 7.12

Motor Vehicle Accidents in the State - 1978

Sl. No.	Details of accidents	State	District average	Ernakulam Dt.		Idukki Dt.	
				Number	%age	Number	%age
1.	Total no. of vehicle accidents	7018	638	1077	15.35	128	1.8
2.	Number of persons killed	1057	96	136	12.87	39	3.69
3.	Number of persons injured	7514	683	1175	15.64	246	3.27
4.	Number of accidents due to causes 7, 8 and 9 (including atmospheric pollution	526	48	78	14.83	9	0.17
5.	Casualities in accidents due to causes 7,8 and 9	642	58	95	24.79	20	3.12
	1. Persons killed	79	7	10	12.66	3	3.8
	2. Persons injured	563	51	85	15.10	17	3.02

Source: Compiled from, Industries and Industrial Labour and Infrastructure, Transport and Industries Division, State Planning Board, Trivandrum, June, 1980, p.285

CHAPTER - VIII

FINANCIAL ESTIMATE

Environmental distrubances have, today, become an inevitable concomitant of the development process. But advances in technology have made it possible to minimise such disturbances. In order to ensure optimum environmental quality in a specified area, the economic feasibility of adopting various environmental protection measures are to be examined. For this purpose, the trade offs between benefits and costs involved in the process are evaluated in financial terms.

The role of benefit-cost analysis in decision making, especially in the context of project evaluation, is widely recognised as important. It has its practical importance not only in project evaluation, but it also has a bearing on such areas as investment planning, taxation, commercial and development policies, environmental impact assessment etc. Benefit-cost analysis consists simply of the work necessary to present a decision taker with the information which he requires in order to take a decision. When appropriate schemes are selected from a proposed package of measures for implementation, the estimation of incremental revenue and incremental costs is necessary to asses the economic feasibility of such a programme. Various stages are involved in this process of financial estimation of environmental protection of a specific area or locality. As per those stages listed in Chapter I, the harmful pollutants emitted or present in the project area have been identified, impacts of those pollutants have been analysed; and the specific impacts of

those pollutants have on the living and the non living have alsobeen identified. A package of measures for the control and abatement of environmental pollution of the area is to be proposed before making an estimation of benefits and costs of protecting the environment of the area and before presenting a comprehensive benefit-cost analysis table.

Package of Measures Proposed

Controlling the discharge of contaminants may be accomplished through a number of techniques ranging from in-plant changes in production methods to the installation of equipment designed to remove or reduce specific pollutants or change the characteristics of the wastes. Change in the process or operation with respect to water pollution control aims at reducing the volume and strength of waste water. This can be brought through neutralisation and equalisation and apportioning of pollutants in different effluent streams. Suspended solids in the effluents may be removed through the methods like sedimentation, flotation and screening. Colloidal solids can be removed through chemical coagulation and adsorption. some of the accepted methods for the removal of inorganic dissolved materials in the waste water are precipitation, ion exchange, carbon adsorption, reverse osmosis and evaporation. For organic dissolved materials, the treatment methods are lagooning, biodisc treatment, spray irrigation etc. The techniques of anaerobic digestion, deep-well injection, and foam phase separation can also be used for this purpose. Likewise, bacteria and

micro organisms can be removed through chlorination, ozonation and ultraviolet radiation.[1]

The method suggested everywhere in the world for the control of air pollution is increasing the stack heights to facilitate the removal of impacts from the immediate locality and the dispersal of pollutants to further dilution. Gases can be purified to remove contaminants either by adsorption, absorption or some type of chemical process usually catalytic conversion. Particulates in the emissions can be removed by adopting any of the methods such as filteration, sedimentation, centrifugal separation, electrostatic precipitation or wet scrubbing. Sanitary land-fill, leachate control, shredding and incineration are some of the methods that can be used for the treatment and disposal of solid wastes.[2] In-plant techniques for the control of sound pollution may be adopted. Such techniques of economic feasibility are yet to be developed. For the time being, trees and plants can be used as effective check against sound. Planting of more trees, viz., neem, casurina and the like, around the industrial units helps to reduce noise levels significantly.

Many of the above stated treatment methods and techniques involve the application of advanced technology and imply a huge expenditure. It may be mentioned here that we do not have the

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1. For details on control techniques, see, World Bank/August 1978, Environmental Consideration for the Industrial Development Sector, Washington D.C. 1978, pp. 36-68

2. Ibid.,

know-how at present to provide methods of treatment of economic feasibility for some of the toxic chemicals such as mercury and pesticides. The technology is yet to be developed to contain radioactive substances. Those toxic chemicals and radioactive substances are very much present in the industrial belt. It may only be suggested that fixed investment in those control and abatement measures may equal at least five percent of the paid up capital of all factories in the area. Such investments must not inhibit the indiustrial development of the state and cause cost-induced shut down of the factories, and therefore must be incurred distributively over a peirod of at least ten years.

The government may adopt various policy instruments[3] like publicity, social pressures etc. of moral suasion and regulating the permissible levels of emission, specifying the mandatory process or equipment etc. of direct control. The government may adopt a taxation policy designed to achieve the prescribed standards of environmental quality. It may also allow subsidies to industrial units for per-unit reduction of wastes and to defray the cost of damage control equipment. Investments in pollution control facilities such as dissemination of information on pollution control techniques, opportunities for recycling, administrative mechanisms for the monitoring and control of pollution, establishments for citizen suits etc are to be considered the responsibility of the government. Besides, peoples' participation through a massive educational programme is the

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3. For details on policy measures, see Baumol and Oates, Economics, Environmental Policy and Quality of Life; Printice Hall Inc., New Jersy (1979).

most effective guarantee against environmental pollution. In this context, the role of voluntary agencies, reasearch bodies and university centres in monitoring and research, and for creating more awareness among people of the locality is of great importance, though they involve considerable expenditure.

The Financial Estimate

In this financial estimate, the incremental benefits accrued and the incremental costs involved in the execution of various environmental protection schemes are evaluated. Therefore the estimate consists of two parts:

1. Estimate of incremental revenue; and
2. Estimate of incremental costs.

The following assumptions are made in the estimation of incremental revenue and incremental costs of environmental pollution control and abatement schemes in Eloor-Edayar industrial belt.

1. The households in the area are classified into low, lower middle, upper middle and high income groups in the ratio 35:30:25:10

2. Only twenty five percent of income loss due to diseases in the area are attributed to environmental pollution.

3. The possibility of accidental emission of pollutants from the factories in the area and, subsequent and unforeseen

death of animals and humans and damages to crops etc. are not accounted for.

4. Only ten percent of the monetary value is attributed to casualities by various reasons including environmental pollution (for instance, motor vehicle accidents).

5. Items which cannot be converted into money terms are kept outside this estimate (for example, loss of life due to motor vehicle accidents caused also on account of bad weather conditions and atmospheric pollution).

6. All industrial units in the area would spend an amount equal to at least five per cent of their paid up capital on pollution control and abatement by installing required equipment or adopting appropriate processing techniques etc in their units.

7. The Kerala State Pollution Control Board would spend at least one half of the budget expenditures allocated to it for improving the quality of environment of this area considering that most of the industrial pollution load and more than fifty per cent of the total pollution load originate or are concentrated in this area.

8. The expenditure on various environmental protection measures incurred in the area are spread over a ten-year period with the objective of bringing down pollution to optimum level by the end of this period.

9. A social discount rate of ten percent per annum is considered and the calculations are made using, PV = X{(1+r)^n-1}/r, where, PV is the present value of X, X is any estimate of cost or benefit of the initial year, n is the number of years, and r is the social discount rate. r takes plus or minus sign when the estimate is made respectively at an increasing rate or decreasing rate, as the case may be. Accordingly, it is found that the present value of X becomes 15.9374246X at an increasing rate and 6.513215599X at a decreasing rate of ten per cent per annum by the end of ten years. For nine years, they are respectively 13.57947691X and 6.12579511X ; and so on.

Estimate of Incremental Revenue

Incremental revenue on account of the following factors are worked out:

1. Incremental revenue from the beneficiaries' willingness to pay towards the protection of the environment;

2. Incremental revenue from damages avoided;

3. Incremental revenue from damge avoidance costs avoided, and

4. Incremental revenue from additional employment created.

The procedure adopted for the estimation of incremental revenue on the above items are briefly illustrated below.

Incremental Revenue from Beneficiaries' Willingness to Pay

Altogether 100 households were surveyed (under the household survey) in the project area in order to find out beneficiaries' "willingness to pay" towards the protection of the environment of the area. the households were selected at random in the proportion 35:30:25:10, respectively, from low, lower middle, upper middle and high income groups. In order to counter the beneficiaries' tendency to underestimate the amount they are willing to pay and to overestimate the damages and to demand compensation in consequence, an "adjusted measure" of willingness to pay is calculated. The "adjusted measure" of willingness to pay or "the effective willingness to pay" is the average of compensation demanded and willingness to pay of the households.

The results of the survey with details such as number of beneficiary households, number of people benefited, compensation demanded, willingness to pay and effective willingness to pay - all per households per year in the case of the last three items - are given in table 8.1. The effective willingness to pay is calculated to be Rs.477.48 for low income group and Rs.584 for lower middle income group per household per year. The households in the upper middle and high income groups showed their average yearly willingness to pay as Rs.768.50 and Rs.828 per household respectively.

There are about 16860 households in the affected area of

78.5 square kilometers with more than 109500 beneficiaries.[4] Classifiying the entire households into different income groups in the ratio 35:30:25:10 and multiplying the households in each income group with the respective average (effective) willingness to pay per household, the total incremental revenue on the basis of beneficiaries' willingness to pay is obtained. Table 8.2 gives the estimate of incremental revenue on the basis of beneficiaries' willingness to pay in the project area. The total incremental revenue from the beneficiaries in the entire area is thus obtained as Rs.104.06 lakhs per year. Assuming a social discount rate of ten per cent per year, the incremental revenue in this respect would amount to Rs.1658.49 lakhs during the next ten years.

