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Economic Assessment of Environmental Damage: A Case Study of Industrial Water Pollution in Tiruppur

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PREFACE

The Environmental Economics Research Committee of the Environmental Economics Capacity Building Project funded by the World Bank and Ministry of Environmental and Forests sponsored a study of “Economic Assessment of Environmental Damage: A Case Study of Industrial Water Pollution in Tiruppur”. The draft final report of the study consists of two volumes – Volume I is the text of the report and Volume II contains the Annexures. The study was conducted under my guidance with the assistance of Mr.Prakash Nelliyat, Dr.N.Jayakumar and Mr.R.Manivasagan. The views expressed in the report are those of the authors and must not be attributed to the Madras School of Economics.

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Paul P.Appasamy
Director

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Paul.P.Appasamy

Principal Investigator

LIST OF TABLES

EXECUTIVE SUMMARY

ECONOMIC ASSESSMENT OF ENVIRONMENTAL DAMAGE:

A CASE STUDY OF INDUSTRIAL WATER POLLUTION IN TIRUPPUR

Background

Rapid growth of industrial output and exports has occurred in certain sectors during the post liberalisation period. In particular, the cotton textile and garment industries have grown due to availability of cheap labour and raw materials. The percentage share of textiles in total exports almost doubled from 17 % in 1981-82 to 31.6 % in 1998-99. However, the bleaching and dyeing units in the textile industry have caused severe environmental pollution problems. While the government has passed different laws for controlling pollution, the major enforcement agency, the State Pollution Control Board (PCB) has not been able to implement the pollution control measures effectively, due to the large number of small units. The bleaching and dyeing units use a large quantum of water. Most of this water is discharged in the form of effluents into land and water polluting the local environment. However, these industries provide substantial employment and income to the region and foreign exchange to the country. Considering these facts, there is need for develop an appropriate strategy for balanced development. The present study has made a preliminary attempt to use the principles of environmental economics to analyze the underlying issues.

Conceptual Framework

All the polluting units are required to meet the effluent standards of the Pollution Control Board. For the smaller units, the cost of effluent treatment may be as high as the existing capital investment for production. These units have to either close down or utilise a common effluent treatment plant (CETP). Others who can afford their own facilities have to set up their own treatment plants (IETP) if they are to meet the standards.

Since standards are set without considering either treatment cost or damage, it is rarely clear whether the current policy meets any economic objective (i.e. efficiency, optimality, cost-effectiveness, equity, etc.), and any economic assessment can be done only post-facto. Both in terms of cost and damage the units have to be v iewed collectively. As mentioned earlier, those participating in the CETP programme share the costs of treatment. It must be remembered that there may be economies of scale due to treatment, but there may be diseconomies of CETPs due to transport (the piping and costs of connection are non-trivial). On the damage side, the impact is collective and not attributable to any one unit. Hence, in this analysis we discuss the pollution impact of the 702 bleaching and dyeing units as a collective entity. The PCB on the other hand has to view each unit separately with regard to the legal requirements.

There are some other issues which need to be highlighted.

(1) Accumulation: The simpler models of environmental economics treat pollutants discharged in any particular period as constant. The assumption that pollutants get assimilated or disappear in the next period is rarely true. Many pollutants exhibit stock characteristics. Thus, the damage in any period is a function not only of the pollutants discharged in that period, but the accumulated pollution from previous periods. In certain cases like ground water, saturation may also occur. This means that the damage function is dynamic and may be non-convex, unlike the cost function which is generally assumed to be convex.

(2) Cost of Meeting Standards: Total dissolved solids, one of the measures of pollution caused by the bleaching and dyeing activity, cannot be controlled by conventional effluent treatment. Removal by expensive technologies like reverse osmosis (similar to desalinization) has high capital and operating costs. However, the treated water can be recycled saving the cost of purchasing water. Another option would be to make technology changes which use less water and discharge less salt. Unfortunately, the end-of-pipe regulation has precluded these possibilities.

The pollution problems of Tiruppur can be viewed in a social benefit – cost framework.

(a) Social Benefit : Net value added by the industry (Value of output less value of inputs)

(b) Social Cost : Costs of treatment (annualized) + annual cost of residual damage.

In this study, we focus on the cost side – the cost of treatment and the residual cost of damage. The empirical literature tends to consider only treatment cost as the externality cost of pollution since marginal cost of pollution abatement is assumed to be equal to the marginal cost of damage. However, treatment does not eliminate damage because there may be residual pollution causing damage. This is particularly true when there is accumulated pollution. Thus, we need to measure the pollution load over time and the consequent damage.

Tiruppur

Tiruppur is a fast growing hosiery 'industrial city' in Coimbatore district of Tamilnadu. It is located on the bank of the Noyyal river, a tributary of the Cauvery. At present 9000 knitting, processing, manufacturing etc. units which are functioning in Tiruppur provide employment for more than 2 lakh people and the direct export earnings in 1999 was Rs. 3784 crores. The bleaching and dyeing units use large quantities of water, but most of the water used by these units is discharged as effluents containing a variety of dyes and chemical (acids, salts, wetting agents, soaps, oil etc.). These units discharge nearly 90 mld of effluents on land or into the Noyyal river, leading to contamination of the ground and surface water and soil in and around Tiruppur and downstream. In this study we have estimated the quantity of water used, effluent generation and characteristics, pollution load, efficiency of treatment and its cost and value the damage in monetary terms in the agriculture, fisheries and urban water sectors, using existing secondary data collected from different government agencies. Field level information was also gathered through focal group discussions with NGOs, farmers etc. from the affected area for strengthening the case study results.

Of the 702 bleaching and dyeing units which are functioning, 199 are involved in bleaching, 414 in dyeing and the remaining 89 units are engaged in both bleaching and dyeing activities. The gross fixed assets is Rs. 131.8 crores and cloth processed is 14,924 tonnes per month. The total water consumption by these units is about 86 mld while the water used per kg. of cloth processed is 144.8 litres. The water consumption per kg. of cloth processed has declined from 226.5 litres in 1980 to 144.8 litres in 2000, possibly due to the non-availability of local water due to the textile pollution. The total annual water cess collected by the PCB from the 702 units is Rs.29.42 lakh at an average of Rs. 4191 per unit. The water cess provides some revenue to the Board, but does not act as a disincentive either in the use of water or the discharge of wastewater.

The discharge of effluents has caused severe pollution of both the surface and ground water in the region and has also contaminated agricultural land. Due to pressure from NGOs and farmers' organisations through the High Court, the PCB has insisted that the units are either connected to a CETP or have their own treatment plant. As a result 424 units have constructed IETPs and 278 units are connected to 8 CETPs in Tiruppur. Around 164 units which were not connected either to CETPs or IETPs, have been closed down by the order of the Madras High Court. Even though the units are treating their effluents through CETPs or IETPs, the treated effluents do not meet some of the standards prescribed by the TNPCB especially for parameters like TDS and Chloride.

According to the PCB rules the red and orange category units should be situated 1000 metres away from a river / stream or any other water resource. However, in Tiruppur, as far as information gathered from PCB records, around 239 units are located at a distance of less than 300 metres from the Noyyal river. So, there is high possibility for polluting the river. Around 83 % of the IETPs discharged their effluents directly / indirectly in to the water bodies. It shows that there is a high possibility of pollution accumulation. The pollution load was calculated from 1980 to 2000 with the help of PCB data. During 1980 to 2000, the total pollution load for the 20 years was: TDS 23.54 lakh tonne, Chloride 13.11 lakh tonne, Sulphate 1.25 lakh tonne, TSS 0.97 lakh tonne, COD 0.90 lakh tonne, BOD 0.29 lakh tonne and Oil & Grease 0.01 lakh tonnes. From 1980 onwards the effluents have gradually accumulated causing pollution of the river and ground water in Tiruppur and downstream. This is proved by a number of studies by academic researchers and different government agencies. Further these studies have pointed out that in and around Tiruppur the water is unsuitable for domestic / irrigation purposes.

Efficiency and cost of treatment in Tiruppur

To determine the overall efficiency of treatment for all the units, a comparison is made of the pollution load before and after treatment. The average values of quality of treated and untreated effluent was obtained by the PCB from the samples tested by the Board at different points of time. In the IETPs there is substantial reduction in COD, BOD and Oil & Grease after treatment. Although the TDS and Chloride declined after treatment, it could not meet the PCB standard. In the 8 CETPs case only pH and Sulphate values are within the permissible limit, most of the other parameters did not improve after treatment. The total pollution load has reduced as a result of treatment of all parameters except COD and BOD in CETPs and Sulphate in IETPs.

The cost of effluent treatment of CETPs and IETPs. The variable cost is much higher both in the case of IETPs (86% of total cost) and CETPs (73% of total cost) compared to the annualized capital cost. In the case of the CETPs, the capital cost is subsidized by the Central and State governments. Since there is no corresponding subsidy for operating costs, there is virtually no incentive for good treatment.

Valuation of Damage

Damage assessment has been attempted for the agriculture, fisheries and domestic sectors using appropriate techniques. For valuing the damage in the agricultural sector, the study area can be divided into two categories. The first category consists of 25 (regional study) villages situated in and around Tiruppur. 4 villages heavily affected by pollution were purposively selected for the case study. The regional study data shows that the total irrigated area declined from 16,262 ha. to 14,262 ha. between 1985-87 to 1997-99. On the other hand rainfed / non-irrigated land increased from 2108.3 ha. to 2668 ha. Around 13% of irrigated area was lost, and the net loss of area under cultivation was 7%. In the four case study villages both irrigated (500 ha. to 144.6 ha.) and unirrigated (2308 ha. to 1861 ha.) area have declined between 1985-87 and 1998-99. The loss in the gross value of output of crops in the 4 case study villages was estimated. Irrigated crops like paddy have completely disappeared, resulting in an output loss of Rs. 8.62 lakh in 1994-95 harvest prices. The gross output loss for all crops in the 4 villages is Rs. 25.23 lakhs. The focal group and opinion survey also confirm that the pollution problems are not significant at the regional level, but very specific to those villages which are severely polluted.

The second category is the command area of the Orthapalayam Irrigation Project. Since water in the reservoir is unfit for irrigation, the foregone value of irrigated crop is estimated for a year, as compared to the return from existing rainfed agriculture. Around 10,875 acres of land was to get irrigation and output of 10,000 tonnes/year of paddy was expected from this project. Following the closure of the dam due to pollution, the farmers are not able to cultivate irrigated crops, the foregone value of 10,000 tonnes of paddy is estimated to be Rs. 5.26 crores Even though the dam was closed, the farmers continue to raise the rainfed crops in the command area. The opportunity cost to them is the difference between the value of the irrigated crop (paddy) less the value of the existing rainfed crops, estimated to be Rs. 4.13 crores.

For valuing the damage in the fisheries sector, total value of fish productivity loss is estimated for Noyyal River, System tanks and Orthapalayam reservoir. The total annual loss in the fishery sector is Rs. 14.73 lakh which includes the Rs. 0.15 lakh in Noyyal river, Rs. 2.57 lakh in System tanks and Rs. 12.01 lakh in Orthapalayam reservoir.

For the urban water sector, the damage is calculated on the basis of Replacement or Opportunity cost of fresh water transport and supply for Tiruppur due to the pollution of the local water sources. Since the industrial units pay Rs. 450 per tanker load of water (12,000 litres) from neighbouring villages, the foregone value of the local ground water (78.6mld) is estimated to be Rs. 9.80 crores per year.

Conclusion

Despite the construction of individual and common effluent treatment plants at considerable cost, salts mainly chloride continue to be discharged unabated. The local environment, soil, water etc. can assimilate only a certain quantity of the effluents. Although each individual unit discharges only a small quantity of effluent, the combined discharge of more than 700 bleaching and dyeing units outstrips the assimilative capacity, causing damage to agriculture, fisheries, and local ground water in and around Tiruppur. The units could have considered environmental friendly technologies which use less water and discharge less salts. Although these are capital intensive, the units could have saved in terms of (a) water purchased (b) water cess (c) treatment costs and possibly compensation for damage.

The study points out the limitations of environmental economics methodology which for the most part ignores stock pollution and the consequent damage. Since many pollutants including greenhouse gases have "stock" characteristics, more effort needs to be placed on estimating stock pollutants and their consequences.

CHAPTER I: INTRODUCTION

The nation has witnessed rapid industrial growth during the post liberalisation period. Unfortunately, this rapid growth has caused environmental stress in certain regions of the country. Stimulation of industrial exports, especially during this period has further aggravated the environmental problems, which has imposed social costs on many local communities. During the last decade, different laws have been passed for controlling the environmental pollution caused by developmental activities. The State Pollution Control Boards are the regulatory agencies which have been entrusted with implementing these laws. But in many cases these agencies have not been able to implement pollution control measures to the full extent, especially in respect of small industries which are located in clusters.

India has comparative advantage in certain export industries, such as cotton textiles, leather, etc. due to availability of raw materials and cheap labour. These agro-based industries cause various form of pollution which contaminate the surrounding air, water and land. Often they are also ‘water consuming’ industries since they require large quantities of water for processing. These industries discharge the untreated or partially treated effluents on land or water bodies which end up polluting the environment.

In the initial stages the pollution levels from these units might be low, since the effluent load would be more or less within the assimilative capacity of the surrounding environment. Hence, the local public did not consider these industries to be a problem. But, the gradual increase in the effluent load in proportion with increased output has began to have serious environmental impacts. On the other hand, these industries provide regional socio-economic benefits in the form of income, employment and foreign exchange. Since small industries have historically been promoted as a matter of industrial policy, the government agencies face a dilemma, in regulating the acute pollution problems caused by the small scale sector.

It is necessary therefore, to devise appropriate strategies for the sustainable industrial development of these regions. As a part of existing regulatory programmes, a number of environmental management measures have been undertaken. However, there are few studies which have made an assessment of the impact of pollution caused by these industrial clusters on the surrounding environment, and on the other economic sectors such as agriculture which have been affected by pollution.

An environmental damage assessment study requires inter-disciplinary analysis and adequate time series data. After obtaining a picture of physical environmental quality based on trends for the affected area, appropriate valuation techniques have to be used to determine the impact . The assessment should provide a comprehensive picture of the social cost imposed by industrial clusters which have been unable to adequately control pollution.

The hosiery industry in Tiruppur (Tamilnadu) is an interesting case study of the pollution caused by industrial clusters. Tiruppur is a major hosiery industrial centre in the country, in which more than 700 bleaching and dyeing units are located. These units together discharge nearly 90 million litres per day (mld) of effluents on land or into the neighbouring Noyyal river. Even though the textile-processing units have recently established effluent treatment plants, the level of treatment is not satisfactory. The continuous discharge of untreated and partially treated effluents for more than a decade has contaminated soil, water, riverine ecology, etc. not only in Tiruppur but in the down stream areas as well. The present study attempts to assess the environmental damage which has occurred in Tiruppur and the surrounding places due to textile effluent discharge and its value in monetary terms. Valuation has been undertaken using appropriate methodology developed in an environmental economics framework, with existing secondary data collected from different government agencies. Field level information was also gathered through focus group discussions with NGOs, farmers etc. from the affected area.

Industrial Growth and Environmental Problems of Tiruppur

Tiruppur is a fast growing industrial city in Coimbatore district of Tamilnadu, also known as the `banian city' of India. It is located on the bank of the Noyyal river, a tributary of the Cauvery. The hosiery industry in Tiruppur provides substantial contribution to the economy in the form of income, employment and foreign exchange generation. At present more than 4000 knitting, manufacturing, processing and other ancillary units which are functioning in Tiruppur provide employment for more than 2 lakh people. The city contributes more than 50% of the hosiery garment export from India. The direct export earnings in 1999 was Rs.3784 crores, and a similar quantity of goods is sold in the Indian market as well.

However, the rapid growth of the industry has resulted in serious environmental problems, especially from the bleaching and dyeing units. There is evidence to suggest that these units extract considerable quantity of ground water from the peripheral areas and discharge the effluent without adequate treatment. In the earlier years, industries met their water requirements by pumping water from the Noyyal river or from wells. But the deterioration of surface and ground water quality in Tiruppur has compelled the industrialists to transport water from the peripheral areas to the city through lorry tankers. This ultimately led to the formation of an active water market. Out of the total water consumed by industries, 85% of the water is transported from the peripheral villages within a radius of 25 to 30 kms. Industries pay around Rs.450/- for a tanker load of 12,000 litres of water i.e. Rs.37.50 per kilolitre.

The environmental problems of the hosiery industry are closely associated with the discharge of effluents from the bleaching and dyeing units. Since bleaching and dyeing activities are `non- consumptive' most of the water used by these units are discharged as effluent after processing. The units use a variety of dyes and other chemicals such as acids, bases, salts, wetting agents, soaps, oil etc. Many of these chemicals are not retained in the processed hosiery goods but are discharged as wastewater. The waste water is odorous, acidic/alkaline and also contains soluble solids which in turn result in increased Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Bleaching contributes high level of Chloride and Total Dissolved Solids (TDS) to the waste water.

Recently, due to the continuous pressure from local NGOs, downstream farmers' organisations, the Tamil Nadu Pollution Control Board (TNPCB) and the Court, polluters (bleachers and dyers) ultimately decided to carry out their production process in a more `environment friendly' manner. Out of 866 bleaching and dyeing units, 702 units are involved in effluent treatment programmes either through Individual Effluent Treatment Plants (IETPs) or Common Effluent Treatment Plants (CETPs). According to TNPCB's latest record (during August 2000) 424 units have their own treatment plants, while 278 units have joined CETPs. Presently, 8 CETPs have been constructed in the surrounding villages of Tiruppur. 164 units which were not connected either to an IETP or CETP, have been closed down by the order of the Madras High Court. Even though during the last two years industries have constructed their plants, the treated effluents do not meet the standards prescribed by TNPCB for parameters such as Total Dissolved Solids, Chloride and Sulphate.

The disposal of untreated waste water over decades on land and the Noyyal river has affected the quality of surface water, groundwater and the soil, not only in Tiruppur but in downstream areas also. The Noyyal river water carries high level of TDS and various salts. In Tiruppur Municipality and most of the peripheral villages, well water has become coloured due to dye effluent, and it is unfit for any use including domestic, agriculture and industrial purpose. The ecology of the river, system tanks, down stream reservoir etc. are highly affected. As a result, these has been considerable reduction in fisheries activities. The water stored in the Orthapalayam dam (a reservoir constructed across the Noyyal river downstream of Tiruppur) is not suitable for irrigation. The health impact of water pollution may also be high in certain pockets where protected drinking water supply does not exist or is not sufficient. In brief, all these environmental damages ultimately lead to various social costs and loss of welfare to different communities through reduction in agricultural productivity, fish stock, drinking water contamination and scarcity, health problems, poor quality of natural environment etc.

It is useful to examine the above highlighted problems in an environmental economics framework in which the quantity and quality of water resources (an unavoidable input factor for hosiery industry and also the main source and mode of pollution in the region) is a major concern. In the Tiruppur region [located in the Noyyal River Basin– Map Fig. 1.1] water is an important natural resource, mainly because of its relative scarcity. The booming industrial water demand is the main factor, which creates inefficiency in the allocation and distribution of water resources in this region. Issues pertaining to over extraction of water, inter-sectoral water conflict and externalities, water management strategies etc. require special attention in the Tiruppur area and the Noyyal river basin.

Objectives

1. Examine the growth of the hosiery industry and exports in Tiruppur, in the context of the overall growth of textile industries in Tamilnadu and India.

2. Understand the functioning of textile processing activities in Tiruppur with emphasis on water consumption, input use, effluents and treatment, pollution load etc.

3. Formulate an appropriate methodology of damage assessment for approaching the water pollution issue at the regional level.

4. Estimate the physical impact caused by pollution to surface water, ground water, soil etc. and value the damage to ground water, agriculture and fisheries in the study area.

Methodology

It is very clear that only the bleaching and dyeing activities are associated with the environmental problems in Tiruppur. Since it is an intermediate segment in hosiery business activities, with both forward and backward linkages, any environmental study on bleaching and dyeing units without considering the industry in a broader perspective would be incomplete. Hence, secondary data has been collected from government agencies and industrial departments to understand the growth of the hosiery industry and its socio-economic importance, in terms of the number of units, investment, employment, production and the value of exports etc. over a period.

Special attention has been paid to the growth and functioning of bleaching and dyeing activities in Tiruppur since it is the source of the problem. Beside the technical information, a comprehensive data base has been prepared for both the functioning (702) and closed (104) units. The closed units are equally important here because they have also contributed to the deterioration of the environment since their establishment, and also they may function in the future if they attain the PCB's approval. The data base consists of (a) general information like the name of the unit, year of establishment, category of unit, type of unit, activity; (b) economic information – gross fixed assets, water cess; (c) input (raw material) details –

quantity of cloth processed, different chemicals and acid consumption, (d) water requirement for different uses and (e) environmental information – effluent quantity and quality, mode of discharge, treatment status, solid and hazardous waste, land use, distance from river etc. This data was mainly collected from the PCB records. The analysis of the above information provides a good foundation for estimating the pollution load which has caused the environmental damage.

The geographical coverage of the pollution affected area is identified on the basis of pollution media (groundwater, soil, surface water etc.). Since most of the textile processing units are located in Tiruppur town and the surrounding villages, the municipality (urban area) and 25 peripheral villages (rural area) of Tiruppur block were selected for investigation. Here the ground water is highly contaminated mainly due to the direct discharge of effluent. The downstream affected areas consist of (a) villages located within 10 km distance on either side of the Noyyal river from Tiruppur to Orthapalayam (about 30 km.) and (b) the villages surrounding Orthapalayam dam of about 10 km. radius, since surface water from the river, canals and system tanks are used for irrigation.The affected villages are identified on the basis of earlier studies, and discussions conducted with government officials and stakeholders.

Since uniform water and soil quality data are not available for the entire study area, the physical assessment of pollution is undertaken for only those pockets where data are available. This scientific data is gathered from government agencies like Central Ground Water Board (CGWB), State Public Works Department (PWD), Tamil Nadu Pollution Control Board (TNPCB), Tamilnadu Water and Drainage (TWAD) Board, Fisheries Department, Soil Survey and Land Use Organisation, Agriculture Department, etc. and the research work conducted by various academic institutions and experts. The environmental quality data (especially on surface and ground water) at different locations over the last decade are assessed and compared. This would provide a clear picture of environmental deterioration over a period of time. Analysis of water samples is compared with different standards (drinking, irrigation, fisheries etc.) also.

Economic Valuation

Economic valuation of pollution impact on various sectors like agriculture, domestic water and fisheries was undertaken with the help of appropriate techniques. Environmental economists have developed a number of methods and models for accounting for the non-marketed goods and services. These include Marginal Opportunity Cost (MOC), Effect on Production (EOP) Approach, Preventive Expenditure (PE) and Replacement Cost (RC), Human Capital (HC), Hedonic Method (HM), Travel Cost Method (TCM), Contingent Valuation Method (CVM) etc. All the above mentioned approaches have their own merits and demerits. The economic methodology suitable for the present case study was developed in the following manner. The theoretical aspects of the methodology are discussed in the next chapter.

Agriculture: The agriculture impact due to pollution can be divided into two categories. The first category is the impact on agriculture in villages located around Tiruppur and downstream along the Noyyal river. The village level data on area cultivated, cropping pattern, crop productivity, irrigation source etc. were collected from 1985 onwards from data provided by the Joint Director of Agriculture. The time series data was examined to identify changes in area under cultivation, changes in cropping pattern from more profitable to less profitable crops, decline in crop productivity.

The second category is the impact of the closure of Orthapalayam Irrigation Project. Since the water in the reservoir is unfit for irrigation, the value of the irrigation water released from the reservoir is estimated for a particular duration, say a year, for estimating the anticipated loss in irrigated agriculture, as compared to rainfed agriculture.

Urban Water: The damage to the urban water sector is calculated on the basis of Replacement or Opportunity cost of fresh water transport and supply for Tiruppur. The underyling assumption here is that if the industries had properly treated their effluent, pollution of the ground water in Tiruppur would not have occurred and part of the industrial and domestic demand could have been met from the local ground water as well as the Noyyal river water. Therefore, the cost incurred by industries for transporting water from the peripheral area could be used as the basis for computing the indirect cost of pollution. For domestic water supply the capital and running cost incurred by TWAD Board and Municipalities for transporting and supplying water from distance source is to be estimated. However, since the TWAD Board maintains that the schemes were implemented because of the growing population of Tiruppur and not because of the pollution of local sources, these costs have been omitted from the valuation.

Fisheries: The fisheries activities in the Noyyal river, system tanks and Orthapalyam reservoir have been severely affected by pollution. The productivity loss in the fisheries sector is calculated on the basis of fish catch data provided by the Fisheries Department. The revenue loss for Tamilnadu Fisheries Department Corporation due to the closure of the fishery project is also a major loss to the fisheries sector due to pollution.

Scope of the study and policy implications

Even though the accuracy of this exercise may be limited, an attempt to quantify the damages through valuation in an environmentally sensitive and export oriented industry like knitwear requires special attention.

The study is useful for policy for the following reasons:

(1) The estimation of social cost of textile pollution at Tiruppur is helpful in estimating the quantum of benefits to society as a result of pollution abatement.

(2) A damage assessment of industrial pollution is necessary to strengthen the Pollution Abatement Programmes (Effluent Treatment Plants) and for the application of 'Clean Technologies' include re-cycling techniques.

(3) This study attempts for the first time to estimate "stock pollution" (ie. accumulated pollution over a period of time) in the affected area and the consequent damage.

(4) Since the industrial effluent generates impacts on different sectors like agriculture, domestic water supply, fisheries, etc. the study could also be used to develop an inter -sectoral water resource management strategy.

(5) A damage assessment methodology is useful in case the Court decides that compensation should be paid to victims.

(6) The study would reveal the necessity for (a) strict enforcement of environmental legislation by the State Pollution Control Board, (b) increasing environmental awareness among the public, and (c) strengthening the co-operation from industrialists for pollution management.

Limitations

The secondary data on environmental quality in the study area are very limited and sketchy. The limited data gathered by government bodies do not have adequate coverage in terms of area or time. Since these data are normally collected as part of a Department's routine programme for a specific purpose or objective, it is difficult to draw conclusions from these secondary data.

The CGWB, TWAD Board and State PWD have been monitoring the groundwater quality through observation wells in Tamilnadu. Unfortunately the number of sample wells located in our study area is limited. On a few occasions TNPCB, Environmental Cell of PWD and Fisheries Department have assessed the river water quality for a few stations along the Noyyal river. Besides these government agencies, researchers have also studied the water quality in Tiruppur at different times. The soil quality data available with Soil Survey and Land Use Organisation for the pollution affected area is negligible. No single study has examined the loss of bio-diversity on surface water bodies like river, tanks and reservoir in the Noyyal basin. It is very clear that obtaining an accurate picture and drawing conclusions regarding the deterioration of physical environment for the entire pollution affected area based on the existing data is difficult. The practical difficulties in direct application of various valuation techniques in our case study is also a constraint. The study must be considered only as a <u>first step</u> in carrying out damage assessment in the Tiruppur region.

