Monitoring and Enforcement: Is Two-Tier Regulation Robust? – A case study of Ankleshwar, India

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Abstract:

The regulation of industrial pollution is difficult in a rapidly industrialising, low-income setting. This study looks at the efforts to regulate chemical plants in Ankleshwar, the largest chemical estate in Asia. Pollution comes from many sources, the distribution of information is highly asymmetric and the authorities have meagre resources. The location of plants in an industrial estate does however provide interesting preconditions for a form of two-tier regulation, in which industry association becomes an intermediary between regulator and firms. The association is better informed and has an incentive to regulate its members to maintain a good reputation but doesn't possess much formal authority, and its voluntary monitoring and abatement program is akin to managing a common property resource. The analysis of four preconditions for the success of such management: suitable design principles, effective monitoring, objective implementation of rules, and enforcement, indicates that they are satisfied at least partially in Ankleshwar.

Key words: Industrial Estate, two-tier monitoring, common property resource, industry association, nonpoint sources of pollution

JEL Classification Numbers: Q25, P28, K42

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1. Introduction

The failure of industrial pollution control in many developing countries is due both to the rigid command and control (CAC) regulation and to the prevalence of small-scale and informal sector pollution sources that lack knowledge, funds, technology and skills to treat their effluent. The data shows that in India pollution contribution from small-scale units (SSIs) nearly matches that of large units (CPCB, 2001: 2). The share of SSIs in wastewater generation among 11 industries, where they have a sizeable presence, is about 40%. These units are difficult to regulate because they operate in the 'grey zone' of the economy, where reporting requirements hardly apply (Sterner, 2002: 325; Gunningham, 2002: 21, Sankar, 2001). This makes the use of both CAC and economic instruments difficult and in some cases the regulatory agency faces almost the same kinds of dilemmas as with non-point sources of pollution (NPSP) (*ibid*.).

Thus, the SSIs aggravate the problems of regulator(s) already constrained by meagre resources and limited authority.[1] In settings marked by large unemployment, these weaknesses may together seriously impair the ability of the environmental regulatory agency to conduct effective monitoring and enforcement (Pargal and Wheeler, 1996; Mookherjee and Png, 1992, 1995). The problems are compounded by information asymmetries (Wheeler *et al*., 2000).

The failure of formal regulation in the past has in some cases resulted in informal regulation such as information disclosure and labelling or rating programs gaining importance in controlling pollution. This is sometimes referred to as the "third wave" of environmental policy (Tietenberg, 1998). One of the pillars of this approach is the inclusion of all stakeholders – community, industry, consumers, and non-governmental organisations, along with government and media representatives (Wheeler *et al*., 2000). The approach argues that the policy instrument choices are not a simple tax *versus* regulation, but rather a mix of policies including regulations, information provision, subsidies, charges, and provision of public goods, all moulded together through a *process* of policy dialogue in which the stakeholders really take part (Sterner, 2002). One related instrument that is particularly relevant here is voluntary agreements. Another instrument that has a lot of

[1] Kathuria (2003) gives few anecdotal evidence of meagre resources and limited authority of the regulator in case of India.

bearing on regulation is two-tier monitoring. This is similar to common property resource management since both involve peer monitoring as a key ingredient.

Peer monitoring has long been used to manage resources but to contexts such as fishing, grazing of pasture land etc. (see Ostrom, 1990) where agents are quite homogeneous in terms of caste, level of income, ethnicity, education etc. Recently, peer monitoring has found application in fields such as group lending,[2] education (to monitor site visits by education department officials)[3] etc. The other important area where a form of two-tier regulation has been used is in the case of non-point source pollution. Here the regulator writes contracts with communities, which are encouraged to monitor a resource (for instance reducing run-off from agriculture). The structure of these contracts has two main features: (a) community is encouraged to use peer monitoring and other social mechanisms while (b) the regulator only measures aggregate results such as ambient pollution levels and refrains from detailed regulation but keeps the threat of reverting to regulations if ambient conditions are not met (see Segerson, 1988 and Sohngen, 1998).

Two-tier regulation (or industry co-regulation)

Two-tier regulation in industry is also referred to as 'industry co-regulation' or 'industry self-management' where hybrid policy instruments are used (Gunningham, 2002: 17-18). The two-tier monitoring or industry co-regulation essentially uses a combination of government set targets and industry-based implementation, where industry is also subjected to government controls (*ibid.*).[4] It is to be noted that two-tier regulation is distinct from pure self-regulation, as in the latter, the industry is given considerable autonomy in relation to both goal setting and implementation. On the other hand, in industry co-regulation or self-management, only the administration of regulations is transferred from government to industry. Ideally speaking, this is a policy strategy that leaves the government free to focus on its core business of setting policy directions (in the case of pollution, it will be setting norms and standards and how to achieve that). According to Gunningham (2002), the two-tier or co-regulation requires creation of non-profit, self-funded organisations led by industry councils or similar bodies to deliver services and programmes.

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[2] See Yeon-Koo (2002) (Source: http://www.bepress.com/bejte/contributions/vol2/iss1/art3 accessed on August 1, 2003).

[3] Source: www.edu.uidaho.edu/peermonitoring (accessed on August 1, 2003).

[4] Similar self-regulation is presently being used in Western Australia. There a three step approach is being followed - in which units have been divided into three categories depending upon their pollution potential with each category subjected to different regulatory institution. The highly polluting industries (which include a minority of small and medium enterprises, SMEs) are required to be licensed. The middle category that includes many SMEs, requires only registration, whereas for the third category of units having minimal impact – monitoring is through industry self-management, local government and state agencies (Gunningham, 2002: 24). This third category is essentially a two-tier form of regulation.

The existing evidence and the policy discussion so far assumes that self and co-regulation can only be applied in the context of large units. The two well-known studies, where self or co-regulation has been effectively used are in the context of US chemical (i.e., Responsible care program of Chemical industry) and nuclear power industry (i.e., Institute of Nuclear power Operators of Nuclear Power industry) – both comprising of large units (Gunningham and Rees, 1997). The notion that self- or co-regulation is a credible policy option for large-scale units is because the risk of free riding is minimised when the group to be monitored is not only small but also readily identifiable with a self-interest in protecting their collective reputation (Gunningham, 2002: 19).

Despite pessimism of self-regulation for small units, some of the problems of monitoring SSIs can still be circumvented. This is because a sizeable proportion of the units in many developing countries including India, Thailand, Bangladesh, etc. are clustered in industrial estates. The industrial estates have two important characteristics that may make them useful intermediaries in the regulatory process: (a) they are partly democratic or co-operative structures managed by their respective industry associations, and (b) they have better information on pollution generation and technology of individual units. Although aggregate pollution from an industrial estate is clearly noticeable and attracts attention, it is very difficult for regulators and residents to monitor individual plants. Given the size of the task, the costs involved, and limited budget, the regulatory agency has limited options in its repertoire and may be tempted to resort to two-tier regulation by delegating monitoring and enforcement to the estate representatives.

Since industry associations are insiders and interact with individual units on day-to-day basis unlike the regulator, they have more information on the pollution profile of individual units. Thus, by harnessing the proficiency of peer monitoring, the industry association can achieve higher monitoring efficiency. This has the potential to raise the marginal expected penalty for the plant. Additionally, as the association comprises of member units of different sizes, they are more equipped in providing technical and other support (through large firms), thereby lowering the unit's marginal abatement cost (especially if the firm is small). Evidence from Guadalajara, Mexico is a clear testimony to this as 11 large companies, many of them multinational corporations (MNCs) agreed to provide assistance to 22 SMEs suppliers who were interested in improving their environmental performance. At the end of 9 months of implementation, 80% of plants reported lower pollution and nearly 50% reported improved compliance and waste handling (Wheeler *et al*., 2000).