Incremental Revenue from Damages Avoided

Incremental revenue from damages avoided as the result of the execution of various environmental protection measures is calculated on the following accounts:

1. Revenue from damages on human health avoided;
2. Revenue from damages on domestic animals avoided;
3. Revenue from damages on agricultural crops avoided; and
4. Revenue from damages on materials and structures avoided.

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4. The population of the project area with 5 kilometers radius around the industrial belt is calculated to be 109586 based on the average density of population as per 1981 census of Parur and Alwaye Taluks to which the affected area is spread. The number of households are 16859 as the average membership of a household is 6.5. These figures are used in the classification of households and population in various income groups as given in the tables appended.

Revenue from Damages on Human Health Avoided

Various diseases result in a decrease in the productive efficiency of the people, though they are not the only causes. In the asbsence of illness it is assumed that people of the area could have earned at least 25 per cent more than their present income. Only 25 per cent of such loss of income is attributed to diseases caused by environmental pollution. Accordingly, loss of income due to environmental pollution on housheolds of different income groups is claulated as given in table 8.3. The total income loss per year thus estimated for the entire affected area is about Rs.101.16 lakhs. When environmental protection sehmes are progressively implemented, there will be decline in the damages on human health and in the loss of income due to decreased efficiency. Therefore, the benefits obtained on account of damages on human health avoided in subsequent years will also show a decline every year over the previous year. Considering this, the total revenue accrued from the entire area on account of damages on human health avoided for the next ten years is worked out as nearly Rs.658.86 lakhs.

During the survey, information on the number of workdays lost due to illness could be obtained. On the basis of such information it is possible to calculate the average loss of income due to workdays lost per household per year in each of the income groups. Assigning only 25 per cent of income on workdays lost to diseases caused by environmental pollution, the estimate of loss of income in this respect avoided for the

entire area is obtained and is shown in table 8.4. Yearly incremental revenue from "workdays lost" avoided is approximately Rs.20.43 lakhs and this would become nearly Rs.133.07 lakhs during the next ten years at a social discount rate of ten per cent per year.

Thus the toal incremental revenue accrued from damages on human health avoided during a ten year period would be approximately (658.86 + 133.07) Rs.791.93 lakhs.

Revenue from Damages on Domestic Animals Avoided

In a similar manner incremental revenue from damages on domestic animals avoided is calculated as shown in table 8.5. Illness decreases yield and hence income from domestic animals. Income obtained from domestic animals per household on average in different income groups is calculated from the survey results. Loss of income due to diseases is considered as only 25 per cent of the income from domestic animals and only 25 per cent of such loss is attributed to environmental pollution. the total revenue from damages on domestic animals avoided is estimated around Rs.9.13 lakhs per year. And the total revenue incrementally obtained in this respect during the next ten years on progressively implementing environmental protection measures is estimated as approximately Rs.59.48 lakhs.

Revenue from Damages on Crops Avoided

It was possible to ascertain the yearly average income from agriculture per household in each income group from the

household survey. The reduction in the expected income due to environmental pollution per household could also be calculated.[5] On the basis of such information, the total loss of income from agriculture of all income groups due to environmental pollution is estimated for the area as nearly Rs.226.38 lakhs per year as shown in table 8.6. The incremental revenue on account of damages on agricultural crops avoided duirng the next ten years is estimated as around Rs.1474.47 lakhs.

Revenue from Damages on Materials and Structures Avoided

From the household survey it was also possible to calcuate yearly average expenses per household on maintenance of the houses and other structures and materials in each of the income groups. During the survey it was revealed that, on average the households were spending yearly an amount which in other localities would have been enough for three years. Accordingly, 2/3rd of the average maintenance cost is attributed to the environmental pollution of the area. Therefore the revenue accrued by environmental protection from avoiding damages on structures and materials in the area is worked out to be around Rs.32.61 lakhs as given in table 8.7. And for a ten year period this would amount to Rs.212.42 lakhs.

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5. Actual and expected income from agriculture of every household were noted down during the survey. The difference between them is taken as the "reduction in expected income" of the household which is fully attributed to polluted environment. According to the people of the area, in the absence of pollution, there would not be any other cause for reduction of income from agriculture with the existing methods of production and the pattern of fertilizers, pesticides and other resources used in the area.

Further, as discussed earlier, the number of motor vehicle accidents and the casualities are the highest in Ernakulam District. There occurred 526 accidents in which 85 people were injured and ten killed during the year 1978 in the district caused by reasons including deterioration of the environment.[6] Attributing only ten per cent of the monetary value of the casualities to environmental deterioration of the area, the incremental revenue accrued from such casualities avoided can be calculated. Assuming the above figures of casualities as yearly averages and assuming a loss of Rs.50 per day per person affected or killed in the accidents, the incremental revenue in this respect for a person year of 272 days would be nearly (50 x 272 x 95 / 10) Rs.1.29 lakhs per annum. And for a ten year period it would amount to around 8.42 lakhs, conducting at a social discount rate of ten per cent per annum.

Similarly by assuming a loss of Rs. 1 lakh per accident due to damages on vehicles and attributing ten per cent of this to atmospheric pollution, revenue accrued by avoiding accidents would be (10000 x 526) Rs.52.6 laksh per year. For the next ten years it would cumulatively increase at a ten per cent social discount rate to approximately Rs.342.59 lakhs. Thus the total incremental revenue from motor vehicle accidents avoided by environmental protection of the area during the next ten years would be around (8.42 + 342.59) Rs.351.01 lakhs.

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6. It is widely known that in the national highway No.47 between Palarivattom and Alwaye, a large number of motor vehicle accidents and casualities occur every year. This distance in the highway falls in the project area.

Incremental Revenue from Damage Avoidance Costs Avoided

Various damages caused in the area by environmental pollution are removed or avoided by incurring expenses on medical treatment of the affected people, treatment of the affected animals and treatment of the affected plants and crops. When various environmental protection schemes are implemented such expenses can be progressively reduced and gradually avoided. The revenue accrued by avoiding such damage avoidance costs can therefore be calculated as shown in table 8.8. Only 25 per cent of such damage avoidance costs are attributed to environmental pollution because many of the damages might have occurred also due to other reasons. It is estimated that incremental revenue on account of damage avoidance costs avoided would be nearly 32.75 lakhs per year and for a ten year period at ten per cent social discount rate it would approach Rs.213.32 lakhs.

Incremental Revenue from Additional Employment Created

Capital expenditures by way of control and abatement costs, social afforestation in the immediate locality around the factories, impacts prevention costs of polluted drinking water and contaminated atmosphere, and transaction costs do have the potential for additional employment generation. Such expenditures are of the order of Rs.780 lakhs, Rs.10.41 lakhs (see pages 188 & 189), Rs.48.20 lakhs (see page 190), and Rs.478.12 laksh (see page 191) respectively on the stated items. As per official statistics the capital-labour ratio of the industrial sector for the district of Ernakulam is Rs.45,500, and the

average of wages, salaries and other benefits per employee in the industrial sector in the district is Rs.12,200.[7] Accordingly the total capital expenditure of about Rs.1316.73 lakhs would create approximately 2894 employment opportunities. And the income by way of additional employment would be around Rs.353.06 lakhs during the ten year period.

Estimate of Incremental Costs

In an estimate of incremental costs of environmental protection of the area, the expenditures required for implementing various control and abatement schemes are of prime importance. Till the pollutants are made to conform to the prescribed standards, the damage and damage avoidance costs would continue as major items in the estimate of environmental protection costs. Since the suggestion is for implementing various pollution control and abatement schemes over a period of ten years the cost involved in monitoring, research and administration - transaction costs - must also be included in this financial estimate. Accordingly, the incremental costs on account of environmental protection of the area are estimated under the following heads:

1. Damage Costs
2. Damage Avoidance Costs
3. Pollution Control and Abatement Costs
4. Pollution Prevention Costs - and
5. Transaction Costs

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7. Government of Kerala, Bureau of Economics and Statistics, Industrial Statistics Unit, Annual Survey of Industries, Kerala State 1977-78, Trivandrum, June 1978, p.30.

Damage Costs

Damages on people, domestic animals, agricultural crops, materials and structures have already been discussed in connection with the estimate of incremental revenue on account of those damages avoided by environmental protection of the area during the next ten years. The approximate money values of damages on people and domestic animals were estimated to be Rs.791.93 lakhs and Rs.59.48 lakhs, respectively. The damages on agricultural crops were estimated around Rs.1474.47 lakhs. As has been found in the estimate, the people of the area are also required to bear the maintenance costs on materials and structures of the order of about Rs.212.42 lakhs. It could also be estimated that damages due to motor vehicle accidents in the district attributed to environmental pollution of the area would come around Rs.351.01 lakhs. Thus the total of damage costs identified in the context of environmental protection of the area would amount approximately to Rs.2889.31 lakhs for the period of ten years, estimated at a social discount rate of ten per cent per annum.

Damage Avoidance costs

The damage avoidance costs are those incurred by way of expenses on medical treatment of the affected people and domestic animals and by the treatment of the affected plants and crops. The costs incurred by the people of the area for avoiding damages in these respects total nearly Rs.213.32 lakhs, when we consider a ten per cent social discount rate for a period of ten years.

Pollution Control and Abatement Costs

The factory survey has revealed that during the past ten years, the nine factories in the area together have made an investment of the order of Rs.310 lakhs in various schemes of environmental pollution control and abatement including recurring expenditures. Besides, the factories have been paying more than Rs.7.5 lakhs per annum as water cess to the State Pollution Control Board (KSPCB) since the enactment of the Water Cess Act of 1977.

