WPS 1602

POLICY RESEARCH WORKING PAPER 1602

Program-Based Pollution Control Management

The Indonesian PROKASIH Program

Shakeb Afsah
Benoît Laplante
Nabiel Makarim

Despite the absence of a reliable regulatory framework and credible monitoring and enforcement capabilities, a group of plants participating in the "Clean River" Program (PROKASIH) did undertake efforts to control their emissions. The program also provides information that regulators can use to differentiate polluters willing to practice pollution control from those less willing to do so.

The World Bank
Policy Research Department
Environment and Infrastructure Division
May 1996

Summary findings

In 1989, Indonesia's Minister for Population and the Environment introduced its "Clean River" Program, better known as PROKASIH. The program's purpose is to improve water quality by reducing emissions from the most important sources of water pollution in Indonesia. Though participation in the program is not entirely voluntary, compliance with the terms of the agreement signed by the plants is not legally binding, and to a large extent, is voluntary.

Both total biological oxygen demand (BOD) discharges and pollution intensity (emissions per unit of output) from PROKASIH plants fell significantly during the period analyzed by Afsah, Laplante, and Makarim. But the performance of plants varied widely and the general improvement in BOD discharges was achieved through the efforts of a few plants.

Despite the absence of a reliable regulatory framework and credible monitoring and enforcement capabilities, a group of plants did make efforts to control pollution emissions. A further and important contribution of the PROKASIH program has been to identify the plants willing to practice pollution control and those unwilling to do so. This information should prove useful in the allocation of monitoring resources. A program-based approach targeted at a specific subset of polluters can increase the incentives for pollution control.

It is clear from this experiment that regulators must establish a system for pollution control that analyzes environmental performance of plants reliably. Regulators must confront such issues as self-reporting, information, inspections, compliance assessment, and others. A program-based approach can pave the way to setting in place a reliable compliance management system. It can also provide the foundations of a river basin environmental management system.

This paper — a product of the Environment and Infrastructure Division, Policy Research Department — is part of a larger effort in the department to promote clearer understanding of environmental policy issues. The study was funded by the Bank's Research Support Budget under the research project "The Economics of Industrial Pollution Control in Developing Countries" (RPO 680-20). Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Angela Williams, room N10-021, telephone 202-473-7176, fax 202-522-3230, Internet address awilliams@worldbank.org. May 1996. (41 pages)

Program-Based Pollution Control Management: The Indonesian PROKASIH Program

by

Shakeb Afsah*
Benoît Laplante*
and
Nabiel Makarim**

* World Bank, Policy Research Department, Environment and Infrastructure (PRDEI), Washington, D.C.
** BAPEDAL (Environmental Impact Management Agency), Jakarta, Indonesia.

Acknowledgment

We are grateful to everyone in the PROKASIH team who have allocated time and effort to answer our numerous questions, and assemble the data necessary to conduct this analysis. We also thank John Patterson, David Wheeler, David Witzel, and Muhammad Zakaria for valuable comments and suggestions. Usual disclaimers apply.

Executive Summary

The implementation of environmental objectives is particularly demanding for environmental regulators of developing countries. Policy makers may indeed express concerns about diverting resources to pollution control when poverty, illiteracy and infant mortality are still major problems. Hence, most developing countries typically do not allocate the resources necessary to establish comprehensive and extensive systems of pollution control. This may explain that while regulation does frequently exist in developing countries, the monitoring of the regulated community and the enforcement of environmental standards are often extremely weak. As a result, incentives to comply with environmental standards and to control pollution emissions remain generally very small. It does not follow however that environmental regulators of developing countries have no options and should remain powerless in face of deteriorating environmental quality as a result of excessive emissions of pollution.

Given the fast rate of industrialization and urbanization experienced by Indonesia, the environmental and health costs imposed by the increasing release of pollution was expected to grow rapidly despite the presence of environmental regulations both at the national and provincial levels. The fact is that the behavior of the regulated industries was not closely monitored, and enforcement of the environmental standards was, for most purposes, non-existent. The Ministry for Population and the Environment had limited resources to monitor or regulate industrial pollution, and Governors of provinces had no incentives to do so. Though reliable data is not available, it is widely believed that industrial plants simply ignored (or were unaware of) the environmental regulation. As a result, the Ministry decided in 1989 to focus its limited resources on implementing a program-based approach for controlling the discharge of industrial pollution in waterways. On June 19, 1989, the Ministry introduced its "Clean River" Program, better known as PROKASIH. Upon its establishment in 1990, the Environmental Impact Management Agency (BAPEDAL) chose to use the PROKASIH program to introduce control of industrial pollution of Indonesia's rivers and to begin implementation of the Water Pollution Control Regulations (PP20/1990), and related Ministerial Decree on Effluent Discharge (KEPMEN 03/1991).

The purpose of the program is to improve water quality by seeking pollution reduction from the most important sources of water pollution in Indonesia. Though participation in the program is *not* voluntary per se, a particular characteristic of the agreement signed by the plant is that it is not legally binding. Hence, once the agreement has been signed, *compliance* with the terms of the agreement is to a very large extent voluntary.

We show that total BOD discharges from PROKASIH plants fell significantly over the period of analysis. However, we also show that this aggregate result hides considerable differences in the performance of plants. In particular, the reduction in total BOD discharges has been achieved through an improvement in the environmental performance of a small number of plants. A plant's performance can be explained by both a change in its scale of activity and by a change in its level of emissions per unit of output (pollution intensity). We thus also look at changes in pollution intensity by PROKASIH plants. We show that pollution intensity changed significantly as a result of PROKASIH.

Our analysis of the PROKASIH experience suggests that there does exist a group of plants that have exerted effort to control pollution emissions despite the absence of a reliable regulatory framework and credible monitoring and enforcement capability. A significant contribution of a program like PROKASIH is to delineate plants willing to exert pollution control effort from those less inclined to do so. This division should provide useful information for BAPEDAL, and set the stage for further and more focused intervention if needed. Moreover, the desire to control and monitor closely the environmental performance of a limited number of plants, confronts the regulator to the need of setting and implementing a system by which performance is going to be measured and analyzed reliably. Hence, another significant contribution of a program like PROKASIH is that it forces the regulator to confront issues of *implementation* of the objectives of the program, and more broadly, of the objectives of environmental regulations. Issues of self-reporting, information, inspections, compliance assessment, etc. must be dealt with.

1. Introduction

Two issues in environmental economics have attracted most of the attention and research effort: the control of pollution emissions and the valuation of the costs and benefits of reducing those emissions.[1] With respect to the control of pollution emissions, most of the environmental policy debate has centered around the comparison of command-and-control (CAC) and economic instruments (emission charges, tradable permits, subsidies).[2] Recent experiments with economic instruments have revealed that a combination of both CAC and economic instruments is most likely to be efficient.[3]It remains the case however that the design and implementation of these approaches (or of a mix of them) is highly resource-intensive and impose stringent requirements on the regulator.

The implementation of environmental objectives is particularly demanding for environmental regulators of developing countries. Policy makers may indeed express concerns about diverting resources to pollution control when poverty, illiteracy and infant mortality are still major problems. Hence, most developing countries typically do not

---

1 Cropper and Oates (1992) provide a survey of each of these issues.

2 Bohm and Russell (1985) summarizes the relative advantages of each approach.

3 For example, economic instruments are not easily tailored to location-specific environmental damages. In such circumstances, interventions of a CAC nature may complement the use of economic instruments. See Hahn (1989), Hahn and Hester (1989) and OECD (1989, 1991) for more details. Moreover, the use of an emission charge to meet a given target requires information that is not readily available. Baumol and Oates (1971) suggests a simple iterative process to achieve a given level of emissions reduction in the absence of information on marginal abatement costs. However, this process ignores that firms undertake significant investment when facing a given charge, and that this investment may not be optimal once the charge is changed. There could therefore be large costs associated with changing the tax rate. Moreover, the process proposed by Baumol and Oates ignores that firms engage in strategic behavior vis-à-vis the regulator. The welfare properties associated with this strategic interaction has been recently analyzed by Karp and Livernois (1994).

allocate the resources necessary to establish comprehensive and extensive systems of pollution control. This may explain that while regulation does frequently exist in developing countries, the monitoring of the regulated community and the enforcement of environmental standards are often extremely weak.[4] As a result, incentives to comply with environmental standards and to control pollution emissions remain generally very small.[5]

It does not follow however that environmental regulators of developing countries have no options and should remain powerless in face of deteriorating environmental quality as a result of excessive emissions of pollution. On the basis of the Indonesian experience, we argue in this paper that a program-based approach targeted at a specific subset of polluters can increase the incentives for pollution control, and pave the way to setting in place a reliable compliance management system.

Indonesia has achieved remarkable economic success over the last twenty-five years: per capita income increased annually at a rate of 4.5% after 1970.[6] This success

---

4 It should not be implied that monitoring and enforcement issues have been solved in the United States (and more generally in developed countries). Russell (1990) writes: "What is missing is a commitment of resources to checking up on whether those covered by the law and regulations are doing (or not doing) what is required of (or forbidden to) them." (p. 243). In a recent study, the General Accounting Office (1993) concludes that the EPA cannot ensure the accuracy of the pollution data reported by polluters. In Quebec, while 59 pulp and paper plants were in operation during the period 1985-1990, there has been a total of only 54 sampling inspections by the Ministry of the Environment (Laplante and Rilstone (1995)).

5 See O'Connor (1994) for more details.

6 Per capita income was US$50 in the late 1960s. It is now estimated to be US$650. Poverty fell drastically (from 70 million individuals to approximately 27 million); life expectancy rose from 41 years in 1960 to 61 years in 1990; primary school enrollment nearly tripled and secondary school enrollment increased 8-fold.

was achieved through rapid industrialization: while manufacturing represented 13% of GDP in the 1970s, it represented 23% of GDP in the 1980s.[7] This rapid development had serious adverse impacts on the environment, especially in Java where 75% of the total Indonesian industrial activity is located. In particular, the quality of surface water has become a major source of concern.[8] Given the fast rate of industrialization and urbanization, the environmental and health costs imposed by the increasing release of pollution was expected to grow rapidly despite the presence of environmental regulations both at the national and provincial levels. The fact is that the behavior of the regulated industries was not closely monitored, and enforcement of the environmental standards was, for most purposes, non-existent. The Ministry for Population and the Environment had limited resources to monitor or regulate industrial pollution, and Governors of provinces had no incentives to do so. Though reliable data is not available, it is widely believed that industrial plants simply ignored (or were unaware of) the environmental regulation. As a result, the Ministry decided in 1989 to focus its limited resources on implementing a program-based approach for controlling the discharge of industrial pollution in waterways. On June 19, 1989, the Ministry introduced its "Clean River" Program, better known as PROKASIH. Upon its establishment in 1990, the Environmental Impact Management Agency (BAPEDAL) chose to use the PROKASIH

---

[7] Total industrial output has increased 8-fold since 1970. This development was accompanied with a rapid increase of Indonesia's urban population from 15% to 30% of total population. This was particularly true on the Island of Java, which accounts for 60% of the Indonesian population with a population density that is among the highest in the world. For more details on Indonesia's economic development, see World Bank (1994).

[8] Water is estimated to be an important factor of disease in Indonesia as most water sources are considered unsafe to drink. The benefits of solely reducing the diarrhea-related mortality by 50% were estimated to be in the order of US$300 million in 1990 (World Bank, 1994). This number ignores the gains from reducing the effects of water pollution

program to introduce control of industrial pollution of Indonesia's rivers and to begin implementation of the Water Pollution Control Regulations (PP20/1990), and related Ministerial Decree on Effluent Discharge (KEPMEN 03/1991).[9]

The purpose of the program is to improve water quality by seeking pollution reduction from the most important sources of water pollution in Indonesia. Though participation in the program is *not* voluntary per se, a particular characteristic of the agreement signed by the plant is that it is not legally binding. Hence, once the agreement has been signed, *compliance* with the terms of the agreement is to a very large extent voluntary.