Two-tier regulation has advantages in monitoring but does not solve the problems of collective action, such as free riding. Still the association will have stronger incentive for self-regulation, since it must consider the effect on all its members if the estate draws bad

publicity. This implies that the reputation of the estate is a form of common good, or a common pool resource. The incentive to monitor and regulate recalcitrant polluters increases if the units housed in the estate are not only large but also have multi-market presence.

There is a vast literature on social dilemmas, free riding, and the management of common pool resources, from which we can draw hypotheses concerning the sustainability of an arrangement like two-tier regulation or industry co-regulation. Ostrom (1990) focuses on three major puzzles of common action: the supply of the common good, achieving sustained commitment to the group, and designing appropriate incentives for mutual monitoring. By way of a guide she summarises seven design principles that are prerequisites to sustainable management of a common pool resource. With the wording adapted for our context, the principles are as follows:

1. Because free access to a resource is likely to lead to over-utilization, membership and the rights and obligations that go with it must be clearly defined.
2. The rules governing the rights and obligations must be proportionate to one another and appropriate for the local conditions.
3. Structures for decisionmaking should be democratic.
4. Monitoring must be effective, and monitors should be either the participants themselves or at least accountable at the local level.
5. Reasonable and credible sanctions are needed. They need to be carefully graduated to avoid alienating first-time offenders. Monitoring itself should be rewarded to create incentives for mutual monitoring.
6. Appropriate mechanisms for conflict resolution are needed.
7. Finally, some recognition by external government authorities is also needed.

Against this backdrop, this paper evaluates to what extent the Ankleshwar Industrial Estate (AIE) of Indian state Gujarat has been able to meet these design principles, where this two-tier or industry co-regulation is in use since 1997.[5] Section 2 gives some background on industrial estates in India and AIE in particular. The section also describes the two-tier monitoring in the context of AIE. Section 3 focuses on the provision of common goods such as effluent treatment and the rules concerning use and cost sharing; section 4 looks at the structure of fines and their effect on effluent generation. Section 5 takes a look at the distribution of fines between different types of firms to assess whether they appear to be levied fairly. Section 6 discusses the applicability of Ostrom's design principles in Ankleshwar and section 7 concludes.

[5] Ankleshwar is not the only estate in India where two-tier regulation is in practice. Some other estates like Vapi, Nandesiri, Naroda etc. are also relying on industries association to monitor individual units.

2. Pollution Control in Industrial Estates

India's industrial estates were originally a tool for industrial dispersal. At the time of independence, industries were heavily concentrated in a few regions of the country—essentially around major cities like Calcutta, Bombay, Kanpur, and Madras; the rest of the country was largely unindustrialised. In 1971 planners identified about 245 districts, as "backward", comprising 60% of the population and 70% of the area of the country. Alongside other policies, such as capital investment subsidies, transport subsidies, and income tax concessions, was an Industrial Estates Programme that sought to locate industries in such areas. Besides promoting development by building infrastructure, the program was intended to generate competitiveness through agglomeration economies. At present, there are nearly 867 industrial estates in India (CPCB, 2001: 2). In Gujarat alone, the Gujarat Industrial Development Corporation (GIDC) has set up 257 industrial estates, of which 169 are currently operational.[6]

The environmental awareness of the industrial estates grew in the late 1980s, when the industries' development corporations began developing effluent collection networks, combined effluent treatment plants (CETP), disposal systems for treated effluents, and tree plantations. Currently, the industrial estates also serve as zoning devices and are an instrument of policy by which state authorities can, in principle, prevent development in ecologically sensitive or heavily populated areas. Even within estates, separate zones for pharmaceuticals, dyes, and pesticides can be a tool to reduce air pollution and facilitate better waste collection, treatment and disposal efforts.[7]

Ankleshwar Industrial Estate (AIE)

Ankleshwar Industrial Estate (AIE) is the largest chemical estate in Asia, covering 16 square kilometres and housing nearly 1,600 units in different sectors, including 400 chemical units. Of these 400 chemical plants in AIE more than 65% are SSIs, nearly 25-30% are of medium size and the remaining 5-10% units are of large size.[8] Its situation on the Bombay-Delhi railway makes it highly visible. Figure 1 gives the location of the estate. The plants in Ankleshwar process large quantities of basic chemicals, solvents, acids, and fuels to manufacture more than 25% of Gujarat's (5% of India's) output of pharmaceuticals, chemicals, pesticides, dyes, and intermediaries. Assuming the share of pollution is commensurate, AIE may be producing 5% of India's total chemical pollution in just 16 square kilometres. AIE has estimated that its members generate between 250 million and 270

[6] Source: http://www.gidc.gov.in accessed on July 2000.

[7] This kind of zoning is being tried by GIDC in new estates. Also in other countries, industrial estates are being used as zoning devices to reduce pollution (see Israngkura, 2000: 87).

[8] A recent report puts the total functioning units in the estate as 720 with 250 as chemical including 47 pharmaceutical firms (Source: Jani, 2001: 22).

million litres of liquid waste per day (MLD), and roughly 50,000 tons of solid waste annually (TPA) (Bruno, 1995). A recent report however puts the figures as 45 MLD and 42,500 TPA respectively (Jani, 2001: 26, 32). The (treated and untreated) effluent from AIE is discharged in Amlakhadi[9] Creek, which is now completely void of biological life. According to India's Central Pollution Control Board (CPCB), of the five possible classes of water quality in decreasing order, A to E, the Amlakhadi is even *below* E. Already the groundwater in neighbouring villages has been affected, allegedly leading to the death of some cattle. A high volume of chemical production and visibility of the estate has resulted in significant negative publicity of the estate in the past few years.

Since 1997 AIE is encouraging pollution abatement among its units with such instruments as provision of information, direct regulation of emissions at individual units, and fines if a unit's emissions exceed the standards.[10] According to Ostrom (1990), all efforts to organise collective action must address a common set of problems—coping with free riding, solving commitment problems, arranging for the supply of new institutions, and monitoring individual compliance with sets of rules. The solution to most of these problems becomes more tractable if the institution has suitable design characteristics. Figure 2 gives the schematic diagram of two-tier decisionmaking institution in the case of AIE. Before explaining the two-tier decisionmaking in Ankleshwar, it is imperative to see what institutional mechanism exists in India to control pollution.

Institutional Set-up in India to control pollution and Two-tier decision making in AIE

A basic division of power between the centre and the states exists in India in regard to environmental regulation, reflecting the federal nature of Indian Constitution. The mandate of the Central Pollution Control Board (CPCB), the main Environmental Protection Agency of India is to set environmental standards for all the plants in India, lay down ambient standards (though State PCBs can set even stricter standards depending upon the carrying capacity of the region),[11] and co-ordinate the activities of the SPCBs. The implementation and enforcement of environmental laws, however, are decentralised, and are the responsibility of the SPCBs. In case of Gujarat, though CPCB has laid down standards, but given the highly chemical intensive industrial base, the local PCB i.e., Gujarat Pollution Control Board

[9] The Amlakhadi Creek is 14 kilometres long; it carries effluents from the Ankleshwar, and newly constructed Panoli, and Jhagadia industrial estates and finally flows into the Narmada River, which meets the Arabian Sea.

[10] In the past few years many Industries Associations in Gujarat (e.g., in Vapi, Odhav, Naroda etc.) and elsewhere in India have initiated such precautionary steps. This may be due to easier access to public information and legislative changes (through public interest litigation), along with highly publicised accidents, such as Bhopal, which seem to have made polluters more conscious of the risk of legal action. Even courts and local EPAs have directed Industries Associations to monitor individual units in their respective estates (Kathuria, 2003).

[11] This is similar to the 'subsidiarity' principle followed by EU member countries in regard to setting of environmental standards.

(GPCB) has made the standards somewhat stricter. This can be seen as the mainstay of the first-tier of pollution control.