The factories together have a paid up capital of approximately Rs.15600 lakhs and employ about 12,250 people. It is proposed that these factories make fixed investment of five per cent of the paid up capital in various control equipment and abatement schems during the next ten years. This would cost around Rs.780 lakhs. Assuming five per cent of this as recurring costs including depreciation, the estimate of recurring costs on control and abatement measures for the next years at ten per cent social discount rate would be about Rs.621.56 lakhs. Thus the total costs on control and abatement measures at the factories would amount to approximately (780 + 621.56) Rs.1401.56 lakhs during the period.

It may be observed that about one third of one square kilometer area around the factories is without any sort of vegitation. A social afforestation programme of planting trees of selected species many be suggested as a measure of control and abatement of pollution (especially sound) in the immediate

locality. About 2500 trees may be planted in a hectare incurring a cost of about Rs.50 per tree during the initial year, towards planting, manure, protection staff, etc. which amount to approximately Rs.10.41 lakhs. Further, Rs.10 per tree per annum may be spent towards the upkeep of the trees and the maintenance of the programme, costing around Rs.2.83 lakhs and for the remaining nine year period it would amount to around Rs.28.28 lakhs at a social discount rate of ten per cent per annum. Thus the total cost of social afforestation of the said area comes nearly to (10.41 + 28.28) Rs.38.69 lakhs during the ten year period.

Pollution Prevention Costs

There are two types of prevention costs identified and estimated in the context of environmental protection of the project area. They are those incurred on preventing the damages on people due to polluted drinking water and due to polluted atmosphere. The public water supply cannot, perhaps become a perfect substitute for the fresh and pure ground water. As pointed out earlier about 322 households inhabiting one and a half square kilometer in the project area are seriously affected by the polluted ground water. It may be proposed that the impacts of polluted drinking water may be prevented by installing water purifiers in the households of that area with a fixed investment of Rs.3500 per household and a recurring cost of Rs.250 per houehold per year. Similar expenditures may be made for installing air purifiers in the households of about one and a half square kilometer area around the industrial belt.

For these measures, the households may be assisted by the government or the factories or the financial institutions through an appropriate programme. Both these pollution damage prevention measures[8] together require Rs.7000 by way of fixed investment per household and Rs.500 per household per year as recurring costs. The total of the fixed investment for the households in the said areas comes around (7000 x 322) Rs.22.54 lakhs and the recurring costs, nearly 25.66 lakhs, estimated at a social discount rate of ten per cent per annum during the next ten years. Thus the incremental costs in this account of preventing damages from contaminated water and polluted atmosphere in the most affected areas of the project area are calculated to a total of, approximately, (22.54 + 25.66) Rs.48.20 lakhs.

Many people in the locality have suggested that the effluents of different factories may be combined and pumped through a pipe of enough size to the outer ocean so that various impact of water pollution in the locality could altogether be prevented. A detailed investigation is required on the feasibility and desirability of such a programme. It is feared that it may produce devastating effects on the marine ecosystem and destroy its rich fauna. the cost estimate of any such prevention measure is, therefore, not included in the present study.

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8. These measures do not prevent pollution at the source. They are partial measures as they are effective to check adverse impacts of pollutants in the water and air only if the people are confined to their homes, but provide great relief to the children and the aged in the households.

Transaction Costs

The Kerala State Pollution Control Board (KSPCB) is the official agency entrusted with the responsbility of supervising the various environmental protection measures in the state. The Board has been spending an average of nearly Rs.10 lakhs per annum on adminstering and supervising environmental protection measures all over the state. The state government contributes this amount every year against a budget proposal of the Board for more than Rs.30 lakhs per year on average. The officals of the Board are of the opinion that considering the responsibilities of the Board with respect to pollution control in the entire state even Rs.30 lakhs per year is not sufficeint for the purpose. Since most of the industrial pollution load and about 50 per cent of the total pollution load in the state originate or are concentrated in Eloor-Edayar Industrial belt and its surrounding environmental media, it may be recommended that at least half of this amount may be spent for the administration of environmental protection of this area. It is also expected that various voluntary organizations, research agencies and university centres would incur a similar amount as transaction costs. Thus, it is estimated that transaction costs required to be incurred for the protection of the environment of the area would be Rs.30 lakhs per year and at a social discount rate it would be around Rs.478.12 lakhs for the next ten years.

Benefit-Cost Analysis Results

The total of incremental benefits of environmental protection of eloor-Edayar Industrial belt, accrued in different ways,

is approximately Rs.5114.18 lakhs and the total of incremental costs is around Rs.5069.20 lakhs. Benefits would exceed costs while implementing the suggested package of measures by Rs.44.98 lakhs. Though these figures reveal approximations only, they clearly indicate the trend in favour of the decision maker to adopt the programme of environmental protection of the project area as its economic feasibility is established. The estimates of incremental benefits and incremental costs of environmental protection of the area are summarized in the benefit-cost analysis table given below.

Benefit-Cost Analysis Table

INCREMENTAL BENEFITS				INCREMENTAL COSTS			
Sl. No.	Items	Rs. Lakhs	Rs. Lakhs	Sl. No.	Items	Rs. Lakhs	Rs. Lakhs
1.	On Account of Beneficiaires' Willingness to pay		1658.49	1	Damage Costs		
					On human health	658.86	
2.	On Account of Damages Avoided				Due to workdays lost	133.07	
	Damages on human health avoided	658.86			On domestic animals	59.48	
	Workdays lost avoided	133.07			On agricultural crops	1474.47	
	Damages on domestic animals avoided	59.48			On materials and structures	212.42	
	Damages on crops avoided	1474.47			Due to accidents and Casualities	351.01	
	Damages on materials/structures avoided	212.42					
	Damages due to accidents & casualities avoided	351.01			Total Damage Costs		2889.31
	Total Benefits from Damages avoided		2889.31	2.	Damages Avoidance Costs		213.32
				3.	Pollution Control and Abatement Costs		
3.	On A/c of Damages Avoidance Costs avoided		213.32		On various schemes by the factories	1401.56	
					For a social afforestation programme	38.69	
4.	On Account of Additional Employment generated		353.06		Total Pollution Control & Abatement Costs		1440.25
				4.	Pollution Prevention Costs		48.20
				5.	Transaction Costs		478.12
	Total Incremental Benefits		5114.18		Total Incremental Costs		5069.20

TABLE - 8.1.

Beneficieries Willing to Pay

Yearly income of the households	Classification of the households	Number of beneficiery households	Number of beneficieries involved	Compensation demanded per household (Rs/year)	Willingness to pay per household (Rs./year)	Effective or adjusted measure of willingness pay per household per year (Rs.)
Upto Rs.6000	Low Income Group	35	235	842.85	112.10	477.48
Rs. 6001 and Rs.12,000	Lower middle income group	30	192	1020.00	148.00	584.00
Rs.12,001 and Rs.18,000	Upper middle income group	25	167	1390.00	147.00	746.50
Rs.18,001 and above	High income group	10	58	1418.00	238	828.00

TABLE - 8.2

Incremental Revenue on the Basis of Beneficieries Willingness to Pay

Sl. No.	Income Group	Proportion of total households	Number of beneficiery households	Effective willingness to pay per household per year	Estimate of incremental revenue (Rs.)
1.	Low	35	5900	477.48	2817132.00
2.	Lower Middle	30	5058	584.00	2953872.00
3.	Upper Middle	25	4215	768.50	3239227.50
4.	High	10	1686	828.00	1396008.00
			Total Incremental Revenue		10406239.50 (104.0624 lakhs)

TABLE - 8.3

Revenue from Damages on Human Health Avoided

Sl. No.	Income Group of the households	Yearly average income per household (Rs.)	Loss of Income due to disease (Rs.)	Loss of income due to disease caused by environmental pollution (Rs.)	No.of house-holds in the area	Loss of income due to damages on health (Rs.)
1.	Low	3000	750	187.50	5900	1106250
2.	Lower Middle	9000	2250	562.50	5058	2845125
3.	Upper Middle	15000	3750	937.50	4215	3951563
4.	High	21000	5250	1312.50	1686	2212875
				Total of the revenue from damages on health avoided		Rs. 10115813 (101.15813 lakhs)

TABLE - 8.4.

Revenue from "Loss of Income Due to Workdays Lost" Avoided

Sl. No.	Income group	Workdays lost per household per year	Yearly loss of income due to work days lost per households (Rs.)	Loss of income of workdays lost due to environ-	No.of House-holds in area	Loss of income due to work days lost in the area
1.	Low	15	165.44	41.36	5900	244026
2.	Lower Middle	17	562.50	140.62	5058	711281
3.	Upper Middle	12	661.76	165.45	4215	697335
4.	High	12	926.47	231.62	1686	390507
			Total incremental revenue from loss of income on workdays lost avoided per year			Rs.2043149 (20.43149 lakhs)

Note: Average income of a workday lost = average yearly income per household

TABLE - 8.5

Revenue from Damages on Domestic Annimals Avoided

Sl. No.	Income group	Yearly average income from domestic animals per households (Rs.)	Average loss of income per household due to disease (Rs.)	Average loss of income per household due to death of animals (Rs.)	Total of the loss of income from domestic animals (Rs.)	Average income loss due to pollution ~~per~~ per households (Rs.)	Number of households in the area	Loss of income from animals due to environmental pollution in the area (Rs.)
1.	Low	114.40	28.60	17.10	45.70	11.43	5900	67407.50
2.	Lower Middle	452.50	113.13	75.00	188.13	47.03	5058	237890.39
3.	Upper Middle	440.00	110.00	430.00	540.00	135.00	4215	569025.00
4.	High	204.12	80.48	11.75	92.23	23.06	1686	38874.95
				Total incremental revenue from damages on domestic animals avoided per year in the area				913197.85 (9.1319 lakhs)

