INDUSTRIAL POLLUTION AND ECONOMIC COMPENSATION

A STUDY OF DOWN STREAM VILLAGES IN NOYYAL RIVER, Tirupur, TAMIL NADU, SOUTH INDIA

Contents

Abstract

Tirupur is an Indian textile town which constitutes many dyeing and bleaching units situated in the upstream. Tirupur serves as one of the major exporters of textiles. The industrial pollution have affected not only the surface water but also the soils and ground water. This thesis studies the impacts of industrial pollution on agriculture and livestock. It also explores the implicated problems involved in putting an economic compensation mechanism into practise. The impact study was made on the detailed primary data collected from an intensive study of comparing a pollution affected villages located downstream of the Orathapalyam dam, Tamil Nadu, South India with a control village. The cost estimates that the impact of industrial pollution on predominant crops is quite substantial in monetary terms. This paper argues that the compensation principle might work if the assessment is done to all affected victims. Both quantifying and non quantifying benefits should be incurred in the mechanism. Further, mere passing of fines and creating institutional structures are not sufficient to address the environmental problems. Policies should be implemented in their right perspective. Institutions should be strong enough, with more autonomy and powers, to deal with problems and to monitor the RO plants in dyeing units in Tirupur.

INTRODUCTION

Chapter: 1

Our world has seen essential and persistent change in the last 50 years. The increased economic growth of the developing countries has bitterly affected the quality of the environment, which becomes a menace to sustainable development (Nelliyat, 2007). In developing countries where environmental regulation is fragile, the wastes from different sectors are randomly discharged in to the ecosystems. (Appasamy and Nelliyat, 2007). The Millennium Ecosystem Assessment (2005) recently concluded that most of the world's ecosystems have already suffered major degradation. The most impact of pollution is on air and water resources and associated ecosystems. Wastewater strategies are often not adequate in many developing countries. Therefore the impact of wastewater on the receiving ecosystems is radically high when there is accumulation of pollutants. In developing countries where formal regulation is weak or absent informal regulation has resulted in the control of environmental externalities like industrial pollution or forest degradation (Murty *et al.* 1999; World Bank, 1999). At times new model of pollution control also emerges where market agents like producers, consumers, local communities, and government have stimulus to work for the decline of environmental externalities (World Bank, 1999).

Noyyal River originates from the Vellingiri hills of the Coimbatore district, (Tamil Nadu, India). It passes through Tirupur and it is stored up in the Orathapalayam Dam to be used in agriculture and drinking purposes for the downstream villages in the Erode District. A large number of dyeing units are situated in the upstream in and around Tirupur. They discharge their chemical and toxic effluents either directly or indirectly in to the Noyyal River (Blomqvist, 1996). As a result all the irrigation wells along the river and in the downstream villages have been polluted and the ecosystem has been adversely affected by the seepage and percolation of water stored in the Orathapalayam dam. Eventually it affects the agriculture, livestock rearing, and fisheries of the downstream farmers around the Orathapalayam dam (Appasamy and Nelliyat, 2007). This water pollution causes serious impacts on socio-economic prominence of the people living around the Orathapalayam dam. The local communities through the Karur Noyyal Canal Agriculturists Association filed a PIL (Public Interest Litigation) against the polluters in the Supreme Court to direct Tamil Nadu Pollution Control Board to regulate against the polluting dyeing and bleaching units in Tirupur area (Eswaramoorthi *et al*, 2003). The Supreme Court based their ruling on the Precautionary Principle and the Polluters Pay Principle to extend its statement to the dyeing units to compensate the victims of the pollution along the Noyyal River and also to bear the cost of restoring the environmental degradation (High Court of jurisdiction, 2006).

Even though industrial units have either constructed or connected to effluent treatment plants, the level of treatment has not been satisfactory at most of the places. It has caused serious impact on agriculture, livestock and fisheries. The most affected victims by this industrial pollution are six downstream villages; these villages are situated around the Orathapalayam dam. The dam is situated downstream 20 kms from Tirupur. But the economic value of compensation awarded to these villages was only based on agricultural productivity. However, there is a chance that this kind of compensation based on intervention of the Polluter Pay Principle (PPP) may also face problems if it fails to address the issues properly if, (a) the environmental goals to be achieved by the PPP do not really address the development-environment trade-off, that is industrial development versus environmental quality, (b) if the mechanism outcome does not result in sufficiently compensating the victims of environmental deterioration (Venkatachalam, 2005). **The aim of the study is to focus on the impacts of water pollution on ecosystem services (agriculture, livestock) in five downstream villages and to explore the implicated problems involved in compensation mechanism.** The main questions to be answered include:

1. What is the impact of pollution of dyeing units on farming, and livestock rearing?
2. What problems have arisen within the compensation mechanism

The present case study has two folds. One fold portrays the socio economic prominence of the people living in the downstream villages around the Orathapalayam dam. Another fold uncovers the problems involved in compensation mechanism.

Chapter 2. Background for awarding compensation

2.1 Industrial pollution

During the post liberalization period of the Indian economy, the cotton and textile and garment industries grew swiftly and account for a major share of Indian exports (Compendium of Textile Statistics, 1999). The percentage of textiles in the total exports from India has increased and accounts for 14% of the national industrial production and about 4% of GDP (Ministry of textiles, 1999). Tirupur, a major knitwear centre in India, is holding more than 9000 small-scale units produce one-third of the total apparel exports from India (Swaminathan and Jeyaranjan, 1995). The export earnings from Tirupur during the year 2005-06 were about Rs.10, 250 crores (Nelliyat, 2007).

Wet processing (bleaching and dyeing) is a sub sector of the hosiery industry. There were 702 bleaching and dyeing units in 2001. Presently there are 729 bleaching and dyeing units in Tirupur (p.c).The majorities of the units are small in size and function as job workers[1] for the hosiery industry. Out of the 729 wet processing units, 125 are located in Tirupur municipality and the remaining is extending out in the adjacent villages. Most of the units are located on both sides of the Noyyal River which makes them commodious to discharge the effluent in to the Noyyal River. Most of the chemicals used in the processing are discharged as waste material which leads to high pollution load in the effluents. Water is an inevitable contribution factor for textile processing. The quantity of water consumed by these industries has increased to 86 Millions of Liters per Day (MLD) in 2000. Earlier the textile units suctioned water from the Noyyal River or from their own wells. But during early 1990s the water quality in Tirupur got degraded. The water needed for textile units was transported from surrounding villages through tankers. This constant performance of the water market has affected the ground water availability of the villages and ground water tables have been declined in many places. Currently the water both for the industries and the Tirupur municipality is accessible through the Tirupur Area Development Projects' water supply scheme to transport water from the Cauvery River (Nelliyat, 2007).

2.2 Local communities' action and legal proceedings

The processing units in Tirupur generate around 83 Millions of Liters per Day (MLD) of effluents; these effluents carry different chemicals used in different processing stages of the units. Due to the continuous discharge of effluents, the agricultural lands along the Noyyal River basin have become either partially or totally unfit for cultivation. The agriculturists felt that the industrial wastewater coming from the dam is highly toxic and has caused a serious impact on the farming; livestock rearing.

1 Foot note (1): Doing contract jobs dyeing, knitting, stitching for textile units

Irrigation of agriculture with treated industrial effluents may lead to soil degradation (Appasamy, 2005). The Karur Taluk Noyyal canal Agriculturists Association approached the Court to take action against the dyeing units in Tirupur. By Court's direction the Tamil Nadu Pollution Control Board directed the dyeing units to set up the Common Effluents Treatment Plant (CETPs) (High Court of Jurdication, 2006).

The organizational strength of the Tamil Nadu Pollution Control Board was not able to remain awake with the expansion of the textile industry in Tiruppur (Blomqvist, 1996). In spite of the final order passed by the Court no movements were taken to execute the said order and no attempts were made to install the necessary equipments for the treatment of effluents discharged in to the river. Consequently the Association of agriculturists again approached the court to execute the dyeing units to clean the river water stored at Orathapalayam dam within a specific time frame and to prevent further pollution of the river. The Supreme Court directed the dyeing units to deposit 12.5 crores to clean up the Orathapalayam dam. Further, the Court directed the Tamil Nadu Pollution Control Board to take necessary steps against the dyeing units to prevent further degradation of Noyyal River basin. As the primary treatment was barely insufficient to remove the TDS from the effluents the Tamil Nadu Pollution Control Board (TNPCB) directed all the units in the Tirupur clusters to set up 'Reverse Osmosis Plants' to achieve 'Zero Liquid Discharge'. The Supreme Court of India based on the polluter pay's principle stated in Noyyal River case judgement that the dyeing units must compensate for the loss of ecology caused in the Noyyal River (High Court of Judiciary, 2006).

2.3 Court action

The Supreme Court of India in its judgement in the Vellore Citizens Forum case held that 'Precautionary Principle' and the 'PPP' (Polluter Pay Principle) are part of the environmental law of the Indian Constitution. In the Vellore tannery case the court ordered the creation of a new agency, the Loss of Ecology (Prevention and payments of Compensation) Authority for the State of Tamil Nadu to provide compensation to those affected by pollution from tanneries. Subsequently, the court expanded the jurisdiction of the Loss of Ecology Authority to cover all industries.

The central Government in the Ministry of Environment, and Forests, in compliance of the Supreme Court order constituted the Loss of Ecology Authority. The loss of ecology Authority hunted the assistance of Centre for Environmental Studies, Anna University, to evaluate the loss of ecology and environment in the areas affected by the industries located in the Taluk of Tirupur and its vicinity as responsible for the high Total Dissolved Solvents (TDS) content of the groundwater in the area. The villages are classified based upon Total Dissolved Solvents (TDS) concentration in terms of electrical conductivity in the ground water. The list of villages classified is provided in appendix 1. The entire affected villages fall in the three districts of Coimbatore, Erode, and Karur (Loss of Ecology Authority for the State of Tamil Nadu, 2004).

More than eighty villages along the Noyyal River have been affected by the effluents discharge of the dyeing units in the upstream. The environmental impact on ground water, surface water, soil, fish and natural ecosystem in these five villages Kathangani, Thambureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal are far above the ground. In these villages where ground water is the only source of irrigation, farmers are not able to irrigate their crops. The compensation money awarded was considered too low by the farmers and it has raised many criticisms. As a result these five villages are chosen to investigate the impact of industrial pollution on agriculture, livestock, and to explore the implicated problems in the compensation mechanism.

