POLLUTION REDUCTION WITHOUT FORMAL REGULATION: EVIDENCE FROM BANGLADESH

by
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ABSTRACT
An enterprise survey in Bangladesh offers hopeful evidence that industrial pollution can be reduced significantly, even in an extremely poor economy with little formal regulation. Newer industrial facilities are also much cleaner because their equipment is imported from OECD economies with strict environmental regulation. In addition, riverain villages have proven surprisingly willing and able to negotiate agreements with upstream polluters for monetary compensation and first-stage effluent treatment. With better information and legal services, such arrangements could provide cost-effective local support for a national regulatory system.
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I. INTRODUCTION

Environmental policy analyses generally assume that severe industrial pollution will plague developing economies which have no formal regulation. However, this assumption may be unduly pessimistic for at least two reasons. First, the pollution intensity of an industrial process is often determined by the choice of technology. More recent vintages are generally much cleaner, because they have been developed in OECD economies which are under tight environmental restrictions. New imported plants in developing economies will also tend to be cleaner, even if no formal regulation exists.

Second, governmental inaction does not necessarily imply passivity in communities which are downwind or downstream from polluting facilities. Under some conditions community leaders may become informal regulators, successfully applying social pressure to move neighboring plants toward locally acceptable environmental standards.

This paper evaluates the significance of exogenous technical change and informal regulation in Bangladesh, which has had little formal environmental protection. The analysis draws on a survey of industrial facilities in two pollution-intensive sectors, fertilizer and wood pulp. Four of the five urea fertilizer plants in Bangladesh have been surveyed, along with a superphosphate fertilizer plant and two large pulping facilities. All are public sector enterprises, managed by the Bangladesh Chemical Industries Corporation (BCIC). They have widely varying ages, and are evenly distributed between urban and rural settings in locations scattered throughout Bangladesh.

Section 1 sets the stage for the analysis by describing Bangladesh's industrial pollution problem, its standing in public opinion, and the institutions which have significance for environmental policy. Section 2 examines the clean technology question, while Section 3 considers the pattern of community cleanup pressure and enterprise response. The final section provides a summary, conclusions, and an agenda for more comprehensive research.

II. THE ENVIRONMENTAL PROBLEM IN BANGLADESH

Bangladesh is a riverain country with a land area of 51,703 square miles (slightly smaller than the U.S. State of Wisconsin). In this small, flood- and cyclone-prone area, over 115 million people live at a per capita income level of approximately $US 180. The current population growth rate is 2.5%; the real GDP growth rate in the most recently available year, 1989, was 2.1%. By 2020 Bangladesh is expected to have about 200 million inhabitants, many of whom will remain very poor.

A. Current Environmental Issues

At present, Bangladesh has no significant constituency for “environmentalism” in the Western sense. There is a popular tendency to identify it as another Western fad or, more darkly, as the leading edge of new Western attempt to suppress economic development by raising its cost. Paradoxically, however, specific environmental concerns have already become important public issues. Even the poor, land-hungry majority seem to support protection of the Royal Bengal tiger and the spotted deer in the Sundarban mangrove forest. Widespread concern about global warming has also been sparked by predictions that one third of Bangladesh's land mass will be under the sea within fifty years. Urban air pollution has become an important policy issue for the educated elite of Dhaka, since even their relative affluence affords them no private means of escape.
For the great mass of Bangladeshis, however, the degree of concern about environmental issues seems most closely tied to the rising impact of water pollution. Despite its low level of economic development, Bangladesh is so densely populated that its environmental absorptive capacity is practically nil. Industrial facilities in such pollution intensive sectors as pulp, chemicals, fertilizer, and cement nearly always discharge wastes into rivers which serve large downstream populations. In many cases, communities can clearly identify facilities whose discharges have caused fish kills, illness, and damage to irrigated paddy crops.

B. Institutions With Environmental Concerns
Several organizations in Bangladesh are already playing significant environmental roles:

1. **Government agencies**
   The government division charged with environmental protection has recently begun playing a more active role. It is now setting general emissions standards and considering the institution of charges in some cases. At present, however, its technical capabilities are extremely limited and it has hardly any effective enforcement power.