TABLE - 8.6

Revenue from Damages on Crops Avoided

Sl. No.	Income Group	Yearly average income from agriculture per household (Rs.)	Reduction in expected income due to environmental pollution per household per year(Rs.)	Number of households in the area	Estimate of loss of income due to environmental pollution (Rs.)
1.	Low	852.86	1292.85	5900	7227815.00
2.	Lower Middle	1680.00	1075.00	5058	5437350.00
3.	Upper Middle	472.50	1830.00	4215	7713450.00
4.	High	1044.11	1102.95	1686	1859573.00
			Total incremental revenue from damages on crops avaoided in the area per year		22638188.00 (226.382 lakhs)

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TABLE - 8.7

Revenue from Damages on Materials and Structures Avoided

Sl. No.	Income Group	Average yearly maintenance cost per household (Rs.)	Additional expenses on maintenance cost due to pollution (Rs.)	Number of households in the area	Estimate of maintenance cost due to pollution per year in the area (Rs.)
1.	Low	142.85	95.23	5900	561857.00
2.	Lower Middle	265.00	176.67	5058	893596.85
3.	Upper Middle	445.00	296.67	4215	1250464.00
4.	High	494.11	329.41	1686	555385.26
			Total incremental revenue from damages on materials and structures avoided		Rs. 3261302.11 (32.61 lakhs)

TABLE - 8.8

Revenue from Damage Avoidance Costs Avoided

Sl. No.	Income Group	25% of the medical expenses attributed to environmental pollution per household per year (Rs.)	25% of the treatment costs for animals per year (Rs.)	25% of the treatment costs for plants & crops per household per year (Rs.)	Average total damage avoidance costs per household per year (Rs.)	No. of households area	Estimate of damage avoidance cost avoided in the area (Rs.)
1.	Low	175.00	1.78	19.28	196.06	5900	1156754.00
2.	Lower middle	163.75	7.13	24.63	195.51	5058	988889.58
3.	Upper middle	228.75	2.50	13.50	224.75	4215	1031621.20
4.	High	34.25	1.93	21.93	58.11	1686	97973.46
			Total incremental revenue from damage avoidance costs avoided in the area during a year				3275238.10 (32.75 lakhs)

CHAPTER - IX

THE FINDINGS

Man is only one of the species of a rich and complex ecosystem. Any system that he has created or the system he belongs to is merely a part of this larger system. Hence he should not overexploit the finite resources neglecting the welfare of other species. He should keep in mind the fact that any of his activities that lead to the extinction or exhaustion of other species or resources will ultimately boomarang on his own welfare.

In the past, the earth was considered as an infinite reservoir of resources. This resulted in reckless exploitation of the earth. People took the attitude of a "cow-boy economy" rather than a "spaceship economy".* Besides this conceptual fallacy, population and economic growth are responsible for accelerated increase in resource use rate all over, resulting rapid depletion of natural resources and serious environmental contamination. Environmental pollution renders the resources of environmental media unsuitable for specific and established uses.

Eloor-Edayar Industrial belt which is located on the peripheries of the Ernakulam district is considered to be the

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* In a cowboy economy success is measured in terms of the amount of production; but the criterion for success in a spaceship economy is the maintenance of the existing capital stock in good order. In the spaceship, the provisions - earth's inhabitants and the life support system - are to be conserved and allowed to regenerate to ensure that they last for ever. Their reckless use, as in a cow-boy economy, will be disastrous.

industrial capital of Kerala. The industrialists in this area behave as if they have perpetual rights over the area to do anything. They dump tonnes of toxic chemicals, acids, radio active substances, metal residues, obnoxious gases and other pollutants in the environmental media of the area. These toxic (airborne as well as earth bound) pollutants endanger not only the lives of the present (both plant and animal) generation but the future ones also. Fishes die along the coast, plants and crops wither, cattle imbibe deadly poisonous substances, and drinking water is contaminated - all due to the activities of the factories located in this region. Thousands of people in the area are denied of fresh air and drinking water. Pollutants from industrial units seep into the water and consequently water in the area becomes unsuitable for human and animal consumption. The factories on the banks of the river treat the river as a sewer. Heavy loads of pollutants are flushed into the river. This pollutants reach the Vembanad backwaters through the river and convert it into an aquatic desert. The seriousness of the pollution problem in the region can be realised from the fact that breast-feeding children may get traces of DDT from their mother's milk.

Our study leads to the following conclusions:

1. The environment of the project area is heavily polluted. Natural reasons and human activities are behind it. The pollution caused by natural forces implies principally the salinity intrusion into the river contaminating the water intake points of the factories. The man-made pollution in

the area is mainly caused by effluents, emissions, solid wastes and sound from industrial production and processing.

2. The various industrial contaminants seeping into the ground have contaminated the ground water rendering it unsuitable for consumption, especially in places at the lower reaches of the Eloor branch of Periyar flowing through the project area.

3. The dumping of thousands of tonnes of toxic chemicals, metal residues and other biomagnifiable wastes into the river Periyar has made it virtually a sewer and Vembanad backwaters an aquatic desert.

4. The factories cause atmospheric pollution in an area of about five kilometer radius around the industrial belt.

5. Mercury, insecticides and radioactive substances are among the major pollutants let out by the factories of the area. These are neither treated nor is there any know-how for their treatment. The consequences can be disastrous to all forms of life of the area, now and in times to come.

6. There are serious adverse impacts of pollutants on the health and welfare of the humans and domestic animals, on crops and other vegetation, and on materials and structures of the area.

7. Besides the social costs of environmental pollution on account of reduced welfare, longevity and productivity, the people of the locality have to bear the economic losses due to ill-health and loss of income, and increased expenditure due to blighted crops and corroded materials and structures of the area.

8. The incidences of respiratory, heart, genetic and skin diseases are highly frequent among the residents of the area; the children in the households are worst hit; and about 40 to 45 per cent of the people of the project area are suffering from one or more diseases induced or accentuated by the pollutants let out from the factories; and -

9. The environmental protection of the project area is economically feasible when appropriate measures are adopted to achieve the desired goal of optimum environmental quality within a period of ten years. The economic feasibility has been established as the projected incremental benefits exceed the incremental cost of such a programme.

In the light of the present study, the following recommendations are made to improve the situation:

1. It is important to develop ecotechniques to create output with less scarce resource embodiment. Exhaustible and renewable resource augmenting technological progress enable per capita consumption of resources to remain constant. The

recycling of waste of all factories may be considered as an interim measure.

2. Various social and economic costs due to environmental damages are to be included in the actual cost-price calculations of the producers.

3. Measures are to be adopted to arrest the criminal irresponsibility of the polluters for causing environmental damages.

4. Various social pressure groups and non-governmental organisations engaged in environmental protection activities are to be promoted and their demands conceded.

5. It is necessary to initiate appropriate measures to create environmental awareness and to impart environmental education to the masses. Environmental education must be made an essential part of the academic curriculum starting at school level to continue throughout higher learning.

6. The attitude of the government relating to environmental problems must be guided by 'life and death' rather than 'law and order' considerations.

7. The official environmental protection agencies must be given executive powers to prosecute the polluters even when the culprits are public sector enterprises.

8. Adoption of a compromise formula after discussions between official agencies and polluting enterprises while fixing standards and criteria is totally unscientific and undesirable; and -

9. The polluting enterprises must be compelled to spend a definite portion of their paid-up capital or the sales turnover for the prevention of pollution and the protection of environment every year.

Appendix - 2.1

The United Nations Conference on Human Environment held at Stockholm in 1972

United Nations Conference on Human Environment was held in 1972 at Stockholm to evolve a comprehensive action-plan for the protection of global environment. The consensus at Stockholm centered around the principles and the code of conduct governing environmentally sound development and international arrangements conducive to it. The Stockholm conference highlighted the need for the sustainable husbanding of planetary resources and their equitable sharing to foster development in non-industrial countries facing the acute problem of poverty and to prevent the degradation of environment in industrialized countries, not prudent in the use of technology.[1] It could legitimize the environmental concern by putting it within an enlarged perspective of international relations and co-operation.

The Conference identified six priority areas and three functional tasks for the United Nations Environmental Programme (UNEP).[2] The six priority areas are:-

1. human settlement, health, habitat and well-being;
2. land, water and desertification;
3. trade, economics, technology and transfer of technology;
4. oceans;

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1. Ignacy Sachs, "Environment and Development Revisited", Alternatives - A Journal of Word Policy, Sept.1982, p.383

2. Gladwin Hill, "U.N. Environmental Efforts : A Start, A Long Way to Go" New York Times, Oct 20, 1975, pp.1-4-Cf. Baumol and Oates, Economics, Environmental Policy and Quality of Life; Prentice Hall Inc., New Jersy (1979), p.200.

5. conservation of nature, wild-life and genetic resources; and:
6. energy.

The three functional tasks are:-

1. environmental assessment: "earth watch";
2. environmental management; and -
3. supporting measures : information, education. training, and technical assistance.

The action plan evolved in the Conference with these priority areas and functional tasks provided guidelines to make development socially equitable, environmentally sustainable and economically viable. Towards development, the Conference brought out a balancing "ecodevelopment approach". That is, the conference held that development should proceed unobstructed except for improving and protecting the environment side by side.[3] In contrast to various other international Conferences, Stockholm could attract the interests of developing and the developed countries alike and all of them were involved actively to reach at a consensus in the proceedings.

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3. Ibid.

APENDIX - 3.1

List of Acts for the portection of Indian environment since 1897.