As mentioned, in co-regulation the implementation is delegated to industry, which forms the second tier. In the case of AIE, though no such delegation has taken place legally, still the industry association is monitoring individual units. In this context, it is also important to note that no legal backing exist for Ankleshwar Industries Association (AIA) to levy and collect fines. However, a High Court (HC) ruling in 1995 has led GPCB to issue directions to the industries association to monitor individual units in their respective estates, thereby making the association partially responsible for the effluent generation. Even if the HC or the GPCB had not directed the Industries Association to undertake monitoring, they would have initiated such monitoring of their own at least in Ankleshwar. This is partly because of the presence of many large firms some of which are foreign or Indian MNCs, which, in general, will be more concerned about their image, a direct manifestation of reputation of the estate. Thus we can see that the incentive for agents to self-regulate comes from various sources – direction from the regulatory bodies or the courts, the presence of large scale firms in the estate which have multi-market presence and care for their reputation since they are under constant pressure from the media and NGOs.

In order to monitor individual units, the AIA set up an environment committee in the early 1990s.[12] The setting up of this committee (and other committees in respective fields) is a move towards decentralization of power and also to make available expertise and assistance of highly qualified and experienced members in the area (Source: AIA Annual Report, 1997-98). The setting up of AIA itself is a democratic process, where members are elected for three years. The elected members then select the office bearers for two-years. One-third of the elected members retire every year. However, not all the units in the estate are members of the industries association. The discussion with some of the non-members and members indicated that units, which are polluting in nature or need regular support from the association, are members. The estate is divided into six phases. The analysis shows that in the past few years each phase is getting represented and both small and medium and large units are represented. The association is quite active as is reflected from its activities. The elected members often meet and discuss various issues and problems faced by individual units. The dynamism of the AIA gets mirrored from the fact that in the year 1997-98, more than 850 letters were written from the office of the AIA President / General secretary. Besides, 120 circulars were issued on wide-ranging issues like credit to SSIs, pollution, electricity, allotment of plots etc. (*ibid*.)

3. Collective Action to Reduce Pollution and Provision of Infrastructure

[12] However, the monitoring of individual units and the imposition of fines started in 1996-97. Earlier the samples were tested in a lab run by the company managing CETP. A separate chemical lab to test the samples was set up on 21.12.1997 upon the instruction of the Gujarat High Court.

If we consider what common goods or services the Ankelshwar Industries Association (AIA) could provide its members, two stand out as most important.[13] First is technology for effluent treatment (the CETP) and a centralised landfill facility (CSLF) to deal with wastes. The second is reduced attention from regulators – that is less frequent inspections by the GPCB – something specifically mentioned by many firms in our interviews as the main benefit of membership in the CETP. The inspections take time, and the inspectors expect special treatment, which is onerous and troubling for the firms. The two goals are naturally closely interrelated since reduced attention by the authorities is brought about by lower pollution, which in turn is a result of both technical investments and changes in behaviour among the firms.

The CETP was initially built for the small firms; most of the medium and large units had their own treatment plants. The Ankleshwar plant was the first in Gujarat to undertake primary,[14] secondary, and tertiary treatment and has already been awarded ISO 14000 certification.[15] Treatment yields treated effluent and solid waste or sludge. The treated effluent flows into an underground collection system and is then discharged into Amlakhadi Creek. The cost of this underground drainage, built by the GIDC, has been shared by the industries through capital contribution charges. The recurring cost is being recovered from the industries through a levy of drainage charges at the rate of INR 2 per kiloliter[16] of water consumed.

The other residue of the effluent treatment plant, solid waste, also needs to be disposed of properly. Although some medium and large units have their own disposal pits, as recently as 1997 many were disposing of sludge and solid waste in the open or even discharging it back into the drains – thereby effectively undoing the work of the treatment plant (Down to Earth, 1998). Thus, it was decided that a centralised facility was needed for proper disposal of the hazardous sludge, and the AIA took the initiative to develop it. The Ankleshwar Environment Protection Society (AEPS) in collaboration with the National

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[13] Creating good publicity is another important AIA activity. To quote AIA: "(L)ong before the Judicial activism and various environmental groups started their crusade to safeguard the environment, AIA realised its responsibilities and registered a public charitable trust on 26th April 1989 by the name of Ankleshwar Environment Preservation Society, AEPS" (AIA, 1999). Besides planting trees and creating awareness, AEPS aims (i) to assist industries in controlling air pollution and in disposal of their solid and liquid waste; and (ii) to set up a laboratory for testing stack air and liquid effluent samples. AEPS was also in 1994 one of the very first to be successful in getting pollution control projects eligible for tax concessions.

[14] Considerable debate took place concerning whether to mandate all units to carry out at least primary treatment in-house. The experience from other estates in India – Nandesiri in Gujarat, Kundli in Haryana, however, showed that the small firms were often incapable of doing this adequately, and the effort in the past created more problems than it solved.

[15] ISO is the International Organization for Standardization, see http://www.iso.ch/iso/en/ISOOnline.openerpage.

[16] 1 US $ ≅ INR 46.0 (INR – Indian Rupees, the local currency).

Productivity Council, Delhi, conducted an environmental impact analysis based on guidelines from the Ministry of Environment and Forests and the World Bank. This is the first site in India where a public consultation process was carried out according to these guidelines.[17] The landfill facility, which already has received ISO 14000 certification, was developed under German standards and is paid for exclusively by AIA and its members except for a 50% subsidy in land procurement. The banks may have been wary of financing it, since the landfill had already generated negative publicity, but we do not have any evidence of this.

Table 1 shows the distribution of capital and operating costs and other details for both the facilities. Note that the outside subsidy is limited and firms bear most of the costs. Land has been provided at a concessional rate by GIDC, which has also given INR 10 million covering 14% of the total cost of setting up the CETP. The association has thus managed to cover the largest share of capital costs and also bears the recurring operating costs. The way in which operating costs are shared has been a source of discord within the association, however. Several large units are members even though subsidies were intended for small units' effluent treatment. As can be seen from the table, there are both fixed (membership) fees and variable operating costs. Naturally, the small firms complain that the fixed costs are unfair and seek to base fees on a variable basis. Given difficulty in monitoring, such an arrangement would create incentives to pass untreated effluent into the drains. Thus we observe the classic dilemma between distributional and efficiency goals. Still, it seems that the tariff structure could be improved to allow for greater flexibility for the smallest firms, which have to pay a fixed charge even if they do not generate enough waste for a tanker (see note d of Table 1).

4. Effluent Monitoring and Imposition of Fines

The mere provision of infrastructure is of course not enough. To achieve an acceptable environmental performance, the behaviour of firms must also be modified to discourage inappropriate actions. Individual firms may save costs by not complying while benefiting from the positive effects of other units' compliance (i.e., the free riding problem). To overcome the temptation for free riding, some sanctions are needed, and following point 5 of Ostrom's design principles, it is generally the case that sustainable common pool resources need to have a carefully designed system of graduated sanctions.

Monitoring and imposition of fines are, in fact, the most important instruments employed by AIA to control the pollution in the estate. AEPS is responsible for monitoring and has adopted the following procedure. Two effluent samples are taken from each chemical

[17] In fact, the public consultation process in Ankleshwar grew out of a previous instance of bad publicity in 1996, when an attempt to set up a landfill in an adjoining village was aborted after stiff local resistance and a public interest lawsuit (Down to Earth, 1998).

unit every month. If samples exceed the GPCB standards in pH, chemical oxygen demand (COD), or other indicators, the test reports are sent to the environment committee of AIA. The committee calls the concerned units for discussion, and if the firms remain in non-compliance, financial penalties are levied or other sanctions are imposed. Table 2 gives the structure of the penalties for each type of measure and industry size group.