Recent literature has pointed out the potential role of other policy tools to induce greater pollution control effort from industrial units. In particular, programs based on "voluntary" participation and programs based on the provision of information to various stakeholders increasingly attract attention.[10] There is some evidence from the US experience that emissions can be reduced through voluntary programs. Such an experience is the 33/50 Program, initiated by the US Environmental Protection Agency (EPA) to reduce releases of 17 toxic chemicals by 33% and 50% by the end of 1992 and

---

on morbidity. Air pollution and toxic wastes are also important issues. However, in this paper we focus solely on water pollution.

9 Because of its limited resources, BAPEDAL created a program called JAGATIRTA whose purpose is to respond to complaints raised by local communities. The program is therefore extremely focused, and a follow-up is made only on those complaints judged by BAPEDAL to be significant.

10 On the role and impact of information provision programs, see Hamilton (1995), Kennedy, Laplante and Maxwell (1994), Laplante (1995), Laplante and Lanoie (1994), and Muoghalu et al. (1990).

1995 respectively (hence the name 33/50). Participation in the program is voluntary, and commitments to achieve reductions are not enforceable by law. As of February 1992, more than 700 plants had committed their participation.[11] Early evidence suggests that for the period 1988-1992, toxic emissions fell by 40% (7 points above the target). After more than 20 years of CAC, the EPA claims that its 33/50 Program is an effective alternative to traditional regulation.

The purpose of this paper is to identify the impact of PROKASIH on both total discharges of biological oxygen demand (BOD) as well as on the pollution intensity (pollution per unit of output) of participating plants. Looking at changes in BOD load is justified by the regulator's concern over ambient quality. Indeed, ambient quality is primarily affected by the total load of emissions discharged in receiving waters. Changes in total discharges is therefore of relevance to the regulator. We show that total BOD discharges from PROKASIH plants[12]fell significantly over the period of analysis. However, we also show that this aggregate result hides considerable differences in the performance of plants. In particular, the reduction in total BOD discharges has been achieved through an improvement in the environmental performance of a small number of plants.

---

11 Arora and Cason (1995) analyze the characteristics of the plants participating in the 33/50 program. In particular, they show that large plants are most likely to participate.

12 We use the expression "PROKASIH plants" to identify plants that are participating in the program.

A plant's performance can be explained by both a change in its scale of activity and by a change in its level of emissions per unit of output. We thus also look at changes in pollution intensity by PROKASIH plants. We show that the pollution intensity of PROKASIH plants fell significantly over the period of analysis. These results suggest that environmental regulators of developing countries, despite a lack of resources, can proceed forward to control pollution emissions and achieve significant results through a program-based approach targeted at a specific subset of polluters.

In the next section, we discuss PROKASIH in more detail, and describe the dataset that has been used to perform the analysis. In Section 3, we analyze changes in BOD discharges by PROKASIH plants while in Section 4, we examine changes in pollution intensity. In Section 5, we discuss in more detail the role of a pollution control program of the PROKASIH nature. We conclude in Section 6.

2. The PROKASIH Program and the dataset

(a) *The PROKASIH Program*

The primary objective of PROKASIH is to prevent further decline in river quality. The program is based on pollution reduction agreements co-signed by provincial Vice-Governors, BAPEDAL, and participating plants. In 1989, 8 provinces were participating in the PROKASIH program. This number increased to 13 provinces in 1994.[13]Vice-Governors serve as local coordinators. In each province, an implementation team (called

[13] Four new provinces became PROKASIH provinces in 1995/96: Bali, Sulawesi Selatan, Manado, and Jambi.

PROKASIH team) has been constituted with representatives from various institutions: public works, regional development planning board (BAPPEDA), health department, laboratories, environmental study centers, etc. Both BAPEDAL and the provincial governments provide financial resources to the PROKASIH team. The responsibilities of the PROKASIH team include the following:

- Identification and selection of industrial units that are significant polluters;
- Measurement of the quality of polluters' effluents and water ambient quality;
- Data collection and reporting to BAPEDAL

In order to achieve the objectives of PROKASIH, priority is given to specific rivers, or portion of rivers where concerns over water quality are most serious, and by seeking pollution reductions from the largest polluters along the chosen rivers. It is the responsibility of the provincial PROKASIH team to choose both the rivers and the polluters. In 1994, 1405 establishments were participating in PROKASIH. Given the importance of industrial plants in the program (industrial plants account for 90% of participating establishments), we focus solely on these plants in this paper.

The number of PROKASIH plants varies considerably across provinces. As shown in Table 1, Jawa Barat and DKI Jakarta represent by far the largest number of participating plants, with approximately 75% of the total number in 1994. Jawa Barat itself covers 56% of the total number of plants, and exhibits a substantial increase in participation since 1990. Though both Jawa Barat and D.K.I. Jakarta appear to be very active in terms of enrolling plants in the

Table 1: Number of PROKASIH Plants Per Province

Province	1990	1991	1992	1993	1994
Jawa Barat	100	326	529	723	723
DKI Jakarta	96	193	220	228	228
Jawa Tengah	44	44	44	64	64
Jawa Timur	39	45	45	45	45
Lampung	9	30	30	34	34
Sumatera Selatan	33	33	33	33	33
Kalimantan Timur	30	30	30	30	31
Sumatera Utara	30	30	30	30	30
Kalimantan Selatan	0	0	0	0	20
Riau	0	18	18	19	19
D.I. Aceh	0	14	14	14	17
D.I. Yogyakarta	0	0	0	0	16
Kalimantan Barat	0	15	15	15	15
TOTAL	381	778	1008	1235	1275

PROKASIH program, it is interesting to note that they are also the two provinces where the budget of the PROKASIH team *per plant* is the smallest. As will be shown in the next section, this may explain that *none* of the PROKASIH plants in Jawa Barat and D.K.I. Jakarta survive our selection criteria for inclusion in our final sample of analysis. In particular, plants in D.K.I. Jakarta and Jawa Barat report their emissions at a frequency that is insufficient to estimate reliably their pollution profile.[14]

(b) *The dataset*

Our dataset has been constructed in the following way. First, we identified plants that became PROKASIH plants in 1990, and for which there is at least one measurement per year, for each of the years covering the period 1990-94. A similar exercise was performed for the plants that became PROKASIH plants in 1991. Second, we develop a

[14] Appendix 1 describes the process by which BAPEDAL collects information from PROKASIH plants.

strict set of guidelines that allowed us to identify and reject observations that could not be technically explained.[15] As described in Table 2, the final dataset for the period 1990-94 covers 100 plants located in 6 provinces along 24 rivers, and for which a total of 2819 observations are available (this represents an average of 5.6 observations per plant per year over the time period); the 1991-94 dataset covers 55 plants located in 5 provinces along 10 rivers, and for which 937 observations are available (for an average of 4.5 observations per plant per year).

The number of plants in our dataset (100 and 55) may appear small relative to the total number of PROKASIH plants participating in the program in 1990 and 1991 (381 and 778 respectively) . However, as noted above, observe in Table 2 that none of the plants in D.K.I. Jakarta and Jawa Barat are included in our dataset since the data from those provinces is too sparse and unreliable. If one excludes PROKASIH plants from those two provinces, the total number of PROKASIH plants in the remaining 11 provinces in 1990 is 185 (Table 1). Our 1990-94 dataset therefore covers more than 50% of the participating plants. Similarly, excluding D.K.I. Jakarta and Jawa Barat, 74 plants became PROKASIH plants in 1991. Our 1991-94 dataset therefore covers approximately 75% of those plants. The coverage of our dataset per province is described in Table 3.

---

15 These guidelines are available upon request.

Table 2: Description of Datasets

Provinces	Rivers	Period of analysis			
		1990-94		1991-94	
		Number of new plants	Number of observations	Number of new plants	Number of observations
Jawa Tengah	Anyar	2	46	--	--
Jawa Tengah	Bengawan Solo	2	46	--	--
Jawa Tengah	Kaligarang	2	44	--	--
Jawa Tengah	Ngringo	6	134	--	--
Jawa Tengah	Palur	1	21	--	--
Jawa Tengah	Pengo	4	92	--	--
Jawa Tengah	Pepe	1	23	--	--
Jawa Tengah	Premulung	1	25	--	--
Jawa Tengah	Sroyo	4	89	--	--
Jawa Timur	Kali Brantas	14	612	--	--
Jawa Timur	Kali Lesti	3	132	--	--
Jawa Timur	Kali Porong	2	100	--	--
Jawa Timur	Kali Surabaya	10	518	--	--
Jawa Timur	Kanal Mangetan	1	51	--	--
Jawa Timur	Kali Mediun	--	--	6	140
Kalimantan Timur	Mahakan	8	147	--	--
Lampung	Way Pangubuan	4	80	--	--
Lampung	Way Seputih	1	20	--	--
Lampung	Way Pegadungan	--	--	5	50
Lampung	Way Sekampung	--	--	6	81
Lampung	Way Terusan	--	--	2	24
Lampung	Way Tul. Bawang	--	--	5	59
Sumatera Selatan	Kramasan	1	15	--	--
Sumatera Selatan	Musi	16	257	--	--
Sumatera Selatan	Ogan	2	33	--	--
Sumatera Utara	Asahan	5	129	--	--
Sumatera Utara	Deli	6	143	--	--
Sumatera Utara	Merbau	2	54	--	--
Sumatera Utara	Semayang	2	52	--	--
D.I. Aceh	Langsa	--	--	3	37
D.I.Aceh	Tamiang	--	--	3	39
Kalimantan Barat	Kapuas	--	--	5	119
Kalimantan Barat	Kapuas Kecil	--	--	5	119
Riau	Siak	--	--	15	269

Table 3: Coverage of Datasets per Province

PROVINCE	1990 - 1994			1991 - 1994		
	Number of Prokasih plants in 1990	Number of Prokasih plants in dataset	% coverage	Number of new Prokasih plants in 1991	Number of Prokasih plants in dataset	% coverage of new plants
Jawa Barat	100	0	0	226	0	0
DKI Jakarta	96	0	0	97	0	0
Jawa Tengah	44	23	52.3	0	0	-
Jawa Timur	39	30	77.0	6	6	100
Lampung	9	5	55.5	21	18	85.7
Sumatera Selatan	33	19	57.5	0	0	-
Kalimantan Timur	30	8	26.6	0	0	-
Sumatera Utara	30	15	50.0	0	0	-
Kalimantan Selatan	0	0	-	0	0	-
Riau	0	0	-	18	15	83.3
D.I. Aceh	0	0	-	14	6	42.8
D.I. Yogyakarta	0	0	-	0	0	-
Kalimantan Barat	0	0	-	15	10	66.6

Both datasets will be used to assess the overall trend in pollution load and pollution intensity of industrial sources participating in the PROKASIH program.

In the next section, we examine the *aggregate* changes in BOD load by PROKASIH plants for each of the rivers along which PROKASIH plants are located. In Section 4, we disaggregate this result to examine the response of individual plants following their participation in PROKASIH.

3. Changes in aggregate BOD load

In this section, our interest is to analyze the trend in *aggregate* BOD load by PROKASIH plants. For this purpose, let C_{it} be a measure of BOD concentration of plant i's effluent in year t, and $\overline{C}_{it}$ be the average BOD concentration of plant i's effluent in year t. Similarly, let F_{it} be a measure of flow rate by plant i in year t, and $\overline{F}_{it}$ be the average daily flow rate for plant i in year t. Let BOD_{it} be the BOD load of plant i in year t measured in kg/day. Then, BOD_{it} is given by:[20]

$$BOD_{it} = \frac{\overline{C}_{it} \cdot \overline{F}_{it}}{1000}$$

Finally, let N_j be the number of PROKASIH plants discharging in river j. Let BOD_{jt} be the total BOD load by PROKASIH plants, in river j in year t, measured in kg/day. Then, BOD_{jt} is simply:

$$BOD_{jt} = \sum_{i=1}^{N_j} BOD_{it}$$

We examine the evolution of the variable BOD_{jt} for both the 1990-94 and 1991-94 dataset, along each of the PROKASIH river. Results are presented in Table 4 and Table 5 for each of the dataset, and then grouped into three categories in Figure 1, 2 and 3 according to whether aggregate BOD discharges increase, decrease or are uncertain along each of the river. As can be observed, the evolution of total BOD load is of a similar nature for both datasets: there are strong indications that total BOD discharges from PROKASIH plants have been significantly reduced in 18 of the 34 rivers in our dataset. However, in 9 rivers, BOD discharges by PROKASIH plants have reached higher levels in 1994 than in 1990 or 1991. In the aggregate, total BOD discharges fell significantly

20 (mg / liter) * (cubic meter / day) = (mg / liter) * (1000 liters / day) = kg / day.