1897 Indian Fisheries Act.

1905 Bengal Smoke Nuisance Act.

1912 Bombay Smoke Nuisance Act.

1917 Mysore Destruction by Insects and Pests Act.

1919 The Poison Act.

1919 Andhra Pradesh Agricultural, Pest & Diseases Act.

1923 The Indian Boilers Act.

1927 The Indian Forest Act.

1946 Bihar Wastelands Act (Reclamation, Cultivation and Improvement)

1947 Mines and Minerals Act (Regulation and Development)

1948 The Factories Act (Pollution and Pesticides).

1949 Andhra Pradesh Improvment Schmes Act (Land Utilization).

1951 Industries Act (Development & Rgulation).

1953 Orissa River Pollution & Prevention Act.

1954 Assam Agricultural Pests and Disease Act.

1954 Prevention of Food Adulteration Act.

1954 U.P. Agricultrual Pests and Disease Act.

1955 Acquisition of Land for Flood Control and Prevention of Erosion Act.

1956 River Boards Act.

1958 Ancient Monuments and Archeological Sites and Remains Act.

1958 Kerala Agricultural Pests & Disease Act.

1958 Atomic Energy Act (Radiation Protection Rules 1971).

1963 Gujarat Smoke Nuisance Act.

1964 Delhi Restriction of Land Uses Act.

1968 The Inseticides Act.

1969 Maharashtra Prevention of Water Pollution Act.

1970 Merchant Shipping (Amendment) Act. (harbour and Coastal Water, Dumping of Oil etc.).

1972 Wildlife Protection Act.

1974 Water (Prevention & Control of Pollution) Act.

1976 Urban Land Act (Ceiling & Registration).

1977 Water Cess (Prevention and Control of Pollution) Act.

1980 Air (Prevention and Control of Pollution) Act.

1986 The Environment (Protection) Act.

ANNEXURE I

FORMAT OF THE SCHEDULE FOR THE FACTORY SURVEY

1.0 Introduction

1.1 Factory visited .....

1.2 Personnel Contacted.....

1.3. Location of the Factory.....

1.4 Year of Establishment.....

1.5 Year of Commencement of Production.....

1.6 Ownership of the Factory : Private/Public/Joint/Cooperative.

1.7.0 Capital:-

.1 Share Capital : Rs.....

.2 Paid up Capital : Rs.....

.3 Working Capital : Rs.....

1.8.0 Number of Employees:-

.1.Number of Daily Wage earners.....their pay Rs.....per day

.2.0 Number of salaried people:-

.2.1 Below Rs. 500 .....

.2.2 Between Rs.501 & Rs.1000 .....

.2.3 Between Rs.1001 & Rs.1500 .....

.2.4 Rs.1501 & above .....

1.9.0 Please give the following details:-

Main Product	Designed Capacity (MT*)	Rated capacity (MT)	Achieved capacity (MT)	Cost per unit (MT)	By products (MT)	Cost per Unit (MT)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
.1						
.2						
.3						
.4						
.5						
.6						
.7						
.8						
.9						
.10						

2.0 Water Pollution - Effluent Treatment and Disposal

2.1 Quantity of water consumed per day:.....Kilolitres.

2.2 Total Cess paid during a year : Rs.....

2.3 Cost involved for the installations (eg: watermeters, power consumption etc.) as per regulations under the Cess Act:

Rs.....

2.4 0 Please give the following details:-

Purpose for which water is consumed	Quantity consumed	Cess Rate	Rebate (%age)
1. Industrial cooling,spraying in mine pits or boiler feed		3/4 paise	
2. Domestic purposes		1 paise	
3. Processing whereby water gets polluted and the pollutants are easily biodegradable		2 paise	
4. Processing whereby water gets polluted and the pollutants are not easily biodegradable and are toxic		2.1/2 paise	

2.5 Water supplied to other factories:.....liters per day
2.6 Charge (rate) for which water is supplied.....
2.7 Do there exist any effluent treatment system? YES/NO
2.8.0 If No, please give the reasons:-
.1 Shortage of finance
.2 absence of proper technology
.3 treatment plant is yet to be installed
.4 there is no waste water
.5 there is no pollutant in the waste water
.6 other reasons, if any .....
2.9.0 If YES, please specify which of the following treatment methods is followed:-
.1 Recycle and fully recover
.2 Recycle, partially recover and disposal
.3 Recycle and disposal
2.10.0 Please give the following details of effluent treatment:

Details of the treatment systems	Date of installing	Investment incurred (Rs.)
.1		
.2		
.3		
.4		
.5		
.6		

2.11.0 What are the major water pollutants:-

	Major pollutants	Intensity before treatment	Intensity after treatment	Permissble limits
.1				
.2				
.3				
.4				
.5				
.6				
.7				
.8				
.9				
.10				

2.12 Are the existing systems functioning satisfactorily ? YES/NO

2.13 If No, what are the reasons?.....
.....

2.14 Whether the measure (intensity) of pollutants are reduced to the designed/permissibale standard? YES/NO.

2.15.0 If No, what are the reasons:-

.1 Poor design

.2 Mal-operation

.3 Old plant

.4 Poor maintenance

.5 No reason

.6 Absence or proper technology

.7 Any other:.....

2.16.0 Please specify whether any useful products are recovered from the effluents, methods to recover them, cost involved and the uses of the recovered products:-

	Products recovered	Method of recovery	Cost (Rs.)	Uses of the recovered products
.1				
.2				
.3				
.4				
.5				
.6				

2.17.0 If any, please specify the improvements required for the present effluent treatment systems:-

New Proposals	Period of implementation	Probable costs (Rs.)	Standards to which the level of pollutants will confirm to	
			Pollutants	Standards
.1				
.2				
.3				
.4				
.5				
.6				

2.18.0 Number of employees in the treatment plants:-

.1 Number of daily wage earners:.....their pay.....per day

.2.0 Salaried people:-

.2.1 Below Rs.500.....

.2.2 Between Rs.501 & Rs.1000 .....

.2.3 Between Rs.1001 & Rs.1500.....

.2.4 Rs.1501 and above.....

.3.0 Total number of employees in the treatment plants:

2.19 Where to the effluents are finally let out:.....

2.20.0 Do you have any regular inspection of the effluent standard by any agency/authority ? YES/NO.

2.20.1 If YES, name the agency/authority .....

2.20.2 Periodicity of inspection: daily/monthly/quarterly/yearly.

2.20.3 Remarks if any.....

2.21 Effluent treatment plants are designed by.....

3.0 Air Pollution Control and Treatment:-

3.1 How many stacks/chimneys are there in your factory?.....Nos.

3.2.0 Please give the following details of chimneys/stacks:-

Plants	Meterials of construction	Hight	Diameter	Quantity of gas emission
.1				
.2				
.3				
.4				
.5				
.6				
.7				
.8				
.9				
.10				

3.3.0 Kindly furnish the following details regarding the nature of air pollution:-

	Source & Pollutant gases	Quantity of emission (M^3/hr.)	Concentration pollutants (Mg/M^3)	Ground level concentration (Mg/M^3)
.1				
.2				
.3				
.4				
.5				
.6				
.7				
.8				
.9				
.10				

3.4 Do you treat your waste gases? YES/NO.

3.5.0 If No, please indicaste the reasons:-

.1 Shortage of finance
.2 Absence of proper technology
.3 Treatment plant is yet to be installed
.4 No pollutants in the gas emitted
.5 Pollution is not upto a significant level
.6 Other reasons, if any.....

3.6.0 If YES, specify which of the following treatment method is adopted:-
.1 recycle and fully recover
.2 recycle, partially recover and disposal
.3 recycle and disposal

3.7.0 Also, give the following details:-

	Details of the treatment systems	Date of installing	Investment(Rs.)
.1			
.2			
.3			
.4			
.5			
.6			

3.8.0. Please give the following data:-

	Major pollutants	Concentration/ intensity of pollution before treatment (mg/M^3)	Concentration/ intensity of pollution after treatment(mg/M^3)	Permissible limit
.1				
.2				
.3				
.4				
.5				
.6				
.7				

3.9 Are the existing treatment systems functioning satisfactorily? YES/NO

3.10 If No, what are the reasons:.....
.....

3.11 Whether the intensity of pollutants are reduced to the designed/permissible standard? YES/NO.

3.12.0 If No, what are the reasons:-

.1 Poor design
.2 Mal-operation
.3 Old plant
.4 Poor maintenance
.5 No reason
.6 Absence of proper technology
.7 If any other.....

3.13.0 Please specify whether any useful products are recovered from the emissions, methods adopted to recover them, cost involved and the uses of the recovered products:-

products recovered	Method of Recovery	Cost	Uses of the recovered products
.1			
.2			
.3			
.4			
.5			
.6			

3.14.0 Please specify the improvements required for the present waste gases treatment systems:-

Improvements required	Probable cost	Period of implementation	Standard to which the level of pollution will confirm to.	
			Pollutants	standard
.1				
.2				
.3				
.4				
.5				
.6				

-3.15.0 No.of employees in the air pollution control activities:-

.1 Number of daily wage earners:.....their pay Rs. ...per day
.2.0 Number of salaried people:-
.2.1 Below Rs.500.....
.2.2 Between Rs.501 & Rs.1000 .....
.2.3 Between Rs.1001 & Rs.1500.....
.2.4 Rs.1501 & above.....

3.16.0 Do you have any regular inspection of air pollution standard by any agency/authority ? YES/NO

.1 If yes, name the agency/authority.....
.2 Periodicity of inspection.....

3.17 Air pollutant treatment plants are designed by:.....

4.0 Solid Waste Treatment and Disposal:-
4.1 Do you have a solid waste treatment system? YES/NO
4.2.0 If No, please give the reasons
.1 There is no solid waste in the production process
.2 Solid waste does not contains polluting elements
.3 No treatment system exists
.4 Treatment system is yet to be installed
.5 Absence of technology
.6 Any other .....
4.3.0 Kindly furnish the following details:

Solid waste contents	Pollutants	Concentration before treatment	Concentration after treatment	Permissible limit
.1				
.2				
.3				
.4				
.5				
.6				

4.4 Quantity of solid waste:.....tonnes per day.
4.5 Total cost of waste treatment and disposal:Rs.....per day
4.6 Briefly describe the method of treatment & disposal:.....
.....
4.7 Whether there is any useful products recovered form the solid waste YES/NO
4.8.0 If YES, give the following details.