2. **Non-governmental organizations (NGO’s)**
   Some NGO's are active on environmental issues, mostly as promoters of public awareness. Shortages of funds and technical skills have, for the most part, prevented them from engaging actively in research or project-related work. A few have recently tried to enter into cooperative technical and financial assistance agreements with international NGO's.

3. **Donor agencies**
   Donor assistance has had major significance for the economy of Bangladesh: During the period 1970-1987, U.S. aid commitments to Bangladesh totaled approximately $3.2 billion and the COMECON states provided $1.5 billion. In the 1980's, non-U.S. Western sources accounted for over $9 billion. Until recently, Western donor agencies have not promoted general environmental regulation in Bangladesh. Nevertheless, as shown in the following section, their policies have had a major impact on trends in industrial pollution.

C. **Non-traditional Sources of Pollution Reduction**
   To summarize, Bangladesh's extremely limited absorptive capacity has made industrial pollution a serious problem, even in the first stage of development. The populace is already aware of this and seems in principle willing to support same regulatory response. However, the present institutional infrastructure is very weak. The search for cost-effective measures should therefore look beyond traditional regulatory approaches. In this paper, we draw on our survey results to introduce two other potentially powerful agents of change: Enterprise technology choice and community pressure for cleanup.

III. TECHNOLOGY BUNDLING
   A growing industrial sector may have significantly declining pollution intensity (emissions per unit of output), even in developing economy with no regulation. Newer equipment is also generally cleaner, because it has been developed in OECD economies under strict environmental regulation. Many large scale imported plants are now designed around relatively clean processes,
implicitly forcing investors in developing economies to accept higher environmental standards than local regulations would mandate.

Such “technology bundling” is clearly visible in our survey results for four urea fertilizer plants (Table 1). Each was built with foreign aid tied to technical assistance and equipment acquisition from the donor country. Environmental performance therefore reflects donor-country standards at the time of installation. The three Japanese plants, constructed in 1961 (NGFF), 1968 (UFF), and 1989 (CUF), have been successively cleaner. The latest plant, CUF, has internalized environmental concerns to such an extent that there is little need for “end-of-pipe” waste treatment. By contrast PUFF, installed by China in 1985, has process technology and environmental performance similar to those of UFF, which was constructed by Japan in 1968. [Note 1]

<table>
<thead>
<tr>
<th>Plant Vintage, Donor Country, and Process Pollution Intensity: Seven Public Enterprises in Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant</strong></td>
</tr>
<tr>
<td>Natural Gas Fertilizer Factory Ltd. (NGFF - Fenchuganj, Sylhet)</td>
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<tr>
<td>Urea Fertilizer Factory Ltd. (UFF - Ghorasal, Narsingdi)</td>
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<td>Polash Urea Fertilizer Factory Ltd. (PUFF - Polash, Narsingdi)</td>
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<td>Chittagong Urea Factory Ltd. (CUF - Rangudia, Chittagong)</td>
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<td>Triple Superphosphate Complex Ltd. (TSPC - North Patenga, Chittagong)</td>
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IV. COMMUNITY PRESSURE FOR CLEANUP

When clean production standards are embodied in process technology, management has little scope for trading environmental standards against profits. Such trades are perfectly possible, however, for “end-of-pipe” (EOP) waste treatment options. In Bangladesh there are no regulation-based incentives for EOP treatment. Consequently, our expectation prior to the survey was that little or no EOP investment would have been undertaken by the sample enterprises.

We were wrong. Some of our survey plants have made substantial investments in waste treatment. Although formal regulation has been very weak, polluting firms have often accepted neighboring communities' assertion of environmental property rights. Negotiated settlements have included monetary compensation for damage to fisheries and paddy fields, and installation of EOP treatment. In the following sections, we present a plant-level summary of our survey results.
A. **UREA FERTILIZER PLANTS**

The five urea fertilizer plants currently operating in Bangladesh are all under the control of BCIC, a state corporation. Our survey covers four plants, whose operating characteristics are quite similar. They are all located on rivers, into which they discharge their wastewater. All use natural gas as the basic feedstock; include both ammonia and urea facilities; and operate on self-generated electricity. Their common technology produces carbon dioxide by steam reforming and separates it with the Benfield process. Despite all these similarities, however, the facilities exhibit widely varying pollution intensity and investment in EOP treatment.