Chapter: 3 Research Methodology

The main steps undertaken were

1. The water samples were collected and analysis was done to substantiate the EC value.

2. Questionnaires were undertaken during a household survey.

Semi structured interviews were performed to explore the working of the compensation mechanism

One hundred respondents from 5 affected villages and twenty respondents from non-affected villages were selected for this household survey which was conducted using pre-tested three questionnaires during June and August 2007. Also two interviews with loss of ecology Authority, Vetenary doctors, and Monitoring committee was conducted

3.1 Source of Information

The source of information includes written sources, interviews with key informants and field visits. The written sources include published documents; unpublished documents produced by government departments and also unpublished material of the farmer's organization. The written sources were used to obtain a background description of the region. Since one of my aims was to study the mechanism of compensation from the point of view of the polluters and affected people both the polluters and the affected farmers were the ideal sources of information.

3.1.1 Analysis of Water Samples

The ground water quality in wells in Kathangani, Thammureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal villages are analysed. As the Noyyal River has a high electrical conductivity (EC) and high concentrations of Total Dissolved Solids (TDS) from Tirupur to the Orathupalayam dam these two parameters were used as indicators of pollution.

3.1.2 Field Procedures

The water samples were collected from the wells in Kathangani, Thammureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal in 1 litre white plastic bottles. It was rinsed carefully with water and discarded. Again it was rinsed with well water and the sample water was collected in the bottle. Four water samples were collected randomly from each well in these villages.

3.1.3 Analytical Work

The chemical analytical work was carried out at the Water Technology Centre, Tamil Nadu Agricultural University. Coimbatore. The water samples were analysed for PH, EC and major cations and anions like sodium, potassium, calcium and chloride.

3.2 Agriculture Sector

Agriculture is the area affected mainly through water and soil contamination. The loss due to pollution in the agriculture sector was analyzed by 'Reflexive comparison by double difference' getting the data on cropping pattern, crop productivity, before and after the water gets polluted from the farmers both in affected and control(non-polluted) villages.

3.3 Reflexive Comparison by Double Difference Method

Reflexive comparisons, in which a "baseline" survey of participants is done before the intervention, and a follow-up survey done after. The baseline provides the comparison group, and impact is measured by the change in outcome indicators before and after the intervention. (Ezemenari, Rudqvist, and Subbarao, 1999). If the survey is only undertaken in a project area, a reflexive comparison approach can be used. (Carvalho & White, 1995).A major drawback of this method is that participant circumstances are likely to be affected by a multitude of factors, thus making attribution of changes to the intervention difficult. This type of design involving comparing values for a population at an earlier period with values observed for same population later period is considered one of the least methodologically precise evaluation method because isolating the impact of an intervention from the impact of other influences on observed outcomes is difficult without a comparison or control group that does not receive the intervention (Grossman, 1994)

Measurement of changes in some of the variables such as income, employment assets and savings is straight forward; but measurement of change in variables like water resources is rather tricky as it involves many indicators like change in depth of water table, changes in area under irrigation and so on.

An appropriate base line survey of the households would help in capturing changes better. However such baseline data sets are often not available. This is the major weakness of the study. One way of addressing the problem is to have a control group which is similar to participating group in all respects except the pollution. So that the control group provides the realistic picture of the participating group. In a reflexive comparison by double difference method where before and after scenarios are compared for participating households and control household groups. (Ravallion, 2001).

In this field study Kathangani, Thambureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal are taken as treated (polluted villages) and Karaikatupudur and Arasampalayam are taken as control (non-polluted) villages.(Fig 1). The same questionnaires were used at both groups of villages. The questionnaires were constructed and performed to collect data about for cropping pattern before pollution (early 90s) scenario I (S I) and after pollution (late 90s) scenario II (S II). The before and after scenarios in the polluted village give the absolute incidence of loss in agriculture after the incidence of pollution. These two measures are estimated and presented as scenario-I and scenario-II. The double difference between before and after situations in both the affected and control (non-polluted) villages [(Bi-Ai) - (Bj-Aj), where i and j represent polluted and control (non-polluted villages)] gives the net impact of pollution. The before and after difference in the non-polluted villages is due to natural factors which needs to be netted out.

The difference between the two scenarios for the affected villages gives the impact on agricultural crops. The impact will provide data regarding the loss in agricultural crops. Discussions with the monitoring committee of Orathapalayam dam and medical practitioners have helped in cross checking the damage losses. Reflexive comparison by double difference method was done to analyze the impact on agriculture and livestock. Impact on livestock rearing can be analyzed by getting the data from the farmers having livestock rearing animals living in the villages around the Orathapalayam dam.

3.4 Selection of Villages

The villages Kathangani, Thambureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal are taken as polluted villages and Kaaraikatupudur and Arasampalayam are taken as control (non- polluted) villages. The five villages Kathagani, Thambureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal are situated near the Orathapalayam reservoir. Karaikatupudur and Arasampalayam are situated 6 to 10 kms apart from the dam and belong to Sivanmalai panchyat union, Erode District. Farmers are selected randomly from both the affected area and non affected area. Farmers may have the different size of land holdings, and use different sources of irrigation.


PUNJAI PALATTOLOVU
PUDUPPALAYAM
KODUMANAL
ORATHUPALAYAM
ELLAIGRAMAM
NOYYAL RIVER
DAM SITE
TAMMAREDDIPALAYAM
MARAVAPALAYAM
SIVAMALAY
KIRANUR

3.4.1 Profile of sample villages

Five villages were selected to represent the polluted and two villages to represent non-polluted villages. These villages have similar socio-economic and occupational patterns. These villages are located at 21 km to the northeast of Tirupur, Tamil Nadu, and India. The villages Kathangani, Thambureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal are taken as polluted villages and Kaaraikatupudur and Arasampalayam are taken as control (non- polluted) villages. The five villages Kathagani, Thambureddipalayam, Ganapathypalayam, Orathapalayam, and Kodumanal are situated near the Orathapalayam reservoir. Karaikatupudur and Arasampalayam are situated 6 to 10 kms apart from the dam and belong to Sivanmalai panchyat union, Erode District.

Agriculture is the dominant sector in all these villages. It's also observed that along with cultivation, most of the villagers work for the nearby industries in Tirupur as laborers. Around 50% of the populations in both the sample villages are illiterate.

The households in all these villages predominantly belong to backward caste (BC) categories. Small and marginal farmers are majority in both the sample villages (Table: 1). Small and marginal farmers are high in both these sample villages. The land distribution pattern among the households is presented in Table: 2.

Table: 1 Social category wise distribution of households

Category	Polluted villages	
	No of house holds	Occupation
T.Redipalayam BC	120	Cultivation and laborer
OC	15	Cultivation and laborer
G.palayam BC	113	Cultivation and laborer
OC	13	Cultivation and laborer
O.Palayam BC	120	Cultivation and laborer
OC	31	Cultivation and laborer
Katagani BC	130	Cultivation and laborer
OC	28	Cultivation and laborer

Kodumanal BC	190	Cultivation and laborer
OC	21	Cultivation and laborer
K.Katupudur BC	120	Cultivation and laborer
OC	20	Cultivation and laborer
Arasampalaym BC	160	Cultivation and laborer
OC	25	Cultivation and laborer

BC- backward class, OC- other caste

Source: Village Survey

Table: 2 Size class-wise distribution of land holdings

Category of cultivators	No of households	% of total cultivators	No of households	Area owned by sample cultivators (ha)	% of total are (ha)
Polluted villages (5)			100		
T.R.Palayam	135	100	26	37	100
Marginal farmers(MF)	25	16	8	3	32
Small farmers(SM)	60	44	7	8	24
Medium farmers (Md.F)	35	30	4	8	24
Large farmers (LF)	15	10	7	18	20
G.Palayam	113	100	14	22	100
M F	30	27	4	3	20
S F	55	49	5	8	32
Md. F	20	18	2	4	32
L F	8	08	3	7	16
O.Palayam	151	100	12	22	100
M F	28	19	4	3	22
S F	65	43	4	6	30
Md. F	38	25	2	5	30
L F	20	13	2	8	17
Katagani	158	100	21	25	100

M F	45	28	7	3	23
S F	60	38	8	5	27
Md. F	43	27	2	4	36
L F	10	06	4	13	14
Kodumanal	211	100	27	36	100
M F	70	33	9	5	15
S F	76	36	9	7	35
Md.F	50	24	5	8	30
L F	15	07	3	16	20
Non polluted villages (2)					
K.Katupudur	145	100	23	26	100
M F	60	41	5	3	15
S F	40	28	9	6	30
M F	35	24	4	7	35
L F	10	06	2	10	20
Arasampalayam	185	100	18	23	100
M F	55	30	5	6	26
S F	60	32	7	7	30
MD F	50	27	4	8	35
L F	20	11	2	2	09

Large farmers (LF) >5 acres, medium farmers (MD F) 3-5 acres, Small farmers 2-3 acres marginal farmers (M F) 0-2 acres

Source: Village Survey

The land distribution among the households is presented in Table: 2. Small and marginal farmers are in majority in both the sample villages. Around 50% of cultivators belong to marginal farmers in the polluted villages, whereas in the case of non-polluted village the percentage is high in Small farmers rather than in medium farmers.

3.5 Sampling Technique

Random Sampling technique is used to get first hand information about pre and post pollution agricultural and allied economic activities of the farmers, livestock details in these villages. Agricultural activities explore the crop productivity, crop pattern, economic status before and after pollution. One hundred respondents were given questionnaires and interviewed by the researcher for the affected area. Ten respondents each from non affected area are interviewed. In random sampling, a number is given to each individual in the group under investigation and a set of random number is then used to select the members of the sample. In this way, each individual has a known probability of being selected the researcher can also predict with some degree of certainty that the sample is a representative of the group as a whole.

3.6 Methods of Data Collection and Analysis

By primary data, it refers to a situation in which the researcher collects information directly from his respondents. Primary data was used to collect the data of respondent through the use of questionnaire and semi structured interview method. The following steps (A-D) were followed:

A. The questionnaires were prepared and the following information was collected from the farmers. (Before water gets polluted (early 90s) and after water gets polluted (late 90s)

1. Cost of cultivation the farmers used different proportion of inputs based on the extent of impact.
2. The input costs could be broadly classified into laborer cost, fertilizer (other costs). For getting the average cost of cultivation on different crops the data are compiled for the affected farmer,
3. Current occupation for their livelihood.

B. The questionnaires were prepared for the farmers doing livestock rearing and the following information was collected from them

1. Total number of year's livestock rearing was done, and what are the effects on livestock rearing due to this water pollution?

Questionnaires are also a cheap, fast and efficient method for obtaining large amount of quantifiable data on a relatively large population. Questionnaires are open-ended as open ended questionnaires enable the respondent to compose his own answer rather than choosing between a number of given answers

D. The data collected will be analyzed based on descriptive statistics (converted in to percentages) While the before and after scenarios in the polluted village gives the rational loss in agriculture, livestock rearing, Discussion with the monitoring committee of the Orathapalayam dam helps to cross check the damages for agricultural land and discussion with medical practitioners helps to cross check the diseases caused in the livestock rearing.