Note that the penalty (except for COD and pH) increases with both the severity of the infringement and the frequency with which the polluter has violated rules in the past. It is also to be noted that the fines differentiate units on the basis of their size and hence ability to pay. This is exactly the main feature Ostrom considers important. The last "threat point" punishment to which AIA resorts, after repeated (and perhaps) grave infractions is reporting the polluter to GPCB. This is critical: some form of ultimate threat is needed because the association does not have the authority to force plants to pay fines or to close them down. On the other hand, AIA may not be very keen to report polluters to GPCB because this is a sign of failure, and such reports may lead to inspection not only of the unit but of the whole estate, with dramatic social ramifications if plants are closed, given the high unemployment in the region. In the period studied, up till early 1999, the AIA only reported defaulters on three occasions to the GPCB.[18] The distribution of penalty letters is interesting and raises the question whether there may have been some under-reporting by the AIA. Of 202 letters issued to 64 firms, 74 letters to 26 firms are for serious offences. Of these 26 firms, 11 firms were issued letters referring to their second violation.[19] 7 firms were issued letters for seriously violating more than thrice. Thus it seems that most offenders abstain from further violations after they have been admonished and punished one or two times. Clearly, GPCB's response to reports will also be important for the success of AIA's "voluntary" activities in future monitoring and detection situations. Although the data covers too short a period to be conclusive, there is no strong evidence of under-reporting.

The imposition of fines, which vary with infraction size and frequency as well as type of firm definitely goes beyond what a regulator would normally have achieved with simple regulations. The variability indeed induces flexibility in monitoring and enforcement as different kinds of polluters – small, large, first timers, recalcitrant etc. are treated differently. Another major difference between government and AIA monitoring is that the participants themselves have framed the rules in light of the information they have, making it more amenable to success. According to Ostrom (1990: 17), the self-interest of those who have negotiated the rules will lead them to monitor one another and report observed infractions so

[18] Source: Personal communication with the executive committee member of AIA on March 6, 1999. This information needs to be interpreted with some caution however. It may be possible that all the three times it is the same firm or only two firms.

[19] Interestingly of these 11 firms, six are pharmaceutical firms.

that the rules are enforced. The agency, however, hires its monitors and thus faces the principal-agent problem of ensuring that they do their job (Mookherjee and Png, 1995).

Monitoring Effectiveness

Successful monitoring should lead to compliance and lower pollution. The available data only show pH and suspended solids of the effluent from the estate for 1998.[20] The sampling point is at Valia Chokdi, after the effluent has been treated by individual units and the CETP, and is at the mouth of the Amlakhadi. AEPS takes three effluent samples a day from the Valia Chokdi. Figures 3 and 4 give the monthly averages, extreme values and quartiles for pH and suspended solids for different months.

The figure shows some improvement (less acidity and reduced suspended solids) over the period studied. The reduction in effluent acidity over the first few months is quite significant since a pH of 4 is 100 times worse than one of 6. It is not possible to state any particular level as safe or excessively dangerous as the levels will change with successive dilution throughout the course of the river. The creek is devoid of life close to the industrial estate but as the water is diluted and particularly as it flows into the Narmada, there is aquatic life that is affected. There are also many people who use the river and thus the less acidity (and other measures of pollution) the better, the quartile 1 and quartile 3 values of the two parameters as given in Figures 3 and 4 reinforces the impression of this improvement. This change could be due to (1) stricter regulations through enforcement of penalties; (2) seasonal variation, such as dilution by monsoon rains; or (3) increased publicity leading to behavioural changes in the firms. To judge the importance of these effects, a model was formulated to explain the variation in the effluent characteristics.

Model

The effluent characteristic from a plant in an industrial estate depends on a number of factors, including technology used, production level, abatement, and management attention. Lacking data on production levels or technology, we will assume these are constant during the year. The main variable on which we focussed is perceived detection probability for discharge of untreated effluent. We assume that enhanced monitoring will result in a high probability of detection if untreated effluent is discharged. As a consequence, plants will prefer to treat their

[20] pH and suspended solids may not be ideal indicators of water pollution, but unfortunately they are the only indicators we have. Another, although very general, indication of this decline in pollution is a “Press Note” issued on January 2, 2002 by the local regulator (i.e., GPCB). The note states that during Oct-December 2001, the visit by the GPCB staff to polluting units in the State found that the units in the Ankleshwar region had the smallest number of violators. The data shows that of the units visited only 1.2% were operating without legal environmental permit. On the other hand, the violation was quite stark in a number of other regions - 20.5% operating without permit of the total 712 visited in Ahmedabad, 11.6% of those visited in Baroda region and 39.6% of the firms in the Rajkot region were found to be in violation. (Source: GPCB, 2002).

effluent before discharge rather than risk being caught. Thus effluent quality will be a function of monitoring.

We also assume that illegal disposal is easier to hide at certain times of the day. Since AEPS takes samples at 8 a.m., 4 p.m., and 12 mid-night, corresponding to the three work shifts, we included shift dummies. It is also possible that dumping may vary by day of the week, depending on details in the schedule of monitoring that are unknown to us but may be known to the plants. Samples are not taken on public holidays; discharge of untreated effluent on these days would be manifested in samples taken immediately after the holiday. To account for this, a holiday dummy is included in the model. Finally, since the samples are taken in the creek itself, water flow will be decisive. Local daily rainfall figures over the year, obtained from the meteorological office in Ahmedabad, should give a good proxy for water flow. (The variable used is the rainfall in the day before the observation in order to better reflect water flow). To capture other seasonal variations and development over time, monthly dummies and a time trend are included.

Further, there may be short-term effects from one shift to another. Many technical processes involve the use of intermediary storage tanks, and if a tank is emptied in one period, giving high values, the following period may be cleaner. Alternatively, one might also find some form of persistence effect—that is, if the effluent quality is extremely bad in one shift, the effect may persist into the next shift. To capture such effects, a lagged value of the dependent variable is included. Thus, the model to be estimated is

$$E_t = f(E_{t-1}, M, \text{Shift}, \text{Weekday}, \text{Holiday}, \text{Time}, \text{Month}, \text{Rainfall}) \quad (1)$$

The measure of pollution used (the only one that was regularly measured and available to us) is the absolute value of the deviation of the pH from 7 (which is the pH of clean water). The point of measurement is after the common and individual effluent treatment plants and thus reflects the joint behaviour of the collective of all firms, as well as the possible effects of the treatment plants. Given the predominantly acidic nature of effluents from most of the industries in Ankleshwar, this is quite an appropriate indicator however it is only one possible indicator and fails to capture many other toxic components of the waste stream. Since pH is measured for each of three shifts, the lagged value is that of previous shift.[21]

The most interesting variable is the monitoring (plus enforcement) (M) in the estate. As mentioned, each chemical plant is sampled regularly, and if samples exceed the standard, the defaulting units are notified and penalties are imposed. Compliance hinges on the periodicity and effectiveness of enforcement—that is, how frequently fines are imposed and

[21] On the other hand, it is to be noted that rainfall is lagged by one day i.e., the rains one day before the observation.

collected. We don't have information on individual fine collections. We however had information about when and to whom fines were issued.[22] We hypothesised that each such event (i.e., issuing of letters indicating fines) has a considerable signalling effect within the estate. Since the estate is a close-knit community, the issuance of a notice will be well known to all units. In the days immediately following the highly publicised issuance of notices, the plants will be reminded of AIA's monitoring efforts and thus be more cautious with their effluent. Thus, the variable (PENALTY) was constructed, based on the assumption of adaptive expectations, to reflect both frequency and number of letters.

The Breusch-Pagan test gave a chi-square value of 176.41 for 20 degrees of freedom, which is much higher than the tabulated value, thereby indicating the presence of heteroscedasticity in the data.[23] The model is thus estimated with White's (1980) correction for unknown form of heteroscedasticity. Table 3 gives the results for the heteroscedasticity-corrected model.