Table 4: Percentage Change of BOD Load by River (1990-94)

Province	River	1990 kg/day	% change 1990-91	% change 1990-94
Jawa Tengah	Anyar	70	62	141
Jawa Tengah	Bengawan Solo	1519	-80	29
Jawa Tengah	Kaligarang	14	79	277
Jawa Tengah	Ngringo	1542	21	-57
Jawa Tengah	Palur	52	-9	1
Jawa Tengah	Pengo	436	-27	11
Jawa Tengah	Pepe	89	-58	-65
Jawa Tengah	Premulung	826	31	65
Jawa Tengah	Sroyo	255	143	-73
Jawa Timur	Kali Brantas	5842	-32	-3
Jawa Timur	Kali Lesti	8624	-49	-59
Jawa Timur	Kali Porong	3771	346	51
Jawa Timur	Kali Surabaya	10913	-8	-18
Jawa Timur	Kanal Mangetan	8575	26	-63
Kalimantan Timur	Mahakan	400	-18	-7
Lampung	Way Pangubuan	2784	-39	-59
Lampung	Way Seputih	709	-16	-94
Sumatera Selatan	Kramasan	1599	-66	-58
Sumatera Selatan	Musi	10406	-44	-53
Sumatera Selatan	Ogan	2391	-52	-35
Sumatera Utara	Asahan	3022	-38	-71
Sumatera Utara	Deli	405	-48	-49
Sumatera Utara	Merbau	586	56	-62
Sumatera Utara	Semayang	247	-5	-80

over the period of analysis. In Table 4, while aggregate BOD discharges by the 100 plants were 65 077 kg/day in 1990, these discharges fell to 41 846 kg/day in 1994, a decline of 36.25%; in Table 5, total discharges fell from 106 147 kg/day in 1991 to 59 489 in 1994, a reduction of 44%.

That such reductions were achieved by PROKASIH plants is certainly of clear interest to BAPEDAL. However, of potentially more significance for BAPEDAL, there is a clear indication, in Figure 1, that BOD load is on an upward trend in 1993 and 1994. Though additional data will

Table 5: Percentage Change of BOD Load by River (1991-94)

Province	River	1991 kg/day	% change 1991-92	% change 1991-94
Jawa Timur	Kali Mediun	743	-10	-41
Lampung	Way Pegadungan	22670	-59	-98
Lampung	Way Sekampung	3463	85	473
Lampung	Way Terusan	717	166	124
Lampung	Way Tul. Bawang	18627	-28	-61
D.I. Aceh	Langsa	729	-34	-47
D.I.Aceh	Tamiang	4993	-90	-87
Kalimantan Barat	Kapuas	2594	153	306
Kalimantan Barat	Kapuas Kecil	9024	-83	-48
Riau	Siak	42587	-67	-68

reveal whether or not this trend persists, it is worth pointing out that a number of factors may explain this development. First, it should be noted that total BOD discharges increase, ceteris paribus, with actual production. The important economic growth rate currently experienced by Indonesia may therefore explain this increase in BOD discharges. It is important to note that these increases could take place *despite* greater pollution control efforts by PROKASIH plants. This is why we examine, in the next section, BOD emissions *per unit of output* (pollution intensity), instead of total BOD discharges. Second, for some rivers, the number of participating plants in our dataset is small. Finally, this upward trend could also indicate that there may be a limit to the ability of a program of the nature of PROKASIH (in which agreements to reduce emissions are not legally binding) to induce *persistent* pollution control efforts on the part of the firms. This may be particularly the case in a situation where industrial growth is rapid, and where the enforcement of the environmental regulation has traditionally been, and to a large extent remains, lacking.[21]

[21] As mentioned earlier, currently most enforcement actions are undertaken through JAGATIRTA following complaints of local communities. The number of such actions is very limited.

Figure 1: PROKASIH Rivers Where Average BOD Load per Day Declined 1990-94 and1991-94

(Kilogram of BOD per day)

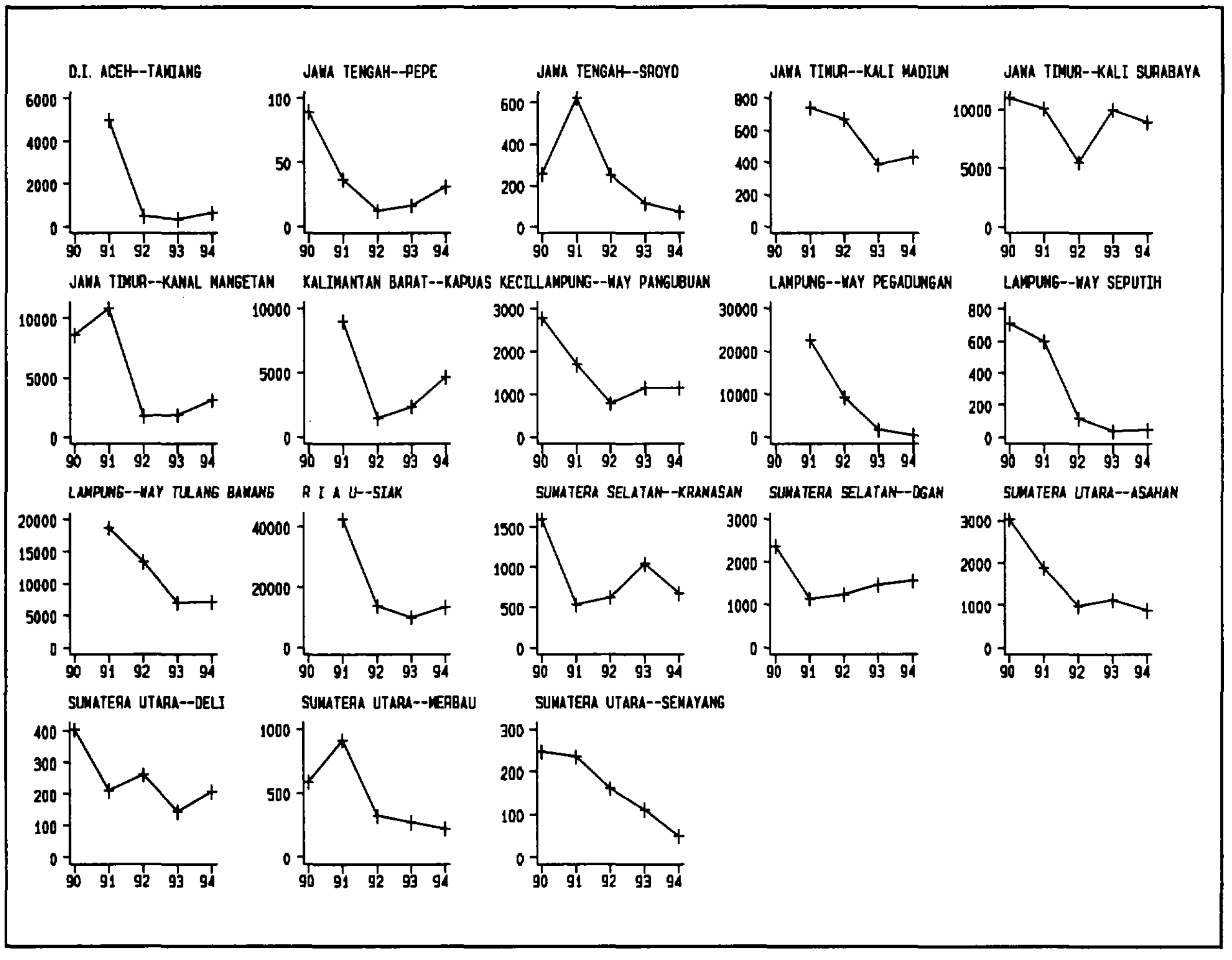


Figure 2: PROKASIH Rivers Where Average BOD Load per day Increased 1990-94 and 1991-94 (Kilogram of BOD per day)

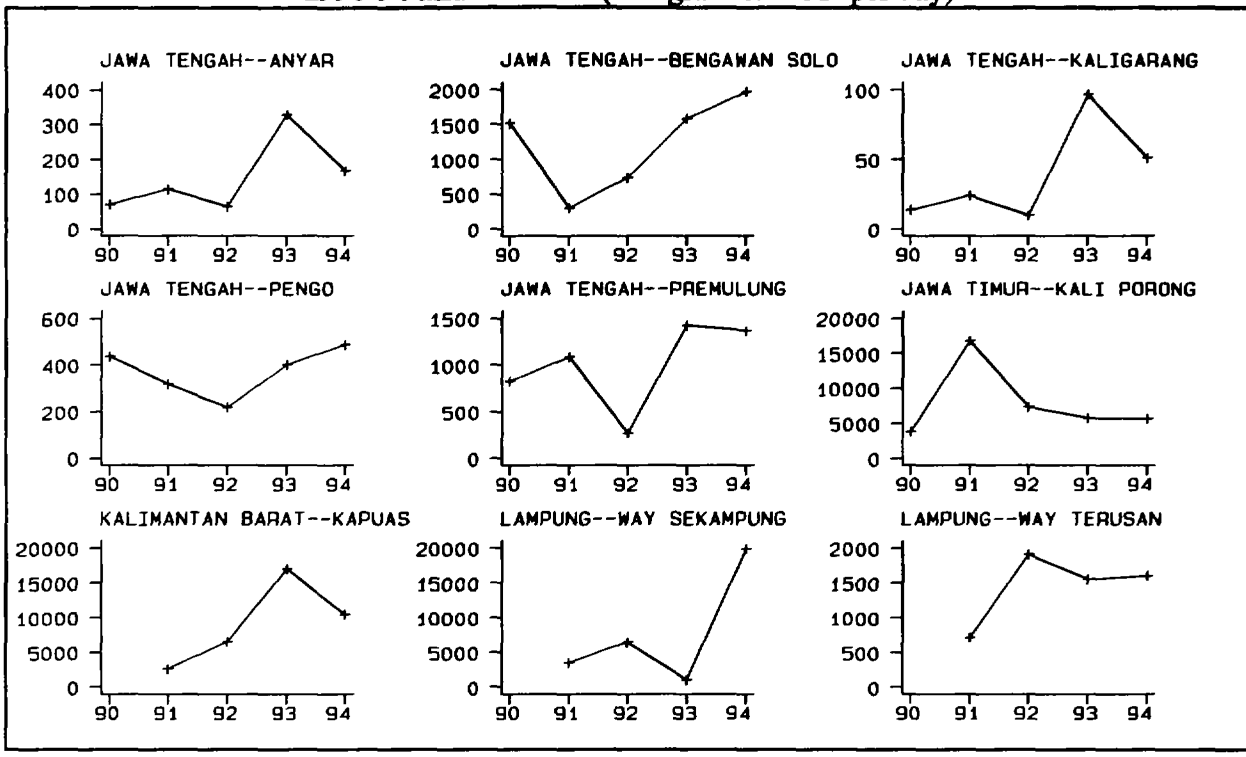
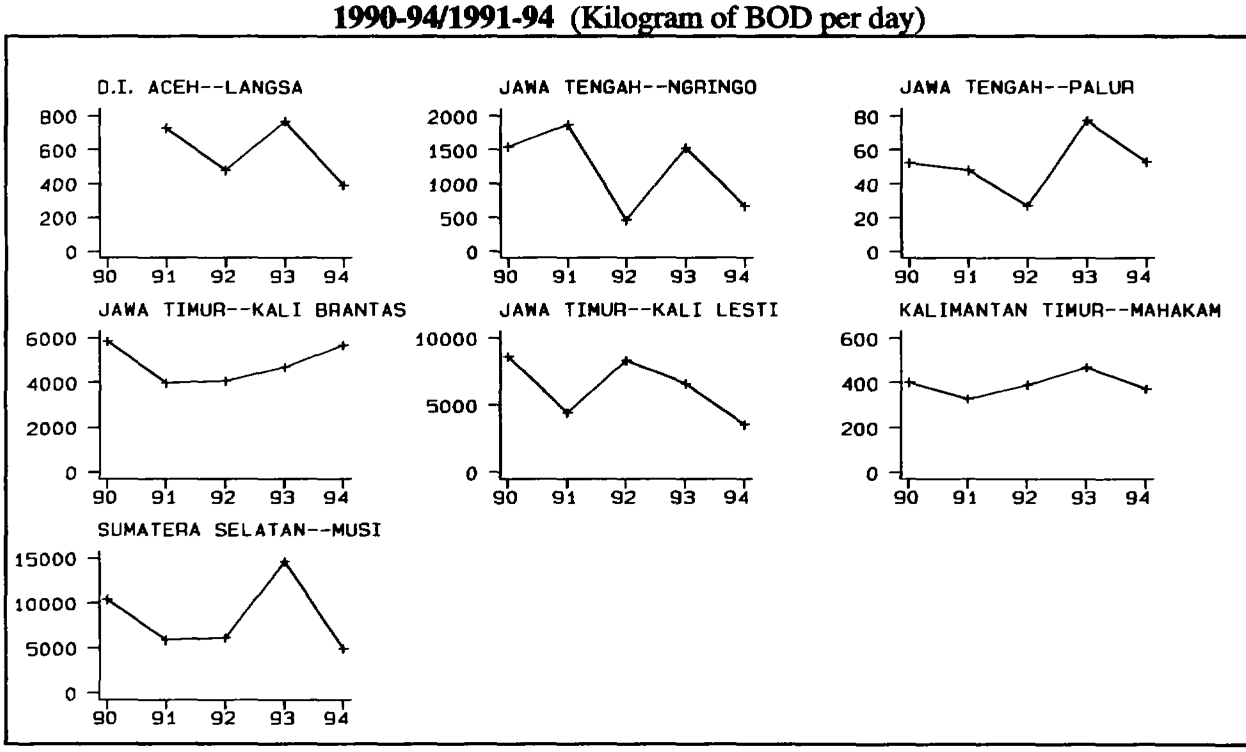