3.7 Implicated problems in Compensation Mechanism

To explore the establishment and implicated problems in compensation mechanism qualitative interviews were performed. The compensation mechanism is based on the polluters pay principle, which claims that the polluters have to pay for the ecology loss and also for the prevention of loss of ecology. Questionnaires in any form proved to be an unreliable method of collecting information concerning complicated and sensitive issues regarding the payment of compensation from individual dyeing units in Tirupur. Since the legal proceedings are still undergoing in the Court apprehension was stronger among the dyeing units, so it is rational to assume that a questionnaire would not have been useful. Instead, semi-structured interviews were conducted for the dyeing units and it was used as the main method of data collection for compensation during field periods.

Large scale dyeing Units: 2 [2]

Medium Scale dyeing Units: 4

Small Scale dyeing Units: 3

In this study dyeing units are the polluters and for establishing the compensation mechanism the dyeing units has to pay for the ecology loss. Therefore interviews with the dyeing units are very essential. As the farmers are the affected victim interviews were also done with the farmers.

Total Number of Farmers: 6

Foot note[2]: Large dyeing unit's category uses more than 1 crore liters of water a day for dyeing operations

Medium scale dyeing units uses about 50 lakh liters of water per day

Small scale dyeing units uses below 30 lakh liters of water per day

Even though dyers and the farmers are the key informant in this study interviews were also performed with the Government officers in the Loss of Ecology and also with the pollution control board.

Pollution Control Board (Chennai)-1

Loss of Ecology Authority- 2

Monitoring Committee-1

Most government officers normally didn’t split their own views and choose to be a strict official position.

Semi-structured interview was performed for the compensation mechanism. It was a research interview in the form of a conversation that is transcribed to texts and will be interpreted. Texts were created and interpreted through the collective information from the interviews (Kvale, 1997). After the field study I organized and structured the information based on the aim of my study.

Chapter 4. Formulation of compensation

4.1 Polluter pays principle

The first major orientation to the PPP appeared 1972 in the OECD Guiding Principles Concerning International Economic Aspects of Environmental Policies (henceforth called OECD Guiding Principles). The judiciary in India recognizes the Polluter Pays Principle as is seen from the judgment delivered by the Supreme Court of India in Bichhri case writ petition no 657 of 1995. In this case the units manufacturing Oleum and H-acids without obtaining the requisite permissions were held liable for causing the pollution to the wells, soil and the aquifers and were directed to defray the costs for remedial measures. The Court ruled that "Once the activity carried on is hazardous or inherently dangerous, the person carrying on such activity is liable to make good the loss caused to any other person by his activity irrespective of the fact whether he took reasonable care while carrying on his activity. The rule is premised upon the very nature of the activity carried on".

Therefore the polluting industries are "absolutely liable to compensate for the harm caused by them to villagers in the affected area, to the soil and to the underground water and hence, they are bound to take all necessary measures to remove sludge and other pollutants lying in the affected areas". The "PPP"(Polluter Pays Principle) as interpreted by the Court means that the absolute liability for harm to the environment extends not only to compensate the victims of pollution but also the cost of restoring the environmental degradation. Remediation of the damaged environment is part of the process of "Sustainable Development" and as such polluter is liable to pay the cost to the individual sufferers as well as the cost of reversing the damaged ecology (AIR1996SC2715).

4.2 Vellore tannery case

In Vellore citizens case the court held that the precautionary principle and the polluter pay principle have been accepted as part of the law of the land. 'The Precautionary Principle' and 'The Polluter Pay Principle' are essential features of 'Sustainable Development'. The 'Precautionary Principle' – in the context of the municipal law means the State Government and the statutory authorities must anticipate prevents and attacks the causes of environmental degradation. It is stated that the tanneries are discharging untreated effluent into river Palar that is the main source of water supply to the residents of the area. The entire surface and subsoil water of river Palar has been polluted resulting in non-availability of potable water to the residents of the area. It is stated that the tanneries in the State of Tamil Nadu have caused environmental degradation in the area. Further in the order it's stated that The

Central Government shall constitute an authority under Section 3(3) of the Environment (Protection) Act, 1986 and shall bestow on the said authority all the powers necessary to deal with the situation created by the tanneries and other polluting industries in the State of Tamil Nadu.

The authority so constituted by the Central Government shall implement the "precautionary principle" and the "polluter pays" principle. The authority shall, with the help of expert opinion will assess the loss to the ecology/environment in the affected areas and shall also identify the individuals/families that have suffered because of the pollution and shall assess the compensation to be paid to the said individuals/families. The authority shall further determine the compensation to be recovered from the polluters as cost of reversing the damaged environment. The authority shall compute the compensation under two heads namely, for reversing the ecology and for payment to individuals (AIR1996SC2715).

4.3 The principle of different class compensation for victims in Noyyal River

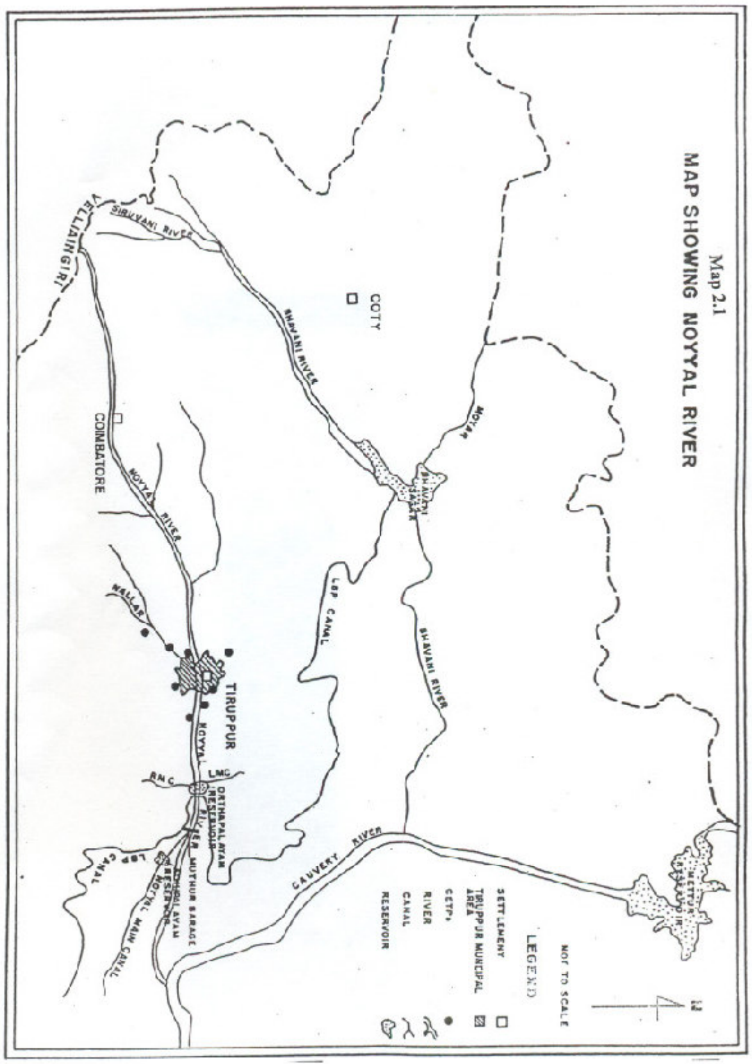
The Loss of Ecology Authority required the Anna University to carry out the water quality studies and identify the list of villages affected by the effluents discharged by the dyeing units. Each of the villages was classified based upon a weighted average of electrical conductivity in the sample wells of the village. The University also calculated the monetary loss of agricultural productivity loss based on type of crop, average yield, and procurement price. The rates are based upon the theoretical agricultural productivity loss corresponding to TDS in irrigant fields. It was also based with basic statistics on type of crop, average yield during the recent years and purchase price of the predominant crops. The compensation to the farmer was calculated on the basis of the cropping pattern as well as the average level of pollution in that village.

The cropping patterns are taken according to the major crops cultivated in each Taluk. In Avinashi Taluk (Coimbatore District) Cholam, pulses, groundnut, cotton is the major crops. Tirupur Taluk (Coimbatore District) cholam, pulses, coconut. Erode Taluk (Erode District) paddy, cholam, groundnut, and pulses are the major cultivated crops. The University estimated the monetized loss to ecology/environment in terms of Rs/ha/y depending upon the class of villages (Loss of Ecology, 2004).

Table 3 – Rates arrived by University based on the TDS value. Source: (Loss of Ecology Authority for the state of Tamil Nadu, 2004)

		Rate Rs/ha/yr	Rate Rs/ha/yr
Class of villages	EC Value	Erode & Karur Dist	Coimbatore Dist
Class II	1.5 to 3mS/cm	900/-	300/-
Class III	3+ to 5.25mS/cm	4,600/-	1,400/-
Class IV	5.25+ to 7.5 mS/cm	14,400/-	5,800/-
Class V	More than 7.5mS/cm	21,400/-	9,300/-

Chapter 5. Description of Noyyal river and Orathapalayam reservoir



5.1.1 Noyyal River

The Noyyal River is a tributary of the Cauvery, a large interstate river which cuts through the States of Karnataka and Tamil Nadu and enters the Bay of Bengal. It flows through Coimbatore, Erode and Karur districts. The Noyyal river basin covers a total area of 3510 km2. The length of Noyyal River is about 170 km from west to east. The average width of the basin is 25km. The annual rainfall is varied for this basin. The Noyyal is a seasonal river, which has good flow during the North-East and South-West monsoons. Apart from the monsoon periods, there is only scanty flow for most part of the year. The river supplies water to several irrigation tanks located in and around Coimbatore town and downstream. Nearly 6,000 acres of cultivable land are irrigated using the river water. (Govindarajalu, 2003). Noyyal River has around 29 system tanks, 20 channels, and two reservoirs together irrigate 35,974 acres of land. After 1991-92 Noyyal river consist of 20 channels, which irrigate about 6910 acres of land, 30 tanks that irrigate around 9,246 acres and the command area (five villages) acres irrigated by Orathapalayam and Authupalayam reservoirs. (Public Water Department, 1999). The command area is to be highlighted because these villages situated around the dam gets directly the polluted water from Tirupur where the dyeing units' effluents have been discharged.