1. **Natural Gas Fertilizer Factory (NGFF)**
   
   **Fenchuganj, Sylhet**

   This is Bangladesh’s oldest urea fertilizer plant, built with Japanese assistance in 1961. It is located in the northeastern part of the country on the Kushiara River. The plant's discharges contain toxic ammonia, high BOD and Ph levels, and substantial residues of grease and oil. They have been clearly identified by downstream villages as the cause of major fish kills, paddy field damage, and health threats. In addition, there have been regular atmospheric releases of ammonia and sulphur di- and trioxide.

   Nevertheless community pressure for change has been only moderate. The area is primarily non-industrial, so few other factory jobs are available. BCIC regards the facility as obsolete and keeps it open only to preserve the local employment base. Everyone concerned recognizes that the age and technology of the plant preclude cleanup to a very high standard. Making the best of a bad situation, neighboring communities have settled for some compensation and a rather modest first-level cleanup effort.

   Before 1986, all effluents went directly into the Kushiara River. Since then the plant has constructed two lagoons, in which the effluent is diluted by adding the staff colony's waste water and local spring water. In addition, acidic and alkaline injections are used to neutralize the Ph level. Some separation of oil and grease from the water has been undertaken, and an improved method is currently planned.

   The cleanup effort has improved ambient quality modestly. Fish kills are now less frequent, and the plant makes sure that communities downstream are warned before periodic cleaning operations discharge large quantities of ammonia and other pollutants into the river.

2. **Urea and Potash Urea Fertilizer Factories**
   
   **(UFF; PUFF): Narsingdi (Ghorasal, Polash, respectively)**

   These two plants were built in different eras: UFF with Japanese assistance in 1968 and PUFF with Chinese assistance in 1985. Technologically, however, they are approximately at parity. The Chinese design closely reflects the two-decades-old Japanese design. Both plants are clearly identifiable polluters whose intensity falls in the mid-range for our survey. The major water pollutants are the same as those of NGFF: BOD, Ph, ammonia, urea, alum sludge, oil, and grease. Before 1980, UFF discharged directly into the Sitalakhya River. Downstream fish kills and paddy damage from polluted irrigation water were common, particularly during startup after maintenance shutdowns when large, concentrated effluent loads were dumped. In the 1980's, however, very strong community pressure for cleanup has been exerted,[Note 2] Clearly, community militancy in this region has been enhanced by the relative abundance of local employment alternatives.
The pressure has registered on UFF and PUFF, and their qualitative response has been similar. UFF has increased the number of employees working on pollution control. Both pay some local compensation for damage claims. The two plants also share a first-stage treatment lagoon, which was constructed by UFF in 1980. Both factories use the lagoon to dilute the effluent with wastewater from their staff colonies. In addition UFF employs urea hydrolysis, an ion exchange facility, and an oil/grease separation plant. PUFF reduces the ammonia load in its effluent with a steam stripping method, and spreads a simple cloth barrier over the outfall to capture some of the oil and grease.

This case clearly illustrates the circumstances under which polluting facilities and neighboring communities have negotiated informal regulatory arrangements. However, a closer look at our process information also reveals an important asymmetry in the information available to the negotiators. With little or no information about individual pollutant concentrations and risks, affected villages are forced to estimate damage from the most immediate and visible manifestations. First stage EOP treatment is frequently sufficient to reduce these below the local tolerance threshold. However, many toxic pollutants which would require second stage treatment are simply unknown to the villagers and do not become the object of negotiations.

A good example is provided by UFF, which operated until 1990 with the Vetrocoke separation process despite close community scrutiny. This process uses arsenic oxide for separation and produces extremely hazardous, arsenic-laden effluent. UFF finally switched to the more benign Benfield process in 1990, but not because it felt any community pressure to do so. Management simply wanted to profit from a common inventory with the other urea fertilizer plants, all of which use Benfield separation. It seems quite likely that the switch would have been sooner, or compensation higher, if better information had been available to village negotiators.