The lagged dependent value is negative, suggesting that larger deviations in one shift lead to smaller deviations in the next. This effect is not very strong but it is significant which is interesting since it allows us to discard the notion that there would be stock effects in the system such that for instance acidic emissions in one shift would still be present and affect the readings of the next shift. With respect to the dilution effect of rainfall, the variable is significantly negative, as expected. This implies that rainfall in the region leads to improvement in water quality the following day.

The signs and significance levels of shift dummies ($SHIFT_1$ and $SHIFT_3$) suggest that the maximum deviation is for samples collected in the morning (i.e., shift 1). That is, units appear to be discharging untreated effluents at night. The samples collected at midnight were also elevated, but the difference is not statistically significant. Since the discharge of acidic or untreated effluent would be visible during the day, units may refrain from discharging untreated effluent during the second shift.

The effect of holidays is not statistically significant, although it has the expected sign. With respect to weekday dummies, none of the days seem to have any effect on water quality,

[22] We had data on penalty letters for COD violations, but the effluent parameters measured at the end of the estate are pH and suspended solids. We are aware that the relationship between COD and pH may be very complex, still we presume there will be negative relation between them. A simple correlation between these two parameters at 4 monitoring stations in Gujarat for the period January 1995 to December 2000 shows a high correlation to the tune of –0.6. This indicates the two variables move in opposite direction. Our estimation and hence the use of pH gets further strength because fines were assessed only for severe violations that would probably have affected both indicators equally.

[23] A possible bias could arise from measurement error in the dependent variable. To deal with this, a Probit model was estimated with the dependent variable taking the value 1 if $6.0 \leq pH \leq 7.0$ and zero otherwise. The results are not reported, since the predictive power of the model was low. This in turn suggests that a model on the actual values of the dependent variable is preferred.

perhaps because of the absence of a unified weekly schedule. The industrial estate observes a staggered schedule because of problems in its electric power supply, and units take turns in having one day off. Thus all days are symmetric and there is no "weekend" or other pattern to observe.

The result showed that this monitoring, as proxied by penalty notices (PENALTY), does appear to have a deterrence effect in altering the units' behaviour. However, the effect is somewhat transitory and sensitive to econometric specification[24]. In addition to this effect there is a negative trend over time. Although it is not significant, it may perhaps be takes as one more sign of some clean-up that at least potentially is related to all the environmental activities undertaken at the estate. Many of the variables are dummies that take a value of one or zero and thus the coefficients for these are comparable. A comparison shows that the absolutely strongest of the (dummy) effects observed is that of the morning shift while the weakest is that related to the penalty. There are thus strong signs that illicit dumping is still rampant and the effects of penalties are by comparison fairly weak.

5. Levying and Collecting Fines

The fines serve several purposes: (a) to induce compliance in mitigating the pollution and to deter illegal disposal, (b) to remove any competitive advantage for those firms that do not comply, and (c) to finance the current and future monitoring and testing activities of the AEPS. The short life of the deterrence effect may be explained by the difficulty of actually collecting the fines. Since having to pay a fine is a more severe punishment than merely receiving notices, the collection rate would have been a better variable but we have only annual aggregate data on fines collected.

In Table 4, note that though the penalty amounts increase, the collection rate appears to be falling, suggesting some erosion of authority for the AIE. The number of observations is too limited to be sure that we actually are observing a trend, but figures point in that direction, with a reduction from 80% to 60% collection between 1996–97 and 1997–98. The figure for 1998–99 is only 18% but this only covers the first nine months of the financial year 1998–99, and it is conceivable that the firms have tax or other reasons for wishing to postpone payments.[25] Nevertheless, the decline in collection may also be partly attributed to AIA's and AEPS's lack of legal authority to impose or collect fines. As a consequence, the defaulting units may not feel obliged to pay.

Although all industries should realise that it is in their common interest to collaborate, since their collective reputation is at stake, compliance depends on voluntary participation.

[24] When periods longer than three days after the levying of penalties were chosen the effect becomes weaker

[25] Source: Personal communication with the executive committee member of AIA in February 1999.

This is similar to the classic Prisoner's Dilemma situation, and the fall in collections represents a move from an initial collaborative equilibrium of 1996-97 when the penalty system began towards a non-cooperative Nash equilibrium. Once a few firms notice that nothing really serious has happened to the 20% of polluters who did not pay their fines the first year, other firms lose their incentive to collaborate, too. In this context, it is to be noted that though AIA did not admit directly that there is a decline in member's willingness to cooperate over the period. However, it was indirectly apparent, during the discussion, the AIA kept on insisting that the decline is because they do not have any formal authority to levy and collect fines.

It is also interesting to consider the distribution of fines and payments between different categories of firms. As Table 4 shows, the percentage of the *number* of fines collected is much smaller than the percentage of their total *value*. This suggests that the larger fines, presumably levied on the larger firms, are typically paid, but the collection of small fines appears to be difficult presumably due to the very severe cash constraints that many of these firms face.[26]

For the first half of 1998 we were given some more details concerning penalty notices for COD violations. About 60% of these firms were medium or large, which suggests that AIA is fairly objective and levies fines irrespective of the size of the unit. Objectivity is also apparent in the fact that even plants managed by AIA executive members are targeted. Of the 64 units fined, 10 are or were members of the executive committee of the AIA. For 12 units, the default rate was very high, as they were issued at least six notices in as many months.[27] Interestingly, of these 12 units, one is still (at the time of study) holding an executive position in the environment committee of AIA. One might deem it highly disturbing that a plant managed by executive officers of the industrial estate are themselves defaulters. Our interpretation is, however, the opposite: that there is a fair degree of objectivity and that corruption and nepotism do not appear to characterise the monitoring and enforcement system. That units managed by executive committee members are fined clearly adds to the credibility of the monitoring and enforcement efforts.

6. Is two-tier monitoring robust – compliance with Ostrom's design principles

Based on the earlier sections, we can now summarize how well the two-tier monitoring institution of Ankleshwar accords with Ostrom's design principles that are often taken as

[26] It thus seems that the big firms got their discharges under control after the first year or two. However, in order to be certain about this, we would need to know the distribution of penalties in 1998 and subsequent years. Unfortunately, we have not had access to any further data from the AIA and could hence not verify this.

[27] The high default recurrence rate could also be due to the lack of any deterrent for the violation of COD standards, since there are no graduated sanctions for repeated violations (see Table 1).

prerequisites for sustainable management of a common pool resource (CPR). Table 5 summarises the main points.

The first condition – clearly defined membership – is definitely applicable because all firms have membership rights within the industrial estate. However there are some (few) firms that have failed to join and there were conflicts concerning the right of medium & large units to benefit from the CETP, which was built with subsidies intended for small plants. Conditions 2 and 3 – rules are appropriate to local conditions and are democratically decided – can also be considered fulfilled: rules are made by the association board members, who are democratically elected by the individual units, and thus the participation is indirect. In practice, however, larger firms presumably dominate the formulation of rules, and when it came to the costs of effluent treatment, some small firms felt discriminated against. Condition 4, monitoring by the members themselves, which is one of the basic ideas of the two-tier arrangement, is clearly fulfilled.

Condition 5 on graduated sanctions is largely satisfied. An important part of the sanctions are graduated and there is some evidence that these sanctions do lead to reduced effluents, if only temporarily. The difficulty in getting units to actually pay fines and the lack of legal authority for the association to enforce its penalties, however, cast doubts on the efficacy and long-run sustainability of this system.

Condition 6 concerns conflict resolution and the non-payment of fines can be seen as a case in point. It is not clear how conflicts among members or between members and the association are to be handled. The legal authority of the association to enforce penalties or to act as an arbiter is not well established. Last is condition 7 – government approval. As mentioned, in some of verdicts of the HC and well supported by the GPCB, the association is to monitor individual units. Although association is not formally mandated to levy and collect any fines, there seems to be tacit approval of its efforts as neither GPCB nor the HC has objected to its efforts. Thus the industrial estate appears to have at least partial backing by the relevant authorities.