Structure of the Report

Including this chapter, the report consists of 9 chapters. Chapter II provides the methodological aspects of damage assessment especially for stock pollutants.

Chapter III focuses on a brief introduction of the textile industries in India, hosiery industry growth in Tiruppur and its socio-economic importance. Chapter IV explains textile wet processing (bleaching and dyeing) and the implications for water consumption in Tiruppur. Chapter V provides a detailed picture of effluent discharge by textile industries over a decade, pollution load, etc. Chapter VI gives detailed economic analysis results of pollution abatement in the textile processing activities in Tiruppur Chapter VII gives the available details on the quality of ground and surface water in the Tiruppur region. Chapter VIII identifies on the pollution impact on different sectors (agriculture, industry domestic and fisheries) and provides economic valuation wherever possible. Chapter IX contains the conclusions, findings and policy suggestions and agenda for future research.

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CHAPTER – II: VALUATION OF ENVIRONMENTAL DAMAGE: SOME THEORETICAL ASPECTS

"The present efforts to explore the non-use value of environmental resources through contingent valuation methods and related techniques beg the most important question that needs to be posed about our use of environmental resources: what is the value of the loss in output in production and consumption that is due to the degradation of environmental resources?" – C. Perrings (1995)

Rationale for the Study of Damage

The World Bank report "The Cost of Inaction: Valuing the Economy-wide Cost of Environmental Degradation in India" highlighted the magnitude of environmental damages in India, and the economic impact of not attending to our environmental problems. Carter Brandon and Kirsten Hommann (199) estimated environmental damages to be of the order of $ 9.7 billion per year or 4.53% GDP based on macro-level data for India. The impact of water pollution on health alone accounted for $ 5.71 billion or 58.8% of the total cost of damage. While one may quibble about the methodology or the assumptions made in the study, the importance of the report is that it brought "damages" to the forefront of the debate on environmental protection.

In the case of air and water pollution, the focus so far had been on the technology of pollution control and the costs of abatement to meet environmental standards. There is continuing debate on the appropriateness of standards, subsidies for abatement, fiscal incentives, and more recently economic instruments. "Command and Control" has been criticized as being ineffective, and a case has been made for trying out economic instruments such as effluent taxes and marketable permits. In the meantime, effluents continue to be discharged untreated or partly treated into the air, water or land. Very little is said about the accumulating damage resulting from continuous discharge of effluents, while the receiving environment in many regions of the country is getting seriously affected in terms of its functioning. When the services provided by environmental resources are impaired, there is a reduction in the productivity of the economic sectors which use those environmental resources, and therefore of welfare. As Brandon and Hommann have shown at the macro-level, the output of the nation / state/ region is reduced by not controlling pollution. (A similar argument can be made for not managing renewable resources such as forestry, fisheries, etc. properly.)

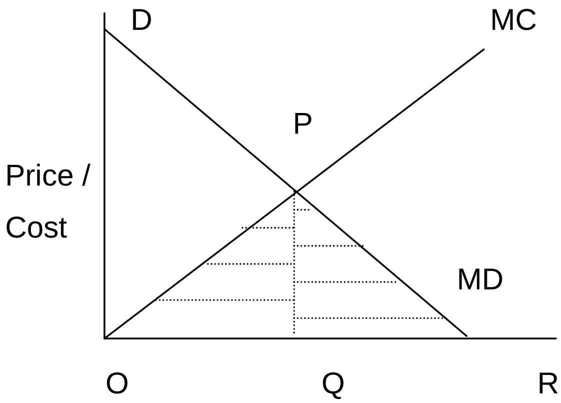

Fig 1. Optimal level of pollution abatement

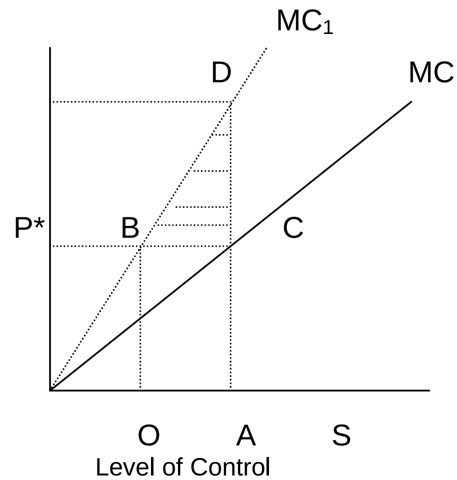

Fig 2: Taxes and Standards Approach

The focus of environmental economics has been on optimizing the level of pollution / level of pollution control. (These can be shown theoretically to be equivalent. In the following discussion we will use level of control of pollution as the yardstick, since it is easier to follow the reasoning.) If MC is the marginal cost of abatement and MD the marginal damage per unit of pollution abatement, then the "optimal" level of abatement is when MC = MD i.e. corresponding to point Q (Fig. 1). The cost of abatement is the area OPQ. It must however be noted that even at this level, there is damage amounting to the area PQR. Damage can be reduced to zero, only if the level of abatement is R. What is of interest to us however, is the damage cost when there is no abatement i.e. corresponding to level O. Then the damage cost is not PQR but ODR. The "cost of inaction" is ODR on a recurring basi.s.

Since damage functions are difficult to estimate, economists like Baumol and Oates (1988) have shown that environmental targets or standards can be used as a basis for determining the "efficient" rather than the optimal level of pollution control. If S is the level of pollution abatement corresponding to the standard, then the marginal cost of abatement to achieve S would be P*. Any firm which finds abatement more expensive (MC_1) would control upto A and pay a tax corresponding to AS at the tax rate P*, instead of controlling upto S i.e. the cost to the firm would be the area (OAB + ABCS) instead of the larger area OSD. The taxes and standards approach is therefore supposed to be more “efficient” than the regulatory approach because the firm and society have saved the unnecessary cost of area BCD.

While all of this is fine in the rarefied realms of theory, setting an appropriate target “S” for a particular pollutant in a particular setting is as difficult as estimating the damage function. (There are also serious problems in getting the value of P* right, i.e. there are social costs of either overestimating or underestimating P* which we will not discuss here).

Some of the real world problems with setting the standard are mentioned below:

(1) In India, different effluent standards have been set for discharge to water, land, marine system for particular pollutants. Take for example, the Biochemical Oxygen Demand (BOD) standard which is most commonly used in regulation. The BOD standard is 30 mg / litre for discharge to inland water bodies. But the standard does not discriminate between discharge into a small stream or the Ganga river. The impact of a discharge of 30 mg / litre in the two cases are very different. In other words, the standard is totally silent on the assimilative capacity of the receiving medium. (In the United States, the regulatory agency has the option of using a more stringent requirement after modelling the impact on the oxygen level of the water body).

(2) An extension of the same point is the cumulative impact of effluents from many sources. An inland water body may be able to assimilate 30 mg / litre of BOD from one pollution source, but it may not be able to deal with discharge from 500 sources in the same stretch of river. Here again, it is the assimilative capacity of the medium and not the effluent standard which should be the critical factor in determining the acceptable level of pollution.

(3) Yet another related issue is that many streams and rivers in South India are not perennial whereas industrial activity takes place throughout the year. In the so-called “dry” months, the river will be carrying only effluents (even if they meet the standard) with virtually no hope of assimilation. The 30 mg / litre BOD standard was set with the expectation that the oxygen in the water body would ultimately oxidize the organic matter (BOD) to a point where it would have no detrimental impact to the health of the ecosystem. None of this is likely to happen if there is

no fresh water in the river. The same argument is true not only for BOD, but for many of the other pollutants.

It may be argued that Baumol and Oates were referring to a target not an effluent standard, which could be handled by using load based standards. However, setting a load based standard also assumes that one knows what load a particular ecosystem can assimilate, which is precisely the same information needed to estimate a damage function! Hence, reliance on standards per se does not circumvent the need to estimate damage or the cost of damage*. As Perrings (1995) has pointed out economists are engaged in all sorts of valuation exercises except the most important one of damage estimation. This case study is a modest attempt to move in that general direction despite the obvious difficulties.

Stock Pollution

So far, we have been discussing the difficulties with setting a standard or an appropriate level of abatement for a "flow" pollutant. In other words, our analysis has been primarily independent of time. The analysis changes if pollutants are not assimilated and accumulate in the environment over time. It is well known that heavy metals, inert solid wastes etc. accumulate. However, even comparatively less toxic pollutants such as salts can also accumulate in the ground water, in reservoirs, or on land. Since accumulation of pollutants is a major concern of our study, it may be worthwhile to discuss stock pollutants and the appropriate damage assessment methodology. Perman, Ma and McGilvray (1996) provide an analytical framework for stock pollution, which is summarized below.

Most pollution problems are really a combination of stock and flow pollution. Part of the pollutant load gets assimilated in each time period (say a season or a year) while the rest of the local accumulates in the environment. This accumulated load may decay slowly over time. When the pollution load is very small compared to the assimilative capacity, there will be no accumulation. When the load is large, there is

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* Some authors have recommended that in this "Veil of ignorance", one may wish to use a "safe minimum standard" as a precautionary principle. However, we are left with the problem of determining such a standard. It is unlikely that the MINAS standard (minimum acceptable standard) used in India is really a safe minimum standard for the reasons mentioned earlier.

a high likelihood of accumulation. In our case study, the rapid expansion of the textile industry and the consequent increase in the discharge of effluents is in all likelihood beyond the carrying capacity of the receiving media. This is accepted virtually by everyone including the industrialists themselves, which means that there is some level of stock pollution.

After estimating flow pollution from load information, one must examine the impact on the receiving media. Stock pollution is the cumulative load, not just the pollution in any one year. If P(t) is the quantity of pollution flow in time k, for a perfectly persistent pollutant (i.e. there is no decay) the stock of pollutant, S_T can be defined for the period T:

$$S_T = \int_{O}^{T} P(t)\, dt \ldots\ldots\ldots\ldots\ldots \quad (1)$$

However, if part of the stock dissipates, and θ is the fixed proportion of the stock which decays

$$S_T = \int_{O}^{T} [P(t) - \theta S(t)]\, dt \ldots\ldots\ldots \quad (2)$$

In the first case, when the stock grows indefinitely, the corresponding damage due to stock pollution could reach a stage when either a technology switch is needed at the source of the pollution, or the source must be phased out or closed down. (Perman, Ma and McGilvray, 1996). In other words, the net benefit of the production or consumption activity is outweighed by the damage caused by accumulated pollution.

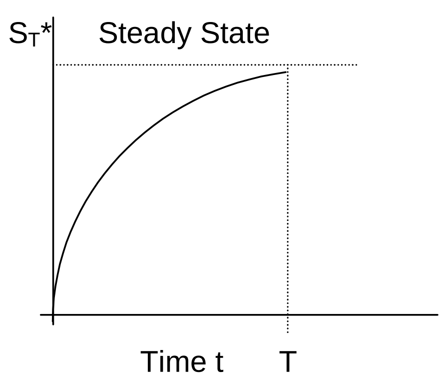

Figure: 3 Steady State Stock Pollution

In the second case, it can be shown mathematically that a steady state may be reached at time T, when the inflow of pollutants is balanced by the amount of stock decay as shown in Figure 3. In this case, the damage function has two components – damage due to flow pollution and damage due to stock pollution.

A further complicating factor is that the damage function may not remain convex as the stock pollution rises, since pollution can reach a saturation point. For example, when the productivity of land or water body is destroyed it is unable to support animal or plant life. In such a case, the damage function becomes flat beyond the saturation point, i.e. addition to stock pollution does not cause incremental damage.

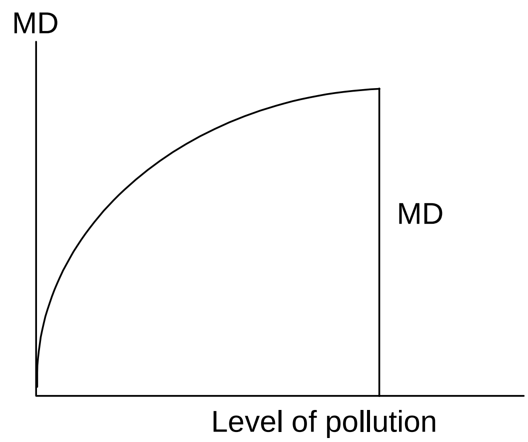

Fig 4: Non-Convex Damage Function

As shown in Figure 4, the marginal damage drops to zero. This situation may or may not be reversible depending on the pollutant. The total loss (V) then is the foregone value of the services provided by the natural system for all time to come.

$$\bar{V} = \int_0^\infty V(t)\, e^{-bt}\, dt$$

when V(t) is the foregone value in any time period t and b the discount rate. For example, if agricultural land is destroyed, V (t) would be the net value added in time t in the absence of pollution. Or if the irrigation source is destroyed due to pollution then V_t would be the difference between net value added for irrigated crop less that for a rainfed crop. In this case study, we attempt to estimate the damage in three sectors:

(a) agriculture (b) fisheries and (c) urban water due to stock pollution.

One way to investigate if stock pollution is a problem is by studying the ambient levels of environmental quality. If the ambient levels increase over time (apart from seasonal fluctuations) then there would be sufficient evidence of stock pollution. Unfortunately, there is very limited ambient data over time in our study area. Most of the studies that have been undertaken were one time studies. In the case of ground water data, the available time series data are largely from wells outside the affected area. Similarly, there is very little data on soil quality in the affected area. Monitoring programmes would be needed atleast in the future if one wishes to accurately estimate stock pollution.

Policy Instruments

The following policy instruments have been suggested for controlling stock pollutants.

(1) Phased reduction and ultimately abolition of discharge (eg. CFC emissions)

(2) Safe minimum standards – Regulation at levels higher than effluent standards

(3) Avoiding price instruments such as taxes and subsidies, since these are less appropriate than quantity instruments (Perman et al, 1996)

After estimating the level of damage and determining if this could be attributed to stock pollution, one must consider whether the existing level of abatement is sufficient. At the very least, the industries should be required to meet the effluent standards for all parameters. If this is not sufficient, they would have to meet a standard which is higher than the existing standard, or establish a safe minimum standard for that area.

In the case study area, the accumulation of pollutants has occurred since there was virtually no abatement. At the present time, abatement is selective in the sense that some parameters like total dissolved solids, chloride and sulphate remain uncontrolled. Damage continues to increase as a result. However, if pollution is controlled, the situation may be reversed over a period, since part of these pollutants can be diluted or washed away over time i.e. a steady state situation may be reached. While a technology switch may be desirable, closing down the industry may not be warranted in this case.

Compensation

Lastly, there has been considerable discussion on whether compensation should be paid to those affected by pollution damage. This debate has been initiated in India following a Supreme Court decision in the tanneries case that compensation should be paid to those affected by tannery pollution. An agency has been set up to determine the level of damage and the amount of compensation to be paid. In the case of "flow" pollutants, Baumol and Oates have shown theoretically that it is inefficient to pay compensation to victims. The argument is that compensation would serve as a disincentive to take averting action and / or be an incentive for others to move to the affected area. The latter may not be relevant in the case of land, where the quantity of land is fixed. There are also practical problems of identifying victims.

Baumol and Oates in a later section concede that when pollution affects the asset value, it would indeed be efficient to make lump sum transfers to victims. Asset value is affected when there is either cumulative damage (stock pollution) due to limited assimilative capacity or catastrophic damage as in the case of an accident. Coase had argued earlier that in the absence of transaction costs, the polluter(s) and the victim(s) could arrive at an efficient solution. In our case, if it can be proved that the asset value of agricultural land, drinking water, etc. has been reduced due to pollution, the issue of compensation may be relevant. However, we do not specifically address the issue of compensation in this report, since it is outside the scope of the present study.

CHAPTER – III: THE HOSIERY INDUSTRY IN TIRUPPUR

Textile Industry in India

The textile industry is one of the largest segments of Indian industry, and contributes over one fifth of the value of industrial production. This industry occupies a unique place in the national economy through contribution to industrial output, employment generation and foreign exchange earnings. India has more than 9 million hectares under cotton cultivation and an annual crop of over 3000 million kilograms. The industry has witnessed a phenomenal growth during the last two decades in terms of installed spindleage , production of yarn (both spun and filament), output of cloth and also export. Liberalisation which began in the last decade has forced the industry to become more competitive, not only in terms of price but also quality. At present India has more than 1504 spinning units, over 278 composite mills and around 1.49 million registered looms, which provide employment for about 1.5 million people.

The textile exports from India increased substantially over a period (Table 3.1). The textile export earnings (in normal value) increased from Rs.1336 crore (1981-82) to Rs. 44739 crore (1998-99). The percentage share of textile export in total export increased from 17 % to 31.6 % during this period.

The growth of registered small scale cotton textile and textile product units of Coimbatore district (where Tiruppur is located) as a percentage of total industrial units for 1984-1996 is given in Table 3.2 and Fig. 3.1. The percentage of textile units to total industrial units was only 32 % in 1984, but had sharply increased to 45 % in 1996.

Hosiery Industry

'Hosiery' generally refers to all kind of knitted fabrics which include cotton, synthetic and woollen. Knitting is a process, which involves interlocking of threads. This craft has been practiced all over the world since time immemorial. In India, the first cotton hosiery industry was established at Calcutta in 1893. Subsequently in 1935, a hosiery factory with hand operating machines was set up in Tiruppur. Other main hosiery centres are at Delhi, Mumbai, and Ludhiana.

The knitwear industry in India has emerged as a primary supplier of value added items earning high foreign exchange. The technological changes experienced by industry during the past ten years has been phenomenal. A large number of sophisticated computerised knitting and embroidery machines, full fledged processing machines, individual machines, computing machines and other machinery required in knitwear manufacturing was imported. Moreover, during this period, exporters have started concentrating on value added products and high unit value realisation. According to Apparel Export Promotion Council (AEPC), "in the new millennium, the most promising segment of the Indian apparel industry is the phenomenal growth which occurred in the knitwear sector. Its contribution has increased in the apparel export basket to 50%". The Indian knitted garments includes men's and women's casual and formal wear, children's wear, sportswear, lingerie and industrial wear. Presently, Indian knitwear manufactures are supplying to sophisticated world markets like Europe, America, Canada and Japan. World renowned labels like Nike, Crocodile, Lacoste, St.Michael, Benneton, Jockey, Calida, Marks and Spencer, C&A etc. are sourced from India.

The major garment export centres include Delhi, Mumbai, Calcutta, Madras, Bangalore, Jaipur, Tiruppur, Ludhiana, Cochin and Hyderabad. The total garment exported from India showed a considerable increment in both quantity and value. The quantity increased from 49.41 crore pieces (1989) to 133.77 crore pieces (1998) and the value increased from Rs. 3090.87 crore (1989) to Rs. 20834.03 crore (1998). (A comparative analysis among centres reveals that the percentage share of Delhi, Mumbai and Madras has reduced over a period both in quantity and value. In the case of Bangalore and Jaipur, the percentage variation is not noticeable. Tiruppur, Ludhiana and Calcutta have experienced growth in their percentage share. Among these 3 centres, Tiruppur's growth ratio (both in quantity and value) is considerable.

In 1989, Tiruppur exported 614 million pieces garments worth Rs. 16,739 lakh, which increased as 3,461 million pieces worth Rs. 2,61,925 lakh in 1998. This also represented a high percentage of India's garment export. In quantity, Tiruppur's percentage share was 12.43% (1987) and it increased to 25.87% (1998). In value the increase was from 5.4% to 12.57% during the same period.

Reasons for Industrial Growth

The emergence of the hosiery industry in Tiruppur and its contribution in knitting segment including export is highly appreciable. The transformation of Tiruppur from a 'village agrarian economy' to 'knitwear capital of India' is within a very short period (3 to 4 decades). There are a number of reasons are behind this quick transformation, which include (a) climate and water (b) availability of good quality raw materials and labour, (c) infrastructural facilities, (d) industrial structure and its functions, (e) export culture etc.

(1) Climate and Water Availablility: The favourable climatical condition and availability of appropriate quality of water in sufficient quantity is a major reason behind the development of hosiery industry in Tiruppur area. The high temperature with of annual mean of 31^0 and low rainfall (617 m.m) facilitates the smooth functioning of the industrial activity especially for drying the yarn / cloth after the wet processing (bleaching / dyeing / printing). The water available in the Tiruppur region (hardness less than 75 ppm) was most suitable for textile processing purposes.

(2) Availability of Good Quality Raw-Material and Labour: Good quality of cotton and yarn, (the basic raw material for hosiery industry), had been available both locally and from other place in huge quantity. Most of the fabrication and garment units get raw material from the textile mills of Tiruppur / Coimbatore and thereby reduce the transportation cost considerably. Besides labour available in this region, there are specialists in cotton and allied manufacturing from time immemorial. In brief, easy availability of low paid labour has also been a major reason for the development of the hosiery industry in Tiruppur.

(3)Infrastructure Facilities: Tiruppur town posses good transportation facilities. It is well connected with the national North-South broad gauge railway line. The road networking facilities are also satisfactory. Coimbatore Airport is situated not far from Tiruppur (less than 40 Km.). This airport enable foreign buyers to make frequent visits as wells easy export of products. Besides, Cochin and Chennai Ports are also convenient for shipment. The banking system, industrial complexes, water supply projects etc. have also facilitated the growth of the industry.

(4) Industrial Structure: The Tiruppur hosiery cluster includes all other related ancillary units. Hence garment manufacturing can be undertaken in a centralised manner under one shed, but also in decentralised manner through different units as job-work. The close contact among different firms provides flexibility in manufacturing, and it ultimately helps to accommodate various size of orders and the ability to provide product mix items.

(5) Export Culture: Tiruppur manufacturers have been interested in export, from late 1970s onwards. Initially the volume of export was very low level and limited to a few countries. But after the establishment of 'Tiruppur Exporter's Association' (TEA) in July 1990, the garment export started to accelerate. At present more than 500 companies (who are the major producers in Tiruppur) are members of TEA, and TEA has played a positive role in re-organising the thinking of the industry on many fronts. In 1995, Apparel Export Promotion Council in association with TEA organised the first All India-Knit Fair at Tiruppur.

Industrial Growth

The growth of cotton textile and textile product (hosiery) units in Tiruppur area from 1980 is estimated with the help of data gathered for different periods (Fig. 3 2). Upto 1980 only 1,143 registered small scale units functioned in Tiruppur. The number of units increased to 2,470 - 216% - (1987), 7,081 - 206% - (1994) and 9,319 - 131% - (1997). It is very clear that the marginal increase on units during the second stage was $3^1/2$ times higher than that of the first stage. From 1994 onwards the industrial growth-trend was very rapid and the number of units increased to 9,319 during 1997. That is the growth of units between 1994 – 1997 (3 years) was 2,238. In brief the analysis on the growth of industrial units reveals the rapid growth that occurred during the liberalisation period of the 1990s.

Activity-wise industrial growth between 1980 – 1997 is compared in Table 3.3. Units registered under cotton textile and textile product category are divided into 12 types. Normally different agencies are classifying the industries in various ways. The present data is classified as the Small Scale Industries (SSI) data tabulation format.

According to the table out of 1143 units which existed during 1980, 977 units are garments and knitting. The number of ancillary units are not much. During 1997 the number of total units increased as 9319 of which 7295 units are garments and knitting. The number of ancillary units also increased considerably with 298 tailoring units, 184 bleaching and dyeing units, 271 printing units etc. Unfortunately the number of water consuming units registered under SSI was only 184 up to 1997.

Investment and Value

The total capital investment and value of annual production (single shift base) is calculated during different time period on nominal value terms(Table 3.4). In proportion with the growth in units the volume of investment and the amount of value generated through production have increased. The growth is compared for different periods. The volume of investment upto 1980 by 1,143 units was Rs. 8.27 crore and it increased to Rs. 28.58 crore - 345% - (1987), Rs. 728.90 crore - 2550% - (1994) and Rs. 858.07 crore - 117% - (1997). The absolute growth in investment between 1987 – 1994 was Rs. 70,032 lakh and it was far higher than the growth between 1980 –87, (Rs.2,031 lakh). The assessment of average investment at different durations reveals its increasing trend over a period. During 1980s per unit investment was only Rs. 8 lakh and it increased to Rs. 1.2 lakh (1987) and Rs. 10.3 lakh (1994). But in 1997 a slight decline occurred to Rs. 9.2 lakh. It is very clear the volume of investment occurred in industry during 1990s was more significant than the growth during 1980s. It might be because of the introduction of modern technologies by industries during 1990s.

The quantum of value generated by units over different periods is compared both in absolute and in average terms (see Table 3.4). The annual value generated as single shift base during 1980 by all units was Rs. 99.85 crore, which increased to Rs. 280.02 crore - 280 % - (during 1987), Rs. 1300.84 crore (during 1994) and Rs. 1909.69 crore (during 1997). The annual value generation during 1990s was far higher than 1980s, both in absolute and in average (per unit base) terms. In brief, the growth of investment and output value in the textile industry is an indicator of the rapid industrialisation which occurred in Tiruppur region during 1980s and 1990s.

Employment

The employment opportunity generated through registered small scale cotton textile and textile products industrial units at different time periods and the growth trend is given in Table 3.5. The number of persons employed by the 1,143 units during 1980 was 10,606 with an average of 9. But in 1987, 31,436 people are employed. The number increased to 84,023 - 267% - (1994) and 1,04,958 - 125%) - (1997). The average number of persons employed by units also increased from 9 to 12 and 13. Since registered units furnish only the permanent employees details, the exact employment picture is not available. According to the Apparel Export Promotion Council, the hosiery industry in Tiruppur generates 2.5 lakh employment opportunities.

Export

The garment export from Tiruppur started during early 1980s and its volume has increased over a period. Reasons behind the rapid accelaration of knitwear products from Tiruppur are many: which include (a) the export culture that existed among Tiruppur knitwear manufacturers, (b) favourable textile export policy introduced by the Government especially in the liberalisation period, (c) positive approach followed by the institutions like AEPC, TEA etc. Besides the wide range application of sophisticated production technologies, especially during early 90s, helps for manufacturing value added knitwear products with excellent quality and design.

Table 3.6 provides a comprehensive picture on hosiery garment export from India and Tiruppur from 1984 to 1999. The national and Tiruppur export data showed a steady growth both in quantity and value, over a period. The quantity of hosiery garment pieces exported from India increased from 495 lakh pieces (1984) to 6,820 lakh pieces (1998) - 1377% - with a progressive annual increase except in the year 1994. Value also showed the same trend and increased from Rs. 89.22 crore - (1984) to Rs. 6,720.72 crore (1998) with 7750%.