Products recivered	Method of recovery	Cost (Rs.)	Income from the sale of recovered products	Uses of the recovered products
.1				
.2				
.3				
.4				
.5				
.6				

4.9 Responsibility of the solid waste disposal is of 4: Municipality/ Management/ any other agency .....
4.10.0 Nature of location where the solid waste is finally disposed to:
.1 Factory's own land
.2 Private property
.3 Governments property
.4 Any other .....
5.0 Noise Pollution Control:-
5.1 What is the noise level near the factory.....decibels
5.2 Permissible limit/accepted standard.....decibles

5.3.0 Cases of disablencess observbed due to excess of noise:-
5.3.1 temporary:.....
.....

5.3.2 Permanent:.....
.....
5.4.0 Measures adoped to abate noise pollution:-
5.4.1 machineries or equipment installed and their cost:.....
.....
5.4.2. Natural measures adopted:.....
.....
6.0 General Analysis

6.1.0 If any, please give the unexpected/new pollutants resulting from the treatment of pollutants:-

New pollutants from the water treatment	Level of pollution	Pollutants resulting from the gas waste treatment	Level of pollution	New Pollutants from the solid waste treatment	Level of pollution	Any other
.1						
.2						
.3						
.4						
.5						
.6						

6.2 What are the methods adopted to treat the resulting new pollutants and what is the cost incolved?
.....
.....
6.3 Do any other factory's effluents/emissions cause deterimental impact on your functioning ? YES/NO
6.4 If YES, please give the following details:-

Name of the factory	Pollutants	How they affect your functioning (& cost involved)
.1		1. Materials/Products:
.2		2. Personnels directly or indirectly
.3		3. Agriculture:
.4		4. Animals:
.5		5. Any other:

6.5 What are the remedies suggested to solve the above problem (& the cost).....
.....

6.6 Please indicate the %age of increase in cost due to the expenditures on pollution control schemes .....

6.7.0 Please give the following information

Products	Cost of production when there is no pollution control measures adopted	Increase in cost due to pollution contrtol	Percent-age of increase
.1			
.2			
.3			
.4			
.5			
.6			
.7			
.8			
.9			
.10			

6.8.0 Impact of increase in production cost on demand and the sale of the products:-

- .1 Quality sold remain unchanged
- .2 Quantity sold gets reduced by.....per cent.
- .3 Quantity sold is increased by.....per cent.
- .4 Any other possibility.....

6.9 Do you think that a joint effort by all (or more than one) factories in the locality will greatly save the cost of pollution control? YES/NO

6.10.0 If no, please give the reasons:-

- .1 A joint effort is not possible
- .2 Other factories are not willing
- .3 That may adversely affect competition in the field of production & sale
- .4 Cost of production will be more than that at present
- .5 Any other.....

6.11.0 If your answer to question No.6.9 is YES, please give the following information regarding the advantages of a joint treatment system:-

Suggestions for a joint treatment system	Advantages	%of reduction in cost/benefits
.1	1.In the cost of	
.2	production	
.3	2. Capital investment	
.4		
.5	3. Social objection	
.6		
.7	4. Any other	

6.12 Increase in export prices due to treatment expenditures ..... percent.

6.13 Does this increase in cost causes severe consequences on your competition in the foreign market ? YES/NO

6.14 If YES, please explain the impact .....
.....
.....

6.15.0 Money spent by R&D for designing and installing the treatment systems:-

.1 Yearly (at present) Rs.....

.2 Total expenditure incurred so far Rs.....

6.16 Do you have a separate department for environmental protection and pollution abatement? YES/NO

7.0 Place:.....

Date :.....

Annexure II

FORMAT OF THE SCHEDULE FOR THE HOUSEHOLD SURVEY

1. Head of the Household :

2. Name of the Household :

3. Panchayath : Ward:

4. Number of members in the Household :

5. Details of the Household members :

Name	Relationship with the Head of the Household	Educational qualification	Employment	Monthly income Wages/Salaries

6. Health Status of the Household Members.

Name	Casualty or temporarily effected diseases	Cantinuing diseases	Number of workdays lost due to diseases during last one year

7. Last years total medical expenses.(Rs.):.....

8. Amount received from the employer towards treatment during the last one year.(Rs.):.....

9. Land holding of the household :.....

Land (Purayidam).....Hactares.....Ares:.....

Field (Nilam) ..... Hactares.....Ares:.....

Total..... Hactares.....Ares

10. Details of Cultivation.

	Purayidam			Nilam		
Crops	Area under Cultivation	Yeardly (In come)	Crops	Area under Cultivation	Yearly (In come)
Total					

11. Details of crops diseases

Crops	Diseases	whether any remedial measures taken	Pesticides insecticides etc.ussed.	Expenditure for treatment during the last year (Rs.)

12. Do you belive that industrial pollution has caused reduction in your agricultural income YES/NO

13. If Yes specify the amount of loss in income (Rs.)

14. Details of income yielding domesticeted animals and birds:-

Animals/ birds	No.	Monthly (In come)	Salable value(Rs.)	affected diseases	Whether treated	Expenditure for treatment (Rs.)

15. Details of House, Buildings and materials:

Type	Last years expenditure on repairs and maintenance	Saleable value (Rs)	Any other releted information

16. The amount you would demand if the government or any other agency are about to compensate for the losses due to pollution: Rs..... per year.

17 Specify how much you are willing to pay towards the implementation of various schemes for protecting the environment of the area. Rs....per year.

18. Any other information you would like to provide in this respect.

19. Your suggestions for the protection of the environment of the area.

20. Notes:

ANNEXURE III

FORMAT OF THE SCHEDULE FOR EMPLOYEE WELFARE SURVEY

1. Introduction

1. Name :
2. Age and marital Status :
3. Nature of employment :
4. Name of the factory :
5. Years of service :
6. Monthly salary :
7. Place of residence :
8. Distance from the factory :

II. Occupational and Health Aspects

9. Have you been on medical leave during the last five years :

10. How many days a year :

11. Reasons for leave :

12. Period of hospitalisation :

13. Are you a patient of (and how long):-

a. Asthma	F. Cancer
b. Tuberculosis	g. Hearing troubles
c. Bronchitis	h. Eye troubles
d. Skin disease	i. Any other
e. Genetic disorders	

14. Give the detils if any of your family members are suffering from any of those diseases.

15. Costs of treatment during the last year :

16. Amount claimed for reimbursement and the amount obtained :

23. Have there been any accients in your factory or in the neighbouring factories in the recent past ? If so, give details:-

Factory	Nature of accidents	Consequences	Remedical measures adjusted

24. State your comments on the environmental pollution of Eloor-Edayar Industrial belt

25. Propose your suggestions

26. Notes:

ANNEXURE - IV

FORMAT OF THE SCHEDULE FOR THE HOSPITAL SURVEY

Name of the Hospital/Clinic/Nursing Home: _____ Year: _____

No. of Patients reported for treatment:

Diseases	MONTH												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Respiratory													
Heart													
Genetic													
Intestinal													
Skin													
Others													
Total													

Minutes of the discussion with doctors:-

Notes:

BIBLIOGRAPHY

ARTICLES:

Anil Agarwal, "Policies of Environment", The Illustrated Weekly of India, Sept 1, 1985.

Arun Ghosh, "The 1987-88 Budget: A Birds-eye View of Central Expenditures", Economic and Political weekly, April 11, 1987.

Bharat Dogra ,"Genetic Erosion of Plant Wealth" Yojana October 16-31, 1986.

Chakraborti D. and Chakravorthy R.,"Chemicals Pollute Environment", Science Reporter, August, 1983.

Dakshina Murthy K.S., "Politics of Environment", Economic and Political Weekly, May 3, 1986.

Das T.M., "Programme of Environmental Science," paper read in the First National Environmental congress, New Delhi, Dec. 28-30, 1982.

Dilip K. Biswas, "Environmental Programmes of the Government of India", paper presented in the Conference of Non Governmental Organisations Working on Environmental protection March 11-13, New Delhi, 1982.

Dinesh Mohan, "Food Vs Limbs: Pesticides and Physical Disability in India", Economic and Political Weekly, March 28, 1987.

Gadgil R.L., "Tolerance of Heavy Metals and the Reclamation of Industrial Waste", Journal of Applied Ecology vol.6, 1969.

Gopalan U.K., Environmental Consciousness", paper presented at the World Environmental Day Seminar on Development and Environment, Cochin, June 5, 1982.

Gordon R.L., "A Re-interpretation of the Pure Theory of Exhaustion", Journal of Political Economy 75, pp.274-85, 1957.

Gray. L.C., "The Economic Possibilities of Conservation", Quarterly Journal of Economics, 32, pp.82-95, 1912.

Gupta K.B. and Malik S.B., " Environment and its relation to Spiritral Education". in the first National Environmental congress, New Delhi, Dec.28-30, 1982.

Hansen J.A.,"Towards an Ecologically Based Economic philosaphy", Environmental conservation, vol.4., 1977.

Hardin Garrett, "The Tragedy of the Commons", Science 162, pp.1243-48, 1968.

Hottelling H., "The Economics of Exhaustible Resources", Journal of Political Economy, 39,pp.137-75, 1931.

Ignacy Saches, "Environment and Development Revisited", Alternatives - A Journal of World Policy, September 1982.

Jagdish Bahadur, "Environmental problems in Developing Hymalayan water Resources", Yojana, November 16-30, 1986.

Jyoti K. Parikh, " Environmental Problems in India and Possible Trends in future", Environmental Conservation (quarterly) Vol.4, 1977.