7. Concluding Remarks

Gujarat, and in particular Ankleshwar, figures prominently on the chemical-industrial map of India. It houses a large number of highly polluting industries with few resources or inclination for abatement. The local environmental authorities have a very limited budget[28] and cannot hope to monitor or control pollution effectively. This paper has examined the ability of the Ankleshwar industrial estate and its association to act as an intermediary for

[28] The budget allocated in real terms for Gujarat having 169 working industrial estates is not only inadequate but also declining in the past three years. From a high of INR 29.97 million in 1998 it fell to INR 20.32 million in 1999 and then to INR 16.6 million in the year 2000 (Kathuria, 2003).

government regulators by monitoring and disciplining its own members and building infrastructure for effluent treatment. The provision of these forms of local public goods places considerable demands on the organisation to avoid the problems of free riding.

We have here shown that there is some possibility of success in a two-tier arrangement that delegates monitoring to the industry association. However, to supplement the traditional regulatory approach, the association must deal with free riding. The participants in an industrial estate are quite heterogeneous and vary greatly in terms of assets, ownership, skills, and size; their owners or managers likewise vary in knowledge, educational background, and ethnicity. Such characteristics might make it more difficult to create the necessary conditions for long-standing collaboration than with traditional CPRs like fisheries, irrigation canals, or forest meadows.

Our description and analysis of the two-tier monitoring in Ankleshwar has, however, shown that most of the conditions required to manage a CPR can also exist in an industrial estate setting. Industrial estates wishing to gain collective benefits need to cope with free riding, solve commitment problems, have the backing of institutions, and monitor individual compliance. Though the analysis finds that two-tier monitoring is functional in Ankleshwar, there are still various enforcement difficulties as some units are recalcitrant and some units refrain from paying any fines.

Some of the enforcement difficulties appear to be due to differences in incentive structure between small versus large firms, members versus non members of the AIA Executive Board, members versus non-members of the water treatment facility. In fact, the difference in incentive schemes between small and large firms coincides with that of members versus non-members of the water treatment facilities. This is because all the small-scale units are members of water treatment facilities. Whether there will be any difference in members versus non-members of the AIA executive board is rather difficult to find out, but our conjecture is – there should be no impact because the board is well represented by both category of units – small and large.

The co-operation of large firms in particular may be secured relatively easily by using the threat of public disclosures, since large firms value their reputations more. Sufficient evidence exists in developing countries, where large firms show high sensitivity to rating process or stock market for good / bad environmental performance (see for example, Wheeler *et al*., 2000 and Dasgupta *et al.*, 2001 for stock market reaction). They may even be concerned about the reputation of the whole estate and help monitoring small units to avoid negative publicity for the estate. Olson (1965) argues that voluntary collective action by individuals to achieve their group interest is not possible unless there is coercion or some other device to make individuals behave in the group interest. Given the nature of units in Ankleshwar, this may not be difficult. This also suggests that disclosure and liability may be

good complementary instruments that would help enhance the efficacy of the two-tier regulation.

For SSIs the co-operation can be sought by using other means in conjunction with effluent treatment. Since the SSIs depend heavily on the industry association for day-to-day activities for matters pertaining to legal, finance, marketing, technical etc., the continuation of such support can be used as a lever to garner commitment for reduced violations.

The study has useful policy implications because regulation of SSIs as alluded in the books is not likely to be effective in altering the behaviour of SSIs unless enforcement is credible. And credible enforcement is a daunting task for already over-stretched regulatory agencies in the developing countries, especially where SSIs abound. Gunningham (2002) argues that even in areas with relatively good resources, an SSI can anticipate being inspected about once every 80 years and most SSIs may not encounter any environmental regulator ever. In fact, in a significant minority of cases, the regulator may not even know that the polluter exists (*ibid*.: 23). Under such a situation delegating monitoring and enforcing power to industries associations may be one of the few strategies available. This study shows that it has some potential to be successful and identifies some of the areas, which need more attention in order to improve performance.

References

AIA (1998a), *Ankelshwar Industries Association—Environment Policy for the Year 1998–99*, Ankleshwar: AIA, August.

_____ (1998b), *Ankelshwar Industries Association—Details of Penalty for COD Violation*, Ankleshwar: AIA, various months.

_____ (1999), *Ankelshwar Industries Association—Role in Preservation of Environment*, Ankleshwar: AIA.

_____ (1997-98), *Ankelshwar Industries Association—Annual Report*, Ankleshwar: AIA.

_____ (various years), *Ankelshwar Industries Association—Annual Report*, Ankleshwar: AIA.

Bruno, K. (1995), 'Gujarat's Industrial Sacrifice Zones', *Multinational Monitor* **16**(7,8), July–August.

Central Pollution Control Board (CPCB) (2001), Clean Technology Options in Small Scale Industries. *Parivesh: Newsletter*. Delhi: CPCB, Ministry of Environment and Forests, July.

Dasgupta, S., B. Laplante and N. Mamingi (2001), 'Pollution and Capital Markets in Developing Countries', *Journal of Environmental Economics and Management* **42:** 310-35.

Down to Earth (1998), 'Hell Hole', *Down to Earth* **7**(14), December 15: New Delhi.

GPCB (2002), 'Press Note – GPCB catches brings units functioning without environmental permission', Gujarat Pollution Control Board, Gandhinagar, January 2.

Gunningham, N. (2002), 'Regulating Small and Medium Sized Enterprises', *Journal of Environmental Law* **14**(1): 3-32.

Gunningham, N. and J. Rees (1997), 'Industry Self-Regulation: An institutional perspective', *Law and Policy* **19**(4).

Israngkura, A. (2000), 'Thai Industrial Estate Water Treatment Fee' in Rietbergen-McCracekn, J. and H. Abaza eds. *Economic Instruments for Environmental Management*, London: Earthscan Publication: 86-91.

Jani, B.M. (2001), Management of Water Pollution in Organised Industries in Gujarat, EERC Working Paper Series: IPP-7, IGIDR, Mumbai.

Kathuria, V. and T. Sterner (2002), 'Monitoring and Enforcement – Is two-tier regulation robust?', Resources for Future, Discussion paper – 02-17, April.

Kathuria, V. (2004), 'Informal Regulation of Pollution – Empirical evidence from India', paper presented in the 12th EAERE conference held in Bilbao, Spain during June 28th – 30th.

Mookherjee, D., and I.P.L. Png. (1992), 'Monitoring vis-à-vis Investigation in Enforcement of Law', *American Economic Review* **82**(3): 556–65.

Mookherjee, D., and I.P.L. Png. (1995), 'Corruptible Law Enforcers: How Should They Be Compensated', *The Economic Journal* **105**(January): 145–59.

Olson, M. (1965), *The Logic of Collective Action*. Cambridge, MA: Harvard University Press.

Ostrom, E. (1990) *Governing the Commons*. Cambridge, UK: Cambridge University Press.

Pargal, S., and D. Wheeler (1996), 'Informal Regulation of Industrial Pollution in Developing Countries: Evidence from Indonesia', *Journal of Political Economy* **104**(6): 1314–27.

Sankar, U. (2001), *Economic Analysis of Environmental Problems in Tanneries and Textile Bleaching and Dyeing Units and Suggestions for Policy Action*, Delhi: Allied Publishers.

Segerson, K. (1988), 'Uncertainty and Incentives for Nonpoint source Pollution Control', *Journal of Environmental Economics and Management* **15**: 87-98.

Sohngen, B., (1998), Incentive Based Conservation Policy and the Changing Role of Government. American Farmland Trust Center for Agriculture in the Environment. DeKalb, Illinois. Working Paper CAE/WP98-6. July

Sterner, T. (2002), *The Selection and Design of Policy Instruments*: *Applications to environmental protection and natural resource management*, Resources for Future and the World Bank.