The quantity of hosiery garment piece exported from Tiruppur in 1984 was 104 lakh pieces, which increased as 3,784 lakh piece in 1994. The rate of growth in exports accelerated during the 1990s. Regarding the export value, the value increased from Rs.969 lakh to Rs. 3,01,700 lakhs (see Fig. 3 3).

The quantity and value of the products exported in Tiruppur is compared with All India exports to obtain Tiruppur's share in hosiery garment export (Table 3.5). In quantity, Tiruppur's contribution increased from 21.01% (1984) to 50.91% (1998). The increase in value are also the same direction from 10.86% to 39.15%. From the above analysis it is clear that the increase in value has not been the same magnitude as the increase in volume. This might be because of Tiruppur's domination in manufacturing certain hosiery items which have relatively lower unit value.

From the above analysis one can easily understand the socio-economic importance of hosiery industry in Tiruppur region in the form of output, income, employment, foreign exchange etc. Moreover, the industry has a strong historic roots in this region. There is no doubt regarding the contribution of hosiery industry to the regional prospects of Tiruppur. Hence, any environmental study or investigation and the Pollution Control Policy for a segment of the industry (bleaching and dyeing activities) must also consider the contribution of the hosiery industry to the region.

On the output front, different variety of hosiery products manufactured by Tiruppur knitwear units, have a good domestic and international market. Regarding employment, more than 2.5 lakh people are directly or indirectly involved in hosiery related activities and among this considerable percentage are from Tiruppur. Besides, the foreign exchange earning capacity of the industry is also very substantial. Most people in Tiruppur are one way or other dependent on this industry. There is no doubt that the textile industry has contributed significantly to the economic prosperity of the Tiruppur region. Thus, the environmental consequences (social costs) have to be weighed against the regional and national benefits of the industry. However, the industry also needs to meet regulatory requirements and be accountable to the local communities affected by its activities.

Table – 3.1

SHARE OF TEXTILE EXPORTS IN TOTAL EXPORTS FROM INDIA

(Rs. In Crore)

Year	**All commodities**	**Textile**	**Percentage Share of Textile in Total Export**
1981-82	7,798	1,336	17.13
1982-83	8,788	1,384	15.75
1983-84	9,738	1,449	14.88
1984-85	11,705	1,918	16.39
1985-86	10,847	2,086	19.23
1986-87	12,417	2,666	21.47
1987-88	15,611	3,796	24.32
1988-89	20,148	4,434	22.00
1989-90	27,681	6,636	23.97
1990-91	32,555	8,251	25.34
1991-92	44,042	12,041	27.34
1992-93	53,688	16,295	30.35
1993-94	69,751	21,187	30.37
1994-95	82,674	26,607	32.18
1995-96	1,06,353	29,734	27.96
1996-97	1,17,525	34,851	29.65
1997-98	1,20,614	39,160	32.47
1998-99	1,41,604	44,739	31.59

Source: Compendium of Textile Statistics, 1999

Table – 3.2

COMPARISION OF GROWTH TREND OF THE REGISTERED SMALL SCALE COTTON TEXTILE AND TEXTILE PRODUCTS UNITS OF COIMBATORE DISTRICT

Year	Cotton Textile	Textile Product	Total Textile Units	Annual Growth Rate (%)	Total Industrial Units (All)	% of Textile Units to Total Industry
1984	768	1515	2283	-	7120	32
1985	1002	1759	2761	21	9339	30
1986	1042	1790	2832	3	9687	29
1987	1183	1773	2956	4	10968	27
1988	1241	2049	3290	11	12103	27
1989	1418	2408	3826	16	12534	31
1990	1623	2940	4563	19	15089	30
1991	1796	3682	5478	20	16826	33
1992	1882	3746	5628	3	17252	33
1993	2136	4486	6622	18	19524	34
1994	2191	5580	7771	17	21865	36
1995	3195	7398	10593	36	24792	43
1996	3785	8555	12340	16	27635	45

Source: Based on Tamilnadu An Economic Appraisal, (1999)

Table – 3.3

GROWTH OF DIFFERENT COTTON TEXTILE AND TEXTILE PRODUCTS UNITS IN TIRUPPUR

S.No.	Type of Units	No of Units		Variation	
		Upto 1980	Upto 1997	Actual	%
1	Garments & Knitting	977	7295	6318	746
2	Tailoring	0	298	298	-
3	Blea+Dye+Printing	36	184	148	571
4	Printing	5	271	266	5420
5	Fabrication	15	174	159	1160
6	Ginning	3	35	32	1166
7	Labling	3	17	14	566
8	Yarning	13	152	139	1169
9	Calendering	2	72	70	3600
10	Hosiery Cloth	54	457	403	846
11	Powerloom Grey Gada	18	127	109	705
12	Others	17	237	220	1394
	Total	**1143**	**9319**	**8176**	**813**

Source: Computed with the help of data gathered from SSI Directory and Directorate of Industry and Commerce, District Industrial Centre, Coimbatore.

Table – 3.4

CAPITAL INVESTMENT AND VALUE GENERATION FOR COTTON TEXTILE AND TEXTILE PRODUCT UNITS IN TIRUPPUR

Time Period (Upto)	No. of Units	Investment (Rs. Lakh)			Annual Value (Rs. In Lakh) [Single Shift Base]		
		Amount	Absolute Change	Average	Amount	Absolute Change	Average
1980	1,143	827	-	0.8	9,985	-	8.7
1987	2,470	2,858	2,031	1.2	28,002	18,017	11.4
1994	7,081	72,890	70,032	10..3	1,30,084	1,02,082	18.4
1997	9,319	85,807	12,917	9.2	1,90,969	60,885	20.5

Source: Computed with the help of data gathered from SSI Directory and Directorate of Industry and Commerce, District Industrial Centre, Coimbatore.

Table – 3.5 EMPLOYMENT GENERATION BY TEXTILE INDUSTRIES IN TIRUPPUR

Time Period	No. of Units	No. of persons Employed	Variation in Employment	Employment Per Units
1980	1,143	10,606	-	9
1987	2,470	31,436	20,830	13
1994	7,081	84,023	52,588	12
1997	9,319	1,04,958	20,935	12

Source: Computed with the help of data gathered from SSI Directory and Directorate of Industry and Commerce, District Industrial Centre, Coimbatore.

Table – 3.6

EXPORTS OF HOSIERY GARMENTS FROM INDIA AND TIRUPPUR

(Quantity in Lakh Piece & Value in lakh Rupees)

Year	India				Tiruppur				% of Tiruppur	
	Quantity		Value		Quantity		Value		Quantity	Value
	Actual	Vari.	Actual	Vari.	Actual	Vari.	Actual	Vari.		
1984	495	-	8922	-	104	-	969	-	21.01	10.86
1985	567	72	10489	1567	172	68	1869	900	30.34	17.82
1986	802	235	15938	5449	289	117	3748	1879	36.03	23.52
1987	1122	320	28385	12447	334	45	7448	3700	29.77	26.24
1988	1209	87	35819	7434	459	125	10424	2976	37.97	29.10
1989	1805	596	67991	32172	614	155	16739	6315	34.02	24.62
1990	2359	554	98580	30589	889	275	28985	12246	37.69	29.40
1991	2501	142	121841	23261	905	16	42948	13963	36.19	35.25
1992	3130	629	203835	81994	1399	494	77493	34545	44.70	38.02
1993	4332	1202	323868	12033	1839	440	116243	38750	42.45	35.89
1994	4260	-72	350965	27097	1964	125	131800	15557	46.10	37.55
1995	4367	107	371265	20300	2171	207	159183	27383	49.71	42.88
1996	5402	1035	512998	141733	2651	480	207684	48501	49.07	40.48
1997	6324	922	595601	82603	3122	471	222571	14887	49.37	37.37
1998	6820	496	672072	76471	3472	350	263100	40529	50.91	39.15
1999	-	-	-	-	3784	312	301700	38600	-	-

Source: Computed with help of AEPC and TEA data - 2000

CHAPTER – IV: TEXTILE WET PROCESSING WITH BLEACHING AND DYEING ACTIVITIES IN TIRUPPUR

The transformation of raw textile product like cotton to final usable form involves different stages. These are classified into 4 broad categories including: (1) Fibre production (2) Intermediate dry processes like spinning, weaving and knitting (3) Intermediate wet processing like slashing, desizing, kiering/scouring, bleaching, mercerising and dyeing and (4) Finishing like printing, cutting, stitching, packing etc. (See the Flow Diagram Fig. 4.1) Wet processes may be carried out on yarn or fabric. Since, the environmental issues of textile industry result from intermediate wet processing, the various steps in processing are discussed.

Textile Wet Processing; Chemical Usage, Water Consumption and Effluent

Like any other production activity, in textile manufacturing also a number of modern devices are introduced at various stages to enhance the quality of fibres / fabrics. In the wet processing stage, wide spectrum of chemicals are applied with huge quantity of water of appropriate quality. The study on “Water used in Textile Processing” and “Treatment of Textile Processing Effluents” by Manivasakam (1995) is a comprehensive work on textile wet processing. Table 4.1 provides details on water consumption and effluent discharge by different wet processing at textile industries from which the following details are taken.

1. **Sizing / Slashing:** It is the process by which yarn is sized with starch or polyvinyl alchohol (PVA) or carboxy methyl cellulose (CMC) to give necessary tensile strength and smoothness required for weaving. The water required for sizing varies from 0.5 to 8.2 litre / per kg. of yarn with an average of 4.35. The effluent discharged through this process is the same quantity of water used in the process. The sizing effluent has a pH of 7.0 – 9.5 8500 – 22500 mg/l of Total Solids and 620 – 2500 mg/l of BOD.

2. **Desizing:** In this process, sizing components (rendered water soluble during sizing) are removed from the cloth to make it suitable for dyeing and further processing. This can be done either through acid (sulphuric acid) or

with enzymes. The required water at this stage is varied from 2.5 to 21 litre /per Kg. with an average of 11.75. The entire water consumed during this process is discharged as effluent and it contain 6 – 8 pH, 16000 – 32000 mg/l of Total Solids and 1700 –5200 BOD.

3. **Scouring / Kiering:** To remove the natural impurities such as greases, waxes, fats and other impurities, the desized cloth is subjected to scouring. This can be done either through conventional method (kier boiling) or through modern techniques (continuous scour). Kiering liquor is an alkaline solution containing caustic soda, soda ash, sodium silicate and sodium peroxide with small amount of detergent. The water required for this process varies from 20 – 45 litre / per Kg. with an average of 32.5. The volume of effluent generated through this process is the same as the water intake. Effluent contains 10 –13 pH value, 2200 – 17400 Total Solids and 100 – 2900 BOD.

4. **Bleaching:** For removing the natural colouring materials and to render the cloths white, bleaching is undertaking. Alkaline hypoclorite or chlorine is used for bleaching cotton textiles. Normally for bleaching the good quality fiber, peroxide is used. The chemicals used in peroxide bleaching are sodium peroxide, caustic soda, sulphuric acid and certain soluble oils. The water and chemical requirement and the effluent generation normally varies based on the type of operation and the material (yarn / cloth) to be processed. Bleaching the yarn both through hypo-chlorite and hydrogen peroxide methods requires same quantity of water and it fluctuates between 24 to 32 litre/Kg. But in the cloth bleaching, the water requirement is far higher and it fluctuates between 40 –48 litre/Kg. The effluent discharged from the bleaching processes is slightly lower than the water intake and its quality changes according to the process method. Chlorine bleaching effluent contains the pH value of 6, total suspended solids (TSS) of 6500, total dissolved solids (TDS) of 22,000 and chloride of 3600. In peroxide bleaching, the pH value gone upto 10.5. But the TSS, TDS and chloride values are reduced to 430, 2390 and 560 respectively.

5. **Mercerising:** Mercerisation provides lustre, strength, dye affinity and abrasion resistance to fabrics. It has generally carried out for cotton fabrics only for easy dyeing. Mercerisation can be carried out through cold caustic soda solution followed by washing with water at several times. The water required for this processess varies between 17 to 32 Litre / per kg. with an average of 24.5. The formation of effluent is the same volume of water use. Mercerising effluent contains 12 – 13 pH value, 430 – 2700 TSS, 10940 – 31700 TDS and 150 – 280 BOD.

6. **Dyeing:** Dyeing is the most complex step in wet processing which provides attractive colour for the product. Dyeing is carried out either at the fibre stage, or as yarn or as fabrics. For dyeing process, hundreds of dyes and auxiliary chemicals are used. In brief, the water requirement for dyeing purpose (include all types and shades) varies from 36 – 176 litre/kg with an average of 106. The effluent generation during dyeing process is slightly lower than the water intake and fluctuates between 35 to 175 litre/kg with an average of 105. This effluent contains pH of 10.5, TSS of 10200, TDS of 29800, COD of 1490 and chloride of 1800.

From the above discussion it is very clear that water is the lifeline of textile processing and it is the only material which can be used several times. Water is the best medium for processing, moreover, it is an excellent wetting agent and also the best solvent for dyes and chemicals. Hence, the suitable quality of water of adequate quantity is a major factor in textile wet processing.

The general requirements of the water used in textile processing are as follows: (a) Water should be colourless, clear and free from suspended impurities, (b) not be hard and not have the tendency to deposit, scale on fabric or on water supply structure, (c) non-corrosive, (d) free from metals such as iron, manganese, aluminum and copper, (e) neither be too acidic nor alkaline.

Bleaching and Dyeing Activities in Tiruppur

According to the above analysis, it is very clear that water is required for the various stages of wet processing activities in the textile industry. But in Tiruppur hosiery cluster all the wet-processing are carried out in an integrated manner in the bleaching and dyeing units. Among the underlying reasons for the emergence and growth of the hosiery industry in Tiruppur are (a) the availability of good quality water and (b) the dry climate. The quality of water available in Tiruppur and the surrounding villages meet the rquirements (mentioned in the previous section) which are essential for textile processing. The climatical factors like high temperature (31^0C as mean annual value) and very low rainfall (671 m.m as annual mean) are also favourable elements for textile processing.

Since the environmental problems of Tiruppur are strongly associated with wet textile processing activities, a thorough investigation of these units considering different facts at various stages of its evaluation is essential. Moreover this would provide a better basis to understand the possibilities of the impact of pollution on environment during its expansion.

Industrial Establishment and Growth

In correspondence with the hosiery industry expansion, the number of bleaching and dyeing units also increased in Tiruppur. The data gathered through TNPCB and other agencies reveals the growth performance. Up to 1940 there were no textile processing units in Tiruppur. In 1941 two units where established and the number increased to 26 in 1980. After that the growth was very fast, 80 (1985), 324 (1990), 819 (1995) and 866 (1997) (see the Figure – 4.2). From the graph it is very clear that the growth between 1985-95 was tremendous with the addition of 739 units in 15 years. The number increased further to 866 during 1997 but then declined to 702 at present. This had occurred because of the closure of 164 units, due to the order of High Court in connection with their failure to control pollution.

(A) Classification of Units

The 702 textile processing units, which are functioning in Tiruppur, are classified in different ways. TNPCB has generally catagorised units as red, orange and green based on the intensity of pollution discharge. Out of the 702 units, 503 (73.7%) fall in red category and 199 (38.3%) in orange, and none in the green category. Based on activity of the units in Tiruppur 199 (28.3%) units are involved in bleaching activities, 414 (59%) units in dyeing, and 89 (27.7%) units are engaged in both bleaching and dyeing activities. Out of 702 units, 683 (97.3%) are small ones. The number of medium and large units is 17 and 2 respectively.

(B) Gross Fixed Assets (GFA)

Upto 1980, the GFA was around Rs. 311 lakh. It increased to Rs.974 lakh (1985), Rs. 4,586 lakh (1990), Rs. 13,613 lakh (1995) and Rs. 14,093 lakh during 1997. The nature of GFA among different textile processing sectors based on 702 existing units is given in Table – 4.2.

(C) Cloth Processed

The growth in the total quantity of cloth processed during different time period is given in the Figure - 4.3. The cloth processed during 1980 was only 486 T/M but it increased to 1624 T/M (1985), 6550 T/M (1990), 16682 T/M (1995) and 17551 T/M (1997). Since number of units are closed during 1997 – 99 the volume in cloth processed has reduced to 14925 T/M during 2000. The average quantity of cloth processed by units at different period is also given. An increasing trend over a period (18.6 T/M during 1980 to 21.3 T/M during 2000) is also noticed. This might have happened because of the intensive production method adopted by the units over the period. Table 4.3 provides the details on cloth processing by 702 units.

(D) Chemicals and Acid Consumption

Soda-ash, Dyes, Bleaching Powder, Salt, Caustic Soda, Sodium Silicate, Hydrogen Perioxide etc. are the major chemicals used by the textile processing units in Tiruppur. Consumption of these chemicals has increased over the period in connection with the growth of units and cloth processed. The quantum of chemicals used by textile processing units in Tiruppur at different time duration is given in Table – 4.4. It should be noted that nearly 6500 tons of salt and 570 tons of bleaching power are used every month in processing. These chemicals contribute significantly to the TDS and Chloride load in the final effluent. The details on acid consumption by textile processing units is provided in Table 4.5.

The above discussions provide a clear picture regarding the usage of chemicals by the textile processing units as inputs. Here we must note that, in the processing, much of the chemicals and acids used are not retained in the cloth but discharged as waste material. Hence, the effluents discharged carry a high pollution load.

(E) Water Requirement

Water is an unavoidable input factor in textile processing. Hence, the availability of suitable quality of water (which is fit for textile processing) in good quantity should always be a major factor in the growth of this industry in any region, including Tiruppur. In the initial stages, units located in the Tiruppur region met their water requirement either through extraction of water from Noyyal river or from the local aquifer. But the gradual deterioration of both surface and ground water quality compelled the units to transport water from peripheral villages of Tiruppur which are located within a radius of 5 – 30 kms. Water is transported through lorry tankers. Presently more than 300 tankers with an average capacity of 12,000 litres are engaged in water supply business. The trips per tanker would vary on the basis of water demanded by industry. It is estimated that more than 85 per cent of the water required for industry is mitigated through transported water. The current price per tanker is around Rs. 450/-, which means that the units pay Rs. 37.50 per kilolitre of water.

The quantity of water used by units at different periods is compared with the volume of cloth processed (Table – 4.6). Water used during 1980 was 4.4 million litres per day (MLD) with an average of 169 kilolitres per day (KLD). In the subsequent periods, in proportion with the unit growth, total water consumption also showed an increasing trend of 11.4 MLD during 1985, 40.8 MLD during 1990, 101.8 MLD during 1995 and 106.9 MLD during 1997. But the average water used by the units has declined from 169 KLD to 142 KLD (1985), 125 KLD (1990), 124 KLD (1995) and 123 KLD (1997). Since a number of units closed after 1997 the total water consumption also declined as 86.4 MLD with an average consumption of 123 KLD per unit.

The water used by the units is also compared with the volume of cloth processed at different period (see Table - 4.7). The data show a gradual declining trend in water used per kg of cloth processed over a period. During 1980s 226.5 litres of water was used. But it declined as 175.9 litre (1985), 155.8 litre (1990), 152.7 litre (1995), 152.3

litre (1997) and 144.8 litre (2000). This might be because of (a) scarcity of water in Tiruppur area due to gradual accumulation of pollution in ground water and surface water, (b) increase in the cost of water transportation (c) application of modern sophisticated production techniques instead of traditional manual processing (hand bleaching / dyeing) which consume less water.

Among the existing units, activity wise water consumption through different source (cooling, domestic, easily bio-degradable and not easily bio-degradable) is given in Table 4.7

(F) <u>Water Cess</u>

As per the Water (Prevention and Control of Pollution) Cess Act 1977, industries are levied a cess on the quantity of water consumed. In Tamilnadu, TNPCB is collecting water cess from all water consuming industries. Water cess is estimated based on the purpose for which water is used in the industry. The existing cess rates are: industrial cooling 2.25 paise per kilo litre (P/KL), industrial domestic 3.00 P/KL, industrial processing (which consists of two categories) (a) easily bio-degradable 7.50 P/KL and (b) not easily bio-degradable 9.50 P/KL. But the minimum cess amount for a unit is Rs. 60 per year.

Table – 4.8 provides the details on water cess among various water consuming units in Tiruppur. The total amount of water cess collected by TNPCB during 1999-2000 from 702 textile processing unit has as Rs. 29,42,098 . The average amount per unit was Rs. 4,191. The breakup analysis shows that bleaching units paid relatively less average amount of annual water cess (Rs. 2267) than dyeing units (Rs. 4965) and bleaching and dyeing units (Rs. 4894). It is very clear, in general, the existing rate of water cess is very meagre and is considered as a source of revenue for TNPCB to meet their expenditures. At the current rates, the cess does not act as a disincentive in any sense.

Table 4-1

WATER CONSUMPTION AND EFFLUENT GENERATION IN DIFFERENT WET PROCESSING STAGE AT TEXTILE INDUSTRIES

(Quantity in Litre / 100 Kg.)

S.No	Activities	Water Consumption		Effluent	
		Variation	**Average**	**Variation**	**Average**
1.	Sizing / Slashing	50 - 820	435	50 – 820	435
2.	Desizing	250 - 2100	1175	250 - 2100	1175
3.	Kiering / Scouring	2000-4500	3250	2000 - 4500	3250
4.	Bleaching a. Yarn (Hypochlorite) b. Yarn (Hydrogen Peroxide) c. Cloth (Hypochlorite) d. Cloth (Hydrogen Peroxide)	2400-4800 2400-3200 2400-3200 4000-4800 4000-4800	3600 2800 2800 4400 4400	2250 -4600 2250-3050 2250-3050 3800-4600 3800-4600	3425 2650 2650 4200 4200
5.	Mercerising	1700-3200	2450	1700 - 3200	2450
6.	Dyeing a. Yarn (Light and Medium shades) b. Yarn (Dark shades) c. Yarn (Very Dark shade) d. Cloth (Light and Medium Shade) e. Cloth (Dark shade) f. Cloth (Very Dark shade)	3600-17600 3600-4800 4800 – 6400 6600-8800 7800-9600 10400-12800 14300-17600	10600 4200 5600 7700 8700 11600 15950	3500-17500 3500-4700 4700-6300 6500-8700 7700-9500 10300-12700 14200-17500	10500 4100 5500 7600 8600 11500 15850

Source: Data computed from Manivasakam (1995) and MSE Study (1998)

Table – 4.2
STATUS OF GROSS FIXED ASSETS IN VARIOUS TEXTILE PROCESSING SECTOR

(Value in Rs.Lakh)

S.No	Type of Units	No. of Units	Total Fixed Asset (Rs.Lakh)	Average	Variation Mini.–Maxi.
1	Bleaching	199	1435	7.2	1.1– 287.0
2	Dyeing	414	10145	24.5	0.5 – 900.9
3	Bleaching and Dyeing	89	1595	17.9	0.3 – 185.0
	Total	**702**	**13175**	**18.8**	**0.3 – 900.9**

Source: TNPCB Records.

Table – 4.3
CLOTH PROCESSED THROUGH DIFFERENT ACTIVITIES IN TIRUPPUR

S.No	Activities	No. of Units	Total Cloth processed (T/M)	Average
1	Bleaching	199	3969	19.9
2	Dyeing	414	9230	22.3
3	Bleaching and Dyeing	89	1726	19.4
	Total	**702**	**14924**	**21.26**

Source: TNPCB Records.

Table – 4.4
CHEMICAL CONSUMPTION (T/M)

Time Period (Upto)	No. of Units	Chemicals						
		Soda Ash	Dyes	Bleaching Powder	Salt	Caustic Soda	Sodium silicate	Hydrogen Peroxide
1980	26	20.5	16.8	4.8	127.1	13.3	7.7	1.6
1985	80	74.5	48.7	45.5	364.9	43.8	16.2	7.5
1990	324	319.8	60.2	415.8	1595.6	201.4	94.6	163.6
1995	819	1388.7	720.5	638.3	7447.7	335.2	182.4	204.1
1997	866	1421.2	737.6	694.8	7687.3	347.1	185.6	247.9
2000	702	783	614.1	572	6424.2	281.9	151.7	206.4

Source: TNPCB Records.

Table – 4.5
ACID CONSUMPTION (T/M * and KL/M @)

Time Period (Upto)	**No. of Units**	**Hydro-Chloric Acid**	**Sulphuric Acid**	**Acetic Acid**
1980	26	9.80 * 0.22 @	1.24 *	0.82 * 0.22 @
1985	80	26.64 * 4.42 @	4.36 *	2.94 * 0.94 @
1990	324	165.44 * 18.32 @	31.54 * 1.95 @	18.04 * 1.27 @
1995	819	769.94 * 96.02 @	320.34 * 74.90 @	85.34 * 4.35 @
1997	866	789.44 * 8270.68 @	324.28 * 75.99 @	87.11 * 6.12 @
2000	702	636.80 * 6830.9 @	264.3 * 62.8 @	71.80 * 2.86 @

Source: TNPCB Records.

Table – 4.6

STATUS OF WATER REQUIREMENT FOR INDUSTRIAL UNITS AND CLOTH PROCESSED DURING DIFFERENT PERIODS

Time Period (Upto)	No. of Units	Cloth Processed Kg/D		Water Consumption L/D		Water Consumption per Kg. Cloth Processed(in Lit.)
		Total	Average	Total	Average	
1980	26	19,440	747.7	4,403,090	1,69,350	226.5
1985	80	64,920	811.5	11,419,950	1,42,750	175.9
1990	324	2,62,000	808.6	40,820,650	1,25,990	155.8
1995	819	6,67,280	814.7	101,892,520	1,24,411	152.7
1997	866	7,02,040	810.7	106,907,620	1,21,134	152.3
2000	702	5,97,000	850.4	86,456,900	1,23,158	144.8

Source: TNPCB Records.

Table – 4.7
ACTIVITY-WISE WATER CONSUMPTION IN TIRUPPUR (L/D)

S.No.	Activity	No. of Units	Daily Cloth Processed (kg)	Daily Water Consumption					Water per Kg. of Cloth
				Cooling	Domestic	E.B.D.	N.E.B.D	Total	
1	Bleaching	199	158760	105000	151300	50360	13234150	13540810	85.3
2	Dyeing	414	369200	2631000	557900	426100	55526790	59141790	160.2
3	Bleaching and Dyeing	89	69040	620000	82000	0	13072300	1377430	199.5
	Total	**702**	**597000**	**3356000**	**791200**	**476460**	**81833240**	**86456900**	**144.8**

Note: E.B.D = Easily Bio-Degradable; N.E.B.D. = Not Easily Bio-Degradable
Source: TNPCB Records.