Figure 3: PROKASIH Rivers Where BOD Load per day Trend is Uncertain 1990-94/1991-94 (Kilogram of BOD per day)



In the next section, we analyze the data at the plant level, and seek to identify the individual contribution of the plant to the overall BOD reduction measured above.[22] We also examine changes in pollution intensity and suggest, through counterfactual analysis, that the impact of PROKASIH may be larger than measured above.

4. Changes in BOD load and pollution intensity at the plant level

In this section, we analyze the pattern of plant-level responses, using pooled data across rivers from the 1990-94 dataset.[23] First, we examine changes in BOD load, and then analyze changes in pollution intensity.

(a) *BOD load*

Before looking in the details of the plant-level responses, it is interesting to rank the PROKASIH plants in terms of their individual contribution to total BOD discharges. In order to do so, we have computed an index that is similar in nature to the Lorenz curve developed in industrial organization.[24] Let BOD_{90} be the total BOD load, in 1990, by the 100 plants of the 1990-94 dataset:

---

22 It should be noted at this point that no attempt is made in this paper to obtain a measure of the relationship between ambient concentration at any given point along the rivers and BOD discharges of individual plants; nor is an attempt made at measuring in dollars the impact of BOD discharges in any given river by any given plant. If the PROKASIH plants in our dataset were the only sources of BOD discharges, this exercise could be performed, albeit obtaining a dollar measure of marginal damages would still be problematic. However, (1) we have eliminated a significant number of PROKASIH plants due to a lack of data; (2) PROKASIH plants are not the only industrial sources of BOD discharges along a river; and (3) one must also account for non-industrial sources of BOD discharges. These are the object of ongoing research.

23 For the purpose of this section, we are solely using the 1990-94 dataset since it offers a longer period of observations. This is particularly important for the analysis of pollution intensity since we have output data up only to 1993. The 1991-94 dataset would thus offer only 3 years of observation.

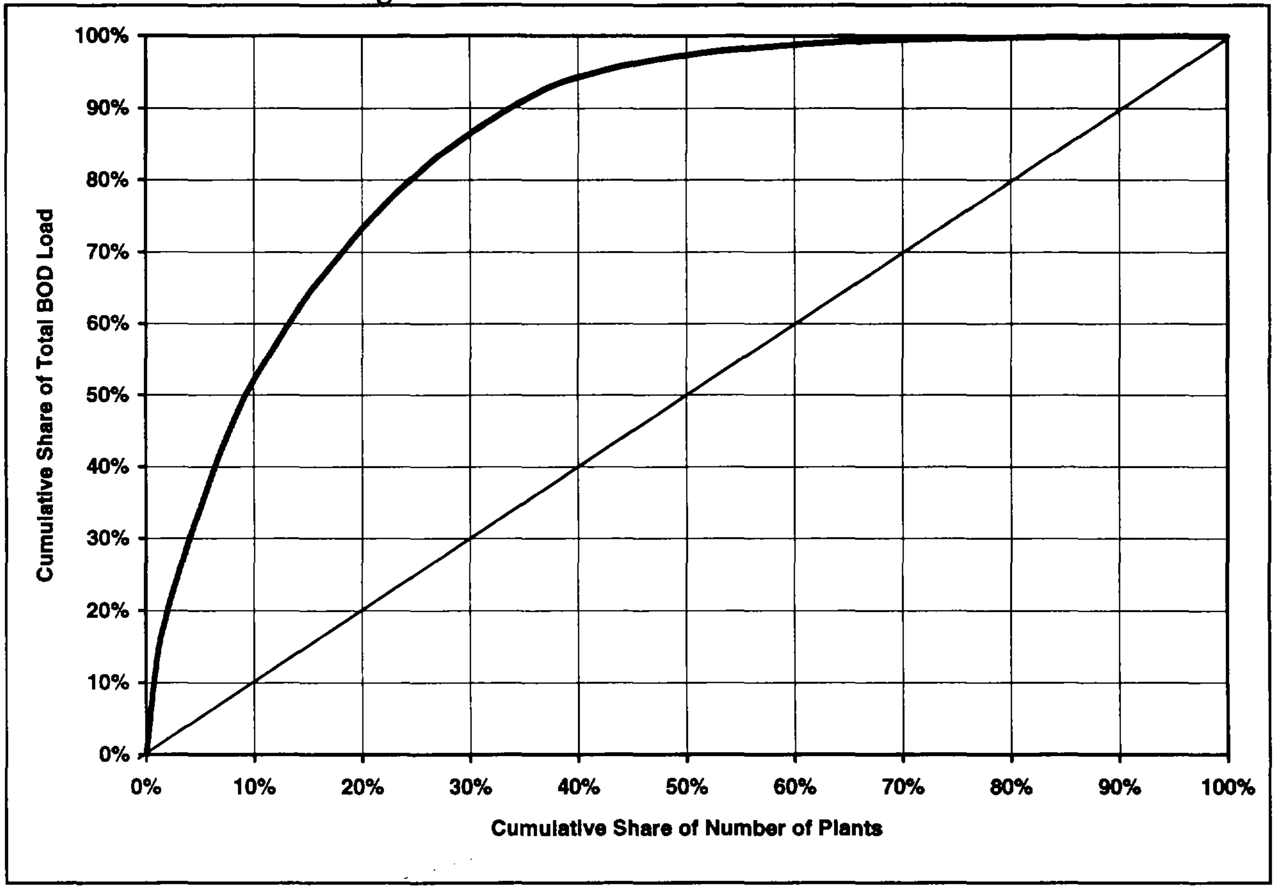
24 The Lorenz curve shows the percentage of total industry sales accounted for by any given fraction of the firms of the industry, with the firms ranked in decreasing order of market share.

$$BOD_{90} = \sum_{i=1}^{100} BOD_{i90}.$$

Then rank the plants such that $BOD_{190} > BOD_{290} > \cdots > BOD_{10090}$. The curve in Figure 4 represents the ratio $\sum_{i=1}^{n} BOD_{i90} / BOD_{90}$ accounted for by the fraction n / 100 of the largest plants in the dataset. When computed for the entire dataset (n = 100), the ratio is equal to 1. In Figure 4, the x-axis represents the cumulative proportion of plants, while the y-axis represents the cumulative proportion of total BOD accounted for by these plants. If each plant were contributing equally to aggregate discharges ($BOD_{190} = BOD_{290} = \ldots = BOD_{10090}$), the computation of the ratio described above would yield a straight line diagonal in Figure 4. The black curve indicates very clearly however that this contribution is far from being uniform: 50% of total BOD discharges is accounted for by less than 10% of the plants; 20% of the plants accounts for approximately 75% of total BOD discharges in 1990. Without any doubt, this suggests that most of PROKASIH's impact on total BOD discharges crucially depends on the behavior of a relatively small number of plants. A large reduction in BOD discharges by the largest 10% of the plants would significantly reduce pollution emissions. On the other hand, if 50% of the plants at the bottom end of the distribution were abating their emissions from current levels to zero, total discharges would fell by less than 5%.

There are various ways by which one can analyze the contribution of each individual plant to *changes* in total BOD load during the period of observation, and identify the extent to which these changes are driven by the behavior of a relatively small number of plants. In order to account for the large variation in the BOD discharges across plants, an interesting way

Figure 4: Distribution of BOD Load- 1990



to analyze the contribution of individual plant to changes in total BOD load is to express the change in total BOD discharge between 1990 and any given subsequent year t ($\%\Delta BOD_t$), as a weighted sum ofthe changes by each individual plant ($\%\Delta BOD_{it}$), with the weight being the plant's contribution to total BOD discharge in 1990 (s_i). The percentage change in total BOD discharges between 1990 and any subsequent year t is given by:

$$\%\Delta BOD_t = \frac{BOD_t - BOD_{90}}{BOD_{90}}$$

After some manipulation, this can be rewritten as:

$$\%\Delta BOD_t = \Sigma_i\left[\frac{BOD_{it} - BOD_{i90}}{BOD_{i90}} \bullet \frac{BOD_{i90}}{BOD_{90}}\right]$$

which becomes:

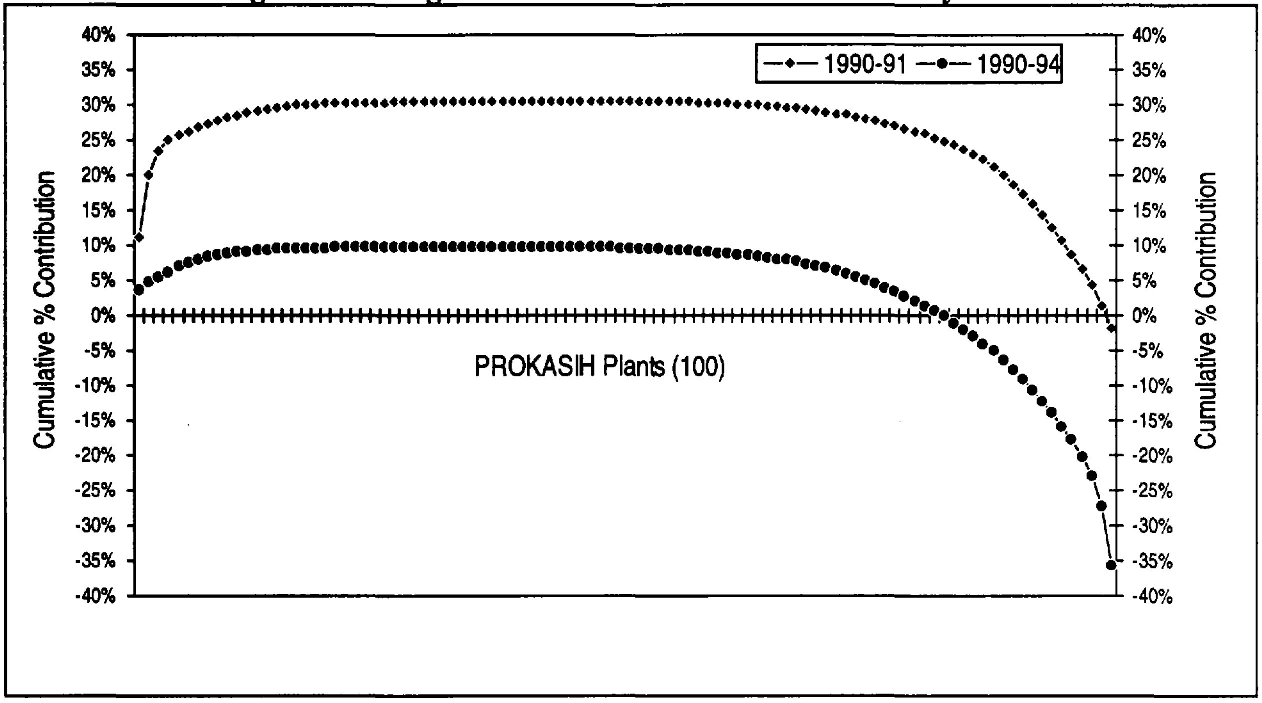
$$\%\Delta BOD_t = \sum_i s_i \bullet \%\Delta BOD_{it}$$

Hence a large variation in the BOD load of a plant which accounts for only a small portion of total BOD discharges will have only a small effect on total BOD load. Conversely, large changes from plants accounting for a large share of total BOD load in 1990 will have a significant impact on the total measure. To illustrate, we have arranged the contribution of individual plants in descending order, from the largest *positive* contribution to changes in total BOD discharges (i.e. firms increasing their BOD load) to the largest negative contribution (firms decreasing their BOD load).[25] Results appear in Figure 5.

From the figure, it appears clearly that many plants did not meet the terms of their pollution reduction agreements. Indeed, over the period 1990-91 and 1990-94, approximately 10 plants increased their BOD load significantly. The figure also suggests an extremely skewed distribution of plant contributions to total changes in BOD discharges. In particular, the bulk of the reduction in BOD load is explained by less than 20 plants. Most strikingly, more than 65% of the plants had a negligible impact on the change in BOD load.

[25] In other words, we have ranked the plants so that $s_1\ \%\Delta BOD_{1t} > s_2\%\Delta BOD_{2t} > \bullet\bullet\bullet > s_N\%\Delta BOD_{Nt}$. It shall be understood that the plant with the largest positive contribution is not necessarily the plant that has increased the most its BOD discharges since our index accounts for the plant's share in total BOD discharges in 1990.

Figure 5: Change in BOD Load Contribution-Share by Plant

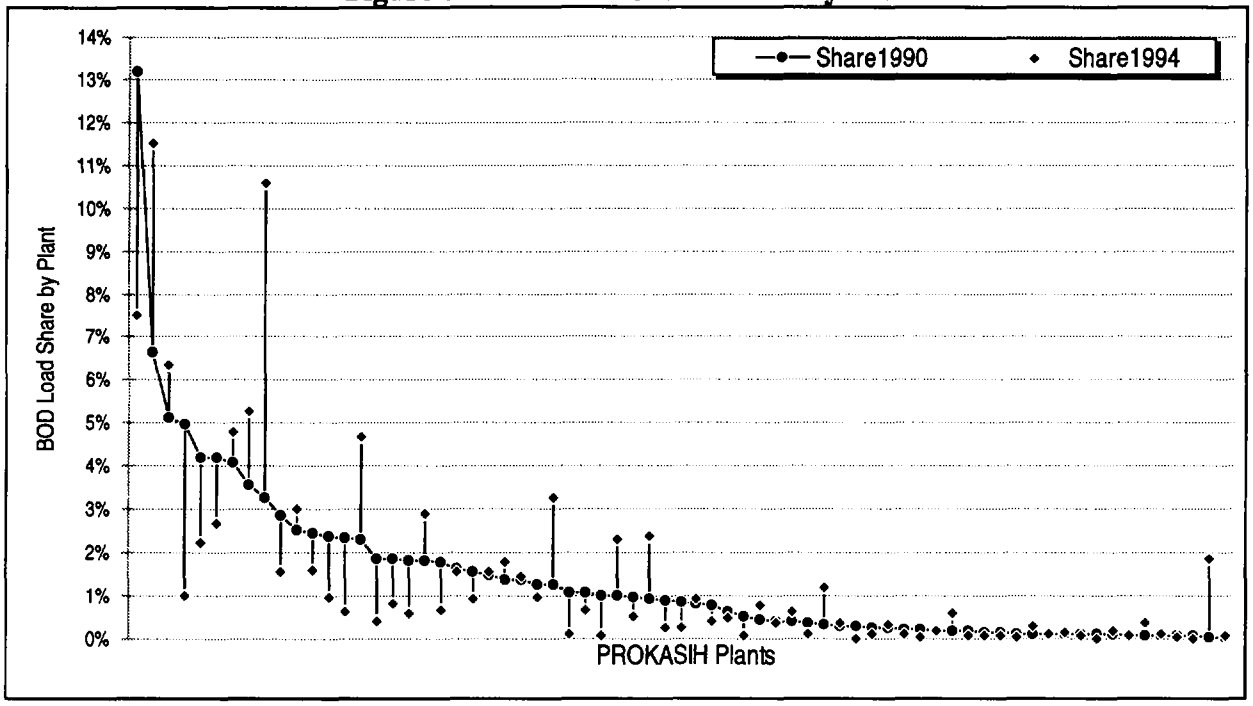


As a result of these changes, the distribution of BOD load across the 100 plants of our dataset changes significantly from 1990 to 1994. This is illustrated in Figure 6 where the dotted line represents plants' share of total BOD load in 1990, ranked from the plant with the largest share (in 1990) to the plant with the smallest share.[26]

In 1990, the plant with the largest share explained approximately 13% of the total BOD load of the plants in our dataset; this same plant explains 7.5% of total BOD load in 1994. In general, observe that the "pollution share" of individual plants fell significantly between 1990 and 1994. However, some plants exhibit a very sharp increase. For example, plant number 9 went

26 For the purpose of clarity, we have truncated the figure at n = 64. The individual share of the plants not represented in Figure 6 is close to zero in both 1990 and 1994.

Figure 6: BOD Load Share Trend by Plant



from 3% of BOD share in 1990 to almost 11% in 1994. Such plants would obviously be prime targets for further intervention if so desired.

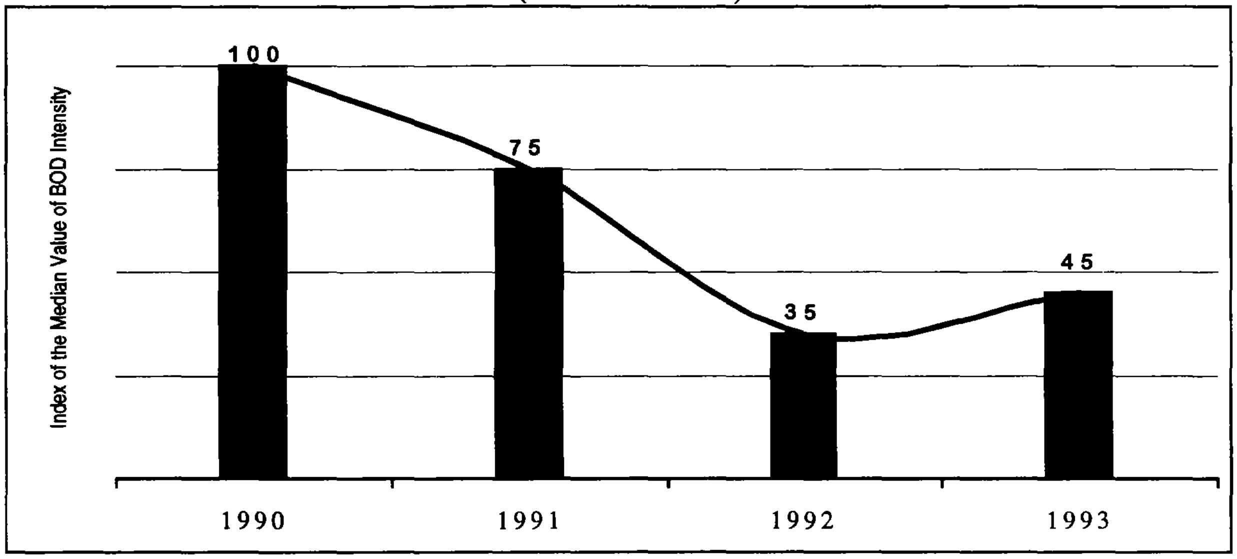
We have noted in Section 3 that BOD load by PROKASIH plants fell significantly from 1990 to 1994. The current results however strongly indicate that the overall reduction in BOD discharges is actually driven by a small number of plants in the dataset. Indeed, some plants have increased their discharges and a large proportion of the plants did not have any significant impact on BOD load (either because of their small size or because indeed their BOD load has not changed). Hence, though one may claim that PROKASIH has been successful at reducing total BOD load in the PROKASIH rivers, a closer examination reveals that the plants' response to PROKASIH varies considerably across plants.

Thus far, we have simply compared the BOD discharges in 1990 to the discharges in subsequent years. Since the regulator is primarily concerned with ambient quality of the receiving waters, changes in BOD load is clearly of relevance. Such a comparison ignores however that were it not for the program, BOD discharges could have been much higher than those observed. Indeed, total BOD discharges are a function of both the plant's scale of activity (ceteris paribus, the higher the level of output, the higher the level of discharges), and the BOD intensity (BOD load / total output). Changes in total BOD discharges will reflect changes in both of these parameters. Therefore, an *important* indicator of the impact of PROKASIH is changes in pollution intensity: constant BOD discharge from a rapidly-growing plant (which can happen only if pollution intensity falls) is clearly a sign of environmental progress.