Tietenberg, T. (1998), 'Disclosure Strategies for Pollution Control', *Environmental and Resource Economics* **11**: 587–602.

Wheeler, D., *et al*. (2000), *Greening Industry: New Roles for Communities, Markets and Governments*. World Bank Policy Research Report. New York: Oxford University Press.

Yeon-Koo, C. (2002), 'Joint Liability and Peer Monitoring under group lending', *Contributions to Theoretical Economics* **2**(1), Article 3.

Figure 1: Location of Ankleshwar Industrial Estate

Source: Map downloaded from http://www.gidc.gov.in/ on July 18, 2000.

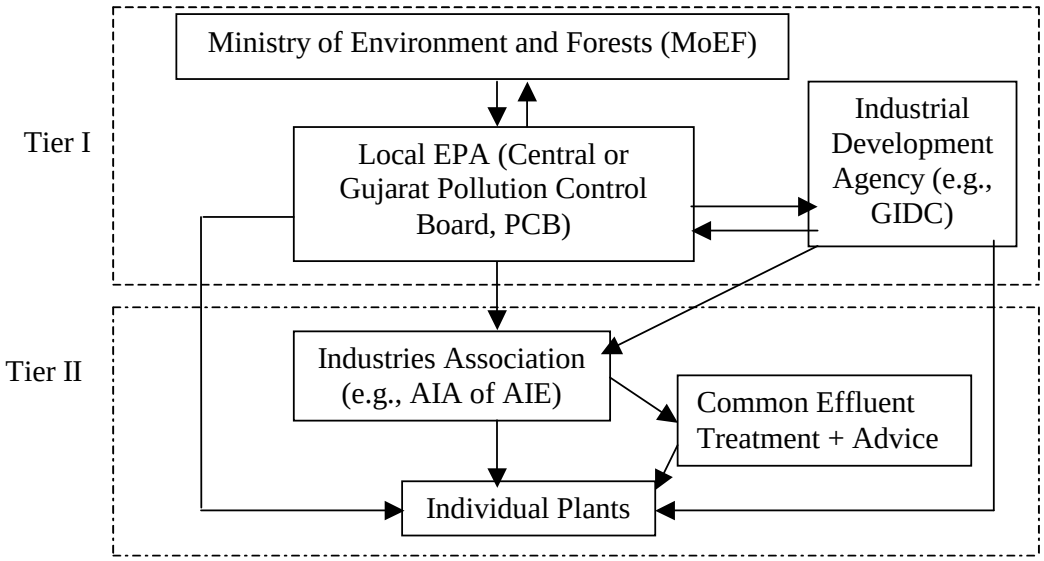

Figure 2: Two-Tier Decisionmaking to Control and Mitigate Pollution

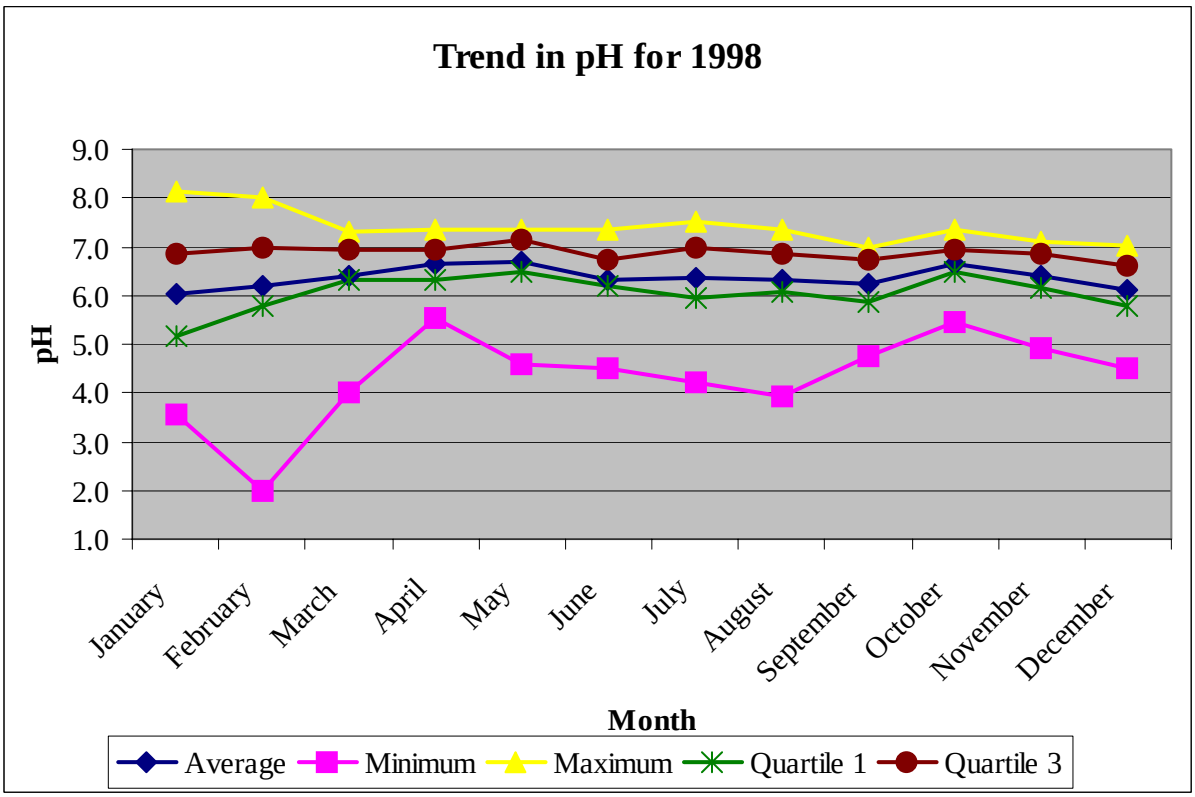

Figure 3. Trend, Range and Quartiles of pH during 1998

Note: For pH quartile 1 is important as this quartile effectively represents the most serious pollution: one aim of pollution management in Ankleshwar Industrial Estate is that pH should increase.