Table – 4.8
WATER CESS AMONG TEXTILE PROCESSING UNITS IN TIRUPPUR

S.No	Activities	No. of Units	Total Annual Water Cess (Rs.)	Annual Average Water Cess
1	Bleaching	199	4,51,185	2267
2	Dyeing	414	20,55,375	4965
3	Bleaching and Dyeing	89	4,35,538	4894
	Total	**702**	**29,42,098**	**4191**

Source: TNPCB Records.

CHAPTER – V : TEXTILE EFFLUENTS AND POLLUTION LOAD IN TIRUPPUR

In the last chapter a comprehensive picture of the water consumption by various textile processing activities at Tiruppur was provided. Since bleaching and dyeing activities are non-consumptive, most of the water used by the units is discharged as effluents. The effluents carry considerable volume of chemicals used at different processing stages in the units. The estimation of total volume of effluents discharged by the units over time is of importance in this study, since most of the environmental damages in the region is the result of cumulative impact of effluents. When the pollution load exceeds the assimilative capacity of the receiving land and water bodies, the pollutants tend to accumulate over time.

Volume of Textile Effluents

In proportion to the growth in the number of units, the volume of effluents discharged has also increased as shown Table 5.1. During 1980, only 4.2 MLD of effluents were discharged by 26 units. The volume increased to 11.21 MLD (1985), 39.5 MLD (1990) 98.4 MLD (1995) and 103.42 MLD (1997). Of the 866 units functioning in 1997, 245 were bleaching units, 508 were dyeing units, and the remaining 113 combined bleaching and dyeing. After the closure of units during 1998 and 1999, the volume of effluent was reduced considerably. At present, 702 units discharge 83.14 MLD of effluents daily. The variation in effluent generation for different periods is also analysed and very high variation (increase) was noticed between the period 1985-1990 (28.29 MLD) and 1990-95 (58.9 MLD). Variation during 1995-97 was 50.12 MLD. The quantum of effluents discharged for the period 1997-2000 declined by 20.28 MLD, due to the closure of 164 units.

After the closure order from the Court, textile units which did not have treatment plants were phased out between 1997 and 1999. Among the functioning units, the volume of effluent generated by the three category of industries (Bleaching, Dyeing and Bleaching & Dyeing) are given in Table – 5.2. The average effluent discharge with its minimum and maximum for each category is also provided. The range is from 3.7 KLD for the small units to 901 KLD for the largest unit. Among the total effluent 99% is trade effluent, and only 1% is due to sewage.

After the Common Effluent Treatment Plants (CETP) were constructed, the effluents from 278 units are treated at 8 CETPs. The remaining 424 units have their own treatment plants. Thus of the total 83.14 MLD of effluents generated, about half 37.98 MLD are treated is the CETPs, while 45.16 MLD are treated by the individual plants. The details are given in Table – 5.3.

Location of Industry and Mode of Effluent Disposal

The physical location of the textile processing units in respect of effluent generation is important for the present study. Table 5.4 provides details regarding landuse-wise distribution of industry and effluent generation. From the data, it is evident that 77% of units are functioning in non-industrial area and they generate around 75% of the total effluents. Hence the possibility for contaminating the soils and ground water, in agricultural and residential area is very high. Since 239 units are located at a distance of less than 300 metres from the Noyyal river, the potential for polluting the river is also quite high.

The 424 units which have individual treatment plants discharge the effluent into Noyyal river, streams, industries on land and irrigation land. Around 83% of the units are disposing their effluent in water bodies (18.27 MLD in Noyyal and 19.06 MLD in streams). 4.33 MLD effluent (9.05%) is discharged in industries on-land and 3.5 MLD (7.75%) is on irrigation land.

The above analysis on textile effluent (quantity generated, discharge mode etc.) during last two decades in Tiruppur clearly reveals the possibility of pollution accumulation and its impact at Tiruppur and downstream.

Treatment Programme and Effluent Quality

As explained earlier, the 702 functioning units in Tiruppur treat their effluents through IETPs (424 units) and CETPs (278 units). At present 424 units have established IETPs which treat 45.16 MLD of effluents. The quality of the treated effluent is compared with untreated effluent and the effluent standard for bleaching, dyeing and bleaching & dyeing units respectively Table 5.5. The average values of quality of the treated and untreated effluent was obtained by the Pollution Control Board from the samples tested by the Board at different points in time. From the table it is evident that there is substantial reduction in the concentration of COD, BOD and Oil &Grease and the treated effluents meet the PCB standard for these parameters. In the case of Sulphate, the untreated effluent itself meets the standard but the level does not decrease after treatment. The TSS concentration in treated effluent shows a decrease for all 3 types units, but in most cases the effluent standard of 100 is not met. The TDS and Chloride levels remain unaffected after treatment, since there is no provision for removal of dissolved salt. Both TDS and Chloride level are far in excess of the respective effluent standard (2100 and 1000 mg/l) and are the primary cause of pollution in Tiruppur and downstream.

The details regarding the Common Effluent Treatment Plants, such as the location, area, registration date, number of units, water consumption, effluent, project cost and actual expenditure are given in Table 5.6. 5 CETPs were registered in September 1994 and 3 are in 1996. The number of units served by each CETP varies between 11 to 79. The total water consumption for all 278 units is 39.82 MLD (nearly 40 million litre per day), which the discharge quantum of effluent is 37.98 MLD. The estimated project cost was Rs. 2,689 lakh while the actual expenditure accounted to Rs. 2,724 lakh (Rs. 27.24 Crore).

The detailed assessment of untreated and treated effluents in the 8 CETPs is given in Table 5.7. The data furnished in the table is the average of 12 samples (both untreated and treated) collected by the PCB during 1998, 1999 and 2000. The pH value of the all CETPs treated effluent is within the permissible limit. TDS concentration in treated effluent is very high in all CETPs and it varies between 5,607 (Kasipalayam) to 7,662.8 (Manikapurampudur). The concentrations of TSS, COD, BOD and Oil &Grease do not seem to reduce significantly after treatment and in some case have actually increased ! The Chloride concentration is much higher than the effluent standard for all the CETPs. Sulphate concentration in the treated effluent in all the CETPs is within the tolerance limit.

During the effluent treatment, large quantum of sludge is formed. 289 units provided this information and according to it the total sludge generation would around 8,210 kg / day and of which 4,062 kg is solid and 4,058 kg is hazardous. The proper disposal of sludge especially hazardous sludge might be a big problem for the units which are involved in the treatment process. We do not discuss the disposal of sludge in this report, since environmental problems have not emerged as yet. There is no evidence of “damage” from improper disposal.

Pollution Load

The total pollution load generated by textile processing units from 1980 is estimated for the parameters like TDS, Chloride, Sulphate, TSS, COD, BOD, and Oil & Grease. For load estimation, the quantity of effluent and its quality is considered. Since none of the units treated their effluents till 1997, untreated effluent quality is considered for estimating the load from 1980-1997. But during 1998 and 1999 both untreated and treated (through IETPs and CETPs) effluents were generated. During 2000 pollution load is limited to only treated effluents. The table provides information on the annual load as well as the cumulative load from 1980 (Table – 5.8).

Total Dissolved Solids (TDS)

TDS concentration in textile effluent is very high. Moreover the reduction of TDS is a major challenge in terms of treatment. From the analysis of effluent concentration (before and after treatment) it is evident that both IETPs and CETPs are not in a position to reduce their TDS limit considerably and none of the treatment plants met the tolerance limit prescribed by PCB for the parameter.

The activity wise TDS load generated over a period is given in Table 5.14. In brief the overall total TDS load generated through both untreated and treated effluent discharge from 1980 – 2000 is 23,54,463 tonne. There is no doubt that huge quantity has contributed substantially to TDS accumulation in the ground and surface water both in Tiruppur and dowstream, and in salinity of the soil.

Chloride

The same conclusion may be drawn from the Chloride data since the chloride is the major contributed to the TDS load. It showed a steady increase from 6,052.62 tonne (1980) to 1,37,413.97 tonne (1997), but decreased to 91404.03 tonne in 2000 due to plant closure. The total Chloride load generated from 1980 to 2000 is estimated to be 13,11,721 tonne.

Sulphate

Sulphate also shows the same pattern as TDS and Chloride. In the case of Sulphate a steady growth has noticed after 1980, with an increase from 419.95 tonne (1980) to 12,227.79 tonne (1997). An interesting point here is that after the introduction of treatment programme (1998-2000) the total load has not declined at all. It increased from 12,227.79 tonne (1997) to 12,647.69 tonne in 1998, and in subsequent years a slight decline is noticed. The total Sulphate load generated between 1980 – 2000 is 1,25,774.47 tonne.

Total Suspended Solids (TSS)

Only 481.86 tonne TSS load was generated in 1980, which gradually increased to 11,009.82 tonne in 1997. After the introduction of treatment programme the TSS load generation declined substantially (around 50%). The total TSS load generated in 1998 was only 5,720.51 tonne, which declined to 5,147.60 tonnes (1999) and 4,592.40 tonnes (2000). The cumulative load from 1980 – 2000 is estimated to be 97151.75 tonne.

Chemical Oxygen Demand (COD)

The COD load data is provided in Table 5.8. In 1980 only 412 tonne COD was generated by textile processing units. It gradually increased over a period and reached 10,023.31 tonne in 1997. But after the treatment programmes it reduced substantially. The COD load generated in 1998 was 5643.91 tonne, which is nearly 50% less than the previous year (1997) load. It again declined as 5279.74 tonne (1999) and 4,928.05 tonne (2000). The cumulative load discharged between 1980 to 2000 is 90,160.18 tonne.

Biological Oxygen Demand (BOD)

The BOD load also increased over the period. BOD load generated during 1980 was only 169.34 tonne and increased as 3,649.92 tonne in 1997. But in 1998 a substantial reduction occurred due to plant closure and due to treatment resulting in a load of 1,014.61 tonne. It further declined to 863.44 tonne (1999) and 714.30

tonne in (2000). The cumulative load discharged between 1980 to 2000 is 29847.65 tonne.

Oil and Grease

The Oil & Grease load generated in 1980 was very meager to the tune of 8.30 tonne. It increased over a period and reached a peak, 183.61 tonne during 1997. After the treatment programme started, the oil and grease load reduced considerable and it declined to 57.97 tonne (1988), 49.06 (1999) and 40.35 (2000). The cumulative amount of Oil & Grease between 1980 to 2000 is 1512.90 tonne.

From the above analysis one can draw the following conclusions:

(a) The pollution load for all parameters increased over the period 1980-2000 due to the growth in the number of units and correspondingly high effluent generation (b) The possibility of accumulated pollution impact is very substantial in the case of TDS, Chloride and Sulphate. In the case of these three pollutants the discharged load concentration was very high and showed only a marginal decline after the effluent treatment plants were set up. (c) While TSS, COD, BOD and Oil & Grease load concentration increased over a period, they have reduced substantially after the introduction of treatment and also due to plant closure. However, the common effluent treatment plants do not seem to reduce the load significantly.

Pollution Load Vs Efficiency of the Plant

The analysis of effluents quality - both treated and untreated - undertaken in the earlier section revealed that for certain parameters the pollution concentration has not reduced considerably after treatment and the effluent does not meet the PCB standard. Hence for derivinobtaining a comprehensive picture on the ‘efficiency’ of the existing treatment process at Tiruppur, a comparative assessment of the pollution load in effluents before and after treatment is done in Table – 5.9. The total pollution load has reduced as a result of treatment for all parameters but the rate of reduction varied substantially. In CETPs COD and BOD load has increased after treatment at rates of 16.82 % and 102.24 % respectively. But in IETPs only Sulphate concentration has shown some increase. There is only a marginal reduction in TDS, Chloride and Sulphate after treatment, since there is no provision in the treatment process for removal of salts. Thus, 174,200 tonne/year of total dissolved solids are discharged after treatment at the present time.

Pollution Abatement / Treatment Cost

Since all the functioning textile processing units in Tiruppur are involved in effluent treatment either through IETPs or CETPs, it is worthwhile to examine the cost details of treatment Details regarding the IETPs capital cost, variable cost etc. with its average are provided in the Table –5.10. The average capital cost is higher for bleaching & dyeing unit (Rs. 7.27 lakh) than the dyeing units (Rs. 5.57 lakh) and bleaching units (Rs 2.68 lakh). The annual total cost is estimated along with capital and variable cost. The average annual capital cost is only Rs. 0.77 Lakh, while variable cost would be Rs. 4.56 lakh. The total cost for treating 1 KL effluent through IETP is estimated as Rs. 16.03, of which only Rs. 2.31 is capital cost and Rs. 13.72 is variable cost.

The treatment cost analysis for the 278 units which treat their effluents through 8 CETPs also showed as a high annual average variable cost (Rs.4.27 lakh) than the annualized capital cost (Rs. 1.56 lakh) – Table 5.11. For treating 1KL effluent the total cost is Rs. 13.66 of which capital cost is Rs. 3.67 and variable cost is Rs 9.99.

If we compare the above tables, the average capital cost for the units belonging to CETP (Rs. 9.80) is far higher than the IETPs (Rs. 4.82). This would be because of the conveyance cost (capital cost for transporting effluents through pipe lines) and land value involved in CETPs. Hence, the capital cost per KL of effluent is higher in CETP than IETP. The lower variable cost per KL of effluent at CETP, as compared to the IETP reflects the 'economies of scale' in treatment.

The treatment cost per Kg of cloth for IETP and CETP are also estimated (Table – 5.12). Total treatment cost for 1 kg of cloth through IETP would come Rs. 2.02, in which Rs. 0.29 is fixed cost and Rs. 1.73 is the variable cost. But in CETP, the cost would be Rs. 2.16, Rs. 0.58 and Rs. 1.58 respectively.

The cost analysis provides the following insights:

1. The variable cost is <u>much</u> <u>higher</u> than the annualized capital cost both in the case of IETPs (86% of total cost) and CETPs (73%). Since there are no subsides for operation, it remains to be seem whether the units will operate the treatment plants in the expected manner.

2. CETPs exhibit <u>economies of scale</u> in respect of variable cost or treatment if we use the variable cost per KL or per Kg. Unfortunately, the CETPs do not seem to be achieving any treatment for most of the parameters, at the present time, while the IETPs are reducing BOD, COD, and TSS load substantially.

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Table – 5.1

EFFLUENT GENERATION BY TEXTILE PROCESSING UNITS OVER A PERIOD IN TIRUPPUR

(Effluent in Kilo Litre)

S.No.	Duration (Upto)	Total		Variation	
		No. of Units	Effluent	No. of Units	Effluent
1	1980	26	4,203	-	-
2	1985	80	11,214	54	7,011
3	1990	324	39,502	244	28,288
4	1995	819	98,405	495	58,903
5	1997	866	1,03,417	47	5012
6	2000	702	83,139	-164	-20,278

Source: Computed from PCB Data, 2000

Table – 5.2

ACTIVITIY-WISE TREATED EFFLUENT GENERATION IN TIRUPPUR

(Effluent in KLD)

S.No	Activity	No. of Units	Effluent			Average	Variation	
			Trade	Sewage	Total		Mini-mum	Maxi-mum
1	Bleaching	199	13,300	152	13,452	67.6	15.1	741.6
2	Dyeing	414	55,881	558	56,439	136.3	3.7	901.0
3	Bleaching + Dyeing	89	13,166	82	13,248	148.8	10.3	451.0
	Total	**702**	**82,347**	**792**	**83,139**	**118.4**	**3.7**	**901.0**

Source: Computed from PCB Data, 2000

Table – 5.3

TREATED EFFLUENT DISCHARGE BY 424 IETPs and 8 CETPs (278 UNITS) FROM 1998

S.No	IETP / CETP	No. of Units	Effluent (KLD)
	424 IETP	**424**	**45,160**
1	Bleaching	137	8,805
2	Dyeing	241	30,739
3	Bleaching and Dyeing	46	5,616
	8 CETP	**278**	**37,979**
1	Angeripalayam	79	7,454
2	Andipalayam	23	4,836
3	Chennakarai	35	4,571
4	Kasipalayam	16	2,201
5	Kunnengalpalayam	20	3,222
6	Manikapuram Pudur	11	2,351
7	Mannarai	21	3,394
8	Veerapandi	73	9,950
	Total	**702**	**83,139**

Source: Computed from PCB Data, 2000

Table - 5.4

LOCATION OF TEXTILE PROCESSING UNITS AND EFFLUENT GENERATION

S.No	Land use	No. of Units		Effluent Generation (KLD)	
		Actual	%	Actual	%
1	Industry	158	22.50	20,973	25.23
2	Agriculture	179	25.50	19,610	23.58
3	Residence	225	32.05	16,787	20.20
4	Public land	140	19.95	25,769	30.99
	Total	**702**	**100.00**	**83,139**	**100.00**

Source: Computed from PCB Data, 2000

Table – 5.5

EFFLUENT TREATMENT CHARACTERISITCS FOR DIFFERENT TEXTILE PROCESSING ACTIVITIES IN TIRUPPUR (IETP)

(Other than pH all values are in mg / L)

S.No	Parameters	PCB Standard	Bleaching		Dyeing		Bleaching + Dyeing	
			Untreated	Treated	Untreated	Treated	Untreated	Treated
1	pH	5.5 – 9	7.5	8.05	8.6	8.05	7.78	8.04
2	TDS	2100	7709	6970	8220	7285	4354	4925
3	TSS	100	293	189	397	163	159	64
4	COD	250	316	143	320	201	266	96
5	BOD	30	55	17	145	18	41	11
6	Oil &Grease	10	4	2	7	1	2	1
7	Chloride	1000	3245	2869	4990	4449	2270	2552
8	Sulphates	1000	801	769	278	274	358	499

Source: Computed from PCB Data, 2000

Table – 5.6

STATUS OF COMMON EFFLUENT TREATMENT PLANT (CETPs) IN TIRUPPUR

S. No	Name of the CETP	Location (Village)	Area (Acres)	Date of Registration	No. of Units	Water Consumption (KLD)	Effluent (KLD)	Project Cost (Rs. Lakh)	Actual Expenditure (Rs. Lakh)
1	Angeripalayam	Mannarai	4.53	28.9.94	79	7,653	7,454	720	620
2	Andipalayam	Andipal-ayam	1.50	28.9.96	23	5,066	4,836	215	254
3	Chennakarai	Veera-pandi	2.45	28.8.94	35	5,119	4,571	245	298
4	Kasipalayam	Agrahara Periyapa-layam	3.00	28.9.94	16	2,311	2,201	220	139
5	Kunnengalpa-layam	Karai-pudur	1.46	14.6.96	20	3,362	3,222	216	113
6	Manikapuram Pudur	Mudali-palayam	1.00	28.2.96	11	2,371	2,351	127	126
7	Mannarai	Mannari	3.00	28.9.94	21	3,465	3,394	271	349
8	Veerapandi	Veera-pandi	4.02	28.9.94	73	10,472	9,950	675	825
	Total		**20.96**		**278**	**39,819**	**37,979**	**2,689**	**2,724**

Source: Computed from PCB Data, 2000

Table - 5.7

AVERAGE VALUE OF EFFLUENTS FOR 8 CETPs (12 SAMPLES COLLECTED DURING 1998, 1999 AND 2000) IN TIRUPPUR

(Other than pH all values are in mg/l)

S.No	Parametre	Tolare-nce Limit	Angeripalayam		Andipalayam		Chinnakarai		Kasipalayam		Kunnangal palayam		Manikapuram pudur		Mannari		Veerapandi	
			Treated	**Untreat.**	**Treated**	**Untreat.**	**Treated**	**Untreat.**	**Treated**	**Untreat.**	**Treated**	**Untreat.**	**Treated**	**Untreat.**	**Treated**	**Untreat.**	**Treated**	**Untreat.**
1	pH	5.5 - 9	8.38	8.13	8.33	9.32	7.74	8.27	8.38	8.15	9.19	8.21	8.05	8.12	7.88	7.81	8.02	7.76
2	TDS	2100	6636.83	6480.91	6524.9	6588	7142.83	7358.5	6543.63	5607	5519.5	5741.33	8487.5	7662.75	6684.8	6889.4	5919.5	5963
3	TSS	100	105.16	96	187.63	82.54	160	167	172.9	150.5	95.66	144.91	217.5	183.5	143.2	149.4	114.01	409.5
4	COD	250	174.66	173.5	205.27	105.45	220.58	192.58	149.45	176.5	118.16	187.16	172.25	107.5	207.6	232.9	158.5	310.91
5	BOD	30	16.83	20.83	31.72	10.45	17.58	21	18	43.33	6.66	24.83	13.12	18.5	29.3	50.8	20.33	83.58
6	Oil & Grease	10	1.8	1.6	2.77	1.4	3.16	2.12	1.8	2.75	1.8	2.54	3	2	4.25	2.28	3.23	2.04
7	Chloride	1000	3316.91	3075.5	3188.09	3222.63	3699.41	3845	3332.9	2656	2740	2758	4118.25	3711.5	3086.6	3067.8	2899.75	2678.75
8	Sulphate	1000	677.16	610.5	535.72	520.63	498	466.41	513.36	434.08	517.83	516.75	705.5	593.25	652.3	623.7	551.58	510.83

Source: Computed from PCB Data, 2000

Table – 5.8

POLLUTION LOAD GENERATED BY TEXTILE PROCESSING UNITS
FROM 1980 to 2000 IN TIRUPPUR
(Quantity in Tonne / Year)

Year	TDS	CHLORIDE	SULPHATE	TSS	COD	BOD	OIL&GREASE
1980	10252.33	6052.62	419.95	481.86	412.56	169.34	8.30
1981	12681.97	7402.87	555.51	589.50	516.99	203.82	10.04
1982	15690.13	9135.25	698.64	726.94	643.15	250.31	12.35
1983	18863.26	10937.06	858.91	870.66	776.06	297.97	14.74
1984	22685.28	13116.61	1050.26	1043.50	938.42	355.55	17.60
1985	25901.92	14778.20	1279.57	1177.99	1081.22	393.57	19.66
1986	38836.94	22131.07	1927.47	1765.33	1619.73	588.86	29.45
1987	53291.43	30332.01	2654.59	2422.02	2218.01	806.79	40.41
1988	67745.93	38532.95	3381.70	3078.72	2816.29	1024.72	51.36
1989	82594.08	46972.88	4122.14	3754.42	3429.89	1249.58	62.66
1990	91628.22	52204.13	4545.69	4166.81	3814.32	1389.89	69.55
1991	119000.25	67753.73	5912.57	5412.61	4943.61	1804.23	90.37
1992	147063.45	83793.70	7275.16	6696.12	6097.70	2234.97	111.92
1993	175129.72	99835.53	8637.87	7979.79	7251.90	2665.77	133.48
1994	203557.62	116096.89	10012.80	9280.93	8420.20	3102.95	155.33
1995	230397.52	131098.73	11447.50	10488.05	9532.84	3494.97	175.27
1996	236307.32	134217.50	11827.09	10746.17	9772.28	3572.09	179.42
1997	242396.85	137413.97	12227.79	11009.82	10023.31	3649.92	183.61
1998	199583.66	101908.48	12647.69	5720.51	5643.91	1014.61	57.97
1999	186655.17	96603.48	12307.52	5147.60	5279.74	863.44	49.06
2000	174200.78	91404.03	11984.10	4592.40	4928.05	714.30	40.35
Cumulative Toal	**2354463.83**	**1311721.71**	**125774.52**	**97151.75**	**90160.18**	**29847.65**	**1512.90**

Source : Computed from PCB Data, 2000.

Table 5.9

EFFICIENCY OF TREATMENT PROGRAMME (IETPs / CETPs) IN TIRUPPUR BASED ON INFLOW AND OUTFLOW OF POLLUTION LOAD

(Quantity in Tonne / Year)

Parameters	CETP			IETP			Total		
	Untreated	**Treated**	**% Variation**	**Untreated**	**Treated**	**% Variation**	**Untreated**	**Treated**	**% Variation**
TDS	77205.17	76557.20	- 0.84	107792.1	97643.58	- 9.4	184997.3	174200.78	- 5.84
TSS	2504.49	2397.8	- 4.26	4890.92	2194.60	- 55.13	7395.41	4592.40	- 37.9
COD	2087.92	2439.31	+ 16.82	4403.12	2488.74	- 43.48	6491.04	4928.05	- 24.08
BOD	235.22	475.70	+ 102.24	1613.55	238.60	- 85.21	1848.77	714.30	- 61.36
Oil & Grease	69.71	23.51	- 66.28	81.63	16.84	- 79.37	151.34	40.35	- 73.33
Chloride	38131.37	36382.86	- 4.59	60748.44	55021.17	- 9.43	98879.81	91404.03	- 7.56
Sulphate	6881.99	6369.45	- 7.45	5493.85	5614.65	+ 2.19	12375.84	11984.10	- 3.16

Source:ComputedfromPCBData,2000.

CHAPTER VI : ECONOMIC ANALYSIS OF POLLUTION ABATEMENT

The bleaching and dyeing units in Tiruppur constitute one segment of the production activities of the hosiery industry. Since the usage of water, the discharge of the effluents and the consequent pollution problems occur almost exclusively in this segment, the economic analysis is confined only to this activity. In this chapter, we first review the size composition of the bleaching and dyeing units, and the relationship between size (as measured by gross fixed assets) and quantity of cloth processed by the units. Similarly the water usage by units of different size is of importance for two reasons: Uneconomic use of water adds to the variable cost since water has to be purchased. Moreover, the quantity of effluents and therefore the cost of treatment will go up when more water is used. Secondly, we examine the options with regard to effluent treatment. Smaller units for example, may find the cost of treatment unaffordable and may either have to close or join a common effluent treatment facility. Next we compare the average cost of treatment – capital and operating cost – in the case of individual effluent treatment plants (IETPs) and the common effluent treatment plants (CETPs). Lastly, we estimate the marginal cost in terms of (i) quantity of effluent treated and (ii) reduction of pollution as measured by chemical oxygen demand.

A. Size Composition of Bleaching and Dyeing Units

The 702 bleaching and dyeing units can be distributed by size class as shown in Table - 6.1 using the Gross Fixed Assets (GFA) as the basis for classifications, ranging from the smallest units with GFA ≤ Rs. 2 lakhs to the largest with GFA above Rs.50 lakhs. About 70 % of the units are in the intermediate range with GFA between Rs. 2 lakhs and Rs. 15 lakhs. Figure 6.1 gives (Figure 6.1A, 6.1B and 6.1C give the activity wise size and average quantity of cloth processed) the average quantity of cloth processed by units of different size. The quantity of cloth processed per unit does not seem to vary much (17 to 24 tonnes per month) in units with GFA below Rs.50 lakhs, but goes up to 70 tonnes/month for the large units.