3. Chittagong Urea Factory (CUF)

Rangudia, Chittagong

CUF is the newest, largest, and technologically most advanced urea fertilizer factory in the country. It was constructed in 1989 with Japanese assistance, and incorporates modern Japanese technology. The plant has not yet reached its design capacity, partly because it is still in the startup phase and partly because of damage suffered during flooding in 1991. Since Japanese industry has long since moved to a higher standard of process cleanliness, CUF is very clean plant. A lagoon has been excavated, but the effluent load is so low that wastewater is discharged directly into the Karnaphuli River. In addition, the Bay of Bengal is a short distance downstream. Although local employment alternatives are plentiful, neighboring communities have put no pressure on CUF. Its built-in environmental controls are locally acceptable and surpass any regulatory standards which the government of Bangladesh is likely to enforce during the coming decade.

B. SUPERPHOSPHATE AND PULP PLANTS

Our other sample plants do not have process similarity and are therefore not directly comparable. Nevertheless, the same kinds of forces are clearly operating.
1. **Triple SuperPhosphate Complex (TSPC)**

   **North Patenga, Chittagong**
   This plant is also located on the Karnaphuli River close to the Bay of Bengal. However, the resemblance to CUF ends there. TSPC is the most pollution-intensive, dangerous plant in our survey, and has been identified by the environmental division of the Bangladesh government as a major problem. The wastewater is loaded with fluoride and sulphur. Despite the use of a scrubber, there are heavy air emissions of sulphur di- and tri-oxide, fluoride, and nitrous oxide. In any case, the water from the scrubber is simply dumped into the river.
   
   Although the nearby CUF plant has had no difficulty with neighboring villages, TSPC is under extreme pressure. Local communities have not hesitated to protest, because there are many other potential employers in the region. The implicit threat of violence is present, and the plant's own employees are quite concerned about the impact of its air emissions on their health. Although the plant managers are fully aware of the problems, little or no cleanup effort is visible to date. In part, this seems to be because the technical and human resource requirements for effective cleanup in such a facility are more demanding. In part, it may simply be a management issue.

2. **Pulp mills**
   
   The two mills in our survey should not necessarily be considered representative of pulp production in Bangladesh. There are two other state-owned facilities, as well as several mills in the private sector. We do not yet know whether the interplay of pollution intensity, community pressure, and cleanup effort is similar for private sector operations.
   
   **a. Khulna Newsprint Mill (KNM)**
   **Khalishpur, Khulna**
   KNM is one of the oldest large-scale plants in Bangladesh, having been constructed with Canadian assistance in 1959. Its pre-environmentalist technology, semi-chemical pulping, is now losing ground internationally to cleaner technologies such as the thermomechanical process. No cleanup has been undertaken at KNM: it emits large volumes of airborne sulphur dioxide, and effluents are dumped completely untreated into the Bhairab River. The wastewater has high biological oxygen demand (BOD), suspended solids, oil and grease, and significant residual sodium sulphite and carbonate from the wood treatment process.
   
   While KNM is a substantial polluter and there are abundant employment options in the area, it has experienced no pressure for cleanup. This is apparently because KNM sits among several polluting installations on the riverbank, and cannot be clearly identified by downstream communities. As in the case of UFF, asymmetric information has apparently hampered their ability to negotiate an optimum settlement.
   
   **b. Sylhet Pulp and Paper Mill (SPPM)**
   **Chatak, Sylhet**
   This facility was installed in 1975 with West German assistance. It employs a soda ash process to produce pulp, which is then bleached. Significant airborne chlorine is emitted, along with wastewater containing high BOD, high pH, and concentrations of chlorine, calcium hydroxide, and sulphuric acid. SPPM is located in a relatively isolated rural area, where it is the only polluting facility. Its air emissions probably pose little threat to the surrounding area, but its effluent discharge into the Surma River is a clearly identifiable source of damage for downstream communities.
The absence of community pressure on the plant seems partly due to the local scarcity of employment options. The plant has also moved preemptively, undertaking significant first stage EOP treatment to reduce BOD and neutralize the Ph level. Acid or alkali are injected to neutralize the Ph of the plant's effluent on its way to an intermediate holding lagoon. In the lagoon, oxidation is promoted with a water paddle and injection of air from the power plant. Part of the lagoon is also covered with water hyacinth, which has been found to reduce odors and remove color. Once again, however, there has been no investment in the second stage treatment which would significantly reduce toxic pollution from the bleaching process.