(b) *Changes in pollution intensity*

In this section, we first want to examine changes in pollution intensity, and on the basis of these changes, provide a counterfactual analysis indicating that the impact of PROKASIH on BOD discharges may be larger than measured above. In order to perform this exercise, we must first identify plants for which production data is available and then calculate pollution intensity for each of the years of interest. As noted before, for the purpose of this analysis we are forced to use 1993 as the end year instead of 1994 since we have access to production data only up to 1993. From our 1990-94 dataset, we are able to identify 73 plants in the Statistical data base for which production data is available. For each of those plants we have calculated pollution intensity for each of the year over the period 1990-93, and then normalized the median 1990 pollution intensity to 100. Results are depicted in Figure 7, and are stunning. Despite the increase from 1992 to 1993, the median

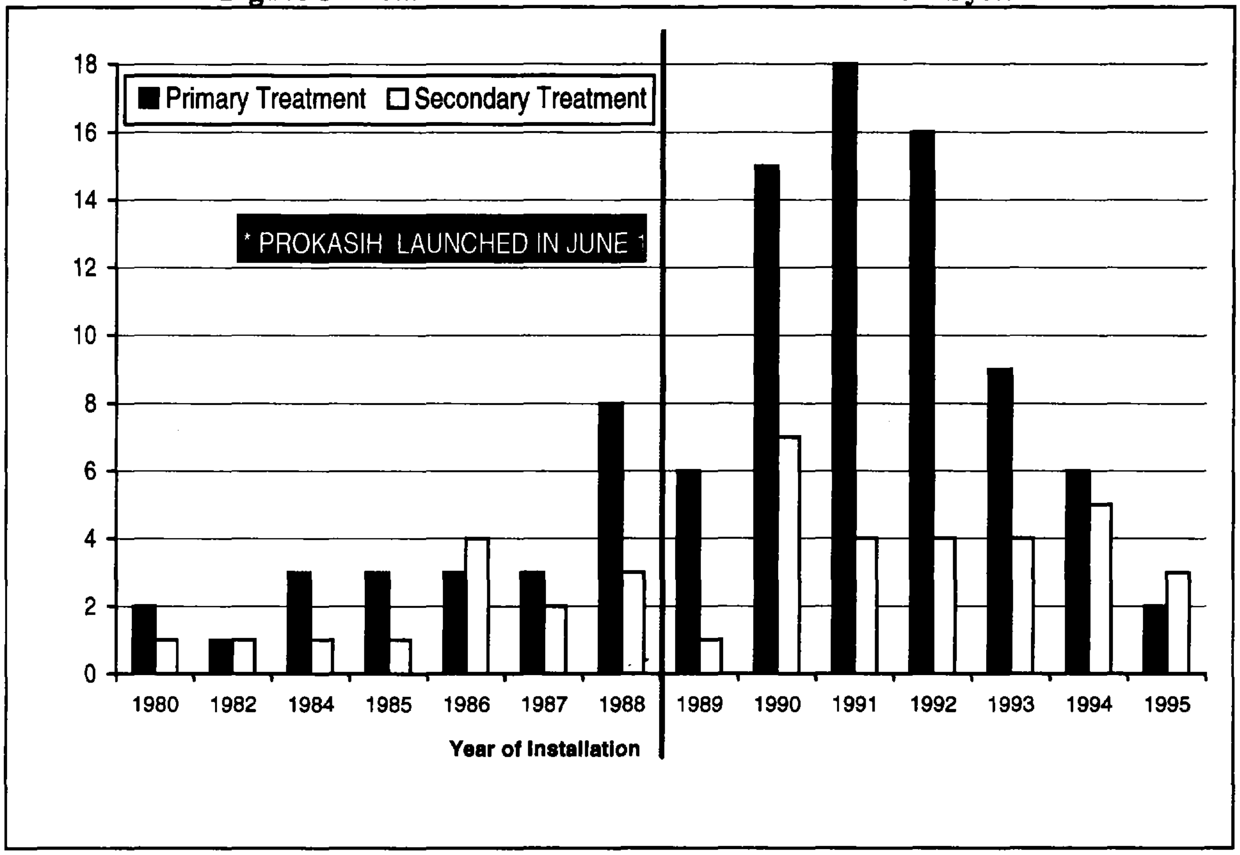
Figure 7: Changes in Median Value of BOD Intensity
(Index 1990=100)



BOD intensity fell by approximately 55% between 1990 and 1993. This is by all means very significant. It strongly suggests that considerable pollution control effort can be generated from a subset of plants even in circumstances where resources devoted to monitoring and enforcement activities are lacking.

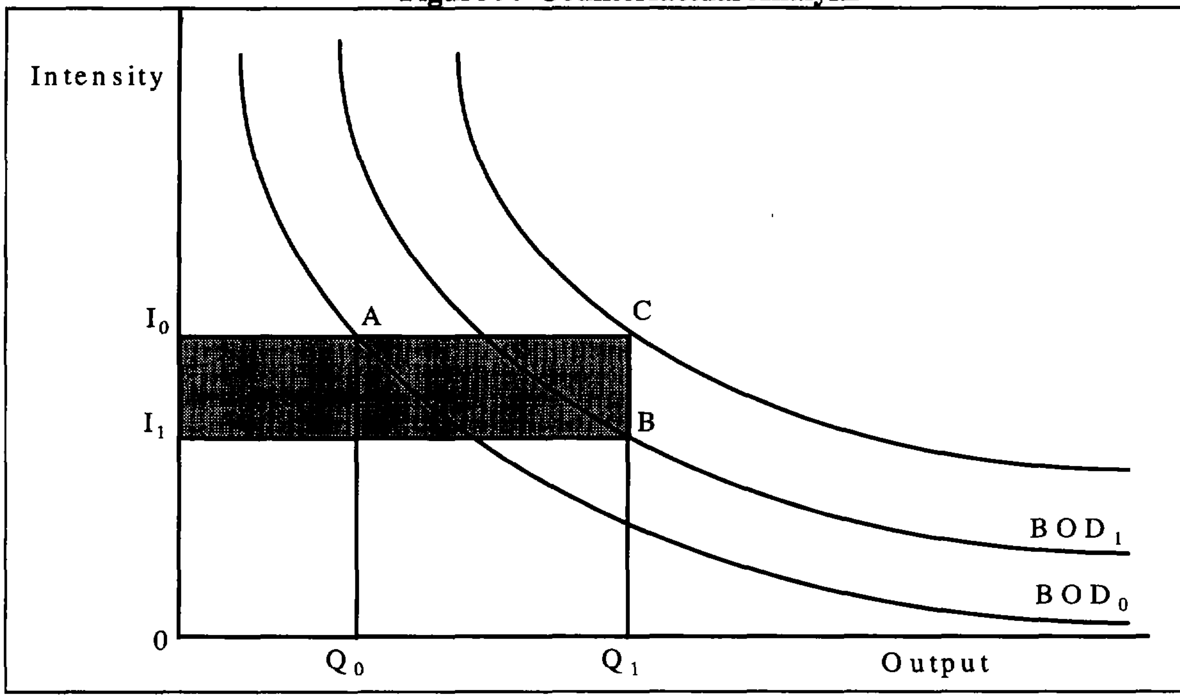
That PROKASIH had an impact on pollution intensity can be supported, to a certain extent, by looking at plants' investment in primary and secondary effluent treatments after PROKASIH was launched in June of 1989. In Figure 8, it appears clearly that installations of wastewater treatment systems increased significantly since 1989. The lack of data does not allow us to link unambiguously this activity to the introduction of PROKASIH. However, such activity is consistent with what we have observed in terms of reduction of pollution load and pollution intensity over the period 1990-94.

Figure 8: Installation of New Waste Water Treatment System



The change in pollution intensity, as observed above, suggests that we may have underestimated the impact of PROKASIH on total BOD discharges. Indeed, let us assume that without PROKASIH, pollution intensity in 1993 would have been the pollution intensity observed in 1990. Then it is easy to show the extent by which we have thus far under-estimated the impact of PROKASIH. This is illustrated in Figure 9. In the figure, the curve labeled BOD_0 (or BOD_1) represents every combination of intensity and output that yield a BOD load equal to BOD_0 (or BOD_1). Note that $BOD_1 > BOD_0$. Let us suppose a plant in 1990 with a pollution intensity I_0 and an output Q_0 thus yielding a BOD load equals

Figure 9: Counterfactual Analysis



to BOD_0. This is represented by the surface $0I_0AQ_0$. Let us suppose that this same plant increases its output to Q_1 in 1993 while decreasing its pollution intensity to I_1, yielding a pollution intensity equal to BOD_1. This is represented by the area $0I_1BQ_1$. If we simply compare BOD_1 to BOD_0, we would conclude, as we did in the previous section, that BOD load *increased* despite the presence of PROKASIH. However, if we take into account that the impact of PROKASIH on pollution intensity, then this conclusion is wrong. Indeed, if pollution intensity in 1993 had remained at the 1990 level, that is I_0, then given the output level Q_1, this plant would have produced a total amount of BOD represented by the area $0I_0CQ_1$. Hence, the impact of PROKASIH is actually to *reduce* BOD load by the shaded area I_1I_0CB. In other words, though we may observe an increase in BOD load in 1993 (from BOD_0 to BOD_1), without PROKASIH actual BOD discharges would have been even higher than BOD_1. The impact of PROKASIH can therefore be measured by the difference between "what would have been", and "what is".

It is possible to obtain an estimate of the amount by which we underestimate the impact of PROKASIH by looking solely at those plants that have shown a decrease in pollution intensity between 1990 and 1993.[27] Of those 73 plants, 40 exhibited a reduction in pollution intensity, and 33 an increase. If we simply calculate the BOD load in 1990 and 1993 for those 40 plants, we observe a reduction of 21 596 kg per day. However, assuming that these plants would not have exhibited a decrease in pollution intensity, this reduction becomes 65 687 kg per day. This therefore indicates that we underestimate the impact of PROKASIH by a considerable margin. Though this is obviously a gross estimate of what may really be the impact of PROKASIH, the purpose of the exercise performed above is to indicate that the simple comparison of BOD load in any two given years is likely to yield a distorted image of that impact.

5. Discussion

Our analysis of the PROKASIH experience suggests that there does exist a group of plants that have exerted effort to control pollution emissions despite the absence of a reliable regulatory framework and credible monitoring and enforcement capability. However, our analysis also shows that there also exists plants which despite their participation into

27 For the plants whose pollution intensity has increased in 1993, it becomes hazardous to calculate the extent of the under-estimation. Indeed, if the impact of PROKASIH is to reduce pollution intensity, then we can only conclude that in those circumstances, the intensity would have been even higher than the one observed. However, it would be difficult to identify what would have been that pollution intensity. We therefore prefer simply to ignore these situations and work solely with the plants that have shown a decrease in pollution intensity.

PROKASIH, have typically not exerted such effort. One could therefore conclude that pollution control programs of the nature of PROKASIH can only have a limited impact on the emissions of pollutants, and on environmental quality. Though our analysis may indeed support such a conclusion, it does not follow that such programs have no role to play.

First, without PROKASIH, it is likely that few or none of the plants would have reduced their BOD load and/or intensity. Moreover, a significant contribution of a program like PROKASIH is to delineate plants willing to exert pollution control effort from those less inclined to do so. This division should provide useful information for BAPEDAL, and set the stage for further and more focused intervention if needed. Finally, the desire to control and monitor closely the environmental performance of a limited number of plants, confronts the regulator to the need of setting and implementing a system by which performance is going to be measured and analyzed reliably. It forces the regulator to confront issues of *implementation* of the objectives of the program, and more broadly, of the objectives of environmental regulations. Issues of self-reporting, information, inspections, compliance assessment, etc. must be dealt with. Such a compliance system is lacking in most developing countries, and to a large extent, is still lacking in Indonesia.

PROKASIH has now reached a point in its development where a certain number of issues have to be dealt with, whether BAPEDAL wishes to focus its effort on current PROKASIH plants or to expand the number of participating plants. Important issues include, among others, the reliability of the data collected by the PROKASIH teams in each of the provinces; the possibility for these teams and BAPEDAL to process and analyze the information; and the monitoring capability of PROKASIH teams. It is important to point out once again that the analysis performed above relies heavily on information provided by provincial PROKASIH teams to BAPEDAL. Though it is possible, as we have done so, to evaluate the quality and reliability of the data reported, the frequency at which PROKASIH teams collect information about the pollution content of the polluters' effluents remains very low. It shall be remembered that out of the 778 plants that have joined the program in 1990 and 1991, only 155 provided sufficient reliable data on which to base our analysis. There is clearly an important work to be done to improve plants' self-reporting as well as PROKASIH teams' data collection system. This is particularly a source of concerns given the possibility of mistakes in the sampling and analysis of the plant's effluent. Similar mistakes can obviously be performed by PROKASIH teams themselves when sampling a plant's effluents. Finally, given the limited monitoring and enforcement capacities of BAPEDAL, the expected costs of under-reporting true emissions levels, or simply avoiding self-reporting may be small.