5.1.2 Orathapalayam Reservoir

During the early 1980s, the government formulated the Noyyal Orathapalayam Reservoir Project (NORP) in two stages to use the surplus water of the Noyyal that flow in to the Cauvery River. During the first scheme a reservoir was constructed in Karur district to irrigate about 9,625 acres of dry area. The second stage of NORP is to construct a new dam across the Noyyal at Orathapalayam village to store the flood water of the Noyyal. It was proposed to provide irrigation facilities to 500 acres of dry areas in Erode district (100 acres from Orathapalayam village) which includes the five villages and Kangayam (400 acres from Semmangulipalayam village). The additional food grain production of about 1000 tonnes was anticipated from this scheme. The total area of 500 acres under the direct irrigation of Orathapalayam reservoir was done by two canals one from northeast (left canal) and another from southeast (right canal). (MSE, 2002).

The total cost of the two schemes was Rs 33.9 crores[3] (339 million rupees). About 20,000 acres of dry ayacut were supposed to benefit from reservoir water, where it also enriches underground water. The industrial pollution from the Tirupur region has, conversely, compressed the objective of the whole project. (MSE, 2002)

5.2 Industrial pollution and loss of ecosystem services in Noyyal river

In recent decades, the ecosystem particularly the water and land resources of the basin have been affected due to industrial effluents. Tirupur is fast growing hosiery 'industrial city' in Coimbatore district of Tamil Nadu. It is located on the bank of the Noyyal River, a tributary of the Cauvery. The bleaching and dyeing unit effluents contain a variety of dyes and chemical (acids, salts, wetting agents, soaps, oil etc.). The loss of ecosystem is due to the accumulation of effluents in the ground water and soil.

3 Foot note (1):10 Crore is synonymous with 10, 00, 00,000, i.e. 10 million. A crore is a unit in a traditional number system, still widely used in India.

5.2.1 Pollution Load Generated by Tiruppur Textile Processing Units

From 1980 to 2003 in Noyyal River Bain (Quantity in Tonnes/year)

Table 4 Pollution load generated by Tirupur textile processing units. Source: (Nelliyat, 2005)

Period	TDS	CHLORIDE	SULPHATE	TSS	COD	BOD	OIL&GREASE
1980-2003	2877066.17	1585933.8	161726.82	110928.95	104944.33	31990.55	1633.95

Key: TDS- Total Dissolved Solids, TSS- Total Suspended Solids, COD- Chemical Oxygen Demand, BOD- Biochemical Oxygen Demand.

From 1980-2002, the collective TDS load discharged by the Tirupur units alone is estimated to be 2.87 million tonnes. Apart from TDS other pollutants have also accumulated during this period is shown in the table. Rainfall (annual average of 617 mm) has only a marginal effect in reducing the impact

5.3 Previous studies on ground water pollution in the region

5.3.1 Ground Water Pollution

Studies have been done by (Senthilnathan and Azeez, 1999 and Prabakaran *et al.*, 2002) by collecting well water samples around Tirupur and along Noyyal up to Orathapalayam reservoir. (Prabakaran, 2002) in his study has collected water samples around the Orathapalayam reservoir and found that many wells have high EC-values, the wells situated near the dam having maximum EC value was 9.56 dS/m in May and the minimum was 8.22 dS/m in December.

Another extensive study was done by the Soil Survey and Land Use Organization (SS&LUO) as a part of the project study conducted by Madras School of Economics during 2001 to assess the environmental impact of industrial effluents in the entire Noyyal River basin. This study covered the entire length of the basin and the whole basin area was divided in to four zones. The area between Tirupur and Orathapalayam reservoir falls under Zone III. This is the zone where the bleaching and dyeing activities are taking place. The water samples are collected and characterised according to the Tamil Nadu system for irrigation water (Table 3 & 4). Nearly 33% (82 water samples) were not suitable to raise the crops and 42% (106 samples) are estimated to be critical for crops. The farmers in this zone have not been able to use both surface and ground water.

Before the 1990s, ground water in and around Tiruppur was potable (PWD, 2002). Open wells and bore wells in and around Tiruppur and the downstream stretch of Noyyal exhibit high levels of TDS (most areas >3000 mg/l and some places even up to 11,000 mg/l) and chloride (generally > 2000 mg/l and certain areas upto 5000 mg/l) due to industrial pollution.(PWD, 2002) The current values of pollution concentration are very much higher than the background levels for this region. There is high concentration of heavy metals like zinc, chromium, copper and cadmium in ground water. (Rajaguru and Subbaram, 2000) The open and bore wells located around 4 km radius of Orathapalayam reservoir are highly polluted with high TDS level and concentration of various salts (Loss of Ecology, 2004).

5.3.2 SURFACE WATER POLLUTION

The pollution (EC/TDS) concentration in Noyyal River is low till the river reaches Tiruppur. But it increases in Tiruppur areas due to effluent discharge, and continues up to Orathapalayam dam. (Central Water Commission). Pollution concentration in the river is more in summer. The existing moderate flow in Noyyal River is not sufficient to dilute the pollutants. High alkalinity, chloride, electrical conductivity, iron, phosphate, and BOD are seen in the water in Orathapalayam Reservoir. (PWD, 2001);(Loss of ecology Authority for the state of Tamil Nadu, 2004). The flow of the Noyyal River is confined to the monsoon periods. For most part of the year, the river carries only dyeing effluents and sewage (Joseph et.al, 2004). The water is saline and no longer useful for irrigation (PWD, 2002). The water is very turbid, pH is highly alkaline, EC and TDS levels are very high, and water hardness is very high (Govindarajulu, 2003). The Orathapalayam dam was filled with industrial effluents; the stagnation of polluted water in the dam has caused pollutants to percolate to the ground water (PWD, 2002). The TDS levels in the surface water at Orathapalayam dam is high (approximately 4000ppm) and decreases further in downstream (Govindarajulu, 2003).

5.3.4 Cropping patterns of left and right main canals in Orathapalyam Reservoir

The total irrigation lands of 500 acres get their irrigated water from the Orathapalayam reservoir through the left and right canals. The cropping pattern in this area is shown in the table: 5. the actual area of irrigation during 1993-94 was minimum. The irrigation water was not released from 1996-97 to 1997-98. It was found that the water was unfit for irrigation purposes and it was closed during that period. From this table it's clear that the farmers during the period (1993-94) have cultivated all types of crops like paddy, sugarcane, tobacco, cotton, cholam, turmeric, gingely, and banana during the early period. After 1998 the cropping pattern has been changed and paddy, which is the staple food grain of India, has disappeared. Cholam, cotton crops and coconut trees has been raised.

Table 5. Cropping Pattern of Left and Right Main Canals in Orathapalayam reservoir (Acres) Source: Water Resources Organization, Irrigation Division (2001).

S No	Crops	1993-94	1994-95	1995-96	1998-99
1	Paddy	3.58	9.04	11.73	-
2	Sugarcane	7.31	2.77	0.99	-
3	Banana	0.00	0.40	0.25	-
4	Tobacco	29.05	28.06	3.63	2.47
5	Cotton	23.81	72.64	1.24	166.725
6	Cholam	2.94	25.17	1.41	253.175
7	Coconut	3.26	4.35	1.26	-
8	Turmeric	3.95	-	-	-
9	Gingely	4.92	-	-	-
10	Others	5.48	17.31	3.38	-
	Total	84.30	159.73	23.88	422.37

Even though irrigation of agriculture with treated industrial effluents was widely spread and advocated by experts particularly in water scarce regions. The continuous irrigation with saline water leads to accumulation. The pollutants upset the physical, chemical and biological conditions of the soil. As the chloride content is high, the soil becomes saline. When the sodium content is high, the soil becomes alkaline (Ahmed et.al., 2002)(Senthilnathan and Azeez 1999) in their study found the solids present in ground water having EC (21000 µ mhos/cm) besides affecting the growth of the plants directly, also affect the soil structure, permeability and aeration with indirectly affects the plant growth. Many plants are very susceptible to salt stress, especially during germination and the early segment of growth. A dry climate further reduces the resistance of the plant. (Furn and Hultgren, 2004).

5.4 Water and soil quality standards

The major ions present in water are sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, and carbonate. The major variables used to characterize water are pH, and Electrical Conductivity. PH indicates the degree of acidity. Electrical Conductivity is a good estimator of Total Dissolved Solvents (TDS). It can be expressed as dS/m(decisiemens per metre) (Hounslow, 1995).

The suitability of irrigation water depends upon the a. nature and amount of salts present in water, soil to be irrigated, climatic conditions and crop species. These conditions vary from place to place and the classification of the irrigation water depends upon the amount and nature of salts present in the irrigated water. (Natrajan et.al, 1998)

Table 6 Ratings on soil reaction (pH). Source: (Natrajan et.al, 1998)

Rating	Status
Below 6.0	Acidic
6.0 to 8.4	Normal
8.5 to 8.9	Tending to alkaline
8.9 and above	Alkaline

Table 7 Ratings of EC. Source: (Natrajan et.al, 1998)

Rating	Status
Below 1.0	Normal
1.0-3.0	Critical
3.0 and above	Injurious

Chapter: 6 Impact of pollution

The impact of pollution has been widespread in all aspects of the village life. However, here we focus on three important impacts for an in-depth analysis. These are (a) impact on crop production (b) impact on livestock. Before going into the details of analyzing the impacts of pollution on various aspects, it would be pertinent to examine the impact of industrial pollution on water sources or bodies.

Impact on water sources.

6.1.1 Water quality parameters in the five villages 2007

Table 8. Water quality parameters in the five villages in Tamil Nadu 2007. (Primary Survey, 2007)

NO	Salts	T.redipalayam	Ganapathipalayam	Orathapalayam	Kathagani	Kodumanal
1	PH	7.9	7.9	7.8	7.8	7.3
2	EC(ds/m)	7.7	5.7	8.00	7.5	7.9
3	Carbonate (mmol/l)	-	-	-	6	-
4	Bicarbonate (mmol/l)	6.6	2.4	9.8	6.6	6.8
5	Chloride (mmol/l)	56.00	12.6	68.00	62.00	61.00
6	Sulphate (mmol/l)	4.5	-	6.1	4.2	4.5
7	Calcium (mmol/l)	9.00	3.8	20.4	23.0	18.6
8	Magnesium (mmol/l)	14.00	7.4	8.9	6.9	20.1
9	Sodium (mmol/l)	35.0	2.85	47.0	46.25	48.3
10	Potassium (mmol/l)	1.33	0.82	1.41	1.20	1.25

All water samples had a pH greater than 7. The open wells had EC-values ranging from 7.0 to 8.0 dS/m with most values in the interval 5-9 dS/m. The chloride and sodium concentration also serves as indicators of the polluted water. The concentration of chloride and sodium was high in Thammuredipalayam, Orathapalayam, Kathagani and Kodumanal where it's less in Ganapathipalayam.