C. **Summary: The Economics of Informal Regulation**

Wheeler (1991) and others have noted that even centralized, efficient regulatory agencies are frequently involved in plant-level negotiations over pollution standards and charges. This is because optimal pollution levels depend on social, environmental, and economic factors which can differ significantly within administrative regions. Regulatory agents have the power to sanction recalcitrant plant managers, but enforcement is likely to be both time-consuming and costly. Both parties therefore have an incentive to negotiate. The terms of final settlement will be strongly influenced by the relative quality of the negotiators' information concerning pollutant volumes, damage, cleanup options, and costs.

In Bangladesh, our survey has revealed a pattern of informal regulation which has remarkably similar characteristics.[Note 3] Fish kills, paddy crop damage, and poisoned drinking water provide a straightforward, but limited, basis for damage estimation by downstream communities. Plant staff members live and work near these communities, and are therefore potentially subject to social pressures ranging from harassment through ostracism to outright violence. The cost of negotiated settlement packages, including both compensation and cleanup investment, will depend on several factors: 1) The firm's identifiability as a polluter; 2) the pollutant volumes and risks known to community representatives; 3) the economics of cleanup options; and 4) the current economic prospects of both the polluting firm and the affected community. Negotiations are unlikely when an affected community is desperate for employment or polluting firm is obviously near bankruptcy.[Note 4]

Table 2 provides a simple negotiating tableau for the seven plants in our survey. With very limited resources and time, we have not been able to obtain good information about all relevant factors. In particular, we have not been able to quantify the economics of cleanup options. We have limited ourselves to simple categorical estimates of the other critical background variables: polluter identifiability, pollution intensity, local employment options, degree of community pressure during the survey period, magnitude of cleanup activity, and payment of monetary compensation. Although the 'fit' is not perfect, the background variables seem clearly related to outcomes.

1. **Community Pressure for cleanup**

All three zero pressure cases have ready explanations: an extremely low pollution intensity for CUF, the new Japanese-donated plant; non-identifiability for the KNM newsprint mill, which is effectively hidden among other plants in large industrial complex; and, for the SPPM pulp mill, considerable prior cleanup effort plus regional job scarcity. Low pressure is reported by the NGFF fertilizer factory which, despite its high pollution intensity, is located in the same job-scarce region as SPPM.
Where high community pressure is reported, some conditions are again consistently met: The plant is readily identifiable as a pollution source; it has medium or high pollution intensity; and the availability of other jobs is also at medium or high levels. The highest pressure (including the implicit threat of violence and tremendous employee dissatisfaction) is reported at the TSPC complex, which rates High on both pollution intensity and employment alternatives.

2. Cleanup and compensation

Community pressure is clearly related to the intensity of cleanup effort. Typical responses have included installation of first-stage water treatment processes; installation of stack scrubbers; and monetary compensation for perceived economic damage. Two of three high-pressure cases feature both significant waste treatment and monetary compensation. Conversely, there has been no activity in two of the three zero-pressure cases. Outliers are the TSP Complex, which despite the highest level of community pressure has undertaken no EOP treatment; and the SPPM pulp mill, which has made substantial EOP investments despite zero community pressure. In the latter case, past cleanup may have been a preemptive move by management. The TSPC case has no ready explanation, although the relative cost of cleanup may have something to do with it.

3. The problem of asymmetric information

Our survey results indicate that even very poor people in Bangladesh can negotiate pollution reduction and compensation when the damage is evident and they have economic alternatives. It is also clear, however, that affected communities are handicapped by poor information. In some cases they cannot identify the offending polluter; they have little basis for assessing pollutant risk; and they generally know little about the cleanup options faced by polluting firms. When they demand monetary compensation, it is usually for the most immediate, visible evidence of economic damage. Better information would almost certainly move negotiated settlements toward more pollution reduction and higher average compensation.
**TABLE 2**
Informal Regulation of Public Enterprises