BAPEDAL must face these issues to preserve and augment the integrity of its PROKASIH program. Plants participating in PROKASIH must be expected to submit measures of the quality of their effluents at regular and frequent intervals; these measures must be performed according to a given set of rules to minimize the possibility of sampling errors; the way in which these measures are reported to PROKASIH teams must be standardized so as to minimize the costs of information processing; and PROKASIH teams must have the resources necessary to perform sufficient sampling and analysis to validate the plants' self-reports. To summarize, a compliance management system must be set to collect data from the plants participating in PROKASIH, and to process, analyze and validate the data thus collected. This must be done without significantly increasing the costs for plants which participate in PROKASIH. The reliability of such a management system is crucial to establish PROKASIH's credibility and to allow PROKASIH to achieve fully its role and impact. PROKASIH forces BAPEDAL to confront those issues. Once this framework is in place, BAPEDAL will be in a position to expand its program to other plants. It will also be in position to use a broader mix of instruments aimed at controlling industrial pollution, such as pollution charges.

BAPEDAL has recently adopted a program known as PROPER PROKASIH. The purpose of this program is to announce publicly the environmental performance of plants, and in particular to indicate, through a color scheme, how the plant deviates from the environmental standards defined in KEP03/MENKLH/II/1991. The program was introduced partly as a response to the trend observed in the 1993 and 1994 total discharges of PROKASIH plants. The viability and reliability of this program crucially depends on BAPEDAL's ability to set in place a comprehensive compliance management system.

6. Conclusion

In this paper, we have analyzed the impact of Indonesia's PROKASIH program on BOD discharges. We have shown that total BOD discharges from these plants have significantly been reduced since the introduction of PROKASIH. We have also shown that if it were not for PROKASIH, total BOD discharges would most likely have been considerably higher than the levels observed in 1990. However, we have also shown that this overall performance is the result of a very heterogeneous response by a small number of individual plants. Indeed, less than 25% of the plants accounted for the observed reduction in total BOD load; most of the plants did not have any significant impact on overall reduction of BOD discharges.

The Indonesian experience suggests that a program like PROKASIH can be a feasible and cost-effective strategy in the initial stages of the development of a comprehensive framework of public intervention to improve environmental quality. They can lead to significant pollution reduction within a relatively short period of time, and at the same time set into motion the development of a *compliance management system* that is necessary to implement any program aimed at reducing industrial discharges to improve environmental quality.

A correct measure of the full impact of PROKASIH remains to be developed. In particular, as pointed out above, a large number of plants have failed to report their emissions. This needs to be improved. Moreover, though the ultimate objective of PROKASIH is to improve the ambient quality of important rivers in Indonesia (or to prevent their further deterioration), we are unable at this point in time to link changes in emissions by PROKASIH plants to changes in environmental quality. The location of PROKASIH and non-PROKASIH plants along every PROKASIH river is known. However, data on discharges of non-PROKASIH plants as well as of non-industrial facilities is clearly insufficient to isolate the impact of discharges by PROKASIH plants. The location of monitoring stations would also have to be modified for this impact to be accounted for. However, given the objective of PROKASIH, its long-term sustainability may very well depend on its ability to demonstrate that ambient quality is improving as a result of the program. Finally, we have not analyzed the characteristics of the plants that have participated in the program (vs. not participated), and of those that have reduced their BOD load (vs. increased). These issues remain the object of on-going research.

APPENDICES 1, 2 and 3

Table 1: Budget of Prokasih Team (millions of Rupiah)

Province	1990/91			1991/92			1992/93			1993/94			1994/95		
	Regional	National	Total	Regional	National	Total	Regional	National	Total	Regional	National	Total	Regional	National	Total
D.I. Aceh	--	--	--	45.0	--	45.0	43.0	48.4	91.4	50.5	50.2	100.7	42.0	40.5	82.5
Sumatera Utara	80.0	--	80.0	90.0	--	90.0	82.0	58.0	140.0	80.0	52.8	132.8	80.0	27.5	107.5
Riau	--	--	--	55.0	--	55.0	38.2	47.8	86.0	49.5	40.0	89.5	52.8	38.2	91.0
Sumatera Selatan	--	--	--	25.0	--	25.0	100.0	--	100.0	93.0	47.0	140.0	96.0	39.0	135.0
Lampung	50.0	--	50.0	60.0	--	60.0	40.0	--	40.0	90.0	87.0	177.0	102.0	72.5	174.5
D.K.I. Jakarta	265.0	--	265.0	150.0	--	150.0	250.0	--	250.0	250.0	--	250.0	350.0	25.0	375.0
Jawa Barat	175.0	--	175.0	375.0	--	375.0	280.0	--	280.0	350.0	--	350.0	300.0	32.0	332.0
Jawa Tengah	65.0	--	65.0	80.0	--	80.0	98.0	--	98.0	130.0	--	130.0	110.0	33.0	143.0
D.I. Yogyakarta	--	--	--	--	--	--	90.0	--	90.0	120.0	--	120.0	155.0	34.0	189.0
Jawa Timur	755.8	--	755.8	280.2	--	280.2	200.0	--	200.0	250.0	20.0	270.0	250.0	35.0	285.0
Kalimantan Barat	--	--	--	150.0	--	150.0	75.0	40.0	115.0	50.0	40.0	90.0	85.0	30.0	115.0
Kalimantan Selatan	--	--	--	--	--	--	--	--	--	--	--	--	40.0	46.0	86.0
Kalimantan Timur	25.0	--	25.0	45.0	--	45.0	50.0	45.0	95.0	50.0	45.0	95.0	100.0	36.0	136.0

[1] Started participation in PROKASIH in 91/92.
[2] Started participation in PROKASIH in 94/95. However, the province had established a PROKASIH team in 92/93.
[3] In Jawa Timur, the industrial sector must finance the analysis of the samples collected by the PROKASIH team. The budget devoted by the industrial sector for this analysis is as follows (millions of Rupiah): 180 (92/93); 180 (93/94); and 250 (94/95). Another government agency (Parum Jasa Tinta) has also financed a number of monitoring activities. Its budget for 94/95 was 200 millions rupiah.
[4] Started participation in PROKASIH in 94/95.

Table 2: Number of PROKASIH Establishments per Category

Category	1990	1991	1992	1993	1994
Dept. store	0	0	0	5	5
Hospital	0	0	22	34	42
Hotel	0	0	19	41	50
Industry	381	778	1008	1235	1275
Laundry	0	1	3	4	4
Supermarket	0	0	0	1	1
Warehouse	0	0	1	2	2
Workshop	0	2	5	26	26
TOTAL	381	781	1057	1348	1405

Table 3: Average Employment per PROKASIH Plant per Province (1994)

Province	Number of PROKASIH plant	Total number of plants[1]	Employment per PROKASIH plant	Employment per plant in province
Jawa Barat	723	4833	267	515
D.K.I. Jakarta	228	2289	517	254
Jawa Tengah	64	2915	905	156
Jawa Timur	45	4195	1729	182
Lampung	34	215	468	155
Sumatera Selatan	33	270	789	206
Kalimantan Timur	31	129	1296	437
Sumatera Utara	30	1058	613	187
Kalimantan Selatan	20	166	909	264
Riau	19	223	1700	296
D.I. Aceh	17	97	446	153
D.I. Yogyakarta	16	250	549	122
Kalimantan Barat	15	171	618	229

Table 4: Average Budget per PROKASIH Plant (1994)

Province	Number of plants	Total budget (millions of rupiah)	Average budget per plant (millions)
Jawa Barat	723	332	0.46
DKI Jakarta	228	375	1.64
Jawa Tengah	64	143	2.23
Jawa Timur	45	285	6.33
Lampung	34	175	5.15
Sumatera Selatan	33	135	4.10
Kalimantan Timur	31	136	4.38
Sumatera Utara	30	107	3.56
Kalimantan Selatan	20	86	4.30
Riau	19	91	4.79
D.I. Aceh	17	82	4.82
D.I. Yogyakarta	16	189	11.81
Kalimantan Barat	15	115	7.66

Figure 1: Coverage of PROKASIH Plants by KEP/MEN/03/1991 in 1994

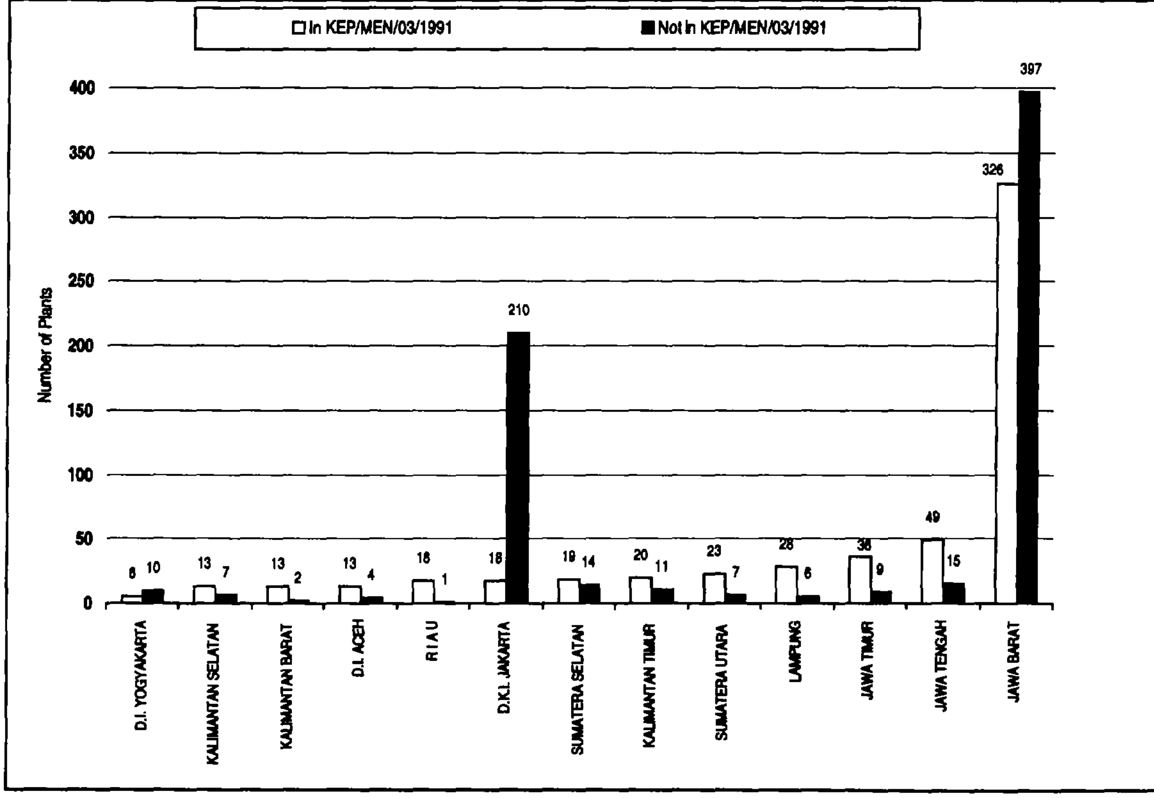
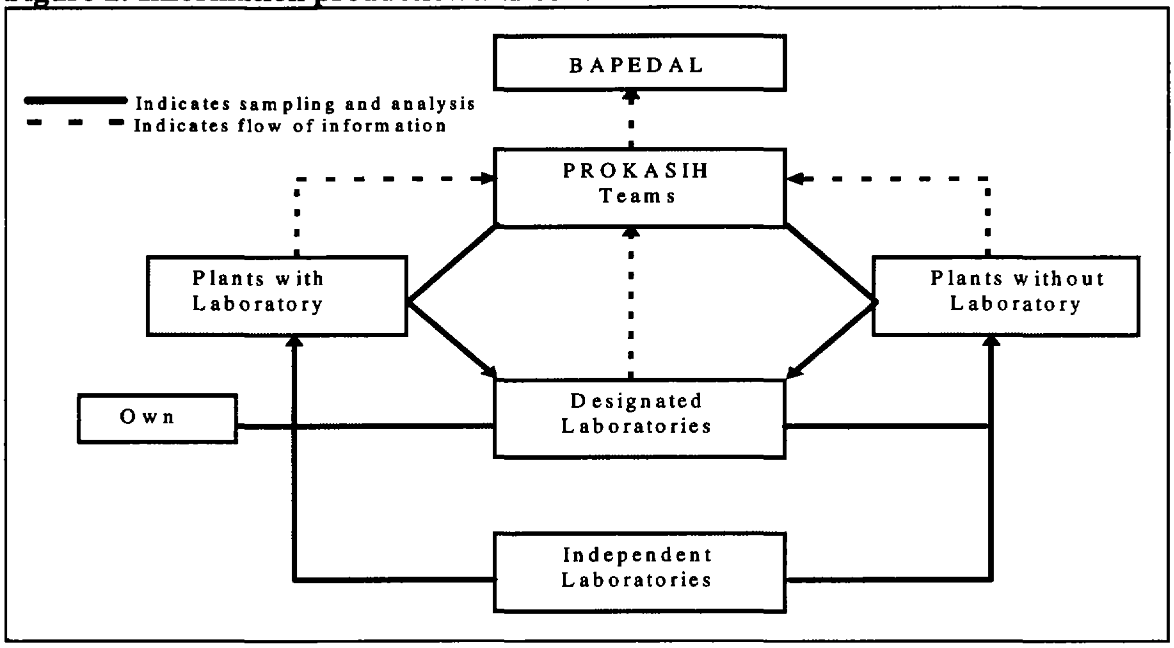