The EC values were high in well water, because these wells are close to the dam with the south of the reservoir. As EC could be used as an indicator of pollution it could be seen that the pollution had been spread in these villages. All these open wells have high concentration of chloride, and Sodium. The sample from open wells shows EC value is > 7.0 mS/cm. When compared with the ratings of (Table: 2) this indicate that the ground water in these villages has been polluted. As we can see the EC level and other important parameters of these samples are quite high in comparison to the normal range, indicating that the water is not safe for many purposes. Therefore this water is not suitable for irrigation under ordinary conditions. All these waters are not suitable for irrigation under normal conditions. The concentrations of Na^+ were, high in open wells and this could cause sodium toxicity to crops. The open wells with a low sodium concentration although with a high salinity could perhaps cause less damage to the physical structure of the soil. The sodium concentration is low in Ganapatipalayam but due to accumulation of pollutants for a long time the water is not so good for agricultural activities. The reason why most open wells were still used for irrigation was that there was no other alternative for the farmers. Most of the open wells were used for irrigation, however, mainly for coconut trees.

6.1.2 Impact on Agriculture

Agriculture is the worst affected. About 123 ha of cultivable land have become uncultivable by soil pollution leading to drastic changes in livelihood systems in polluted villages (Table: 8). As mentioned earlier the water from these polluted villages is found to have high concentrations of electrical conductivity (EC) which is the main indicator of irrigation of water quality (Natraj et.al 1998). EC conveys the intensity of salinity of water bodies. The results (Table: 6) clearly indicated the high concentration of TDS in the polluted villages. The high concentration of TDS not only affected crop production but also damaged the agricultural machinery like pump sets that come into direct contact with water. Here we have estimated the losses in terms of loss of production and replacement costs of the pump sets.

Apart from the decline in agricultural productivity the polluted water imposed enormous costs on various agricultural activities, like corrosion of agricultural equipment, damage of pump sets, repairing costs of machines etc… Only the damage of pump sets is reported from polluted village, though other problems like corrosion of equipment and repairing costs might have occurred earlier, for that reason, the decline of cultivation activities occurred during the last 8 decades and hence they are not able to remember about repairing costs or loss of equipment due to pollution. As the damage of pump sets imposes a major loss to farmers, it is still fresh in the minds of cultivators.

Table: 9 Estimation of damage costs on agricultural activities due to pollution (loss of production)

Thaammuredipalayam

Pump set damaged	Large Farmers	Md F	SM	MF	All
Number	6	3	5	-	14
Cost	72,000	26,000	30,000		128000
Per unit cost(Rs)	12,000	8667	6000		9143
Cost per household (Rs)	10285	6500	4286		7111
Cost/HH/yr	1714	1083	714		1185

Ganapathipalayam

Pump set damaged	Large Farmers	Md F	SM	MF	All
Number	3	2	5	-	10
Cost	36,000	20,000	45,000		101000
Per unit cost(Rs)	12,000	10,000	9000		10100
Cost per household (Rs)	12,000	10000	9000		10100
Cost/HH/ yr	2000	1667	1500		1683

Orathapalayam

Pump set damaged	Large Farmers	Md F	SM	MF	All
Number	2	2	5	3	12
Cost	23,000	19,000	52,000	27000	121000
Per unit cost(Rs)	11,500	9500	10400	9000	10083
Cost per household (Rs)	11500	9500	10400	6750	10083
Cost/HH/yr	1917	1583	1733	1125	1680

Kathagani

Pump set damaged	Large Farmers	Md F	SM	MF	All
Number	4	2	7	5	18
Cost	56,000	21,000	63,000	52,000	192000
Per unit cost(Rs)	14,000	10500	9000	10400	10667
Cost per household (Rs)	14000	10500	7875	7429	9143
Cost/HH/year	2333	1750	1313	1238	1524

Kodumanal

Pump set damaged	Large Farmers	Md F	SM	MF	All
Number	3	5	7	8	23
Cost	42,000	45000	63,000	73000	223000
Per unit cost(Rs)	14,000	9000	9000	9125	9696
Cost per household (Rs)	14000	9000	7000	8111	8259
Cost/HH/year	2333	1500	1167	1352	1376

At least 77 pump sets have been damaged during last 6 years in this entire polluted village. Its total costs are estimated at about Rs.765000 (Table: 7) these costs are acquired during the last 6 years. Accordingly per annum costs of repairing and damage of pump sets have been calculated. The per annum per household average total cost on agricultural activities due to pollution in Thammureddipalayam is Rs.1185, in Ganapathipalayam Rs.1683, Orathapalayam Rs.1680, Kathagani Rs. 1524, and in Kodumanal Rs.1376.

The cost of damage of pump sets is mainly born by large and medium farmers. For that reason only these farmers own bore wells. None of the marginal farmers own a bore well. Per unit cost are high on large farmers. (Table: 7).

6.1. 3 Impact of pollution on agricultural productivity and area under cultivation for paddy

Table: 9 Impact of pollution on agricultural productivity and area under cultivation for paddy

cultivators	Area cultivated in ha		Average yield per ha paddy(q)		Total loss (per ha)	Net loss=(QPL-PP)-CPP (Rs)	Per HH net loss(Rs)
T.R.Palayam	BP	AP	BP	AP			
LF	18	-	90	-	90	775000	43055
Mdf	8	-	30	-	30	100000	25000
SM	8	-	31	-	31	125000	17857
MF	3	-	14	-	14	14000	1750
G.palayam							
LF	7	-	30	-	30	85000	12142
Mdf	4	-	20	-	20	27000	6750
SM	8	-	31	-	31	104000	13000
MF	3	-	19	-	19	21500	7167
O.Palayam							
LF	8	-	41	-	41	149000	18625
Mdf	5	-	33	-	33	62500	12500
SM	6	-	34	-	34	82000	13667
MF	3	-	20	-	20	23500	7833
Kathagani							
LF	13	-	29	-	29	168500	12962
MdF	4	-	20	-	20	32000	8000
SM	5	-	25	-	25	52500	10500
MF	3	-	21	-	21	23500	7833
Kodumanal							
LF	16	-	38	-	38	284000	17750
MdF	8	-	27	-	27	88000	11000
SM	7	-	22	-	22	59000	8428
MF	5	-	18	-	18	32000	6400
Karaikatupudur							
LF	5	3	-	-	0	0	0
MdF	7	6	-	-	0	0	0
SF	6	5	-	-	0	0	0
MF	4	4	-	-	0	0	0
Arasampalayam							
LF	6	6	-	-	-	0	0
MdF	6	5	-	-	-	0	0
SF	7	6	-	-	-	0	0
MF	3	3	-	-	-	0	0

The amount of land under cultivation for paddy has declined about 80% due to the incidence of pollution in the case of all categories of farmers in polluted villages (Table:8). These differences are attributed to uncultivable land under the polluted sources.

In Thammuredipalayam the difference of area under cultivation under pollution is for large farmers is 18 hac, for medium farmers is 8 ha, small farmers are 8 ha and for marginal farmers are 3 ha.

In Ganapathipalayam the difference of area under cultivation after pollution is for large farmers is 7 ha, medium farmers is 4 ha, small farmers is 8 ha, and for marginal farmers is 3 ha

In Orathapalayam the difference of area under cultivation after pollution is for large farmers is 8 ha, medium farmers is 5 ha, small farmers is 6 ha, and for marginal farmers is 3 ha

In Kathagani the difference of area under cultivation after pollution is for large farmers 13 ha, medium farmers is 4 ha, small farmers is 5 ha, and for marginal farmers is 3 ha

In Kodumanal the difference of area under cultivation after pollution is for Large farmers is 16 hac, medium farmers is 4 ha, small farmers is 7 ha, and for marginal farmers is 5 ha.

In proportionate terms the decline is the highest among medium size farmers followed by large farmers, marginal farmers, and small farmers in all these five villages. In all these five villages 29 ha of land has become unproductive for medium farmers. 34 ha of land have become unproductive for small farmers 28.5 ha of land has become uncultivable for Large farmers followed by 17 ha of land has become uncultivable for marginal farmers. These differences are attributed to uncultivable land under the polluted sources. Cultivation no longer takes place under polluted sources. Marginal farmers are badly affected in all these polluted villages due to pollution. Loss of yield is estimated by subtracting the total production of paddy in the before and after situations. Physical losses are converted in to monetary terms using the current prices of paddy. It may be noted that per hectare yields seem to have declined even in the case of non polluted village.

Interestingly the yield loss in Thammureddipalayam is high for large farmers followed by medium farmers. In Ganapathipalayam the yield loss is high for small farmers followed by large farmers. But in Orathapalyam village the yield loss is high for large farmers followed by small farmers. In Kathagani the yield loss is almost the same for large farmers followed by small farmers. In kodumanal village the yield loss is almost the same for large farmers followed by medium farmers. In the non polluted village there are no changes in area and yield though land productivity is low in this village when compared to the polluted villages.

The loss of income from agriculture is estimated on the basis of the difference between average yield earned by the households before pollution (1995) and after pollution (2001). It may be noted here that after pollution the farmers under polluted tank are not cultivating at all. In order to estimate the losses of paddy of unproductive land we have multiplied the per acre yield of before pollution with their respective unproductive land (BPA*BPY-APA*APY). (BPA-Before pollution acre, BPY-Before pollution yield, APA-After pollution acre, APY-After pollution yield). The household level losses due to loss of production are determined on the basis of market prices of paddy. The market value of one-quintal paddy is Rs.500 approximately. However, this is not the net loss to the farmers, as the farmer would not be incurring any production costs in the event of no crop. Hence, the net loss to farmer is calculated after netting out the cost of production. The net loss to marginal farmers is less when compared to large and medium farmers.

The average net loss of income to the farmers is due to pollution is estimated as Rs. 43055 for large farmers in Thammuredipalayam per house hold per year. Per household loss of production is directly related with the farm size. The average losses incurred by the cultivators in the form of pump sets damaged are around Rs.1714 for large farmers per household per year. Together, the average cost per household due to losses to the agricultural sector is (Rs. 43055+Rs.1714=Rs.44769).

In the same way the net loss of income to the farmers due to pollution for medium farmers is Rs. 26083

The net loss of income to the farmers due to pollution for small farmers is Rs.18571

The net loss of income to the farmers due to pollution for Marginalized farmers is Rs.1750

In the same way the net loss of income to the farmers due to pollution for large farmers in Ganapathipalayam is Rs.14142.