Table – 6.1

Classification of Textile Processing Units Based on Gross Fixed Assests

GrossFixed Assets (Rs. in Lakh)	No. of Units			Total Units	
	Bleaching	Dyeing	Bleaching + Dyeing	Number	%
≤ 2	32	14	2	48	6.68
2.1 to 5	93	45	11	149	21.23
5.1 to 10	56	142	36	234	33.33
10.1 to 15	12	89	15	116	16.58
15.1 to 20	2	42	6	50	7.22
20.1 to 50	1	57	16	74	10.54
Above 50	3	25	3	31	4.42
Total	**199**	**414**	**89**	**702**	**100**

Source: Computed from PCB Data, 2000.

Figure 6.1
Gross Fixed Assets Vs Average Cloth Processed

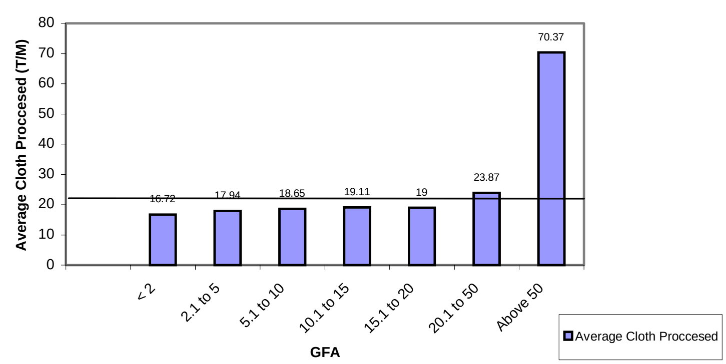


Figure 6.1A
Gross Fixed Assets Vs Average Cloth Processed (T/M) in Bleaching Units

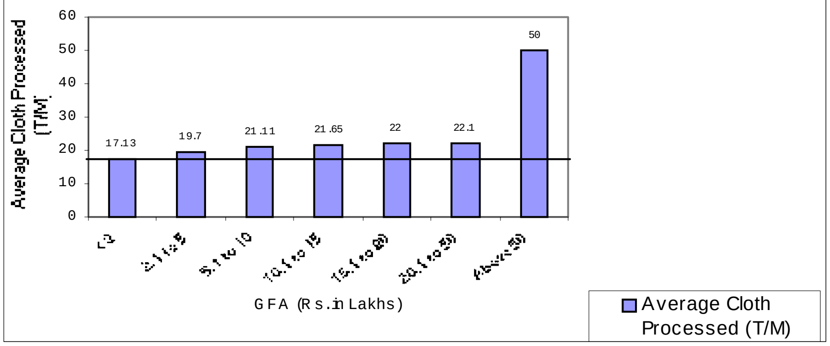


Figure 6.1B
Gross Fixed Assets Vs Average Cloth Processed in Dyeing Units

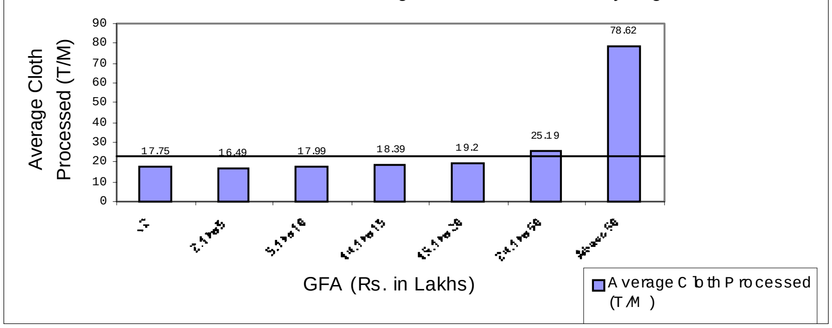
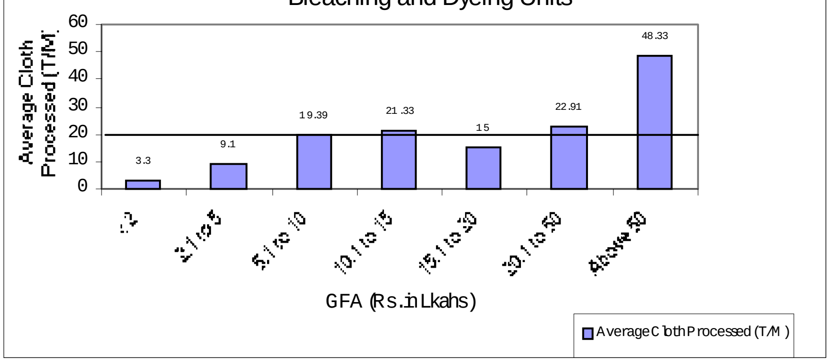


Figure 6.1C
Gross Fixed Assets Vs Average Cloth Processed in Both Bleaching and Dyeing Units



(I) Quantity of Output

We can examine if there are any economies of scale with respect to size from the data for the 702 bleaching and dyeing units by regressing quantity of cloth processed on gross fixed assets. Quantity of cloth processed can be considered as an output of the bleaching and dyeing units.

Table – 6.2

Dependent Variable = Ln Gross Fixed Assets

	Co-efficient	**Std. Error**	**t**	**Sig.**
Constant	0.615	0.166	3.701	0.000
Ln Cloth	0.547	0.057	9.624	0.000

R^2 = 0.117 Adjusted R^2 = 0.116 F = 92.617 Sig. = .000

Ln GFA = 0.615 + 0.547 ln cloth

Thus a 10% increase in cloth processed would require only a 5.47 % increase in the GFA, indicating that there are some scale economies in production in the bleaching and dyeing units. The intermediate range is probably uneconomic in terms of size.

(ii) Quantity of Water Used : Figure 6.2 indicates the relationship between size and water use, further Figure 6.2A, 6.2B and 6.2C give the activity wise the relationship between size and water use.. As size increases, the amount of water used goes up gradually. Water and chemicals are the major material inputs in the bleaching and dyeing units. Optimizing their use is essential for controlling the costs of production. If we regress lnGFA against lnWater used we get the following relationship.

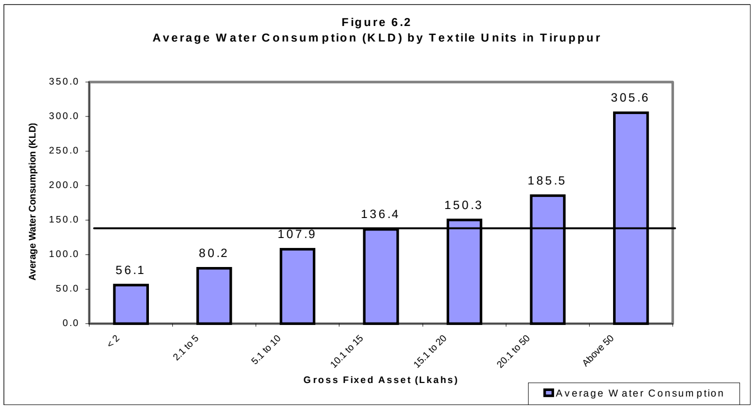


Figure 6.2
Average Water Consumption (KLD) by Textile Units in Tiruppur
Average Water Consumption (KLD)
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
56.1
80.2
107.9
136.4
150.3
185.5
305.6
< 2
2.1 to 5
5.1 to 10
10.1 to 15
15.1 to 20
20.1 to 50
Above 50
Gross Fixed Asset (Lkahs)
Average Water Consumption

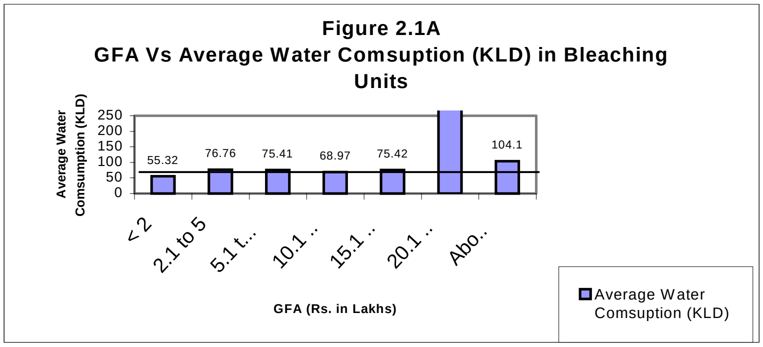


Figure 2.1A
GFA Vs Average Water Comsuption (KLD) in Bleaching Units
Average Water Comsumption (KLD)
250
200
150
100
50
0
55.32
76.76
75.41
68.97
75.42
104.1
< 2
2.1 to 5
5.1 t...
10.1 ..
15.1 ..
20.1 ..
Abo..
GFA (Rs. in Lakhs)
Average Water Comsuption (KLD)

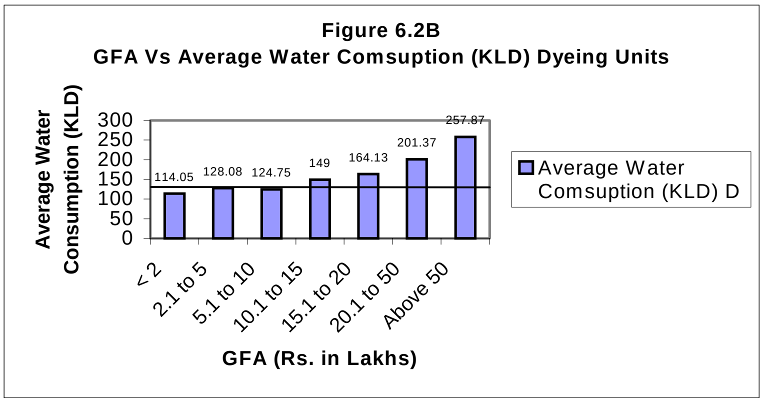


Figure 6.2B
GFA Vs Average Water Comsuption (KLD) Dyeing Units
Average Water Consumption (KLD)
300
250
200
150
100
50
0
114.05
128.08
124.75
149
164.13
201.37
257.87
< 2
2.1 to 5
5.1 to 10
10.1 to 15
15.1 to 20
20.1 to 50
Above 50
GFA (Rs. in Lakhs)
Average Water Comsuption (KLD) D

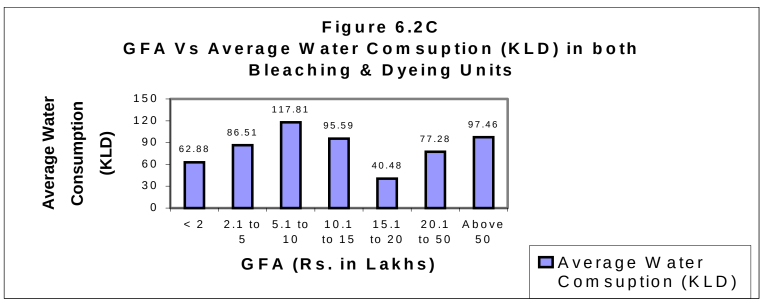


Figure 6.2C
GFA Vs Average Water Comsuption (KLD) in both Bleaching & Dyeing Units
Average Water Consumption (KLD)
150
120
90
60
30
0
62.88
86.51
117.81
95.59
40.48
77.28
97.46
< 2
2.1 to 5
5.1 to 10
10.1 to 15
15.1 to 20
20.1 to 50
Above 50
GFA (Rs. in Lakhs)
Average Water Comsuption (KLD)

Table – 6.3

Dependent Variable : Ln Gross Fixed Asset used

	Co-efficient	Std. Error	t	Sig.
Constant	3.714	0.054	68.257	0.000
Ln Water used	0.389	0.023	17.137	0.000

R^2 = 0.296 Adjusted R^2 = 0.295 F = 293.676

Ln Water Used = 3.714 + 0.389 Ln GFA

i.e, the quantity of water used goes up almost proportionately with size. Similarly, the quantity of effluent goes up as indicated in Figure 6.2 I.

Figure 6.2 I
Gross Fixed Assets Vs Average Effluent Generation

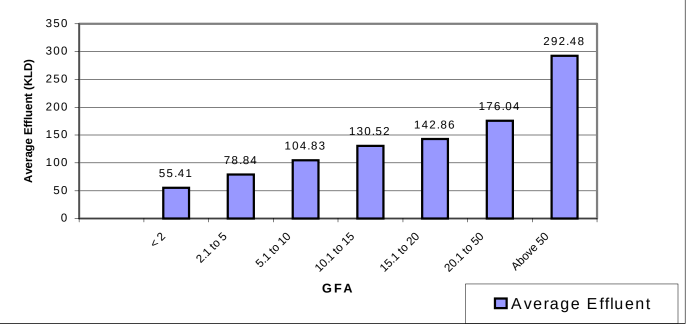
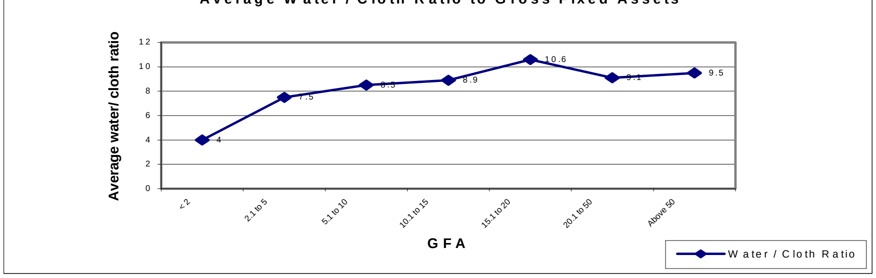


Figure 6.3
Average Water / Cloth Ratio to Gross Fixed Assets



From the environmental point of view, the crucial issue is whether the optimal amount of water is being used in relation to the quantity of cloth processed. If we plot the water / cloth ratio for different size of units (Figure 6.3) we find that the smaller units are more efficient in terms of water use. Since the units have to pay for water, inefficient use of water would lead to increase in cost. The effluent / cloth ratio (Figure 6.4) also indicates that the smaller units generate less effluent per tonne of cloth processed.

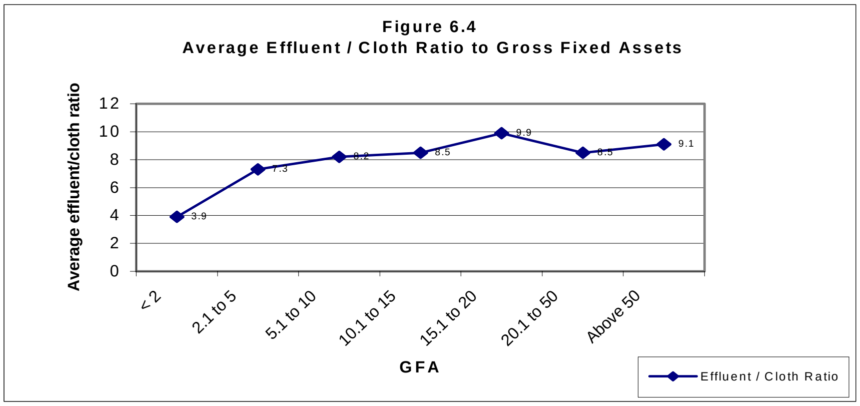


Figure 6.4
Average Effluent / Cloth Ratio to Gross Fixed Assets

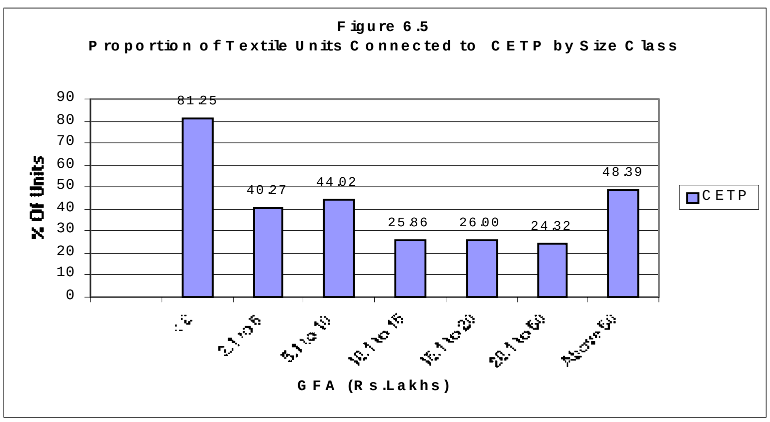
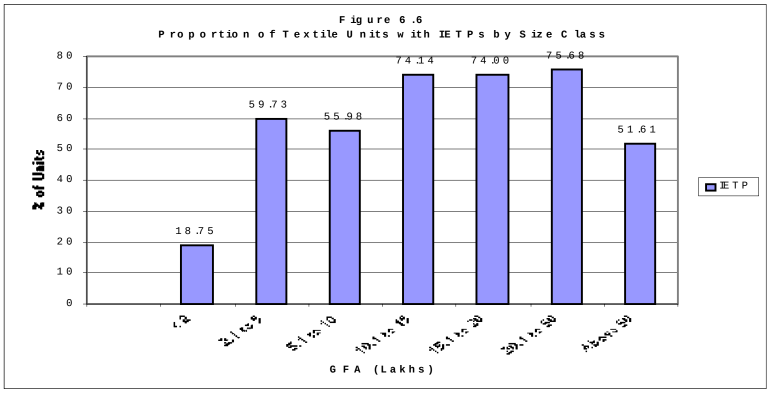


Figure 6.5
Proportion of Textile Units Connected to CETP by Size Class

But, since small units may find it different to bear the additional cost of pollution abatement, the concept of common effluent treatment plants (CETPs) was introduced by the government. Subsidies were given by the Central and State governments for the construction of the plants. CETPs would enable the more efficient bleaching and dyeing units to remain in business. At the request of the units, the Pollution Board, the units were given the choice of either joining a CETP or setting up their own treatment plant. We discuss the economic aspects of these two different options, while keeping in mind that non-economic factors may also govern their choice.

B. Effluent Treatment Options



First, we examine whether size has been a factor in the decision to either join a CETP or build their own IETP. If we look at the proportion of units of each size class that joined CETPs (Figure 6.5) as opposed to IETPs (Figure 6.6) we find that there is a greater likelihood of smaller units joining CETPs, and of larger units having their own individual facilities (IETPs). While 81 % of units with GFA > Rs. 2 lakhs opted for CETPs, 75 % of units between Rs. 10 lakhs to Rs. 50 lakhs opted for IETPs. Surprisingly, the large units (> Rs. 50 lakhs) were almost equally split between IETPs and CETPs. The choice between IETP and CETP does not seem to be based on size alone, but on various other factors.

One of the arguments for CETPs is that there may be economies of scale with regard to treatment. However it must be kept in mind, that there may be costs of connection in the case of CETPs which would not be there for IETPs. In Tiruppur, 278 units are connected to 8 CETPs. Hence, it is possible to relate the capital cost of the CETP to the total quantity of effluent handled by that CETP and to the number of units. In logarithmic form the following equation was obtained.

Ln Capital cost } = - 0.976 + 0.391 ln volume of effluent + 0.53 ln number of units of CETP} (t = 0.80) (t = 1.092)

Although R^2 = 0.825 and Adjusted R^2 = 0.756, the t-values of the co-efficients were not significant, possibly due to small number of observations (8). While it would appear that proportionately more effluent could be handled by the CETPs, we are not in a position to unequivocally conclude if there are economies of scale due to the statistical problems. Nevertheless, other studies (Metha.S et.al, 1997) have indicated that CETPs exhibit scale economies.

C. Average Cost of Pollution Abatement

Since all the functioning textile processing units in Tiruppur carry out effluent treatment either through IETPs or CETPs, it is worthwhile examining the comparative cost of treatment.

(i) IETPs

Details regarding the capital cost, variable cost etc. with the average cost per unit are provided in the Table – 6.4. The total cost for each of the units is estimated along with capital on an annualized basis and variable cost. The average annual capital cost per unit is Rs. 0.77 lakh, while the average annual variable cost would be Rs. 4.56 lakh. The total cost for treating 1 KL of effluent through IETP is estimated as Rs. 16.03, of which only Rs. 2.31 is the capital cost and Rs. 13.72 is the variable cost.

ii) CETPs

The cost analysis for the 278 units (Table 6.5) which treat their effluents through 8 CETPs also show high annual average variable cost per unit (Rs. 4.27 lakh) compared to the annualized capital cost (Rs. 1.56 lakh) . For Treating 1 KL of effluent the total cost is Rs. 13.66 of which capital cost is Rs. 3.67 and variable cost is Rs. 9.99.

Table – 6.4

EFFLUENT TREATMENT COST (COST / KL EFFLUENT) FOR 424 IETPs IN TIRUPPUR

S.No	Type of Unit	No of units	Annual Effluent (KL)	Total Capital cost (Rs. Lakh)	Annual (Rs. Lakh)			Cost per KL (Rs.)		
					Capital cost	Variable cost	Total cost	Capital cost	Variable cost	Total cost
1	Bleaching	137	2747067 (20052)	367.16 (2.68)	58.63 (0.43)	330.7 (2.41)	389.33 (2.84)	2.13	12.04	14.17
2	Dyeing	241	9590692 (399795)	1342.37 (5.57)	214.39 (0.89)	1341.6 (5.56)	1555.99 (6.45)	2.23	13.98	16.21
3	Bleaching & Dyeing	46	1752161 (38090.46)	334.42 (7.27)	53.40 (1.16)	262.1 (5.70)	315.50 (6.86)	3.05	14.95	18.00
	Total	**424**	**14089920** **(33230.94)**	**2043.95** **(4.82)**	**326.42** **(0.77)**	**1934.4** **(4.56)**	**2260.82** **(5.33)**	**2.31**	**13.72**	**16.03**

Source: Computed from PCB data, 2000

Note : The numbers provided in the brackets are Average Values

Table – 6.5
EFFLUENT TREATMENT COST (COST / KL EFFLUENT) FOR 8 CETPs IN TIRUPPUR

S.No	Name of CETP	No. of Unit	Annual Effluent (KL)	Total Capital Cost (Rs. Lakh)	Annual (Rs. Lakh)			Cost per KL (Rs.)		
					Capital cost	Variable cost	Total cost	Capital cost	Variable cost	Total cost
1	Angeripalayam	79	2325523 (29437.0)	620 (7.85)	99.02 (1.25)	232.5 (2.95)	331.5 (4.20)	4.25	9.90	14.15
2	Andipalayam	23	1508832 (65601.39)	245 (10.65)	39.13 (1.70)	150.9 (6.66)	190.03 (8.26)	2.59	10.00	12.59
3	Chinnakarai	35	1426308 (40751.66)	298 (8.51)	47.59 (1.37)	142.6 (4.07)	190.19 (5.34)	3.34	9.90	13.24
4	Kasipalayam	16	686712 (42191.50)	139 (8.69)	22.20 (1.38)	68.7 (4.30)	90.9 (5.68)	3.23	10.00	13.23
5	Kunnengal-palayam	20	1005358 (50267.90)	113 (5.65)	19.25 (0.96)	100.5 (5.03)	119.75 (5.99)	1.90	9.90	11.80
6	Manikapuram-pudur	11	733637 (66694.27)	126 (11.45)	20.12 (1.83)	73.4 (6.67)	93.52 (8.50)	2.74	10.00	12.74
7	Mannarai	21	1058834 (50420.67)	349 (16.62)	55.98 (2.67)	105.9 (5.04)	161.88 (7.71)	5.28	10.00	15.28
8	Veerapandi	73	3104275 (42524.32)	825 (11.30)	131.76 (1.80)	310.4 (4.25)	442.16 (6.06)	4.24	9.99	14.23
	Total	**278**	**11849479** **(42624.03)**	**2724** **(9.80)**	**435.05** **(1.56)**	**1184.9** **(4.27)**	**1619.95** **(5.83)**	**3.67**	**9.99**	**13.66**

Source: Computed from PCB data, 2000**Note :** The numbers provided in the brackets are Average Values.
Subsidies given by the government are not included in calculating costs.

(a) Average Treatment Cost per Kilolitre of Effluent

If we compare the above table, the average capital cost for each of the units connected to CETP (Rs. 9.80 lakhs) is far higher than the IETPs (Rs. 4.82 lakhs). This would be because of the conveyance cost (capital cost for transporting effluents through pipe lines) and land value involved in CETPs. Hence the capital cost per KL of effluent is higher in CETP (Rs. 3.67) than IETP (Rs.2.31). However, the variable cost per KL of effluent at CETP (Rs. 9.99) is lower than in the case of IETPs (Rs. 13.72), probably due to the 'economies of scale' of CETPs.

(b) Average Treatment Cost per KG of Cloth Processed

The treatment cost per Kg of cloth for IETP and CETP are also estimated (Table –6.6). Total treatment cost for 1 kg of cloth through IETP would come Rs. 2.20, of which Rs. 0.29 is fixed cost and Rs. 1.73 is the variable cost. But in CETP, the cost would be Rs. 2.16, Rs. 0.58 and Rs. 1.58 respectively.

Table – 6.6

EFFLUENT TREATMENT COST (COST / KG CLOTH) FOR IETPs AND CETPs IN TIRUPPUR

Mode of Treatment	Annual Effluent (K/L)	Annual Cloth Processed (Kg)	Total Capital Cost (Rs. Lakh)	Annual (Rs. Lakh)			Cost per KG of Cloth Processed (Rs.)		
				Capital Cost	Variable Cost	Total Cost	Fixed Cost	Variable Cost	Total Cost
IETPs (424)	14089920	111209280	2043.95	326.42	1934.4	2260.82	0.29	1.73	2.02
CETPs (278)	11849448	75054720	2724.00	435.05	1184.9	1619.95	0.58	1.58	2.16
Total (702)	**25939368**	**186264000**	**4767.95**	**761.47**	**3119.3**	**3880.77**	**-**	**-**	**-**

Source: Computed from PCB Data, 2000.
Note: The number provided in the brackets are units.