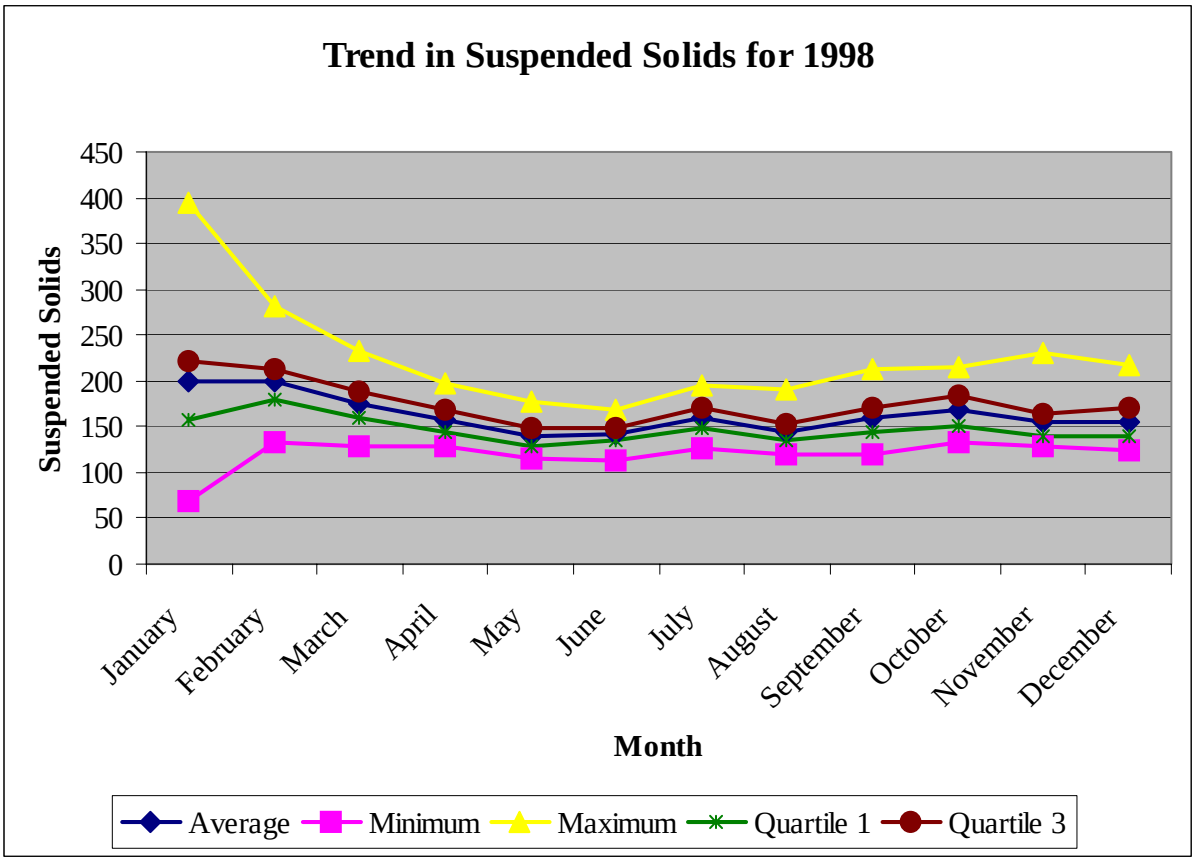

Figure 4. Trend, Range and Quartiles of Suspended Solids during 1998

Note: For Suspended Solids quartile 3 is important as this quartile represents the largest degree of pollution: An aim of pollution management in Ankleshwar Industrial Estate is that suspended solids should decrease.

Table 1: Financing of Centralized Effluent Treatment (CETP) and Solid Waste Landfill Facilities (CSLF)

Item	*Effluent treatment plant*	*Solid waste landfill*
Financing (INR million)	Land: subsidy from GIDC	Land: 50% subsidy from GIDC
	Equity 12.0	Equity and deposit 9.8
	Subsidy from GIDC 10.0	Subsidy
	IDBI[a] term loan 33.0	IDBI term loan
	AIA member deposit 15.8	Total 9.8
	Total 70.8	
Members	193[b]	298[f]
Membership fee (INR)	10,000 fixed	1,500
Membership profile	In principle only small firms[c]	Any unit
Operating charges (INR)	0.18 (fixed) + variable charge for COD load and acidity per kiloliter[d e]	500 per metric ton + transportation charges[e g]
Treatment charges as recovered from members (INR million)	1996–97 3.8 1997–98 49.5 1998 (April–December) 4.9	1996–97 – Nil 1997–98 – Nil 1998 (April–December) – 3.9

Sources: AIA (1999); brochures of the effluent treatment and solid waste landfill facilities; and Enviro Tech. Ltd. members' list.

Notes: [a] IDBI is the Industrial Development Bank of India.

[b] Including four units from another industrial estate (Panoli).

[c] Two multinational corporations and one former subsidiary of a multinational are also members.

[d] INR 0.18 per litre is the fixed component of the charge (which has been worked out on the basis of capacity and capacity utilization of the plant, loan repayment, etc.). In the past five years the fixed component has reduced drastically due to increased capacity utilization and reduction in the tax burden (Jani, 2001: 70). The second component of the charge is variable, which increases in slabs depending on the concentration of the effluent to be treated. If a unit has no effluent for a particular period due to slackness in production, it still has to pay the rental charges amounting to INR 1,500 for a tanker.

[e] It is to be noted that the fixed component of operating charges for both the CETP and the CSLF are same for all the units irrespective of the size, and maximum load or capacity each unit requires.

[f] Including 58 units from Panoli, 7 units from Jhagadia and 50 units from other areas as members (Source: Jani, 2001: 61)

[g] The charges have been revised to Rs. 500 per MT from previous Rs. 385 per MT (Source: Jani, 2001: 61). Members outside the Ankleshwar estate also have to pay some additional charge.

Table 2: Graduated Sanctions Imposed by AIA

Pollution	*Measure*	*Recurrence emissions or other measures of severity*	*Penalty (in INR)*		*Remarks*
			Small firms	*Medium and large firms*	
Water	pH (a)	1st time	2,500	10,000	Pumping acidic effluent into drainage.
		2nd time	5,000	20,000	
		3rd time	10,000	40,000	
		4th time	Reporting to GPCB		
	pH (b)		20,000	50,000	Other discharge methods.
	Suspended solids	1st time	500	2,000	Month 1: no penalty. Month 2: penalty with 300 ppm limit. Month 3: 200 ppm limit.
		2nd time	1,000	4,000	
		3rd time	5,000	20,000	
		4th time	Reporting to GPCB		
	Chemical oxygen demand	600–1,000	500	5,000	Control takes longer but is needed to keep parity with small firms whose effluent is treated in common treatment plant. Review after six months.
		1,001–5,000	1,000	10,000	
		5,001–10,000	2,000	20,000	
		10,001–25000	5,000	50,000	
		Beyond 25,000	7,500	75,000	
Air	Acidic scrubber or incinerator	1st time	1,000	4,000	Two types of air pollution: from process or incinerator. Penalty is more severe if incinerator is acidic.
		2nd time	2,500	10,000	
		3rd time	5,000	20,000	
		4th time	Reporting to GPCB		
Solid Waste	Hazardous	By Tractor	1,000	4,000	1: penalty if dumping outside the landfill. 2: double penalty. 3: triple penalty. 4: reporting to GPCB.
		By Truck	2,500	10,000	
	Non-hazardous	By Tractor	500	2,000	
		By Truck	1,000	4,000	

Source: AIA (1998a). *Notes*: Monitoring is by AEPS. Units may challenge results within seven days.

Table 3: Effectiveness of Penalties: Heteroscedasticity-Corrected Ordinary Least Squares (OLS) Estimates of Pollution as measured by acidity/alkalinity

Variable	*Dependent variable = | pH – 7 |*
Lag Dependent	-0.151* (3.36)
Rainfall previous day	-0.0049* (2.56)
PENALTY	-0.0063* (2.0)
Time	-0.0041 (0.82)
HOLIDAY	0.1 (0.52)
$SHIFT_1$	0.377* (3.98)
$SHIFT_3$	0.095 (1.07)
Intercept	2.19* (1.9)
Adjusted R^2	0.121
N	550

Notes: The exogenous variable is the acidity/alkalinity of the effluent. Clean (neutral) water has a pH of 7 and in Ankleshwar mostly the effluents are acidic although there are a few observations that are alkaline (above 7) To deal with this we use as our measure of pollution in this regression, the absolute value of the deviation from the pH of clean water |pH – 7|. Figures in parenthesis are t-values. Asterisks * indicates significance at minimum 5% level. Data are for January–August, for which we had all variables. Some month and day dummies were also significant.

Table 4: Enforcement Effectiveness: Penalties Levied and Recovered by AEPS and AIA

Year	*Penalties levied*	*Amount (INR 000)*	*Penalties recovered*	
			No. (%)	*% of value*
1996–97	150	685	24%	80%
1997–98	196	976	19%	61%
1998–99*	186	1,512	20%	18%
Total	**532**	**3,173**	**111 (20.9%)**	**1,416 (44.6%)**

Source: AIA (1999).
Note: *April through December.

Table 5: Principles for Managing Common Pool Resources

Ostrom's design principles	*Two-tier monitoring in Ankleshwar*
1. Clearly defined membership and rights	Yes but some non-members and lack of clarity concerning use rights for CETP
2. Rules appropriate for local conditions	Yes but heterogeneity between plants is a potential problem
3. Democratic decision-making	
4. Accountable monitors	Yes
5. Graduated sanctions	Yes for most cases
6. Conflict resolution mechanisms	Not clearly defined
7. Government approval of institution	At least passive approval and non interference