For medium farmers the net loss is Rs.8417

For small farmers the net loss is Rs. 14500

For marginalized farmers the net loss is Rs.7167

In the case of Orathapalayam the net loss of income due to pollution for large farmers is Rs.20542

For medium farmers the net loss is Rs.14083

For small farmers the net loss is Rs. 15400

For marginalized farmers the net loss is Rs. 8958

In Kathagani village the net loss of income due to pollution for large farmers is Rs.15295

For medium farmers the net loss is Rs.9750

For small farmers the net loss is Rs. 11813

For marginalized farmers the net loss is Rs.9071

In kodumanal village the net loss of income due to pollution for large farmers is Rs.20083

For medium farmers the net loss is Rs.12500

For small farmers the net loss is Rs. 9595

For marginalized farmers the net loss is Rs.7752.

The total loss per household loss with total number of households in Thammuredipalayam is that is Rs.91173x135= Rs.12308355 (12 millions). Similarly the total loss to the village for the last 6 years can be calculated.

The total loss per household loss with total number of households in Ganapathipalayam is Rs. 5572476 (5 millions)\

The total loss per household loss with total number of households in Orathapalayam is Rs.8906433 (8 millions)

The total loss per household loss with total number of households in Kathagani village is Rs.7256782 (7 millions)

The total loss per household loss with total number of households in Kodumanal village is Rs.11590230 (11 millions)

The average loss to the crops is calculated for one season (November to April) only. Though farmers cultivate two crops in a year, majority of the farmers while interviewing argued that Kharif (July to November) crop is highly uncertain. For that reason, large area of land remains dry or flooded during the rainy season. Looking at this uncertainity over the kahrif season, the loss to crops during kharif season is not taken into account.

6.1.4 Discussion

The farmers in non affected villages during late 1990s have cultivated various crops like paddy. The yield of paddy and cotton was good during late 1990s in all these polluted villages. Their cropping pattern has not declined. During early 1990s the water/soil in the affected villages was not affected so the farmers were able to cultivate different types of crops. The farmers in the affected villages depicted that the problem became severe during 1997-98 and agriculture sector is the worst affected. Due to water scarcity the water stored in the Orathapalayam Reservoir was released for irrigation during 1997-98 (Table: 5). During the interview with the farmers they told that after 1996 the farmers around the Orathapalayam villages are not able to cultivate paddy, sugarcane, kambu, turmeric, and other crops. Cholam cotton, coconut are only raised around the Orathapalayam villages. The Thammuredipalayam and kodumanal has been adversely affected and the net loss of the agricultural yield is large in these both villages.

Most of the farmers in the affected village who has used this water said that the crop was damaged. Apart from crop damage, the soil and well water were also polluted. According to the farmers the crops got affected after this period and the water and soil has not recovered their original quality. The polluted water serves as one of the main reason for the change in cropping pattern. After 1998 mostly the irrigation was done using the well water. As the pollutants percolated to their wells it damaged the agricultural machinery like pump sets, which comes directly in contact with water. Only the damage of pump set is commonly seen in all these villages.

Both the quality and quantity of coconut has been reduced. The coconut size has been reduced. According to the farmers, the cotton crop grows with the salt water, but they are not getting the yield. Some of the farmers about four years ago they stopped irrigating their lands since the crops did not even germinate when it had been irrigated. When the pollution problem was high the farmers used a high level of fertilizer and manure for getting normal yield. According to the farmers whatever proportion of fertilizer was applied for raising crops did not result in normal yields since the soil was also affected.

One of the contributing factors for turning of fruitful land into infertile land in these villages can be credited due to irrigation with the polluted water from the tank and well water. The well water samples (Table 3) further amplifies that it has high concentrations of electrical conductivity (EC), which is the main indicator of water quality, which proves that these water is not suitable for irrigation.

6.2 Impact on livestock

Livestock is generally considered as one of the main sources of income in rural areas. Since all the local water boides are polluted in the polluted village, it has posed serious threat to the livestock economy in the village. In the absence of sufficient municipal water supplies, livestock is forced to depend on polluted water. Livestock have been suffering from various diseases as they drink polluted water and graze on contaminated grasses or grazing fields. It was reported by the villagers that around cattle died due to drinking polluted water during the last 9 years. Another serious problem observed in the village is that some cows have lost their reproductive capacity. Grazing contaminated grasses and drinking polluted water have resulted in poor quality of milk and dung.

Table: 10 Status and composition of livestock holdings among the households

Village	Before pollution			After pollution		
T.Redipalayam	Goat	Cow	Buffalo	Goat	Cow	Buffalo
LF	00	10	5	00	2	2
MdF	70	5	8	10	2	1
SF	90	3	4	10	00	00
MF	120	2	5	20	00	00
G.palayam						
LF	00	4	5	00	2	4
MdF	30	2	2	10	-	-
SF	90	3	4	10	00	00
MF	120	2	5	20	00	00
Orathapalayam						
LF	20	4	4	00	1	1
Mdf	40	2	2	10	-	-
SF	70	2	2	10	-	-
MF	90	3	2	15	-	-
Kathagani						
LF	30	3	4	10	1	2
MdF	40	2	1	15	-	-
SF	140	1	2	30	-	-

MF	150	3	2	20	-	-
Kodumanal						
LF	00	4	3	00	3	2
MDF	80	3	2	20	1	1
SF	180	4	4	30	2	1
MF	200	5	4	20	1	3
Karaikatupudur						
LF	00	4	3	00	3	2
MDF	80	3	2	85	4	5
SF	180	4	4	183	5	5
MF	150	3	2	170	4	5
Arasampalayam						
LF	00	3	3	00	3	3
MDF	80	2	3	70	2	3
SF	130	3	2	120	3	2
MF	160	2	3	150	2	3

Composition and holdings of livestock have experienced changes due to the incidence of pollution in the affected village (Table 10). On the contrary, the composition and holdings of livestock showed a little change in the non polluted village the only exception being the positive change increase in the case of goats among marginal farmers. It may be noted that the density of livestock is very low in non polluted village when compared to the polluted village. The decline in livestock population across all categories in polluted villages is due to the reasons that either the livestock have got diseases due to consequent drinking of polluted water or the people have sold their cattle on account of fear of death. Except in the case of buffaloes the decline in livestock holding is higher among small and marginal farmers. Besides, farmers have started depending more on tractor to plough their land even in the non polluted villages rather than buying buffaloes.

6.3 Impact on employment

While industrial pollution imposes severe negative externalities on rural communities, advent of industries in the region could possibly lead to some positive externalities such as employment and income generation. On the other hand loss of employment due to the reduction in area under cultivation is another negative impact. Assessment of these aspects would help us understand the extent of net (indirect) compensation to the communities. After pollution there was a significant change in the pattern of employment in all these polluted villages. Most of the people who were depending on agriculture before pollution have shifted to industry, and other sources. Majority of them have become daily laborers. For those who are employed in industry, majority of them complained that they are working in very hazardous conditions. On the whole employment per year has declined in these villages across the size classes (Table 11). The worst affected is the large farmers in these villages/ Before pollution they used to get employment or engaged in agricultural activities for 250 days out of 300 possible working days.

Table: 11 Impact of industrial pollution on employment

Village/sizeclass	Before Pollution						After Pollution					
	Average no of working persons per HH	Working in own farm	Hired out to farm work	Hired out to industry	Others	Ttl	Average no of working persons per HH	Working in own farm	Hired out to farm work	Hired out to industry	Others	Ttl
T.Redipalayam												
LF	3	250	-	-	-	250	2	85	-	-	-	85
MDF	4	160	-	-	-	160	4	25	10	120	-	160
SF	3	110	25	-	-	135	3	15	20	80	-	115
MF	3	85	65	-	20	175	2	15	20	70	40	145
G.Palayam												
LF	3	260	-	-	-	260	3	70	-	-	-	70
MDF	5	180	-	-	-	180	5	30	10	130	-	170
SF	4	180	30	-	-	210	4	30	10	60	-	110
MF	4	80	60	-	30	170	4	15	30	65	30	140
Orathapalayam												
LF	3	280	-	-	-	280	4	70	-	-	-	70
MDF	4	190	-	-	-	190	4	30	10	30	-	170
SF	4	130	40	-	-	170	4	20	20	100	-	140
MF	4	90	50	-	40	180	4	15	10	100	50	115
Kathagani												
LF	3	280	-	-	-	280	3	90	-	-	-	90
MDF	3	150	-	-	-	150	3	30	-	-	100	130
SF	4	100	20	-	-	120	4	20	10	80	-	110
MF	3	80	50	-	10	140	3	15	10	90	20	130
Kodumanal												
LF	3	230	-	-	-	230	3	90	-	-	-	90
MDF	4	180	-	-	-	180	4	90	-	-	-	90

SF	3	120	30	-	-	150	3	10	20	120	-	150
MF	4	60	50	-	40	160	4	-	30	90	20	140
karaikatupudur												
LF	3	250	-	-	-	250	3	260	-	-	-	260
MDF	4	190	-	-	-	190	4	200	-	-	40	240
SF	4	140	40	-	-	180	4	133	-	60	-	193
MF	4	50	50	-	20	120	4	65	-	85	-	150
Arasampalayam												
LF	3	235	-	-	-	235	3	267	-	-	-	267
MDF	4	194	-	-	-	194	4	200	-	-	-	200
SF	4	123	50	-	-	173	4	154	65	80	-	295
MF	4	70	60	--	-	130	4	80	80	95	13	268

However after pollution it has declined to a sparse of 85 days. For that reason, as the data indicates, large farmers in all the polluted villages have not changed their occupation after pollution. They are still cultivating their remaining land, working on their own farm. On the other hand, other size class farmers have shifted to industry or agricultural labor on other farms. This may be due to the false status of the large farmers, as they do not hire themselves out. In the case of small and marginal farmers the number of days employed in a year declined only marginally while it has remained the same in the case of medium farmers. In the control village per year employment has increased marginally for small farmers from 250 days to 260 days. In the case of marginal farmers the increase is from 235 days to 267 days.

6.4 Problems in implementing the compensation mechanism

Determining the adequate level of compensation to the victims is a mere complicated practical problem, through theoretical solutions are available in environmental economics. The total compensation granted for the pollution caused in Noyyal river was Rs.24, 79, 98,548/-. The dyeing units have deposited only the first instalment of Rs. 1.80 crores and the balance amount has not been paid till date. Some of the affected farmers in these five villages have received their first instalment of compensation. The people in these five villages are not content with the compensation. This study tries to highlight the problems where the underlying disciplinary issues for these problems should be properly resolved in a damage assessment exercise.