(i) The variable cost is <u>much higher</u> than the annualized capital cost both in the case of IETPs (86 % of total cost) and CETPs (73 %) (Figure 6.7A and 7B). Since there are no subsides for operation, it remains to be seem whether the units will operate the treatment plants in the expected manner

Figure 6.7A
Percentage of Fixed and Variable Costs of Treatment Per KG of cloth processed - CETP Units

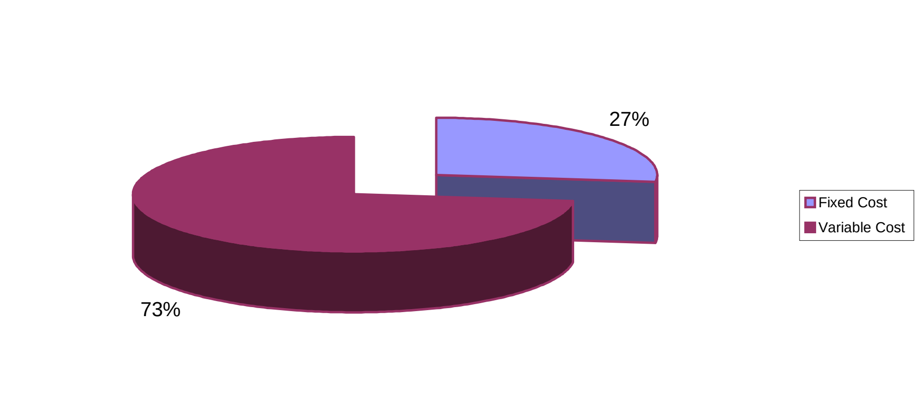
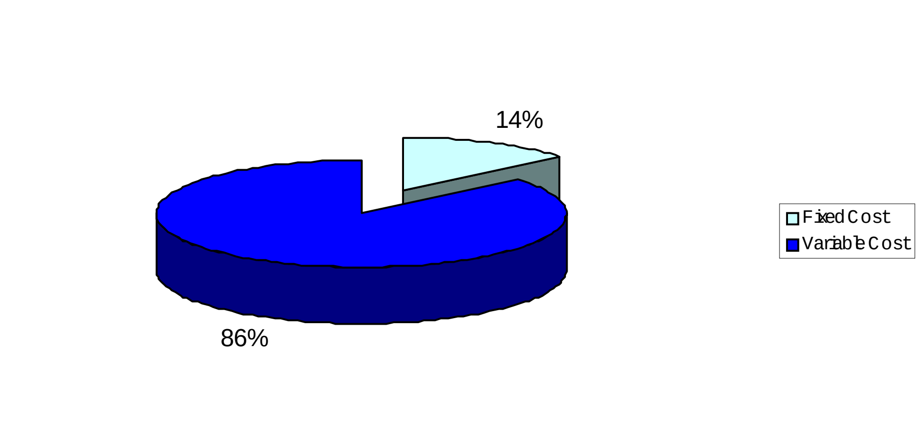


Figure 6.7B
Percentage of Fixed and Variable Costs of Treatment Per KG of Cloth Processed - IETP Units



(ii) CETPs exhibit economies of scale in respect of variable cost or treatment if we use the variable cost per KL or per Kg. The variable cost in CETP is about a third lower than IETP. Unfortunately, the CETPs do not seem to be achieving any treatment for most of the parameters, at the present time, while the IETPs are reducing BOD, COD, and TSS load substantially.

(c) Marginal Cost of Effluent Treatment

Instead of using average values we could estimate the marginal cost of treatment by regressing annualized total cost against quantity of effluent treated per year. Since capital cost also varies with effluent quantity we have used annualized total cost as the dependent variable.

Table – 6.7

Dependent Variable: Annualized total cost of treatment in IETPs in Rs. lakhs(ATC).

Variable	Co-efficient	Std. Error	T value	Sinificance
Quantity of effluent in kilolitres per year (QE)	$15.1 * 10^{-5}$	$2.1 * 10^{-6}$	71.66	0.000

R^2 = 0.992, Adjusted R^2 = 0.867 and a significant F Value =

$$ATC = 15.1 * 10^{-5} (QE)$$

(a) IETP

The co-efficient of the independent variable (QE) is an estimate the marginal cost of treatment, which works out to Rs. 15.10 per kiloliter. This value is fairly close to the average cost of Rs. 16.03 calculated in the previous section.

(b) CETP

Although we have cost data for only 8 CETPs, the relationship between costs and effluent was surprisingly strong (R^2 = 0.917, adjusted R^2 = 0.964) and a significant F Value (66.58).

Table – 6.8

Dependent Variable: Annualized treatment cost in CETPs in Rs. lakhs (ATC).

Variable	Co-efficient	Std. Error	T value
Quantity of effluent in kilolitres per year (QE)	$13.9 * 10^{-5}$	$2.92 * 10^{-6}$	47.55

$$ATC = 13.9 * 10^{-5} (QE)$$

The marginal cost of effluent treatment in CETPs works out to Rs. 13.90 per KL of effluent. This is fairly close the average cost of Rs. 13.66 per KL calculated in the previous section.

(D) Marginal Cost of Pollution Reduction

Table 6.9 provides a summary of the reduction in pollution load in a sample of 8 IETPs for several parameters. The salt load measured by TDS and Chloride remains virtually unaffected by treatment. However, there appears to be significant reduction in the organic load measured by chemical oxygen demand (COD). Hence we regressed annualized treatment cost (Rs. lakhs) against reduction in COD load in tonnes/year. Other parameters like BOD and TSS when included turned out to be non-significant. (Since the CETPs are not functioning properly, it was not possible to do a similar exercise on the cost of pollution reduction for CETPs.)

Table – 6.10

Dependent Variable: Annualized treatment Cost in Rs. lakhs (ATC).

	Co-efficient	Std. Error	T	Sig. Level
Constant	3.339	1.037	3.219	0.015
COD Reduction (in tonnes/year)	0.321	0.071	4.507	0.003

R^2 = 0.744 Adjusted R^2 = 0.707 F = 20.3

Treatment Cost = 3.339 + 0.321 (Reduction in COD load in tonnes/year) (Rs. lakhs per year)

The data indicate that the marginal cost of COD reduction in this industry is Rs. 0.321 lakh / tonne or Rs. 32 per Kg of COD reduced. This value is of the same order as some other studies such as Goldar and Pandey (1997).

Summary

Economic analysis of the data available on the bleaching and dyeing units and the pollution abatement measures taken by them provides the following insights:

1. The size composition of the 702 bleaching and dyeing units indicates very wide variation from small units having gross fixed assets (GFA) less than Rs. 2 lakhs to large units with GFA that exceed Rs. 50 lakhs. However, 70% of

the units fall in the intermediate categories of Rs. 2 lakhs – Rs. 15 lakhs, and 17% between Rs. 20-50 lakhs. The size distribution of units is of some importance in respect of water use, and also in terms of the mode of treatment.

2. Although there is considerable variation in the size of the units (as measured by gross fixed assets), the average quantity of cloth processed remains more or less constant between 17-20 tonnes per month. However, a regression analysis of cloth processed vs GFA, indicates some economies of scale in production.

3. Of even greater importance from an environmental perspective is the fact that water use (and therefore effluent use) increases with size. Taken together with (2) this means that the water use/kg of cloth or effluents/kg of cloth increases with size. In other words, there may be uneconomic use of water, which increases the variable cost, since water has to be purchased or transported. When too much effluent is generated the cost of treatment also goes up.

4. The choice between individual versus common effluent treatment plants seems to be governed by both economic and non-economic factors. While the large majority (82%) of the extremely small units (< Rs. 2 lakhs) have joined CETPs, those in the other size ranges did not show a marked preference. Even the larger units (>Rs. 50 lakhs) seem to be evenly divided on this issue. This ambivalence towards CETPs is probably due to the earlier policy of not permitting IETPs. The Pollution Board relaxed this policy midstream permitting IETPs. Recently, they have revised the policy again and are now insisting that any new units should join CETPs. We will discuss this issue in more detail in the final chapter.

5. Average Cost of Pollution Abatement Per KL Effluent in IETPs and CETPs.

Table – 6.11

	Capital cost	Variable Cost	Total Cost
IETP	2.31	13.72	16.03
CETP	3.67	9.99	13.66

These average costs are also supported by the regression analysis which gives a marginal cost of treatment of Rs. 15.10 for IETPs and Rs.13.90 for CETPs for treating 1 KL of effluent.

6. While the Capital Cost of CETPs is 50% higher than IETPs, the lower variable cost of CETPs results in the total cost of IETPs being 17% higher on a per kilolitre basis. In other words, CETPs might exhibit some economies of scale in treatment. Regardless of whether the units have their own treatment plants or connected to CETPs, the economic analysis clearly shows that the variable costs are very much higher than the annualized fixed costs, in the case of both IETPs and CETPs.

For IETPs : Variable Cost ---------------- = 5.94   Variable Cost ---------------- = 85%

Capital Cost   **Total Cost**

For CETPs : Variable Cost ---------------- Capital Cost = 2.72   Variable Cost ---------------- Total Cost = 73%

Thus, there is a very strong financial incentive for the units to lower their variable cost by not treating the effluents, despite construction of the treatment plants.

7. The marginal cost of reduction of 1 tonne of organic load (measured as COD) is Rs. 0.321 lakh or Rs. 32 per Kg. If a pollution tax were levied for COD reduction, it should probably be of this order.

8. In this study, we did not do a systematic study of the cost of production of the dyeing and bleaching units. However, it has been reported in the literature (MSE, 2000) that the production cost is of the order of Rs. 32 per kg of cloth in large units and between Rs. 14 – 22 per kg in job work units. If the annualized cost of treatment is around Rs.2 per kg of cloth (Rs. 2.02 for IETP and Rs. 2.16 for CETP), than the pollution abatement costs would be about 6 % in large units and 9 % to 14 % in small job work units. Since small units work with very small margins, their reluctance to pay pollution abatement is understandable. The Pollution Board may also have to consider subsidizing the variable cost which forms a significant part of the cost of treatment.

****

Table 6.9

BOD, COD, TSS Reduction Vs Pollution Abatement Costs for Selected IETPS in Tiruppur

	Quantity of Effluent (KLD)	BOD				COD				Activity	Quantity of Effluent (KLD)	BOD				COD										TSS
		Untreated Value (Mg/Lit.)	Treated Value (Mg/Lit.)	Reduction (Mg/Lit)	Reduction in Load (Tonne/Year)	Untreated Value (Mg/Lit.)	Treated Value (Mg/Lit.)	Reduction (Mg/Lit)	Reduction in Load (Tonne/Year)			Untreated Value (Mg/Lit.)	Treated Value (Mg/Lit.)	Reduction (Mg/Lit)	Reduction in Load (Tonne/Year)	Untreated Value (Mg/Lit.)	Treated Value (Mg/Lit.)	Reduction (Mg/Lit)	Reduction in Load (Tonne/Year)	Untreated Value (Mg/Lit.)	Treated Value (Mg/Lit.)	Reduction (Mg/Lit)	Reduction in Load (Tonne/Year)	Fixed Cost	Variable Cost	Total Cost
Bleaching	45.5	84	47	37	0.61	455	314	141	2.34	Bleaching	45.5	84	47	37	0.61	455	314	141	2.34	348	348	0	0	0.46	2.25	2.71
Bleaching	45.2	43	4	39	0.65	238	69	169	2.79	Bleaching	45.2	43	4	39	0.65	238	69	169	2.79	320	228	92	1.52	0.42	2.23	2.65
Bleacing	35.4	144	19	125	1.62	536	168	368	4.76	Bleacing	35.4	144	19	125	1.62	536	168	368	4.76	188	38	150	1.94	0.42	1.75	2.17
Dyeing	86	140	45	195	6.14	415	353	62	1.95	Dyeing	86	140	45	195	6.14	415	353	62	1.95	87	48	36	1.13	0.96	4.25	5.21
Dyeing	200.5	170	5	265	19.44	475	209	266	19.51	Dyeing	200.5	170	5	265	19.44	475	209	266	19.51	510	390	120	8.8	0.72	9.91	10.63
Dyeing	210.5	180	80	200	15.4	650	280	370	28.5	Dyeing	210.5	180	80	200	15.4	650	280	370	28.5	1780	60	1720	132.51	0.99	10.38	11.37
B + D	206	36	7	29	2.09	360	40	320	23.54	B + D	206	36	7	29	2.09	360	40	320	23.54	124	76	48	3.53	1.24	9.93	11.17
B + D	150.2	36	14	22	1.21	182	91	91	5	B + D	150.2	36	14	22	1.21	182	91	91	5	76	50	26	1.42	1.25	7.41	8.66
B + D	121	52	6	46	2.04	257	40	217	9.61	B + D	121	52	6	46	2.04	257	40	217	9.61	276	36	240	10.62	0.99	5.98	6.97

CHAPTER – VII : GROUND AND SURFACE WATER QUALITY IN THE TIRUPPUR REGION

I Water Quality Assessment in the Tiruppur Region

A number of water quality assessment studies have been undertaken by different Government agencies and researchers in Tiruppur and downstream at different time periods. The results of the ground water studies and the surface water studies are summarised below.

A. Ground Water Studies

A detailed study conducted by the Central Ground Water Board as early as 1976 – 79 with the assistance of the Swedish International Development Agency (SIDA) on "Ground Water Resources of Noyyal Basin" provides excellent baseline information on ground water quality in an earlier period. The water quality data from 18 wells which are located in Tiruppur region is provided in Table – 7.1. Electrical conductivity, Chloride and Sulphate concentration for post monsoon and pre-monsoon (January, June) for the period 1976 - 79. In certain wells, Mangalam, Tiruppur, Sarkarperiyapalayam, Chennakarai, Kuppandampalayam etc. the concentration of EC, Chloride and Sulphate was considerably higher than the other wells. This might be because of the functioning of textile processing units in that particular region, even in the seventies.

A study conducted by Central Ground Water Board on "Ground Water Resources and Development Prospects in Coimbatore District" in 1993 summarises the ground water pollution problem in Tiruppur succinctly: *"In the extreme northeastern part of (Coimbatore) district, that is around Tiruppur, the hosiery industries are rampant which use a variety of dyes and other chemicals. The effluents from these industries are discharged without proper treatment into the nearby lands, channels and low-lying areas. Such toxic effluents form pools of stagnant water in the low –lying area, which seep through the surface and pollute the ground water. The analytical results of the water samples collected from the dug wells in and around Tiruppur are found to be highly polluted and carry high concentration of dissolved substances. The dug well waters are changing into a mixed type of water. With the passage of time the* *effects of pollution of ground water may probably turn out to be wide-spread and alarming. Though the extent of the damage is not known, waters from wells in the vicinity of Tiruppur are reported to deteriorate with dissolved solids ranging between 1472 and 2106 mg / l. The effluents have also seriously contaminated the soils thereby damaging the fertility of the lands. The said situation necessitates initiation of detailed studies in and around the industrial town viz. Tiruppur involving continuous monitoring of ground water quality on a regular basis to assess the extent of damage and to evolve necessary remedial measures towards the control of ground water pollution" (Central Ground Water Board, 1993).*

The Central Ground Water Board did a follow-up ground water assessment study during 1999, by analysing the ground water samples from different locations in Tiruppur Municipality. The results are provided in Table – 7.2. These values are compared with the drinking water standards. Except Andipalayam, the TDS and Chloride concentrations are very high. The highest values are 8,342 mg / l and 3924 mg / l respectively in the sample near Nataraj theater.

A detailed study was conducted by Thomson Jacob (1998) which provides a comprehensive picture on the ground water quality of Tiruppur (Table – 7.3). Ground water samples were collected from tube wells and open wells. Among the 4 open wells, 2 are located in dyeing area and other 2 are in the bleaching area. The Chloride, TDS, TSS BOD and Sulphide concentrations are high in most of the samples. But Sulphate value is less in ground water.

The analytical results of 315 water samples (open wells and bore wells) collected by TWAD Board during 1999 is summarised in Table – 7.4. The data reveal that the pollution of ground water is fairly widespread in the region, and not confined to Tiruppur town alone.

A study published by Rajaguru and Subburam (2000) provides physio – chemical characteristics of ground water in different regions of Tiruppur (Table–7.5). The minimum and maximum value of the parameters with mean value is provided. The study concludes that the ground water available in the Tiruppur are region not suitable for domestic, industrial and irrigation activities.

All the ground water studies indicate that both open wells and bore wells in and around Tiruppur exhibit high levels of Total Dissolved Solids and Chloride due to industrial pollution. These values are much higher than the background levels for this region. The studies also indicate that the available ground water is not suitable for domestic, industrial or irrigation, uses.

B Surface Water Studies

Thomson Jacob (1998) did a surface water quality study of Noyyal river near Tiruppur region. Samples were taken from 3 stations, up streams (R1), middle streams (R2) and downstream (R3). Compared to the upstream point (before Tiruppur), the stations in middle stream (Tiruppur) and downstream recorded very high level of Chloride and TDS. The TSS, BOD and Sulphate concentration are also high (Table – 7.6)

Palanivel and Rajaguru's study on the "Present Status of the River Noyyal" (published in 1999) provides a detailed physio-chemical analysis of surface water quality in the Noyyal river at different zones and compared the parameters in summer and winter (Table – 7.7). The water was collected from 28 spots extending over 101 km of the Noyyal river, zone 1 is before Tiruppur (industrial effluent free zone), zone II almost 17 km. distance, where the river receives effluents (highly polluted zone), zone III is down stream of Tiruppur (less polluted zone). The major results of the study are (a) Compared to zone II and III, zone I is less polluted area (b) Self purification capacity of the river is a reason for the marginal reduction in pollution downstream (c) Since the concentration of TSS and TDS is very high in Tiruppur and downstream, the river water is not suitable for any purpose including irrigation. (d) The existing moderate flow, during the monsoon, is not sufficient to wash away the pollutants in the river (Palanivel and Rajaguru, 1999).

The Tamilnadu Pollution Control Board took water samples from Orthapalayam Reservoir during 1997 (9 samples), 1998 (16 samples) and 1999 (11 samples). The results are given in Table – 7.8. The range (maximum and minimum values) and mean values for each year is compared with the irrigation water standard. In brief the TDS and Chloride concentrations in the Orthapalayam reservoir are higher than the respective standards (2100 and 600 respectively) except in the rainy season.

The month wise TDS and Chloride concentration is provided in Graphs (Fig. 7.1 for TDS and Fig. 7.2 for Chloride). Here also except for one or two months during the rainy season, the water quality does not meet the irrigation water standard.

The surface water studies indicate that the Noyyal river and the Orthapalayam dam dowstream have been affected by industrial pollution. Except for the rainy season when there is dilution, the surface water is unsuitable for domestic or irrigation use.

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Table – 7.1

EC CONCENTRATION IN DIFFERENT SIDA WELLS LOCATED IN AND AROUND TIRUPPUR
(1976 TO 1979)

Well No.	Location	1976		1977		1978		1979	
		Jan.	June	Jan.	June	Jan.	June	Jan.	June
62	Mangalam	525	540	715	620	630	510	460	630
63	Mangalam*	3400	3200	3450	3000	3600	4018	4150	4100
64	Tiruppur*	4500	4300	550	970	4300	5390	5850	6750
65	Tiruppur*	2250	2500	2750	2800	3100	3283	3000	2750
66	Ammapalayam	1125	1010	1240	1150	2100	1617	2240	1850
67	Tirumuruganpundi	1925	2250	1400	2400	3200	3048	2100	2200
72	Perumanallur	1875	2100	2000	1110	1850	2107	2240	1650
73	Chengapalli	1550	1650	1550	1860	1980	2205	2270	2100
79	Sarkarperiyapalayam*	NA	5650	3900	3200	3650	7840	5000	6250
80	Chinnakrai*	8000	8400	6300	10000	8400	11270	12000	11300
81	Kuppandampalayam*	8000	8200	9100	7100	5500	6174	5780	5200
82	Tonguttipalayam	875	810	780	940	800	578	600	820
83	Puddupalayam	275	300	275	325	400	304	370	285
84	Nachipalayam	1975	2150	2000	1930	2300	1862	2200	2100
86	Anappalayam	2500	2000	1730	2500	3200	2007	2420	2400
87	Pallapalayam	1525	1300	975	1100	1670	1029	1370	1870
128	Nallur	1825	980	1550	1840	2300	1800	2070	2070
133	Chettipalayam	NA	NA	780	1040	1050	1400	2320	2400

* - Wells affected by effluents.
Source: From CGWB Data, (2000).

Table –7.2

ANALYTICAL RESULTS OF WATER SAMPLES IN AND AROUND TIRUPPUR TOWN

S.No	Parameters	Locations			
		Sugumar Nagar	**Downstream Altra Clean**	**Andipalayam**	**Nataraj Theater**
1	pH	7.30	7.73	7.35	7.47
2	TDS (mg / l)	6640	2730	1400	8342
3	Chloride (mg / l)	2189	975	410	3924
4	Sulphate (mg / l)	596	173	52	424
5	Alkalinity (mg / l)	440	450	316	560
6	Total Hardness (mg / l)	1630	860	550	2690
7	Calcium (mg / l)	276	80	156	288
8	Magnesium (mg / l)	228	160	39	478
9	Sodium percentage (%)	52.6	53.7	34.6	51.7

Source: Prepared by CGWB based on TNPCB Data (1999)

Table – 7.3

GROUND WATER QUALITY IN TIRUPPUR

S.No	Parameters	Ground Water						
		Tube well			Open well			
		T1	T2	T3	D1	D2	B1	B2
1	Ph	7.5	7.6	7.4	7.8	7.6	8	8.2
2	TSS	364	184	60	172	169	112	110
3	TDS	7815	6235	5917	11603	6077	4530	2868
4	Chloride	3381	2741	2118	5293	2647	1868	1195
5	Sodium	1433	1425	1122	17975	1368	903	577
6	BOD	60	13	13	50	23	8.5	7
7	COD	332	82	62	291	164	52	39
8	Sulphide	20	4	12	0	0	0	8
9	Sulphate	422	250	340	484	594	564	414

Note: T - Tube well, T1–Alankadu area, T2 – Silver Jubilee Park, T3 – Noyyal Street

D1 and D2 – wells located in dyeing area

B1 and B2 - wells located in bleaching area

Source: Thomson Jacob (1996)

Table – 7.4

ANALYTICAL RESULTS OF 315 WATER SAMPLES (OPEN WELLS AND BORE WELLS) COLLECTED BY TWAD BOARD IN TIRUPPUR AREA

S.No.	Parameters	Number of samples
1	TDS (> 2000 mg / l)	67
2	Total Hardness (> 600 mg / l)	81
3	Chloride (> 1000 mg / l)	43
4	Sulphate (> 400 mg / l)	18
5	Fluoride (> 1.5 mg / l)	8
6	Iron (> 1.0 mg / l)	12
7	Turbidity (> 10 JTU)	21
8	Nitrate (> 100 mg / l)	107

Source: Prepared by CGWB based on TWAD Board Data, 1999.

Table – 7.5

PHYSIO CHEMICAL CHARACTERISTICS OF GROUND WATER IN DIFFERENT REGIONS OF TIRUPPUR

S.No	Parameters	Range of pollution in different stations					
		A	**B**	**C**	**D**	**E**	**F**
1	pH	6.95 – 7.88 (7.36)	6.98 – 7.5 (7.21)	6.95 – 7.88 (7.52)	7.38 –7.65 (7.52)	6.75 – 7.3 (7.08)	7.03 – 8.83 (7.75)
2	EC	8.35 – 10.2 (8.97)	5.7 – 9.75 (7.77)	6.0 – 10.2 (8.06)	3.48 – 6..08 (4.78)	3.5 – 9.93 (4.44)	0.53 – 3.93 (2.37)
3	TDS	4100 – 5000 (4450)	3100 – 5000 (4480)	2700 – 4500 (3700)	1500 – 2900 (2200)	1800 – 4300 (2060)	300 – 1800 (1192)
4	Sodium	277 – 770 (543)	275 – 805 (568)	220 – 585 (371)	278 – 500 (389)	227 – 450 (324)	95 – 385 (212)
5	Sulphate	215 - 339 (263)	150 - 339 (254)	195 - 459 (278)	236 - 236 (236)	34 - 246 (121)	23 – 183 (52)
6	Chloride	2067 – 4027 (2863)	2072 – 3569 (2695)	1338 – 4027 (2492)	1025 – 1666 (1345)	937 – 3664 (1799)	367 – 982 (661)

Source: Rajaguru and Subburam, 2000

Note: Value in brackets are mean values

A - South side proximal to Noyyal

B – Area between Noyyal and the Western Side of the rivulet A

C – Area between the two rivulets

D – Area between Noyyal and the eastern side of the rivulet B

E – North side proximal to Noyyal

F – North side away from Noyyal

Table – 7.6

SURFACE WATER QUALITY OF NOYYAL RIVER NEAR TIRUPPUR

S.No	Parameters	Surface (Noyyal River)		
		R1	R2	R3
1	pH	7.8	7.6	7.7
2	TSS	25	136	102
3	TDS	400	7439	5213
4	Chloride	70	3287	2760
5	Sodium	44	3850	1600
6	BOD	3.2	33	44
7	COD	11	226	301
8	Sulphide	4	48	12
9	Sulphate	61	478	386

Note: R1 - upstream, R2 - middle stream , R3 - down stream

Source: Thomson Jacob (1996)

Table –7.7

CHEMICAL ANALYSIS OF NOYYAL RIVER WATER

S.No.	Parameters	Zone I (Range)		Zone II (Range)		Zone III (Range)	
		Summer	Winter	Summer	Winter	Summer	Winter
1	pH	7.4 – 7.9 (7.5 ± 0.22)	7.1 – 7.3 (7.2 ± 0.1)	7.9 – 8.8 (8.6 ± 0.3)	7.5 – 7.9 (7.8 ± 0.1)	7.4 – 8.6 (7.9 ± 0.4)	7.3 – 8.0 (7.6 ± 0.21)
2	TSS	223 – 639 (486 ± 161)	211 – 399 (317 ± 67)	938 – 1693 (1480 ± 248)	466 – 1393 (90 ± 372)	301 –1393 (742 ± 282)	270 – 1112 (586 ± 246)
3	TDS	1615 –2139 (2396 ± 980)	1263 – 2120 (1632 ± 337)	109 – 1117 (8946 ± 1928)	2389 – 7430 (5674 ± 1915)	1619 –8000 (4954 ± 2299)	1030 – 4091 (2616 ± 1250)
4	Sodium (Na)	225 –314 (267 ± 39)	129 –198 (164 ± 26)	712 – 2611 (2129 ± 733)	620 – 1906 (1235 ± 4857)	200 –2220 (1256 ± 695)	153 – 917 (597 ± 290)
5	BOD	4 – 28 (132 ± 9.1)	3 – 13 (8.4 ± 4.4)	37 – 129 (80.5 ± 37)	32 – 110 (67 ± 35)	14 –87 (35.4 ± 20.5)	11 – 46 (24.4 ± 12)
6	COD	21 – 46 (33 ± 9.3)	14 – 39 (26 ± 9.6)	81 – 611 (449 ± 185)	230 – 367 (349 ± 59)	56 – 571 (262 ± 153)	36 – 298 (189 ± 134)
7	Chloride (Cl)	1339 – 1939 (1521 ± 280)	925 – 1801 (1129 ± 378)	3901 – 4996 (4606 ± 463)	2198 – 3950 (2904 ± 810)	928 – 4638 (2776 ± 1429)	620 – 1980 (1235 ± 413)
8	Sulphate (SO4)	22 – 93 (45 ± 30.8)	16 – 93 (28.6 ± 22.8)	102 – 393 (330 ± 114)	126 – 220 (153 ± 48)	44 – 299 (150 ± 81)	21 – 120 (46 ± 29)

Note: Figures in brackets indicate the Mean and Standard Deviation
All values except pH are given in mg/l

Source: Palanivel and Rajaguru, (1999)

Table – 7.8

WATER QUALITY DATA FOR ORTHAPALAYAM RESERVOIR (1997 –1999)

S.No	Parameters	Irrigation Standard	Years					
			1997 (9 Samples)		**1998** (16 Samples)		**1999** (11 Samples)	
			Variation	Average	Variation	Average	Variation	Average
1	pH	5.5 –9.0	7.5 – 8.29	7.98	7.76 – 8.51	8.34	8.1 – 8.8	8.60
2	TDS	2100	1128 – 9300	4545.78	590 – 5872	4293.8	792 – 5724	2846.91
3	Chloride	600	470 – 4499	2041.44	270 – 2199	1793.5	325 – 2749	1180.27
4	BOD	-	1 – 8.7	6.74	1 – 15.3	4.24	1 – 12.3	3.92
5	COD	-	32 – 208	76.44	8 – 384	87.2	16 – 160	63.45
6	Hardness	-	370 – 1740	1078.22	230 – 1300	1260	184 – 1160	640.36
7	Iron	-	0.035 – 2.83	1.02	0.01 – 5.19	0.62	0.05 – 1.09	0.21
8	Copper	3	0.01 – 0.52	0.15	0.01 – 1.99	0.59	0.03 – 0.44	0.22
9	Zinc	15	0.03 – 0.7	0.22	0.01 – 1.6	0.65	0.07 – 0.7	0.38
10	Lead	1	0.10 – 1.20	0.54	0.01 – 1.92	0.99	0.02 – .22	0.13
11	Cadmium	-	0.04 – 0.17	0.07	0.12 – 0.8	0.37	0.05 – 0.12	0.085
12	Sulphate	-	-	-	-	-	27 - 736	265.27

Source: Computed from PCB Data, 2000

CHAPTER VIII : DAMAGE ASSESSMENT – SECTORAL ASPECTS

A. AGRICULTURAL SECTOR

The river Noyyal which passes through Tiruppur originates in the Vellayangri hills of the Western Ghats. It flows through Coimbatore South, Palladam and Tiruppur taluks in Coimbatore District; Perundurai, Kangayam and Erode taluks in Erode District; and Arovakurichi and Karur taluks in Karur District before it confluences with the Cauvery. The river has seasonal flow during the North east monsoon period. Return flow from the Lower Bhavani Project (LBP) canal also drain into the Noyyal. The river has 23 anicuts and 28 system tanks for irrigating around 19,799 acres. From Tiruppur to Orthapalayam 8 system tanks irrigate around 1,677 acres in Noyyal basin. Apart from Canal and tanks, dug wells and bore wells are also used for irrigation. In earlier years, farmers cultivated twice (two seasons) per year. The major crops cultivated are paddy, cotton, groundnut, banana, sugarcane, jowar, millet, cholam etc.