Leelakrishnan P. and Chandrasekharan N.S.,"Prevention and cantrol of water pollution. Need to Make Law Effective:, paper presented at the National seminar on prevention and Control of Water Pollution: Problems and Perspectives, Udyogamandal (Kerala), October 16-17, 1981.

Margaret R. Biswas, "Agricultural Productions and Environment: A Review", Environmental Conservation, vol II No.3, 1984.

Martha W. Gilliland, "A conceptial Framework for Environmental protection", Environmental Management Vol.8, No.6, November, 1984.

Namboodiripad P.V.S., "The Air We Breathe", paper read at the world Environmental Day Seminer, Cochin, June-5, 1982.

Nammalwar P., "Pesticides Pollution in Marine Environment", Science Reporter, September, 1984.

News Reports, The Economic Times, February 12, 1982 and Nov. 1985.

The Hindu, October 24, 1982, July 24 and December 13, 1983, March 31, 1985 and July 2, 1985.

The Hindustan Times, October 16, December 12, and 13 1985, and February 17, 1986.

Indian Express, April 1 July 18, and August 1, 1982, April 1, July 18, and 30, 1983, September 4, 1984, March 17, September 10 and 26, 1986.

The Times of India, July 28 & 29, 1982, April 4, 1983, Febryary 20, 21, and July 29, 1985, January 27 and November 5 & 6, 1986.

Osman K.K.(1986), "Effects of Environmental Pollution on Health" paper read at the National Seminar on "Save Periyer", Association for Environmental protection, Alwaye, December 7, 1986.

Padmanabhan V.T., "The Number Game - A Study of Occupational Health Hazards at I.R.E., Alwaye", Economic and Political weekly, March 8-15, 1986.

"All Within Limits: Radio Active Waste Disposal at I.R.E.-I", Economic and Political Weekly, Feb.28, 1987.

"All Within Limits: Radio Active Waste Disposal at I.R.E-II", Economic and Political weekly, March 7, 1987.

Raghunandan D., "Ecology and Conseiousness", Economic and Political Weekly, March 28, 1987.

Raja Ramanna, Inagural address at the World Environmental Day Seminer on Development and Environment, Cochin, June 5, 1982.

Rao V.R., "Remote Sensing for Environment Monitaring: Present and Future Opportunities", Paper read in the First National Environmental Congress, Dec. 28-30, 1982.

Robert P. Lamb and Seifulaziz L.Miles, "Population and Development: Environmental Perspectives", Environmental Conservation, Vol-II, No.3, Autumn, 1984.

Sachitanand N.N., "The Growing Pesticides Hazards", Hindu Daily, June 24, 1983.

Sankaranarayanan K.C. and Karunakaran V., Adaquacy of Tools and techniques in Evaluating Envrionmental Impact", The National Environmental seminar, January 16-18, Cochin, 1983.

Sankaranarayanan K.C. and Karunakaran V., "Economic Growth and Environmental quality", Southern Economist, June 15, 1983.

Sapru P.K., "Environment Administration: Structural and Policy Issues in India", Management in Government, January-March, 1985.

Shynama C.S. and Balakrishnan K.P., "save periyar Which Way to Proceed", paper read at National seminar on "Save Periyar", Association for Envrionmental protection, Alwaye, Dec.7, 1986.

Subhash Chandre Sarkar, "Envrionmental planning must subserve Development"(Review), Commerce. February 15, 1986.

Sukumaran K., (justice, Kerala High Court) Address Delivered at the World Environment day seminar, Cochin, June 5, 1982.

Susan G.Hadden, "Statutes and standards for Pollution Control in India", Economic and Political Weekly, April 18, 1987.

Taghi Farver M., "The Interactions of Ecological and social systems", in William H. Mathews (Ed.) Outer Limits and Human Needs, The Dag Hummarskjold Foundation, Uppasala, 1976.

Trinif Ranjan Mitra, "Economics and Ecology of Man", paper presented at the First National Environmental Congress, Dec. 28-30, New Delhi, 1982.

Uma Devi S.,"International Economics", Institute of Correspondence course, Kerala University, 1985.

Venugopal P., "Polluted Flows the Periyar", Indian Express, Dec.6, 1986.

Venugopal P., " Pollution seeping into Drinking Water Too", Indian Express, Dec.12, 1986.

BOOKS:

Allen Cottrel, Environmental Economics, Edward Arnold Publications Ltd., London, 1970.

Allen S.W., Conserving Natural Resources: Principles and Practice in a Democracy, McGraw Hill, New York, (1985).

Ashok. S. Guha, An Evolutionary View of Economic Growth, Oxford University Press, New York, 1981.

Ayres and Kneese, Economics and the Environment, John Hopkins Press, Baltimore, U.S.A., 1969.

Barbara Ward Progress for a Small Planet, Penguin Books, England, 1979.

Barbara Ward and Rene Dubos, Only One Earth: The Care and Maintenance of a Small Plantet, Norton, New York, 1972.

Barry Commoner, The Closing Circle, Bantam Books, New York, 1972.

Baumol and Oates, Economics, Environmental Policy and Quality of Life, Printice Hall Inc., New Jersy, 1979.

Bertell Roosalie, Hand book for Estimating Health Effects from Exposure to Ionising Radiation, Institute of Concern for Public Health, Toronto, Canada, Ministry of Concern for Public Health, Buffalo, USA and International Radiation Research and Training Institute, Burmingham, UK, 1984.

Bertelmus Peter, Environment and Development, Allen and Unwin, Boston, 1986.

Brian Goodall and Andrew Kirby (Eds.), Resources and Planning, Pergamon Press Ltd., Oxford, 1979.

Centre for Science and Enviroinment, The State of India's Environment 1984-85: The Second Citizen's Report, Centre for Science and Environment, New Delhi, 1985.

Charles Cooper, Economic Evaluction and the Environment Hodder and Stonghtan, London, 1981.

Ciriacy-Wantrup, Resource Conservation: Economics and Policy, University of California Press, Berkely, 1956.

Colin MacAndrews and Chia Lin Sien, Developing Economies and the Environment: The South-East Asian Experience, McGraw Hill International Book Company, Singapore, 1979.

Dales J.H., Pollution, Property and Prices, University of Toronto Press, Toronto. 1968.

Daly Herman E (Ed.), Toward a Steady State Economy, W.H. Freeman, San Francisco, 1973.

Darryl D'Monte, Temples or Tombs? Industry Versus Environment: Three Contraversies, Centre for Science and Environment, New Delhi, 1985.

Das Gupta A.K., The Economics of Austerity, Oxford University Press, New Delhi, 1975.

David W.Orr and Marvin S.Soroos (Ed.), The Global Predicament: Ecological Perspectives on World Order, University of North California Press, U.S.A., 1979.

Digvijay Sing, The Eco-Vote, Printice Hall of India Pvt. Ltd., New Delhi, 1985.

Dominic Alheritiere, Environmental Impact Assessment and Agricultural Development, FAO, Rome, 1982.

Donald R. Kelly et.al., The Economic Super Powers and the Environment - the U.S.A.the U.S.S.R.and Japan, W.H. Freeman and Company, San Fransisco, 1976.

Edward Shapiro, Macroeconomic Analysis, 3rd Edn., Hocurt Brarcea Invsnoich Inc, New York, 1974.

Ehrlich Paul and Ehrlich Anne H., Population, Resources, Environment : Issues in Human Ecology (2nd Ed.), Freeman, San Fransisco, 1972.

Elliott H. Blaustein, Rose T. Blaustein and Peter Greenleaf, Your Environment and You: Understanding the Pollution Problem, Occeana Publications Inc., Dobbs Ferry, New York, 1974.

Ely R.T. and Wehrwein G.S., Land Economics, University of Wisconsin Press, Madison, 1940.

Eric Ashby, Reconciling Man with the Environment, Oxford University Press, New York, 1978.

Eric L. Hyman, The Uses, Validity and Reliability of Perceived Environmental Quality Indicators, East-West Environment and Policy Institute, Honolulu, Hawaii, 1981.

Eric P Echolin, Down to Earth: Environment and Human Needs, Pluto Press, London, 1982.

Essam El-Hinnawi and Manzur Ul-Haque Hashmi(Ed.), Global Environmental Issues, Tycooly International Publishing Ltd., Dublin, 1982.

Eugene Odum , Fundamentals of Ecology, W.B.Saunders, Philadelphia, 1971.

Fedoseyev P., Social Problems of Man's Environment: Where We Live and Work, Progress Publishers, Moscow, 1981.

Food and Agricultural Organisation (FAO), Pesticides Residues in Food : 1982 Evaluations, plant production and protection paper 49, Rome, 1983.

Frolov I., Global Problems and the Future of Mankind, Progress Publishers, Moscow, 1982.

Garret Hardin and John Baden (Eds.), Managing the Commons, W.H. Freeman and Company. San Fransisco, 1977.

Gerald M. Martin et.al., Environmental Considerations for Biomas Energy Development. East-West Environment and Policy Institute, Honolulu, Hawaii, 1981.

Gofman John W., Radiation of Human Health, Pantheon Books, New York, 1983.

Gordan E Beanlands and Peter N. Duinker, An Ecological Framework for Environmental Impact Assessment, Institute for Resource and Environmental Studies, Delhousie University, Halifax, Nova Scotia, Canada, 1983.

Gorden L. Brady and Blair T. Bower, Air Quality Management: Quantifying Benefits , East-West Environment Policy Institute, Honolulu, Hawaii, 1981.

Herman Kahn, William Brown and Leon Martel, The Next 2000 Years, William Morrow, New York, 1976.

Hinde L.E. Jr. and Loring W.C., The Effects of Manmade Environment on Health and Behaviour, Castle House Publications Ltd., Atlanda, U.S.A., 1979.