6.4.1 Scope of damage assessed

The mismatch between the actual damage and the estimated damage may arise if the scope of the damage assessment is not properly defined. Water pollution and the extent of its environmental consequences clearly deserve estimation of economic damage in terms of monetary values, which is a prerequisite for determining the level of compensation for the affected victims. However, the economic assessment of environmental damage and the compensation thereof pose different kinds of methodological problems. In the compensation awarded to the farmers in these five villages there was a noticeable difference between the amounts of compensation arrived at and the actual compensation to be provided to the losers. This mismatch may be attributed to (a) selection of the economic valuation technique to estimate the amount of compensation, (b) the limited 'scope' of damage assessed, and (c) the issues related to the relationship between the property rights over the environmental resources and compensation thereof.

6.4.2 Property rights over the environmental resources

Another important aspect to be addressed in a damage assessment study is the 'property rights' and its relationship with compensation. In the damage assessment there are a large number of different kinds of losers who do not have any well defined property rights over the benefits declined due to pollution. One of the farmers expressed his view that the loss in health status for the human beings has not been counted. '*We have been suffering from various diseases like skin allergy, respiratory infections, general allergy, gastritis and ulcer for the past ten years. We have been spending our income to medical expenses but we have not been compensated for our health problems*'.

In the case of agricultural sector the losers are easily identified as the losers have the 'well defined property rights' over the land that has been affected by pollution. In the case of the five villages the farmers having wells in their lands are identified to claim compensation. Even though the property rights of their farm land have been submitted to receive the compensation some of their farmers are not able to receive the compensation payment in Orathapalayam village. Around thirty of the farmers' names have been mislaid in the revenue department, so the farmers have to struggle to claim the compensation by legal proceedings. Farmers believe that the Orathapalayam dam has served the interests of the dyeing units rather than farmers. The Farmer's Association President said that if we had not filed the petition 10 years ago the damage would have been far greater. "*It has taken so long to get justice. But at least we have prevented ecological damage all the way up to Nagapattinam and Thanjavur along the Cauvery.*"

Another farmer further emphasised that '*I does not owe a well, livestock rearing was my main income before but due to this pollution I have lost my cows, buffaloes only I can do cattle rearing. I am not able to claim compensation as it's given to the people who have land only'.*

There are various types of people affected by this industrial pollution. Another major impact of industrial activity of the dyeing units in the upstream is on the livestock sector. It has affected the downstream livestock rearing among marginalised farmers in all these five villages. The loss in livestock has been discussed in (Table: 8). the compensation has not been fixed to the loss in livestock sector. The compensation has been formulated to the affected victims who have the property rights over their respective lands.

6.4.3 Quantifying the benefits

The impact of water pollution for these villages was estimated in terms of crop loss. The loss of productivity was monetised based on the predominant cultivating crops like paddy, cotton, and coconut. The loss for these crops (table 7) has been monetised for one acre. The practical problem is to identify and quantify the benefits by water resources existed in the unpolluted condition. While calculating the use values both quantifiable and non-quantifiable values should be included. The non-quantifiable value such as loss in agricultural equipments, loss in pump sets, has been considered in this study for these five villages.

One farmer conveys his view '*the authorities came and took the water sample. They didn't question or survey about our farming status. We came to know later that we have been awarded this much amount as compensation. How is it possible to derive compensation with the help of water sample not without any dialogue with the affected people* '?

Though the data for predominant crops can be culled out from government records, the compensation should be formulated in a contemplating way considering the affected farmers estimation of their farming status. The secondary data on agriculture, (loss in pump set, agricultural equipments) livestock, and fishery areas pose much difficulty to derive. Alternative sources such as primary surveys that look at the affected victim opinion about the initial and current levels of benefits and the quantity of agricultural output before and after pollution can be used.

As the dyeing units in Tirupur delay to pay their partial compensation to the District Collectrate, to the affected farmers has raised much criticism from the farmers and the public. The costs of damage would be higher if social costs such as alienation of the villages (marriages, education, social visits, health loss etc.) by others were accounted for.

6.4.4 Selection of the economic valuation technique

In the particular case of the Noyyal River, the discharge of industrial effluents in the urban areas of the river, particularly Tiruppur has an impact on downstream farmers as well as on drinking water. For some parameters like Total Dissolved Solvents (TDS) these standards have in fact been relaxed, by Tamil Nadu Pollution Control Board (TNPCB) without giving sufficient thought to cumulative impact.

The valuation technique to assess the damage in the agricultural sector was straightforward. This method is based largely on scientific data on levels pollution. This approach looked only at the level of Total Dissolved Solvents (TDS) in the ground water and compensation was based on the TDS. If the TDS level is high the compensation amount will be large. In these five villages the water samples were not collected individually from each well it was collected randomly and the compensation amount was fixed. During the monsoon period the pollution load discharged may vary and there will be change in TDS level. Variation in constituents from month to month, year to year does occur. Hence, the level of compensation to the losers may vary. It also depends mainly on the nature of the valuation techniques selected. In this study the TDS level (Table: 8) was found to be high in these five villages, which indicate the range of pollution extent has not been reduced. So the ad-hoc amount of compensation should be fixed for the subsequent years.

6.4.5 Limited scope of damage assessed

The water resource generates two types of benefits, namely use benefits and passive use benefits. In Noyyal River these benefits include water used for drinking purpose in the household sector, for irrigation purposes in the agricultural sector. The five villages around the Orathapalayam dam have used the river water for drinking purpose, irrigation and for fish production. The compensation amount was restricted only for agricultural sector for a period of six years In one of the interview with the farmer he says *'the award has been given up to 2002 is arbitrary. The industries are still discharging their wastewater in to Noyyal River and have to be compensated after 2002 at least close to its original value'*. As the livestock rearing serves as an income for rural household the loss in livestock and fisheries should be incorporated in compensation mechanism. When the non-quantifiable benefits are not incorporated in the damage assessment, there is a possibility that the actual estimated is much lower than the prospective compensation.

The farmers feel that the damaged lands have not been estimated in a proper way. One of the farmers says '*the Anna University has estimated the damage as Rs. 114.91 crores as payable by the way of compensation. However, the Loss of Ecology Authority, reduced the compensation amount to Rs 24, 79, 98,548/-. We are still hiring the court assistance through legal proceedings to award us the right compensation*'. '*The Noyyal River should not be further degraded the RO system should be implemented by all dyeing units*'.

6.5 Zero Discharge process in Tirupur

Clean industrial production requires a cutting edge shift, from the current approach to a positive preventive approach (UNEP, 2001). There are three major ways of achieving clean production: reduction at source, recycling, and product modification (PWD et al., 2002). Examples of clean production measures in textile industries include dye bath segregation, zero discharge: reuse of process water with RO and/or MEE system (Joseph et al. 2004). Currently there is no viable technology available to remove TDS expect RO (PWD, 2002). RO can handle high TDS concentrations and recovers around 80% of the process water (Shankar, 2001). The basic elements of the zero discharge system are RO filtration that recovers pure water from the effluents, Nano Filtration (NF) that recovers salt in solution from the RO reject, Multiple Effect Evaporation that recovers water in the RO and NF rejects, and Solar Evaportation that evaporates the remaining water in the MEE reject. The economic benefits of zero discharge are reuse of water and salt reduces processing expenses, ground water depletion in the surrounding areas is averted, the industry can increase its productivity without concern on discharge units. However, the electricity requirements of the zero discharge system are costly as well as purchase of wood. The electricity costs can however be reduced by establishing windmills or biogas plants.

There are still problems with the RO membranes. The high COD value of the dyeing effluents, even after pre-treatment with lime precipitation causes frequent failures and choking of the membranes.(p.a). One informant for this study told that RO is not the final solution. Recycling of 100% pure water is not possible. For one CETP installing of RO process involves the investment of 750 crores. In the final stage daily 50 crore litres of water should be evaporated.(p.a) Firewood is scarcity and alternatively windmills or biogas plants have to be constructed.

6.5.1 Dyers problems in paying compensation

The PPP originates from Pigou's negative externality analysis which suggests that the negative externality (in the form of pollution) caused by the economic activities deforms the functioning of the product market and therefore, the deformation may be corrected by way of imposing a pollution tax where the marginal cost of controlling pollution is equal to the marginal benefits restored. Conceptually the PPP (Polluter Pay Principle) in many of the developing countries including India is not being properly used. In India the pollution control policies are mainly based on the 'command –and-control method'. When the polluters find the cost of controlling pollution under the command-and-control regime to be high, they are either not willing to control pollution or expect the government to bear a larger percentage of the pollution control cost.

6.5.2 Large Dyeing Units

In Tirupur the dyeing units (polluters) have to implement both the technology needed for the prevention of pollution zero discharge system, cleaning of the dam and to pay the compensation for the affected victims. The large dyeing units involve manufacturing activities like knitting, dyeing, finishing and stitching. The large dyeing units were able to achieve zero discharge through RO, and MEE. The investment cost was Rs.11.4 million (USD 270,000). The Managing Director of large scale dyeing has invested in RO as the recycling of water 70-80% of the water requirement appeared attractive. The membranes are costly part of the process. Membranes are still imported. The overall water consumption is reduced by 30% by zero discharge (p.a.). The factory uses around 1000,000 litres of water per day,1-200,000 litres of fresh water is supplied by the New Tirupur Area Development Corporation Ltd (NTADCL). 900,000 litres of water are recycled daily. The large dyeing units achieving the zero liquid discharge (ZLD) status attain the appropriate certificate and they are not liable to pay the fine and the compensation.

6.5.3 Small Scale Dyeing Units

Most small-scale dyeing industries do not have necessary land, finance or technical and managerial expertise to establish and operate their own ETPs. Collective abatement through CETPs allows these industries to comply with the TNPCB standards at a lower cost. The annual running costs are very high in both individual ETPs and CETPs making up around 80% of the total pollution abatement cost. In one of the interviews with the small scale dyeing units they complain '*that even after pre-treatment with lime precipitation causes frequent failures and choking of the membranes. Frequent installation of RO membranes involves huge amount of money and have to bear the import cost. When we are not able to install the Reverse Osmosis Plants within the time stipulated by the Court, they are imposed fine for the discharge of effluents. The additional fine, cost to invest in installing the RO plants, the compensation amount to be paid makes the condition more decisive for us*'. '*We need the government to support us by providing incentive to construct RO plants'*. Presently the industries do not have enough support and expecting the government to enhance them by providing some incentives to install the RO plants in CEPTS.

6.5.4 Medium Scale Dyeing Units

The annual turnout of medium scale dyeing units is USD 10 million. The medium scale units use around 500,000 litres of water per day. 100,000 litres of fresh water is supplied by New Tirupur Area Development Corporation Ltd (NTADCL). 400,000 litres of water are recycled daily. The two medium scale dyeing units previously treated the dye bath water and discharged the effluent in Noyyal River.