Agriculture is a major sector affected by textile pollution. Since the vast area has been affected to varying degrees in various ways, different approaches have to be used for damage assessment. For convenience the study is restricted to the upstream villages (villages which are located in and around Tiruppur) and the downstream villages in the command area of the Orthapalayam Irrigation Project.

I Pollution of Villages located in and around Tiruppur (Upstream)

Since a number of textile units which are located in the peripheral villages of Tiruppur have been discharging their untreated / partially treated effluents on land, the soil and ground water are highly contaminated. The available water quality data clearly indicates the evidence of ground water pollution in this region. Moreover, in these villages there is no external source of irrigation like the LBP / PAP systems. Farmers in these villages have irrigated their crops with ground water and local system tanks. But after the pollution problem emerged they are not in a position to continue / improve their agriculture. Although the pollution impact on agriculture has been known for some time, there is no comprehensive soil or water quality assessment report for the entire affected agricultural area for physical determining the extent of damage.

In the present study the villages within a radius of 10 km. radius of Tiruppur town (where textile processing units are also spread) were selected for investigation. Around 25 villages come within the zone. The village data pertaining to area under cultivation, cropping pattern, crop productivity, irrigation potential and actual irrigated area etc. were collected from the Agriculture Department for the period from 1985-1999. Based on the above data and the changes that occurred over this period, the approximate loss in agriculture is estimated. Besides collection of data for the 25 villages, 4 villages (where pollution problem is acute) were selected for detailed case study and these data are analysed separately. Besides focal group discussions were also conducted in these villages for understanding the stakeholders' perceptions. And finally, the results obtained through secondary data analysis and focal groups discussion were presented to agricultural officials and other experts for their opinion. These opinion survey results were also helped to confirm the pollution impact on agriculture.

(A) Regional Study (25 villages)

The changes in cultivated area and cropping pattern assessment in this region was estimated with the help of data gathered from Agriculture Department from 1985-1999 for selected crops. The consolidated picture for all 25 villages are provided in Tables 8.A.1 – 8.A.3. The three year averages for the initial and final periods i.e. 1985-87 and 1997-99 were used for the identification of changes for the following variables: irrigated area, rainfed area, area under cultivation, production and productivity of certain crops.

The area under cultivation is divided between irrigated (canal, well and tanks) and non-irrigated areas (Table 8.A.2). The total irrigated area declined from 16,262 ha. to 14,262 ha. between 1985-87 to 1997-99. But the rainfed or non-irrigated area increased from 2108.3 ha. to 2668 ha. Thus, the total cultivated area declined from 18,370 ha. to 16,930 ha. The percentage reduction in irrigated area is provided in Table 8.A.3 between 1985-86 and 1997-99, 12.29% of irrigated area was lost, and the net loss of area under cultivation was 7.8%.

In the case of paddy, millet, cotton, vegetables, turmeric, banana and onion the area under cultivation as well as productivity has declined considerable. Among these crops, millet, cotton, turmeric and vegetable also show declining productivity. But the crops like bajara, greengram, blackgram and maize (generally considered as rainfed) show an on increasing trend for area under cultivation, production and productivity. From the tables the following conclusions can be drawn: (a) Sharp decline in the crop area along with production and productivity is noticed for most of the water intensive (pollution sensitive) crops. (b) In certain case (groundnut) without increasing the area under cultivation, production and productivity has increased considerably. This might be because of intensive cultivation adopted because of the green revolution programme.

(B) Case study (4 Villages)

For getting more focussed assessment of pollution impact on agriculture, 4 villages (Kasipalayam, Periyapalayam, Andipalayam and Murugapalayam) were selected for detailed study. The case study villages are examined on the basis of irrigation source (Table 8 A 4). In 4 villages, the total area cultivated during 1985-87 was 2808.3 ha., and it declined as 2006.2 ha. during 1997-99. The irrigated area declined sharply from 500 ha. to 144.6 ha. The rainfed area also showed a decline for 2308 ha. to 1861.6 ha.

The consolidated data is furnished in Table 8.A.5. According to the table, crops like paddy, millet and ragi have completely disappeared between 1985-87 to 1997-99 and all other crops area under cultivation declined considerably. Thus, the impact in certain villages is much more severe than in the region.

Based on the productivity loss, the value (income loss in agriculture) for the four case study villages is estimated (Table 8.A.6). An irrigated crop like paddy had to be totally discontinued, resulting is an output loss of 8.62 lakh in 1994-95 prices. The output of unirrigated crop like Jowar fell resulting in a loss of Rs. 11.41 lakh. The gross output loss for all crops is Rs. 25.23 lakhs.

(C) Focal Group Discussion and Opinion Survey Results

In the four case study villages, focal group discussion were conducted for understanding the impact of pollution on agriculture. Each group consisted of around 15 members, includes Panchayat President, Ward members, Local NGOs, Farmers and village elders etc. The issues discussed with the groups included, the agriculture status before the industrial pollution (before 1980), the way in which pollution has affected agriculture, groundwater and soil, fertiliser application etc. The summary of the discussion is provided below:

(a) Before the emergence of textile pollution (1980) water quality in all local systems

tanks (all 4 villages have system tanks fed by the Noyyal river) was extremely good, hence it was a primary source of irrigation. Besides the ground water available in the villages was also of good quality and used for irrigation. But at present because of textile pollution both surface (tank) and ground water are unfit for irrigation. Hence the dependence of tank and wells has reduced substantially. Now the farmers are able to cultivate only rainfed crops in these villages.

(b) Before the emergence of pollution, farmers in these villages cultivated crops like paddy, cotton, groundnut, banana etc. The water intensive crops have more or less disappeared from these villages, and farmers are cultivating rainfed crops like chollam, millets, jowar etc.

(c) The soil quality was good in earlier years. But after irrigating with polluted water, soil quality deterioration has occurred. In earlier years, farmers used manure like cow dung, tree leaves etc. and very less amount of chemical fertiliser. Now the fertiliser consumption has increased substantially to compensate for the deteriorated soil quality. Still substantial improvement in production has not occurred.

(d) After the emergence of textile pollution, area under cultivation, production and productivity etc. have reduced considerably.

(e) The primary reason behind the decline of agriculture activity is textile pollution. Other reasons include industrialisation, urbanisation, high cost of cultivation etc.

In the light of the findings of secondary data analysis and the results of focal group discussion an opinion survey was conducted among agriculture officials and regional experts for understanding their perceptions. Most of the respondents (70%) are well aware of the pollution issues and the impact on villages, However they differ on the severity of the pollution impact on the agriculture sector.

Thus, the impact of pollution is not much in evidence at the regional level (the region consists of 25 villages) but is very specific to the case study villages which are severely polluted. This is an indication that the impact of pollution varies substantially within the region. The focal groups discussion and opinion survey are also clearly substantiate the serious pollution impact on agriculture in the severely affected area.

II Pollution Impact on Command Area of Orthapalayam Dam

Another major affected area is downstream of the Orthapalayam irrigation Project. Since the water is not fit for irrigation, the anticipated productivity loss in the command area is important. The salient points of Noyyal – Orthapalayam Reservoir Project are summarised in Table – 8.A.7.

The Noyyal - Orthapalayam Reservoir Project (NORP) consists of two phases, the first phase was started by PWD in 1981, with the objective of diverting the Lower Bhavani Project seepage water flow to the Noyyal river for irrigation. As a part of this, 119 mts length barrage was constructed across the Noyyal river (Muthur village) for diversion of water to the reservoir (Athupalayam) through feeder canals for irrigating 9,625 across. The expected additional food grain production was 9,305 tonnes / year. The work was completed during 1991 at a capital cost of Rs. 13.90 crore. This project has been affected by the effluents in the Noyyal river. But, we are unable to determine the extent of damage, without a detailed field study.

A new dam was constricted in 1984 across Noyyal at Orthapalayam of 2.29 km length with 616 mcft capacity for collection of flood water in Noyyal. The work was completed in 1991 at a capital cost of 19.98 crore. This project was planned for irrigating 10,876 acres of dry lands in Perundurai, Kangayan and Karur Taluks for 8,800 tonnes / year of additional food grain production.

Unfortunately due to the textile pollution NORD (both phases) has completely failed. On one or two occasions when the reservoir was open, heavy crop damage occurred downstream. Hence farmers requested the PWD not to release the polluted water. The downstream (Karur) Farmers Organisation has filed a court case against the textile industries in Tiruppur in the Madras High Court.

For estimation of the productivity loss due to the closure of Orthapalayam irrigation project, the anticipated additional food grain (paddy) producitvity loss for 10,875 acres (irrigated area of the project) is estimated as 10,000 tonnes / year. The gross value of 10,000 tonnes paddy is estimated to be **Rs.5.26 crores**.. This represents the loss in irrigated agriculture due to the closure of the Orthapalayam reservoir. Since farmers continue to raise rainfed crops in the command area, the opportunity cost to them is the difference between the value of an irrigated crops and the value of the existing rainfed crop(s) of Rs. **4.13 crores**.

Table – 8.A.1

IRRIGATION STATUS OF 25 VILLAGES IN TIRUPPUR

(Area in Ha.)

Year	Canal		Well		Tank		Total Irrigated		Rainfed / Non-irrigated		Total	
	Area	**% Total**	**Area**	**% Total**	**Area**	**% Total**	**Area**	**% Total**	**Area**	**% Total**	**Area**	**% Total**
1985-87 (Average)	419.6	2.3	6241.0	33.9	9601.3	52.3	16262.0	88.5	2108.3	11.5	18370.3	100.0
1997-99 (Average)	206	1.2	5555.7	32.8	8500.3	50.2	14262.0	84.2	2668.0	15.8	16930.0	100.0

Source : Computed from Agriculture Department's Data, 2000

Table - 8.A.2

SUMMARY OF IRRIGATION STATUS (25 VILLAGES IN Tiruppur AREA)

(Area in Ha.)

Status of Irrigation	Area Under Irrigation			
	1985-87 (Average)	**1997-99 (Average)**	Variation	%
Irrigated Area	16262	14262	- 2000	- 12.29
Rainfed / Un-irrigated Area	2108	2668	560	26.56
Total Cropped Area	18370	16930	- 1440	- 7.80

Source : Computed from Agriculture Departments Data, 2000.

Table – 8.A.3

AGRICULTURE STATUS OF 25 VILLAGES IN TIRUPPUR AREA

(Area in Ha. , Production in Toones / Year)

Crop	No. of village	Area			Production			Productivity		
		1985-87 (Average)	1997-99 Average)	% Change	1985-87 (Average	1997-99 (Average	% Change	1985-87 (Average	1997-99 (Average	% Change
Paddy	25	532.0	226.7	-57.4	2299.4	1072.9	-53.0	4.3	4.7	9.2
Millet	16	1194.3	774.0	-35.2	1380.1	387.0	-71.9	1.1	0.5	-55.8
Bajra	24	9968.0	10089.7	1.22	7974.4	12115.6	51.9	0.8	1.2	50.0
Cotton	24	854.0	564.7	-33.9	1536.0	851.0	-44.6	1.8	1.5	-16.7
Groundnut	22	1218.7	863.3	-29.2	1135.1	1355.0	19.4	0.9	1.6	67.9
Greengram	24	711.0	892.7	25.6	310.7	537.1	72.9	0.4	0.6	38.4
Blackgram	24	493.0	766.3	55.4	215.5	481.2	123.3	0.4	0.6	46.2
Maize	17	387.3	749.3	93.5	521.8	1164.6	123.2	1.3	1.6	17.5
Vegetable	9	709.3	677.3	-4.5	3472.3	3299.3	-4.9	4.8	4.9	2.1
Turmeric	16	212.0	163.3	-22.9	1032.8	381.4	-63.1	4.8	4.3	-10.2
Banana	12	81.3	80.6	-0.8	621.3	460.1	-25.9	7.1	5.7	-26.1
Onion	7	76.3	54.7	-28.4	771.5	656.0	-14.9	10.1	12.0	18.8

Source : Computed from Agriculture Department Data, 2000.

Table - 8.A.4

IRRIGATION STATUS OF 4 CASE STUDY VILLAGES IN TIRUPPUR AREA

(Area in Ha.)

Year	Canal		Well		Tank		Total Irrigated		Rainfed / Non-irrigated		Total	
	Area	% Total	Area	% Total	Area	% Total	Area	% Total	Area	% Total	Area	% Total
1985-86 (Average)	-	-	466.0	16.6	34	1.2	500.0	17.8	2308.3	82.2	2808.3	100.0
1997-99 (Average)	-	-	146.6	7.2	-	-	144.6	7.2	1861.6	92.8	2006.2	100.0

Source : Computed from Agriculture Department Data, 2000.

Table – 8.A.5

AGRICULTURE STATUS OF 4 CASE STUDY VILLAGES IN TIRUPPUR

(Area in Ha., Production Tonnes / Year)

Crop	Area			Production			Productivity		
	1985-87 (Average)	1997-99 (Average)	% Change	1985-87 (Average)	1997-99 (Average)	% Change	1985-87 (Average)	1997-99 (Average)	% Change
Paddy	60	-	- 100	177.2	-	- 100	2.95	-	- 100
Millet	13.9	-	- 100	21.1	-	- 100	1.58	-	- 100
Bajra/Jowar	2138.7	703.3	- 67.1	356.8	131	- 63.28	0.17	0.19	11.5
Cotton	137.9	39.1	- 71.65	301.7	59.5	- 80.28	2.2	1.5	- 30.59
Groundnut	38.7	13.6	- 64.86	38.2	14.4	- 62.30	0.99	1.05	6.06
Greengram	76.2	48	- 37.0	22.8	12.6	- 44.73	0.3	0.26	- 13.33
Blackgram	40.7	13.3	- 67.32	9.2	1.2	- 86.96	0.23	0.09	- 60.87
Maize	42.7	10	- 76.58	94.3	15.7	- 83.35	2.21	1.57	- 28.96
Ragi	13.3	-	- 100	24.0	-	- 100	1.80	-	- 100
Cow Pea	33.0	30	- 9.09	9.9	10.7	8.08	0.3	0.4	20.0
Tapioca	25.0	3.3	- 86.8	4.3	2.77	- 35.58	0.17	0.84	38.8

Source : Computed from Agriculture Department Data, 2000.

Table – 8.A.6

GROSS VALUE LOSS IN AGRICULTURE FOR 4 VILLAGES LOCATED IN TIRUPPUR AREA

(Rs. In Lakh)

S.No	Crops	Value of Crops		Difference
		1985-87	1997-99	Loss
1	Paddy	8.62	-	8.62
2	Jowar	18.03	6.62	11.41
3	Ragi	0.60	-	0.60
4	Groundnut	1.93	0.72	1.21
5	Greengram	1.67	0.92	0.75
6	Blackgram	0.68	0.08	0.60
7	Maize	2.45	0.41	2.04
	Total	**33.98**	**8.75**	**25.23**

Note : Value Estimated Based on 1994-95 Price

Source : Computed from Agriculture Department Data, 2000.

Table – 8.A.7

SALIENT POINTS OF NOYYAL ORTHAPALAYAM RESERVOIR PROJECT

S.No		First Stage	Second Stage
1	Objective	Collect the LBP seepage water flow in Noyyal river for irrigation	Flood water collection in Noyyal river
2	Attempt	Construction of a 119 mts legth barage across the Noyyal river (Chinna Muthur village) and divertion of water to a reservoir (Authupalayam) through feeder canal	Construction of New Dam Across Noyyal (Orthapalayam village) at 2.29 kms. Length.
3	G.O. No. and Date	748 PWD – 25/5/81	1198 PWD 15/6/84
4	Years of completion	1991	1991
5	Water collection / distribution	98.45 mm^3 / Year	-
6	Irrigated Area	9605 Acres	10,000 tonnes / Year
7	Anticipated additional food grain production	9305 Tonnes / Year	10,000 Tonnes / year
8	Total Capital Expenditure	Rs. 1390 lakhs	Rs. 1998 lakhs
9	Annual maintenance costs	NA	13.12 Lakhs
10	Maximum water level	-	248 mts.
11	Water Spread Area	-	425 Ha.
12	Catchment Area	-	2245.55 sq. ms.
13	Capacity	-	616 mcft.

Source: Public Works Department.

Table 8.A.8

ORTHAPALAYAM RESERVOIR PROJECT – LOSS OF OUTPUT FROM IRRIGATED CROP

Irrigated Area	10,875 Acres
Total Expected Output (paddy)	10,000 Tonnes
Existing Unirrigated Output (Rainfed crop[s])	2175 Tonnes
Return from anticipated output	5.26 Crore
Return from existing rainfed crop(s)	1.13 Crore
Loss of Output (net Value)	**4.13 Crore**

B. FISHERIES SECTOR

Fisheries is another sector which is seriously affected by textile pollution. For convenience this sector is divided into two sections. The first section focuses on fisheries in the Noyyal river and the system tanks, and the second is on fisheries in the Orthapalayam Reservoir. Since the fisheries in the river and tanks are not fully controlled by the Fisheries Department, the data pertaining to yield, revenue etc. are not fully available. Moreover there is no study related to fisheries in Noyyal river and its system tanks. Hence apart from the limited information available with the Fisheries Department and local agencies, some details were collected through focal group discussions and interviews conducted with fishermen and local experts.

The information available with the Fisheries Department from the time that they started their activities at Orthapalayam reservoir was collected. Besides, the pollution studies conducted by the Hydrology Research Station and Fisheries College and other studies on Orthapalayam reservoir are also referred.

Fisheries in the Noyyal River and System Tanks

In the earlier years, before the mass emergence of textile processing units at Tiruppur, the Noyyal water was free from pollution. At that time local people widely depended on the river for domestic and recreational purposes. Moreover, the river also had rich fish population of different varieties. The discussions and interviews conducted with fishermen and villagers at Anappalayam, Orthapalayam and Kodumanal strongly indicates their involvement in fisheries in earlier years (20 years before the pollution of the river). Before the pollution problems a large number of villagers were dependent on fishery activity. At that time different varieties of fish, even of bigger size, were available. But after the deterioration of the river water quality, the fish stock in the river was considerably reduced. Now fish mortality is a common phenomenon in the river. Generally, fishes are of small size with different colours (because of the dye accumulation in water) and are edible. Hence the fish caught are used only for manure.

Table – 8.F 1 gives the recent fish catch statistics in Noyyal river. Earlier data is not available for comparison. In the table, the fish catch (during rainy season) and its estimated value is provided for the year, 1994-95 to 1997-98. The catch his reduced from 2174 kg to 540 kg. during the above period with a overall reduction of 1,634 Kg. Proportionately the value also reduced from Rs. 27,175 to Rs. 6,210 with a over all reduction of Rs. 20,965.

Like the Noyyal the fisheries activities in the system tanks of the river (between Tiruppur to Orthapalayam) are also highly affected. There are eight system tanks (Chinnadipalayam, Murugampalayam, Periyapalayam, Kodumanal, Anaipalayam, Kathankanni, Pallapalayam, Samalapuram Kulam). Fish are available in all 8 tanks and in which 5 tanks have high yield. The concerned Panchayat used to auction the fish catch. The revenue for the concerned Panchayats through fish auctions during 1999 and 2000 is provided in the Table - 8.F 2.

According to the table a considerable reduction in the auction rate has occurred in 2000 compared to 1999 in all tanks and the total reduction would come to Rs. 2,57,000. In the discussion (which we conducted with the auctioneers, fishermen, ward members and Panchayat Presidents) the stakeholders clearly mentioned that the reduction in auction rate / yield in the tanks was due to the pollution by textile effluents carried by the Noyyal river. The fishermen explained that before the pollution problems the tanks had different varieties and much larger quantities of fish. After the reduction in fish stock in the Noyyal river and its system tanks, most of the fishermen have migrated to other regions. Through our investigations we could conclude that the textile pollution has affected the fishermen communities, as well as the villagers adjoining the tanks and the river.

Fisheries at Orthapalayam Reservoir

(A) Scope of Fisheries in Orthapalayam Reservoir

Among the Indian states, Tamilnadu has substantial reservoir resources for development of fisheries. Other than the large reservoirs, a number of small reservoirs including Orthapalayam have high potential for fisheries development. A paper by Sreenivasan (1999) on "Fish Production in Some Small Reservoirs of Tamilnadu" clearly explains the morphometry and fish yield of 25 small reservoirs in Tamilnadu. Among these small reservoirs, Orthapalayam has the third largest Full Reservoir Level (FRL) with an area of 425 hectares next only to Goddar (565 hectares) and Vembakottai (468 hectares). According to the study, Orthapalayam had high annual catch (80,129 kg.) and was in the second position, with the highest average yield (45,386 kg). But the yield per hectare was not a impressive, only 213.6 kg / ha / year. (Other reservoirs had better yield rate, 776.5 kg / ha. / year in Gunderipallam, 3243 / kg / ha in Varadamanadi, 270 kg / ha in Murudanadi and 269.4 kg / ha in Kullansandai).

The study also examined the percentage of Tilapia caught in different periods. From the analysis of revenue from Orthapalayam reservoir, the revenue per kg of fish landed is Rs. 5.66 (1994-95), and Rs. 5.49 (1995-96). From the above data one can reach the conclusion that (a) the fish return rate is very poor, (b) over years the revenue per unit has not increased. Srineevasan concluded that for rise in the total fish yield and revenue for small reservoirs such as including Orthapalayam, low value fish must be eliminated and high value carps stocks need to increase. Moreover, for determining yield potential, limnological studies need to be conducted.

The Fisheries Department started the fisheries activities at Orthapalayam reservoir in 1993. The number of fingerlings stocked in each year is given in Table - 8.F 3. According to the table, the starting stock of fingerlings during the first half of 1993 was 3.85 lakh. It increased to 7 lakh during 1993-94. But a sudden declining trend was noticed during 1995 – 96 (4 lakh) and 1996-97 (4.01 lakh). But during 1996 –97 the stocking increased substantially as 8.01 lakh. But in subsequent years no stocking took place as the reservoir was closed to fisheries activity by the District Collector in 1998.

(B) Pollution Impact on Fisheries

Since the Orthapalayam reservoir is highly contaminated by the textile effluents from Tiruppur, the fisheries activities in the reservoir was affected and frequent fish mortality occurred. At the instruction of the Commissioner of Fisheries, the Hydrology Research Station – Chennai, conducted a pollution study upstream along the Noyyal and at Orthapalayam reservoir in November 1996. As a part of the study, a water quality assessment was carried out in reservoir and upstream (Table – 8.F 4). The values of alkalinity, chloride, hardness, conductivity, iron, phosphate and bio-chemical oxygen demand were found to be very high in all the stations. Other salient findings from the study are:

a. River is unfit for aquatic organisms.

b. Fish landing was observed downstream of Tiruppur and Orthapalayam reservoir – Tilapia is the main variety, but size is small.

c. Plankton pollution was observed in huge quantity in reservoir.

d. Bio-assay test conducted revealed that the fishes are bleached.

e. Fish growth rate will be affected.

f. Survival of Tilapia may not be a problem, but present condition is unsuitable for the growth of other carps.

g. Fishes caught from the reservoir get spoiled in a short period of two hours. Hence fishes cannot be marketed to distant places.

h. High possibility of frequent fish mortality in future. (Dept. of Fisheries, 1998)

In December 1998, the Department of Fisheries Environment, Fisheries College, Tuticorin conducted a study on 'Bacteriological analysis of fish and water samples' for Orthapalayam reservoir. Following are the major results of the study:

a) High level of total viable count (TVC) in fish meat was observed (2.4×10^6 cfu/g). This is higher than the International Micro-biological standard of 5.0×10^5 / g in fresh fish meant for consumption. The TVC in water was (1.6×10^4 cfu / ml).

b) High level of Vibrio counts in fish meat (5.4×10^4 cfu / g) and in water (8.4×10^2 cfu / ml).

c) High level of fecal coliform bacteria is observed in water and fish sample (550 nos / 100 ml and 550 nos / mg). The maximum available level of fecal coliform bacteria in fresh fish for consumption were 11 / g).

d) E – coli count in fish was within the limit of 20 / g.

e) Potential human pathogens like Vibrio Cholerae and Salmonella were absent in both fish and water samples.