<table>
<thead>
<tr>
<th>Plant</th>
<th>Local Pressure</th>
<th>Identifiable</th>
<th>Pollution Intensity</th>
<th>Job Options</th>
<th>Local Comp</th>
<th>Cleanup Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea Fertilizer Factory (UFF - Ghorasal, Narsingdi)</td>
<td>High</td>
<td>Y</td>
<td>Medium</td>
<td>Medium</td>
<td>Y</td>
<td>High</td>
</tr>
<tr>
<td>Polash Urea Fertilizer Factory (PUFF - Polash, Narsingdi)</td>
<td>High</td>
<td>Y</td>
<td>Medium</td>
<td>Medium</td>
<td>Y</td>
<td>Medium</td>
</tr>
<tr>
<td>Chittagong Urea Factory Ltd. (CUF - Rangudia, Chittagong)</td>
<td>Zero</td>
<td>Y</td>
<td>Low</td>
<td>High</td>
<td>N</td>
<td>None</td>
</tr>
<tr>
<td>Natural Gas Fertilizer Factory (NGFF - Fenchuganj, Sylhet)</td>
<td>Low</td>
<td>Y</td>
<td>High</td>
<td>Low</td>
<td>Y</td>
<td>Medium</td>
</tr>
<tr>
<td>Triple Superphosphate Complex (TSPC - North Patenga, Chittagong)</td>
<td>High</td>
<td>Y</td>
<td>High</td>
<td>High</td>
<td>N</td>
<td>None</td>
</tr>
<tr>
<td>Khulna Newsprint Mill (KNM - Khalishpur, Khulna)</td>
<td>Zero</td>
<td>N</td>
<td>Medium</td>
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<td>N</td>
<td>None</td>
</tr>
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<td>Sylhet Pulp and Paper Mill (SPPM - Chatak, Sylhet)</td>
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<td>Y</td>
<td>High</td>
<td>Low</td>
<td>N</td>
<td>High</td>
</tr>
</tbody>
</table>
V. SUMMARY AND CONCLUSIONS

Bangladesh is one of the poorest nations on earth, has barely begun the process of industrialization, and has only recently begun to consider formal environmental regulation. Yet even here, we have found a complex and interesting environmental story:

1. **Technology bundling:** The tied loan policies of aid donors have imposed high de facto standards on some pollution-intensive sectors. In our sample of urea fertilizer plants, pollution intensity is clearly related to mainstream intensity in the donor country at the time of installation. Since most donors have now begun imposing waste treatment standards as well, the degree of "bundled" cleanup in aid-constructed facilities will be even higher in the future.

2. **Informal regulation:** With little or no assistance from national regulators, villages in Bangladesh have shown great willingness to defend their own environmental interests. Community pressure and negotiated agreements for cleanup and compensation are common when polluters are identifiable and employment alternatives are not too scarce. The surprising strength of this informal regulatory system raises a hopeful prospect for cost-effective pollution reduction in Bangladesh. With better information and some legal support, community-level negotiators might well play a valuable regulatory role during the next phase of Bangladesh's development.
REFERENCES


Notes

[Note 1] These results highlight the need for caution in transferring empirical findings across world regions. In Eastern Europe public enterprises have been identified as prime environmental offenders, partly because relative immunity from competitive pressure has allowed them to retain dirty processes which are outmoded by OECD standards (Hughes, 1990). Recent studies of the world pulp and steel industries (Wheeler/Martin, 1992; Wheeler/Huq, 1992, respectively) have shown that adoption of newer, cleaner technologies by the ex-COMECON economies has lagged at least two decades behind their OECD counterparts. In Bangladesh, on the other hand, public enterprises which are also largely immune from competitive pressure have become much cleaner over time. The key is foreign assistance: Technology choice for public enterprises in poor countries is largely determined by donor preferences.

[Note 2] One recent incident illustrates the persistence of the bad reputation which these plants have enjoyed. Neighboring villagers recently blamed UFF for a large fish kill downriver, although it claims the true source was a massive hot water discharge from a nearby power plant.

[Note 3] Economists will recognize this as a good example of Coasian settlement, in which plant management recognizes the implicit environmental property rights of downstream communities. See Coase (1960, 1988).

[Note 4] It is worth noting that such considerations also affect formal regulatory proceedings in the industrial economies.