Both of the units have individual ETPs and they are constructing Multi Effect Evaporation (MEE) to attain zero liquid discharge. In one of the interviews with the medium scale dyeing units they said '*initially the Pollution Control Board left the installation of CETPs to the dyers themselves no scientific solution was suggested that gave a lot of confusion to the dyers, and still they have no basic scientific idea of installation of RO plants in their units'.* The two medium scale dyeing units have paid the compensation and cleaning up of dam. If the court directs notice to pay the compensation the TNPCB will activate the dyeing units to pay the amount. It was not possible to take action against all industries because the industry brings the revenue and generates employment.

The PPP suggests that those who are responsible for the pollution should be made to pay the cost of pollution. Even though the large scale dyeing units face the problem of competitiveness they are able to pay the compensation and install the RO plants for prevention of pollution. The infrastructure of the regulatory agency the Pollution Control Board (PCB) should be improved for monitoring the payment and enforcement to pay the compensation. More precisely, the compensation amount to be collected is being delayed by the small scale dyeing clusters. Any subsidy targeting that the beneficiary firms will have a lower expected marginal benefit of non compliance (Stransland, 1997). Such assistance can do wonders for small scale dyeing units crippled with technical, managerial and financial bottlenecks. If there is no incentives provided there is a possibility that the small scale dyeing units will not be able to sustain in this financial burden and may fade away.

6.6 Regulatory Problems

The pollution control legislations in India reveals that the government of India has tended to rely on command and control (CAC) policy for pollution control. For successful implementation of CAC policy certain facilities are necessary most important is the monitoring and enforcement capabilities of regulatory agencies. In addition the penalty for non compliance is not stringent enough to set up or to operate the treatment equipment (Dasgupta et.al 1998). Previously the wash water was treated with lime precipitation and dye bath with solar evaporation. The treated effluent was discharged in to the Noyyal River. In spite of the big investments in Effluent Treatment Plants (ETP)s and Common Effluent Treatment Plant (CETP)s the industries are not fulfilling the standards (p.c) and many industries are not running their ETPs 24 hrs and end up releasing in Noyyal River. (p.c).As the environmental externalities occurred on a bigger scale with a large number of polluters in Tirupur and the TNPCB has meagre resources the Court implemented the 'two-tier monitoring' in Tirupur. The monitoring committee appointed by the court and the PCB act in this system. The monitoring committee bridges the asymmetric information as they can target the polluters more efficiently. TNPCB acts as a regulator to make the dyeing units to pay the compensation amount. TNPCB and monitoring committee monitors the discharge of effluents in to the river and construction of RO plants. (p.c).

6.7 Impact/Damage Studies

Damage studies are taken up after the damage has occurred. Damage is based on actual measurements which may or may not fully capture the impact on the environment. Measurements have their own limitations in terms of accuracy and quality. However, damage studies do capture cumulative impact over time unlike traditional environment impact studies. The discharge of TDS in any given time period may not be reckoned to be a serious problem. However, if the TDS is not assimilated, the repeated discharge over twenty years may result in build up which has serious impact. The regulations have to ascertain if the environment has the capacity to assimilate the pollution load over time. When the pollution load exceeds the threshold effects of water or soil the ecosystem can totally break down. For example, a crop like paddy can no longer be grown in this area. Thus the regulators must also look in to the carrying capacity of the receiving environment. This damage assessment provides some indication of the cost of inaction. However, the estimate of damage may be lower than the actual impact because of the limitations of the methodology. For example the study area in this case was limited to five villages around Orathapalayam dam.

Chapter: 7 Final evaluation

Water Pollution: Policy and Institutional failure

Judging from the information collected in this study, Tirupur the textile city with rapid industrialization, the disposal of liquid waste is a growing problem. However, when industrial effluents are discharged on land or water they not only pollute the environment but also affect the ecosystem services such as irrigation, livestock, fisheries, drinking water.

To recapitulate, the impact of industrial pollution on rural communities is quite substantial in monetary terms alone, the real impact on health economics is difficult to assess. The losses due to agriculture are difficult to assess the problem in pure economic terms of valuation of losses. Hence, the solution to solving the problem lies not in compensating the loss but in removing the problem altogether. Here compensation means giving the right to pollute. Beyond compensation something has to be done in order to end the problems forever. This could be in terms of strict regulation on the industries to adopt pollution mitigating technologies or face closure. However, this calls for a close look at the economics of pollution mitigating technologies, which will be a worthy exercise. State policy also has a major role to play in this regard.

In the present case the Tamil Nadu Pollution Control Board (TNPCB) is responsible for the area of Tirupur industries. The villagers have complained a number of times regarding the loss of crops, loss cattle and pollution of tank and tube well water. In response to these complaints, the officials visited the village and surveyed the area. They took carious water samples for testing. According to the villagers, this has become a routine for PCB, and no action has been initiated against the industries. Bringing the judiciary into the picture also did not help much in solving the problem. Judiciary entered the scene after a public litigation suite, as the negotiations between polluters and criticism with regard to compensation for damages have failed. Supreme Court had, ordered that a report regarding the damage due to pollution should be submitted and also ordered that even one drop of effluent should not be discharged into the tank. The Supreme Court entrusted the Loss of Ecology Authority the responsibility of estimation of damage cost. They have estimated Rs. 21400 per hectare of agricultural land, leaving out other damages such as livestock and health. However, it is not clear how the estimates were arrived at. Our estimation shows that the damage to crop production itself is Rs.91173 for Thammuredipalayam, Rs. 44226 for Ganapathipalayam, Rs. 58983 for Orathapalayam, Rs. 459259 for Kathagani, and Rs.54930 for Kodumanal per household per year. Therefore, the compensation offered in these villages is a gross under-estimation of the actual losses. On the contrary Supreme Court's compensation package was propitious to industries rather than to the rural community. For that reason, the compensation recommended by the Loss of Ecology Authority was half that of the amount offered by the industry on their own. Moreover, even after 3 years of the Supreme Court judgment, the compensation did not reach the people, though some of the neighboring villages have received the compensation. The Court order was that the money should be collected from the polluting industries and deposited in the account of district Collectroate. Then the Revenue department will distribute the money among the victims. Some villagers even approached the industries for compensation, the industries denied saying that they have already given their money to the collect rate/ The villagers visits to the Collectroate office have also gone in vain. As a result, the villagers continue to be the victims, in the hands of the judiciary as well as the industries.

On the other hand, majority of the households, especially small and marginal farmers, have been compensated indirectly through employment opportunities in the industry. Since these farmers account for 90% of the households the attempts of civil society for better compensation were not effective. In terms of per household losses small and marginal farmers incur in the range of Rs.7000- to Rs.20000 which is much less than that of the losses incurred by large and medium farmers. Moreover, these households are concerned about their day-to-day livelihoods and they are not in a position to join the fight for justice. This indicates the hat homogeneity/heterogeneity in the interest or stakes in the resources makes the collective action strategies, here the heterogeneity of interests is mainly due to the availability of employment opportunities in the industry to majority of the population. Also, the large and medium farmers who are losing more due to pollution are in minority. Besides, their social status prevents them from taking up the jobs in the industry.

Industries have constantly confronted the compensation payment made by the Loss of Ecology Authority on various technical and legal grounds. At the same time compensation amount was found to be meagre for the farmers and do their legal proceedings to attain an acceptable compensation. The cases drag on in the court for several years before the compensation has paid. Another issue is the technology of pollution control. The court has introduced the two tier monitoring system where the monitoring committee monitors the discharge of effluents and imposes fine on the dyeing units those who are not able to attain zero liquid discharge status. The Tamil Nadu Pollution Control Board monitors the payment of compensation to the District Collector Office. If the payment is getting delayed the farmers file a case in the court, the court orders notice to the dyeing units to pay and the TNPCB urges the dyeing unit to pay the amount. The payment scheme for the compensation has not been regular. It's clear that both IETPs and CETPs are forced to incur additional capital expenditures of this magnitude 19 crores for CETP and 20 crores for IETP for Reverse Osmosis (RO) as they are so ordered by the legal institution Court. The legal institution Court has acted on Polluter Pay Principle (PPP) and regulated the pollution to a certain extent. In this scenario the large scale dyeing units are able to sustain though they face competitiveness but the small scale dyeing units may fade away due to financial crisis.

The compensation was drawn to the temporal limits. Can a one-time compensation for ecosystem change is adequate? The ground water to retain to its original quality will take more than ten years and if the loss in ecosystem services are noted the one time compensation is not adequate for the losers. More over compensation should not be a gesture for the polluters to discharge the effluents in to the river as they reimburse. Regulatory infrastructure should be enforced strictly to monitor their effluent discharge.

Due to these reasons, protests in front of the State Secretariat in the form of dharna (mass squatting) have resulted. In spite of the Supreme Court Judiciary the community did not succeed in influencing either industries or regulatory authorities. The movement could not sustain because a majority of the population have shifted to jobs in the industry leaving agriculture. It is clear that mere passing of laws and creating institutional structures are necessary but not sufficient to address the environmental problems. Policies should be implemented in their right perspective. Institutions should be strong enough, with more autonomy and powers, to deal with the problems at hand.

7.1 Actions needed and suggestions

As of August 2007, the local people around these villages has paid a large part of the externalities of the polluting activities of the textile industries in terms of agricultural productivity, agricultural land, fishing, livestock, and working opportunities. Though the compensation is not a bonanza, it should be a solution to the affected people. Though the compensation was awarded in 2004 it has not been awarded to all affected people in these villages.

The government needs to increase the days of providing drinking water to the affected villages. Livestock also needs safe drinking water. The Connections between diseases and the polluted water need to be investigated and information has to reach the affected people. Local people needed to get updated information about the quality of their water. Research should be done to train the farmers to cultivate the crops suitable for their land. Rain water harvesting could be started in these villages in order to utilize more of the highly variable rainfall People should have the facility to receive free health care. Health care programme should be conducted to monitor the health of the affected people and the livestock and to notice if there is any specific problem.

7.2 DYERS

Dyers should use more natural dyes. Adequate financial investment should be available for implying both for paying compensation to the affected people in downstream and to fund for the RO plants. Research on cleaner production and treatment methods for textile industries should be done. Government should provide incentives for small scale dyeing units to implement the RO plants to attain zero liquid discharge. Scientific idea should be provided to all dyers about the RO system. PCB should enforce the dyeing units to pay the compensation amount.The capacity of the PCB need to be enhanced for the enforcement of the effluent water quality standards in the environmental legislation. Co-operation between different government agencies in the water sector, agriculture and irrigation, fisheries need to work together and have a better dialogue with industries and exchange information and data with research units.

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