The above study recommend the need for conducting further studies on organic matter and metals associated with organics.

(C) Fish Catch, Gross Value, Revenue

Table - 8.F 5 provides the detailed picture regarding fish catch at Orthapalayam reservoir and its gross value from 1993 to 1996-97. In early 1993 (up to June) fish was caught only for 2 months. The total fish caught was 1,512.5 kg, of which 1,506.5 kg was Tilapia and 6 kg was Bouri. The gross site value was estimated as Rs. 12,172. The fish catch increased over a period and maximum catch was recorded during 1996-97 (80,129 Kg). The gross value generated during this period was Rs. 12,01,935. From the table one can understand that the growth of Tilapia was not a problem in the reservoir and its yield was substantial during 1996-97. But Bouri which is a better quality fish (also higher value) is more pollution sensitive than Tilapia, has gradually declined and become extinct. Based on the above fish catch / yield data the maximum fish productivity of the Orthapalayam reservoir was 80,129 kg. worth Rs. 12,01,935. But after the closure of fisheries activity at the reservoir, there is no further yield.

(D) Fish Mortality in the Reservoir and Closure Order

The mass fish mortality which occurred at Orthapalayam reservoir during 1997 drew wide attention among the public and regional Government officials. In the early days of December 1997 the floating dead fish near the dam site caused a serious health hazard. Subsequently, the District Collector made arrangements to bury several tonnes of dead fish. The Collector also instructed the Fisheries Department to make immediate arrangements for harvesting all the fish in the reservoir to avoid further fish mortality and health hazards. After the fish tragedy, the Public Works Department realised the problem and the need to restrict the fisheries activities at Orthapalayam. The Public Works Department (PWD) requested the Fisheries Department to stop the fisheries activity. Subsequently, the Director of Fisheries ordered the Regional Office at Erode to stop the fisheries activity at Orthapalayam on
12-3-1998.

Summary

From the above analysis one can understand the extent to which the fisheries sector is affected due to textile pollution. Since the river and the tanks are considered as ‘village commons’, the exact fish catch details may not be recorded. Anyhow based on the available data the total value of fish productivity loss is estimated (Table – 8.F 6). The value of the total <u>annual</u> loss in the fishery sector is Rs, 14,73,816, of which Rs. 14,881 is in Noyyal river, Rs. 2,57,000 in the system tanks and Rs. 12,01,935 at the Orthapalayam reservoir in 1997–98 prices. The capitalized value of the loss in output is Rs.1.25 crores.

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Table – 8.F 1

FISH CATCH AND VALUE IN NOYYAL RIVER

Year	Quantity (Kg)			Value (Rs)	Reduction	
		Actual	%		Actual	%
1994-95	2,174	-	-	27,175	-	-
1995-96	2,094	80	- 3.68	24,081	3,094	- 11.39
1996-97	1,834	260	- 12.42	21,091	2,990	- 12.42
1997-98	540	1,294	- 70.55	6,210	14,881	- 70.55

Source: Computed from Directorate of Fisheries, Chennai.

Table – 8.F 2

FISH REVENUE FROM FIVE SYSTEM TANKS OF NOYYAL RIVER

S.No	Name of the Tank	Area (Acre)	Fish Revenue (Rs.)		Fish Reduction	
			1999	2000	Actual	%
1	Sinnandipalayam	96	1,32,000	32,000	1,00,000	- 75.00
2	Periyapalayam	396	80,000	35,000	45,000	- 56.25
3	Anappalayam	100	40,000	13,000	27,000	- 67.50
4	Kathankanni	300	75,000	25,000	50,000	- 66.66
5	Kodumanal	25	45,000	10,000	35,000	- 77.78
	Total		**3,72,000**	**1,15,000**	**2,57,000**	

Source: Computed from Concerned Village Records, 2000.

Table –8.F 3

NUMBER OF FINGERLINGS STOCK IN ORTHAPALAYAM RESERVOIR

Year	No. of fingerlings stocked (In Lakh)
- 1993	3.85
1993 – 94	7.00
1994 – 95	4.00
1995 – 96	4.01
1996 – 97	8.01
1997 – 98	0

Source: Directorate of Fisheries (1999), Chennai.

Table – 8.F 4

WATER QUALITY DATA FOR NOYYAL RIVER AND ORTHAPALAYAM RESERVOIR

S.No.	Parametres	L1	L2	L3	L4
1	Colour	Black	Colourless	Colourless	Colourless
2	Odour	Foul Smell	Odourless	Odourless	Odourless
3	Water Temp, °C	27	29	28	27
4	pH	8.4	8.8	8.8	8.8
5	EC	55000	56500	55500	59000
6	Total Alkalinity (ppm)	712	336	310	312
7	Dissolved Oxygen	0.8	7.8	4.2	4
8	Chloride (ppm)	2240	2450	2450	2310
9	Total Hardness (ppm)	1240	1440	1280	1510
10	Silicate (ppm)	6	2	2	2
11	Phosphate (ppm)	1.5	0.1	0.1	0.5
12	Iron (ppm)	8	8	10	12

Source: Fisheries Hydrogical Research Station, 1996.

Note: L1 = Uthukuli Kangayam Bridge (10 km. From Dam)
L2 = Kodumanal (1.5 km. From Dam)
L3 = Siviyarpalayam (Middle of the Dam)
L4 = In the Reservoir

Table –8.F 5

GROSS VALUE OF FISH CATCH AT ORTHAPALYAM RESERVOIR FROM (1992-93 TO 1996-97)

Year	No. of Month Fish Caught	Tilapia			Bouri			Total	
		Value Rs. / Kg			Value Rs. / Kg				
		Quantity (Kg)	Average	Total	Qty.	Average	Total	Quantity (kg)	Gross Value (Rs.)
1992-93	2	1,506.5	8	12052	6.0	20	120	1,512.5	12172
1993-94	12	24,235.3	9	218117.7	4.5	20	90	24,239.8	218207.7
1994-95	12	26,943.0	12	323316	-	-	-	26,943.0	323316
1995-96	12	29,085.7	15	436285.5	-	-	-	29,085.7	436285.5
1996-97	6	35,776.5	15	1201935	-	-	-	35,776.5	1201935

Source: Department (Joint Director) of Fisheries, Erode, 1999.

Table – 8.F 6

ANNUAL VALUE OF FISHERIES LOSS DUE TO TEXTILE POLLUTION

S.No	Water body	Quantity (Kg)	Value Rs.)
1	Noyyal River (Reduction from 1997 – 98)	1,294	14,881
2	System Tanks (Reduction from 1999 –2000)	N.A.	2,57,000
3	Orthapalayam Reservoir (Foregone fish value 1996-97)	80,129	12,01,935
	Total	**-**	**14,73,816**

Source: Computed from Different Sources

C. URBAN WATER SECTOR

Historically, the town of Tiruppur had relied largely on local ground water sources to meet its domestic water requirement. The growth of the textile industry resulted in the rapid growth of the urban population on account of migration. The population is estimated to be 3 lakh with a floating population of about 1 lakh. The Tamilnadu Water Supply and Drainage Board implemented a major scheme (in two phases) to transfer water from the Bhavani river. Details of these schemes are given in Table 8 D1.

The textile industry began tapping the ground water from wells in and around Tiruppur. Since the discharge of effluents contaminated the local ground water, the industries were forced to transport water from a wider and wider radius around Tiruppur. Industries pay Rs. 450 per truck load of 12000 litres which works out to Rs. 37.50 per kilolitre.

The Tiruppur Area Development Corporation has been set up by a consortium of funding agencies to improve the infrastructural facilities of Tiruppur. One of the schemes is to transport water from the Cauvery river for both industrial and domestic use. While sewage collection and treatment has been included, industrial effluent treatment is supposed to continue with the existing programme of IETPs and CETPs. The total cost of the project is estimated to be Rs. 569 crore and will be financed by both debt and equity (2.18:1) from the consortium and government agencies. The water cost to households and industry is expected to be Rs. 3 / KL and Rs. 26 / KL respectively.

In its water supply report dated 12.1.2000, the Tiruppur Municipality makes the following observations about the need for the third scheme.

"The ground water within Tiruppur town is highly polluted and unfit for drinking purpose. The supply through the existing two schemes are inadequate to meet the requirements. (Tiruppur Municpality, 2000). As such another scheme to cater to the need of the public is inevitable"

The TWAD Board however maintains that the basis for the new schemes is the growing population and not the ground water pollution. Nevertheless, both domestic and industrial users are unable to use the ground water in Tiruppur Municipality and it can therefore be considered a “lost” resource.

The exact ground water potential in the municipality area (27.2 km^2) is not known. However, the Central Ground Water Board has estimated the replenishable recharge of Tiruppur Block (298.4 km^2) to be 0.00287 million hectare metres per year. This works out to 78.6 million litres per day. If we assume that the ground water resource is uniformly distributed in the block, the replenishable recharge of Tiruppur Municipality would be 9.1% or 7.16 MLD or 7160 KLD. Industry is currently paying Rs. 37.50 per kilolitre for water transported from the periphery. Hence the opportunity cost of not using the local ground water is = 7160 x 37.50 x 365 = Rs. 9.80 crore per year.

TABLE 8.D.1

DESCRIPTION OF WATER SUPPLY SCHEMES FOR TIRUPPUR

Particulars	I Scheme	II Scheme
Source & Headworks	Bhavani River (Mettupalayam	Bhavani River (Mettupalayam)
Cost	Rs. 1.08 crore	Rs. 20.34 crore
Year of Completion	1968	1993
Supply to Tiruppur	4.50 mld	24.0 mld
Per-capita Availability (excluding floating population)	~ 30 lpcd	~ 90 lpcd

Source: Tiruppur Municipality Report (2000)

CHAPTER IX: SUMMARY AND CONCLUSIONS

Summary

This study on "Economic Assessment of Environmental Damage" is a preliminary attempt to address the key issue raised by Prof. Perrings on valuation *i.e.* "What is the value of the loss in output that is due to the degradation of environmental resources?" Tiruppur is a classic case of a region affected by environmental degradation caused by industrial pollution. But, there are several other features about Tiruppur which must be underscored.

- Pollution is caused not by one factory / industry but by effluents discharged by more than 700 units in an industrial cluster.
- Since many of the units are small, the cost of effluent treatment in terms of turnover can be sizable. 164 units have closed down as a result of a Court order.
- Collective action is necessary to abate pollution to any significant extent. Common effluent treatment plants are an institutional means of achieving this objective. However, only 278 units opted to join the CETP system while the remaining (424) have individual effluent treatment plants.
- The pollutants responsible for widespread damage are not only organics, dyes *etc.* but total dissolved solids and largely chlorides. TDS has affected ground water and surface water to a significant extent, resulting in damage to agriculture, fisheries, and ground water.
- The damage is not confined to Tiruppur town and its immediate surroundings, but extends more than 30 Km downstream to the Orthapalayam Dam and beyond. It is the downstream farmers from the next taluk, Karur who have filed the case in the court.

While the environmental degradation is well known, there have been no systematic attempts to assess the economic dimensions of damage. There have been some studies by researchers and government agencies to gather physical data on the pollution of surface and ground water. Unfortunately, no agency has monitored quality in the affected area over a sufficiently long period. The Central Ground Water Board has good time series data on wells going back to the seventies, but these are mostly located outside the zone of severe impact. There is very little soil quality data which is crucial for a study of this kind. Surface water quality data is also limited, since the Noyyal is an ephemeral river.

Since collection of physical data was not envisioned in this study, the analysis is constrained by the availability of secondary data. Nevertheless, we sought to construct a picture of the extent of environmental degradation within these constraints (Chapter VII). We relied therefore on two indirect sources:

a) Output changes in sectors like agriculture, fisheries and water supply

b) Focus group discussions with NGOs, farmers, government representatives and other experts.

The results of these investigations are given in Chapter VIII. Obviously, more work needs to be done to get more definitive results. The study benefited from the extensive data made available by the Tamilnadu Pollution Control Board. The board had collected data on each of the 702 units as well as the 164 which were closed down. Data on inputs, water cess, and effluents provided a very clear picture. Effluent characteristics made it possible to calculate the effluent load for all the major parameters: BOD, COD, TSS, TDS, Chloride, Sulphates and Oil & Grease. We could reconstruct the load discharged from 1985 onward till 2000. This was particularly important since we were trying to estimate the cumulative load. One of the hypotheses of the study is that damage has occurred due to the cumulative load over a period of time, not just the discharge in anyone year i.e. Tiruppur is a case of stock Dollution where the environment has been unable to assimilate the discharge of effluents year after year for more than a decade.

The effluent load is cumulative in two ways:

1. The effluent discharged in Tiruppur is not from one unit but from 700 units located in close proximity to each other. The total pollution load is the sum of the load from each of the units.

2. Effluents were discharged without treatment for nearly two decades. The initial load was small, but the total annual load exceeded 2,50,000 tonnes per year of TDS and 10,000 tonnes per year of COD in 1997. The cumulative load exceeded 1 million tonnes ofmS in the period (1993-97) and about 50,000 tonnes of COD in the same period.

Since damage assessment methodology is at a primitive stage, we cannot distinguish impact of stock and flow pollution precisely. However, one could say that even if flow pollution were totally regulated (which is currently not the case), the impact of stock pollution could continue for many years to come. The Court in fact has ordered that the Orthapalayam reservoir be cleaned up, and that the cost of clean up be borne by the industrial units responsible for causing the pollution. The continuing impact of stock pollution (and any residual flow pollution) can be estimated only if there is a comprehensive water and soil quality monitoring programme in place over the next ten years. The Pollution Control Board has made a start by monthly monitoring of the water quality of the Orthapalayam reservoir. Other agencies such as the Central Ground Water Board and the Soil Survey and Land Use Organisation can take up ground water and soil quality monitoring in the affected area on a continuing basis.

Mode of Treatment

In the initial stages, the Pollution Board had insisted that all the units hook up to the common effluent treatment plants (CETPs) that were planned for the Tiruppur area. CETPs could have provided economies of scale in treatment, although the capital costs may be higher due to land acquisition, hook up costs, etc. It would have been much easier for the Board to monitor 7 or 8 CETPs rather than 700 individual units i.e. the transaction costs associated with regulation could have been minimized. Regulation would have been more effective.

Unfortunately, there was lack of coordination among the owners. There was also a feeling that contributing capital towards a collective entity was more risky, than a plant which was totally under their control. Reports of earlier experiences with CETPs in some other parts of the country also made them apprehensive. The decision of the Courts to accept either IETPs or CETPs as an indication of compliance with environmental regulations, was also an argument used by the owners to be give the choice. The regulatory agency no longer provides the choice to new units - they have to hook up to CETPs. Future decisions by the units and the Board will have to be based on the fact that 424 units have their own treatment plants and 278 units are hooked up to CETPs.

IETPs- Sample data from IETPs seem to indicate that treatment of BOD, COD and TSS is effective. The reduction of pollution load is 85%, 44% and 55% respectively. While there is considerable reduction in parameters like BOD and COD, there is virtually no reduction in chlorides and sulphates, and therefore of ms. Nearly 1,00,000 tonnes/year ofmS continue to be discharged from IETPs.

CETPs - The 8 CETPs which were set up after much effort have been unable to overcome their teething problems. The data available to us indicates no reduction in BOD and COD, and in fact the BOD level had increased. There was a very marginal reduction in chlorides and sulphates and the TDS load had reduced less than 1 %. More than 76,000 tonnes of ms continue to be discharged from the CETPs.

These results raise two issues which need attention:

(1) Improving the efficiencv of treatment in the CETPs

The low / negligible treatment efficiency in all the CETPs has to be investigated in detail, but could be due to two reasons: (a) Unqualified operators in charge (b) Not incurring the operating costs of power, chemicals, etc. It is often not realized that effluent treatment plants require skilled operators and regular monitoring. The Pollution Control Board needs to set up a certification system for all treatment plant operators. CETPs / IETPs cannot be left in the hands of unqualified personnel.

Both the ffiTPs and CETPs have very high variable costs of Rs.l 0/- or more per kilolitre of effluent, which amount to about Rs.12 crore/year for ffiTPs and Rs. 19 crore/year for CETPs. Since there are no subsidies for operating costs, industries may be reluctant to pay the high operating costs. However, if these costs are not incurred, the entire programme will be in jeopardy since the treatment plants will not be treating the effluents at all. The Pollution Control Board needs to ensure that the plants are operated efficiently, by taking the necessary steps in terms of monitoring, regulation, and ultimately coercion if no improvement occurs. Otherwise, the entire capital investment in the CETPs of more than Rs.27 crores would be rendered null and void. Such an eventuality would not be in the interest of all the parties concerned, as well as those affected by the pollution.

(2) Removal ofTDS

If the effluents are to meet the TDS standard, the ffiTPs and CETPs would have to use expensive additional measures such as reverse osmosis (R.O). The capital cost ofR.O would be between Rs. 4 - Rs.5 per kilo litre of effluent which means that the ffiTPs would have to incur additional capital cost of Rs.20 crore and CETPs of Rs.19 crore that would be almost of the same order as the existing investment of Rs.19 crore and Rs.27 crore respectively. It is clear that the industries are unlikely to incur additional capital expenditures of this magnitude, unless they are so ordered by the Court.

The operating and maintenance cost of Rs.8 - 10 per kilolitre for the R.O. plant would mean additional cost ofRs.14.6 crore per year for ffiTPs and Rs.13.9 crore/year for CETPs. However, an ~ benefit ofR.O. is that the treated effluent is almost as good as freshwater. 20% is rejected and has to be disposed in solar evaporation ponds. Since industries are paying upto Rs.37.50 per kilolitre for freshwater, the saving in water purchase costs would be considerable, 80% of the effluents would be recycled, and the remaining 20% would be collected and dried in solar evaporation ponds. Thus, the "damage" due to flow pollution would be almost totally eliminated.

It is therefore upto the government and the industry to work on a financing arrangement for the R.O. plants. This could be taken up atleast at the 8 CETPs which handle about half the effluents. However, R.O. is a sophisticated process which needs to be closely monitored. The experience with CETPs has not been very encouraging in this regard. Another option would be for the units to switch over to a cleaner technology of production, which uses less water and salt.

Cleaner Technology

The current technology employed the hosiery industry uses large volumes of fresh water and discharges an equivalent quantity of waste water containing dyes, .salts, acids and organic materials. The total effluent of about 84 mId contains pollutants such as chloride, BOD, COD, and total dissolved solids which needs to be treated in order to meet environmental standards. Tiruppur is located in an area which has limited water resources. Hence, extracting and transporting a large quantity of ground water or transporting surface water from distant sources and then discharging an equally large quantity of wastewater which causes serious pollution problems downstream is basically unsustainable natural resource management. It would be far better to use a technology that (a) conserves the use of water and (b) discharges less effluent and causes less pollution. However, the "softflow" machines which use less water are ten times costlier than the machines currently used (Kurian and Narain, 2001).

Membrane filtration can also be included in the treatment plants to ensure that illS as well as residual organics are removed before biological treatment. Not only does high TDS cause damage downstream, but it also interferes with the proper operation of the biological treatment. Low salt dyestuff can be used, but has to be imported from Switzerland. If the import duty on these could be reduced, these dyes would be more attractive financially. Instead of providing financial incentives for end-of-pipe effluent treatment, the concerned government agencies could consider incentives for "cleaner technology" which would use less water and chemicals and thereby minimize the effluent problem. Cleaner technology might include some combination of "soft flow" machines, low salt dyes, and membrane filtration which would reduce the pollution problem. In the ultimate analysis, all these additional costs would increase the cost of production.

On the benefit side, the reduction in the use of water will reduce the cost of water currently purchased by industry. Recycling of water after membrane filtration could reduce the water requirement even further. Efficiency of the treatment plant would be very much improved resulting in effluent stands being met. The downstream damage would be considerably reduced if not totally eliminated. However, sludge would have to be disposed off in an environmentally sound manner.

The present arrangement is clearly not environmentally sustainable, and requires urgent attention. Rather than changes at the margin by the end-of-pipe treatment which result in little difference to the downstream damage, the industries could undertake the more radical step of changing to "cleaner technologies". The cost of switching to cleaner technologies may have to be studied in more detail from the perspective of the 700 bleaching and dyeing units. Very small units may find it uneconomical to do so even with assistance from the government to change.

WTO rules in the future may also require that the hosiery industry produce goods for export that are produced in an environmentally sustainable manner. Since the hosiery industry is export oriented it may be under pressure to meet ISO 14000 or other international standards. Not controlling pollution adequately may not remain an option for very much longer. In any case, if the industry takes a long term view, it would be better to make the investment in cleaner technologies as soon as possible. The government and financial institutions could aid the process by offering incentives to make the changes. Research institutions could provide technical support, as they have done in the case of effluent treatment.

Damage Assessment

In this study, we were able to make only rough estimates of the damages in different sectors. These figures can only be taken as a preliminary attempt at estimation.

(a)	Loss of ground water:	- Rs. 9.80 crore / year
(b)	Loss to agriculture :	- Rs.5 crore / year
(c)	Loss to fisheries :	- Rs.0.2 crore / year
Total Loss		~ Rs. 15 crore / year

If one uses a discount rate of 10%, the capitalized loss would be of the order or Rs.150 crore. More precise estimates can be made through detailed studies. In many cases, we have given the gross loss, not the net loss *(i.e.* less of costs), since adequate data on costs were not available.

The proposed Tiruppur III Scheme to transport water from the Cauvery river (a) does not adequately address the effluent problem and (b) serves as a disincentive to industries to spend the money in treatment and recycling. The only advantage would be that the extraction of local ground water may be avoided. It is unfortunate that an otherwise integrated scheme for improving the infrastructure of Tiruppur did not take a holistic look at the water cycle. Such an approach will considerably reduce future damage. Some investment can also be made to clean up the past damage to the extent possible and leave the rest to nature.

The damage assessment exercise that was attempted must be considered preliminary, pending a more comprehensive study. The physical extent of the affected area, and the degree of impact requires soil quality, water quality and toxicity data which are currently not available from secondary sources for the affected area. Ground water data, for example, is available only for wells outside the affected area. There was no provision in the budget to undertake such field studies. Hence, a case study approach based on field investigations was used to get an approximate value of the extent of damage in atleast a few villages that were known to be severely affected. Another dimension that was not examined was the cost of reclamation of remediation of the affected area. These costs, particularly cleaning up of the Orthapalayam Reservoir (which has been mandated by the High Court) could be very much larger than the damage to agriculture.

Regulatory Framework

The Tiruppur case study clearly illustrates the lacunae in the present regulatory system. The rapid growth of the industry over the last decade with the bleaching and dyeing units themselves increasing by a factor of 10, has posed a major challenge to the Pollution Control Board. With limited manpower at its disposed, the Board is hamstrung in verifying the environmental status of more than 700 units on a continuing basis. If regulation is to be effective, the manpower resources of the district office would have to be substantially augmented. More important, in cases where the industries dominate the economy of a town like Tiruppur, monitoring by the community is crucial. It is increasingly recognized worldwide that the regulatory efforts could be strengthened if the local community could playa major role in environmental monitoring. NGOs and other local groups could ensure that effluent standards are met. However, it is essential that regulatory agencies like the Pollution Board realize that NGOs can be an effective partner and not an adversary in the regulatory process.

In the present set-up, there is little incentive for the units to consider any step beyond setting up effluent treatment plants. When these are not operated properly, the goal of meeting environmental standards is lost, negating the regulatory effort. Violation of environmental standards is not in the best interest of the units. They are already facing litigation in the High Court. Adverse publicity in the media will have a negative impact on their overseas markets. The Pollution Board must recognize that the regulatory process has to be made effective not only to protect those who are damaged by pollution, but also in the long term interest of the industries themselves.

Agenda for Future Research

1. MaQPin2: The first priority is to map the extent and degree of the impact through soil and water quality studies in the basin. Agencies like the Soil Survey and Land Use Organisation have the capability to do the mapping. More detailed studies on ground water quality and pollutant transport could be taken up by the Central Ground Water Board.

2. Valuation of Dama2e: In the case of agriculture, the value of land may be a useful indicator of damage. All other things being equal, if the market value of agricultural land declines on account of pollution, then the difference could be attributed to degradation of environmental quality.

3. Benefit-cost Analysis: Abatement costs and damage costs provide only a partial perspective of the issue. Ultimately, one has to make an estimate of the benefits and costs of industrial development. The direct benefit is the value addition in the bleaching and dyeing segment. It is not possible to segregate this segment, since the entire process of production is an integrated system. The indirect benefits are the "multiplier" effects in the region.

The costs include the cost of treatment plus the residual cost of damages due to discharge of effluent. In this study, we have estimated the cost of treatment both in IETPs and CETPs both in terms of costs per kilolitre of effluent and the cost per kg of cloth. The latter is important in carrying out the benefit-cost analysis. As mentioned earlier, we could make only a preliminary estimate of the cost of damage. Also, we did not address the issue of reclamation / remediation. For policy purposes, one would wish to get an overall perspective of all the benefits and costs of having the hosiery industry in Tiruppur.

4. <u>Cleaner Technology:</u> In the long-run, the hosiery industry would have to switch to a technology (for bleaching and dyeing) that is environmentally sustainable. While the capital cost would be much higher (and therefore unaffordable to small units), there may be considerable saving in operating costs, and in treatment. Damage could be minimized or even averted. A comprehensive assessment of the technology both from an economic and environment stand point would have to be taken up. The government may have to provide financial incentives to promote the adoption of cleaner technologies.

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ABBREVIATIONS

COD	-	Chemical Oxygen Demand
EC	-	Electrical Conductivity
TDS	-	Total Dissolved Solids
Cl	-	Chloride
SO_4	-	Sulphate
Na	-	Sodium
BOD	-	Biochemical Oxygen Demand
PWD	-	Public Works Department
AD	-	Agriculture Department
SD	-	Statistical Department
VAO	-	Village Administrative Officer
TWAD	-	Tamilnadu Water Supply and Drainage Board
TM	-	Tiruppur Municipality
FD	-	Fisheries Department
TNPCB	-	Tamilnadu Pollution Control Board
CGWB	-	Central Ground Water Board
CWC	-	Central Water Commission
SITRA	-	South Indian Textile Research Association
AEPC	-	Apparel Export Promotion Council
NIC	-	National Informatic Centre
TEA	-	Tiruppur Exporter's Association
mld	-	Million litre per day
NGOs	-	Non-Governmental Organisations
SIDA	-	Swedish International Development Authority
SAR	-	Sodium Absorption Ratio

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