International Labour Organisation (ILO), Encyclopaedia of Occupational Health and Safty, Vol-II, Geneva, 1983.

IUCN, Conservation of Ecological Processes, Commission on Ecology - paper 8, IUCN, 1984.

James Bridgeway, The politics of Ecology, E.P. Dutton & Company Inc., New York, 1970.

Jarret H. (Ed.), Environmental Quality in a Growing Economy, John Hopkins Press, Baltimore, 1966.

Joe E. and Middle Brooke, Industrial Pollution-vol.I, John Wiley and Sons, New York, 1979.

John A. Butlin (Ed.), Economics and Resources Policy, Longman, London, 1981.

John E. Heer and Joseph D Hagerty, Environmental Assessments and Statements, Van Nostrand Reinold Company, New York, 1977.

John H. Duffus, Environmental Toxicology, Edward Arnold Publishers Ltd., London, 1980.

John M Edington and Ann M. Edington Ecology and Environmental Planning, Chapman and Hall Ltd., Londan, 1977.

Joseph Julian, Social Problems, Printice Hall Inc. New Jersey, 1980.

Katherine Montague and Peter Montague, No World Without End: The Threats to Our Biosphere, Pulman, New York, 1976.

Kenneth E.F. Watt et.al., The Unsteady State: Environmental Problems, Growth and Culture, East-West Centre, The University Press of Hawaii, Honolulu, 1977.

Kerry Smith V., Scarcity and Growth Reconsidered: Resources for Future, the John Hopkins University Press, Baltimore, 1979.

Kneese, Economics and Environment, Penguin Education Series, London, 1977.

Krister Hjalte et.al., Environmental Policy and Welfare Economics, Cambridge University Press, Londan, 1977.

Kurt Dopfer (Ed.), Economics in the Future, the MacMillian Press Ltd, London, 1976.

Larry Korn (Ed.), The One-Straw Revolution, Rodale Press, Emmaus, 1978.

Lowe J. Lewis D and Atkins M, Total Environmental Control: The Economics of Cross-Media Pollution Transfer, Pergaman Press, New York, 1982.

Malcolm Slesser, The Politics of Environment: A Guide to scottish Thought and Actian, George Allen and Unwin Ltd., London, 1972.

Mann R.E., Environmental Impact Assessment, SCOPE, John Wiley and sons, New York, 1979.

Marshall I Goldman, Ecology and Economics, Printice Hall Inc. New Jersy, 1972.

Maynard M. Hufschmidt et.al., Environment, Natural Systems and Development, the John Hopkins University Press, Baltimore, 1983.

Meadows Donnella H., Meadows Dennis L., Randers Jorgen and William Behrens, The Limits to Growth, Signet, New York, 1972.

Michael Radclift, Development and the Environmental Crises, Mithuen & Company Ltd., London, 1984.

Mihajlo Mesarovic and Edward Pestal, Mankind at the Turning Point, E.P. Dutton, New York, 1974.

Mishan E.J., The Economic growth Debate: An Assessment, George Allen and Unwin Ltd., London, 1977.

Nag Chaudhari, Introduction to Environmental Management, Interprint, Naraina, New Delhi, 1983.

Nijkamp P. (Ed.), Environmental Economics - Vol I TheOries, Martin Nijhoft Social Science Division, Leiden, 1976.

OECD, The State of Environment in OECD Member Countries, Paris, 1980.

OECD, Environmental Policis for the 1980s, Paris, 1980.

Padmanabhan V.T., Duranthathinte Noottandileku (in Malayalam), Pusthaka Prasadhaka Sanghom, Pandalam, Kerala, 1985

The Nunmber game A Study of Occupational Health Hazards at I.R.E., Alwaye, Kerala Sasthra Sahithya Parishat, 1980

Pearce D.W., Environmental Economics, Longman, London and New York,1976.

Pearce D.W (Ed.), The Valuation of Social Cost, George Allen and Unwin, London, 1978.

Peter F. Drucker, Toward Next Economics and Other Essays, Allied Publishers Pvt. Ltd., New Delhi, 1981.

Pigu A.C., The Economics of Welfare, M.C.Millian and Co. Ltd.,London, 1932.

Rachel Carson, Silent Spring, Fawcett Publications Inc., Greenwich, Connectient, 1962.

Raymond F. Dasman, The Conservation Alternative, John Wiley and Sons Inc. New York, 1975.

Richard A. Carpenter, Balancing Economic and Environmental Objectives. The Question is Still How?, East-west Centre, Honolulu, Hawaii, 1981.

Richard Lecomber, Economic Growth Versus the Environment, John Wiley and Sons, New York, 1975.

Richard A Musgrave and Peggy B Musgrave, Public Finance, Theory and Practice., McGraw Hill Inc. New Delhi, 1980.

Savage et.al., Economics of Environmental Improvement, Huston Miflin company., Boston, 1974.

Schumacher E.F., Small is Beautiful, Bland and Briggs Ltd., Great Britain, 1973.

Scott A.D., Natural Resources, The Economics of Conservation, University of Toronto Press, Toronto, 1955.

Seneca and Taussig, Environmental Economics, Printice Hall Inc., New Jersy, 1979.

Seymour J. Rubin and Thomas R Graham (Ed.), Environment and Trade, Allenheld Osmun Co. Publishers Inc., New Jersy, 1982.

Sharma R.C., Environmental Education, Metropolitan Book Company Pvt. Ltd., New Delhi, 1986.

Shekhar Sing, Environmental policy in India, Indian Institute of public Administration, New Delhi, 1982.

Sreekumar V (Ed.), Nadinu Chernna Sankethikavidya (in Malayalam), Kerala Sasthra Sahitya Parishat, Trivandrum, 1978.

Sterm Wohless, Bonbel and Lowry, Fundamentals of Air Pollution, Accademic Press, U.S.A., 1972.

Thapar Romesh, The Waste and the Want: Thoughts on the Future, Orient Longman, New Delhi, 1978.

Thomas D. Crocker and Rojers A.J., Environmental Economics, the Dryden Press Inc. Hinsdale, Illinois, 1971.

Timothy O'Riordan and Ralph C. d'Agre, Progress in Resource Management and Environmental Planning, John Wiley and Sons, New York, 1979.

Urs and Natraj (Eds.), Regional Planning and National Development, Vikas Publishing House Ltd., New Delhi,1978.

Ursul A.D. (Ed.) , Philosphy and the Ecological Problems of Civilization, Progress Publishers, Moscow, 1981.

Victor P.A., Pollution: Economy and Environment, Allen and Unwin, London. 1972.

William H. Mathews (Ed.), Outer Limits and Human Needs, The Dag Hammarskjold Foundation, Uppusala, 1976.

Criteria for Selecting Appopriate Methods for Environmental Assessment, East-West Environmental and Policy Institute. Honolulu, Hawaii, 1980.

World Bank, Environmental Consideration for the Industrial Development Sector, Washignton D.C, 1978.

Yusuf J. Ahmed and Frank G. Miller (Eds.),Intergrated Physical, Socio-Economic and Environmental Planning, UNEP, Tycooly International Publishing Ltd., Dublin, 1982.

REPORTS:

George Mathai Tharakan, "Comprative Study of Air Pollution in Eloor-Edayar Industrial Belt", Project Report School of Management Studies, University of Cochin, 1976.

Government of India, Air Quality in selected Cities in India (1978-79), the National Environmental Engineering and Research Institute (NEERI) Nagpur, 1980.

Census of India 1981, Census Commission New Delhi 1982.

Fourth Five Year Plan (1970-75), Planning Commission, New Delhi.

Fifth Five Year Plan (1975-80), Planning Commission, New Delhi.

Sixth Five Year Plan (1980-85), Planning Commission, New Delhi.

Seventh Five Year Plan (1985-90), Planning Commission, New Delhi.

Government of Kerala, Annual Report 1979-80, The Kerala State Pollution Control Board, Trivandrum, 1981.

Annual survey of Industries, Kerala State 1977-78, Industrial Statistical Unit, Bureau of Economics and statistics, Trivandrum, 1978.

Governent of Kerala, Economic Review 1980, The State Planning Board, Trivandrum, 1981.

Economic Review 1981, The State Planning Board, Trivandrum, 1982.

Economic Review 1982, The State Planning Board, Trivandrum, 1983.

Economic Review 1983, The State Planning Board, Trivandrum, 1984.

Economic Review 1984, The State Planning Board, Trivandrum, 1985.

Economic Review 1985, The State Planning Board, Trivandrum, 1986.

Economic Review 1986, The State Planning Board, Trivandrum, 1987.

Environmental Status Report on Greater Cochin-Kerala, The Kerala State Pollution Control Board, Trivandrum, 1982.

Episodal Pollution Caused by a Bund Across Periyar - A case study, The Kerala State Pollution Control Board, Trivandrum, 1982.

Industries and Industrial Labour and Infrastructure. Transport and Industries Division, State Planning Board, Trivandrum, 1980.

Season and crop Report of Kerala State 1977-78, Directrate of Economic and statistics, Trivandrum, 1982.

Government of Sweden, Acidification: A Bountlers Threat to our Environment, National Environmental Protection Board, Ministry of Agriculture, Solna, 1983.

Jolly Joseph, "A Survey of Ground Water in Eloor-Edayar Industrial Belt", Project Report, Department of Applied Chemistry, University of Cochin, 1982.

Satheeskumar M.K. and Vallabhan C.P.G. "A Photoacoustic set up for Atmospheric Attenuation Studies using the Ne Lazer Beam," Project report at the Department of Physics, University of Cochin, 1983.

STATUTES:

Air (Prevention & Control of Pollution) Act, 1980

The Environment (Protection) Act, 1986

Water (Prevention & Control of Pollution) Act, 1974

Water Cess (Prevention & Control of Pollution) Act, 1977