Table 5: Potential Errors in Sampling and Analysis

Designing a sampling strategy • Taking samples at locations or times that do not accurately represent the quality of the effluent being sampled.
Collecting samples • Using equipment made of inappropriate material that may react with samples and contaminate them. • Using sampling equipment that is not decontaminated between sampling episodes.
Handling, preserving, and transporting samples • Improperly refrigerating or holding for too long unstable samples. • Using improper procedures for transporting samples that may result in mismarked or lost samples.
Preparing and analyzing samples in the laboratory • Calibrating instruments improperly. • Using incorrect analytical methods to test samples.
Interpreting data • Transposing numbers. • Using incorrect formulas. • Misplacing decimal point.

Information Collection by BAPEDAL

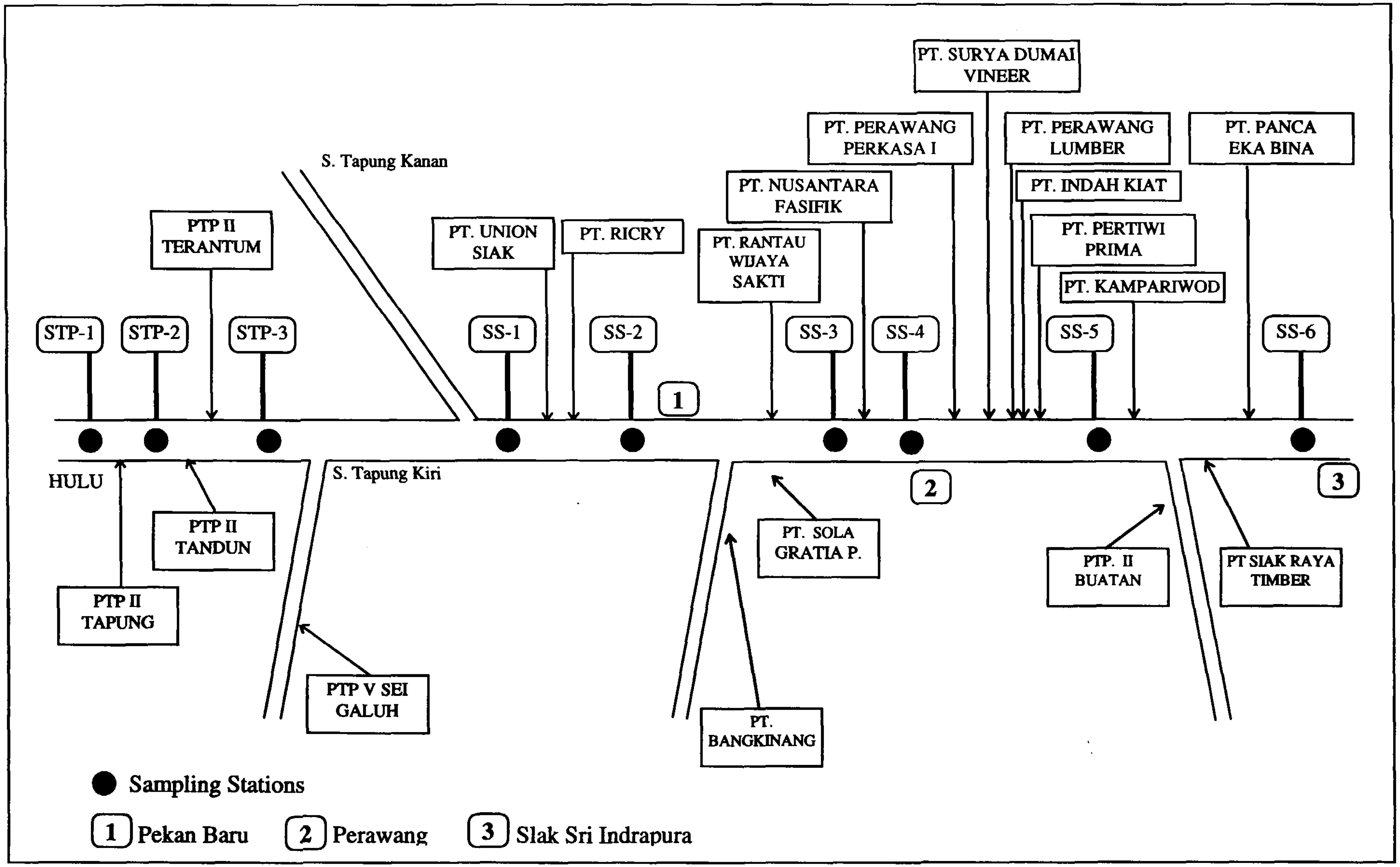
Figure 1: Information production and collection



Upon agreeing with BAPEDAL on a target level of pollution, it is understood that plants will periodically measure the pollution concentration of their effluents, and flow rates (m^3 of water/day).[1]Plants without laboratory facilities must have their samples analysed by independent laboratories or by PROKASIH-designated laboratories; plants with laboratory facilities can also use these independent and designated laboratories. PROKASIH teams collect information from two different sources. First, they have access to the data collected by the plants themselves (whether analysed by independent, designated or plants' laboratories). This is in some sense similar to a system of self-reporting, the difference being that PROKASIH teams must visit the plants and collect the information. Second, they can themselves perform a sampling and analysis of the plant's effluents. The information collected from these two sources is then transferred to BAPEDAL.

1 Reduction in the emissions of total suspended solids are also part of the agreement. However, at the current moment, only BOD data have been systematically collected and computerized.

PROKASIH Plants and Sampling Points
Brantas River, Jawa Timur



REFERENCES

Arora, S. and T.N. Cason (1994), An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program, *Journal of Environmental Economics and Management*, 28, 3, 271-286.

Baumol, W.J. and W.E. Oates (1971), "The use of standards and pricing for the protection of the environment", *Scandinavian Journal of Economics*, 73, 1, 42-54.

Bohm, P., and C.F. Russell (1985), "Comparative analysis of alternative policy instruments", in Kneese, A.V. and J.L. Sweeney (eds), *Handbook of Natural Resource and Energy Economics*, Volume 1, North-Holland, Amsterdam: 395-460.

Cropper, M. L. and W.E. Oates (1992), "Environmental economics: a survey", *Journal of Economic Literature*, 30, 2, 675-740.

General Accounting Office (1993), *Environmental Enforcement: EPA Cannot Ensure the Accuracy of Self-Reported of Compliance Monitoring Data*, Report to the Chairman, Committee on Government Affairs, U.S. Senate, GAO/RCED-93-21.

Hahn, R.W. (1989), "Economic prescriptions for environemntal problems: how the patient followed the doctor's orders", *Journal of Economic Perspectives*, 3, 2, 95-114.

Hahn, R.W. and G. L. Hester (1989), "Marketable permits: lessons for theory and practice", *Ecology Law Quarterly*, 16, 2, 361-406.

Hamilton, J.T. (1995), "Pollution as news: media and stock market reactions to the Toxics Release Inventory data", *Journal of Environmental Economics and Management*, 28, 1, 98-113.

Karp, L. and J. Livernois (1994), "Using automatic tax changes to control pollution emissions", *Journal of Environmental Economics and Management*, 27, 1, 38-48.

Kennedy, P.W., Laplante, B. and J. Maxwell (1994), "Pollution policy: the role for publicly provided information", *Journal of Environmental Economics and Management*, 26, 31-43.

Laplante, B. (1995), "It's Not Easy Being Green: the Politics of Canada's Green Plan: a Comment", *Canadian Public Policy,* forthcoming.

Laplante, B. and P. Lanoie (1994), "The Market Response to Environmental Incidents in Canada: a Theoretical and Empirical Analysis", *Southern Economic Journal*, 60, 3, 657-672.

Laplante, B. and P. Rilstone (1995), "Environmental inspections and emissions of the pulp and paper industry in Quebec", *Journal of Environmental Economics and Management,* forthcoming.

Muoghalu, M.I., Robison, H.D. and J.L. Glascock (1990), "Hazardous waste lawsuits, stockholder returns, and deterrence", *Southern Economic Journal*, 357-70.

O'Connor, D. (1994), *Managing the Environment with Rapid Industrialisation: Lessons from the East Asian Experience*, Development Centre Studies, OECD, Paris.

Organization for Economic Cooperation and Development (1989), *The Application of Economic Instruments for Environmental Protection*, Paris.

---------- (1991), *Recommendation of the Council on the Use of Economic Instruments in Environmental Policy*, Paris.

Russell, C.S. (1990), "Monitoring and enforcement", in P.R. Portney (eds), *Public Policies for Environmental Protection*, Resources for the Future, Washington, D.C.

World Bank (1994), *Indonesia: Environment and Development*, A World Bank Country Study, Washington, D.C.

Policy Research Working Paper Series

	Title	Author	Date	Contact for paper
WPS1585	Public Finances and Economic Transition	Luca Barbone Hana Polackova	March 1996	C. Pelegrin 85087
WPS1586	Did External Barriers Cause the Marginalization of Sub-Saharan Africa in World Trade?	Azita Amjadi Ulrich Reincke Alexander Yeats	March 1996	S. Lipscomb 33718
WPS1587	Payments and Finance Problems in the Commonwealth of Independent States	Constantine Michalopoulos	April 1996	M. de la Puente 31206
WPS1588	Social Insurance in the Transition to a Market Economy: Theoretical Issues with Application to Moldova	Deborah Mabbett	April 1996	L. Biely 36280
WPS1589	The Analysis of Emerging Policy Issues in Development Finance	Sudarshan Gooptu	April 1996	R. Vo 31047
WPS1590	The Latvian Banking Crisis: Lessons Learned	Alex Fleming Samuel Talley	April 1996	S. Coffey 32535
WPS1591	Competition in Network Industries	Michael Klein	April 1996	S. Vivas 82809
WPS1592	The Stockmarkets as a Source of Finance: A Comparison of U.S. and Indian Firms	Cherian Samuel	April 1996	C. Samuel 30802
WPS1593	Rural Finance for Growth and Poverty Alleviation	Saeed Qureshi Ijaz Nabi Rashid Faruqee	April 1996	C. Anbiah 81275
WPS1594	Why Have Some Indian States Done Better Than Others at Reducing Rural Poverty?	Gaurav Datt Martin Ravallion	April 1996	P. Sader 33902
WPS1595	In Search of Owners: Lessons of Experience with Privatization and Corporate Governance in Transition Economies	Cheryl W. Gray	April 1996	M. Geller 31393
WPS1596	Agrarian Structure in Poland: The Myth of Large-Farm Superiority	Johan van Zyl Bill R. Miller Andrew Parker	April 1996	M. Williams 87297
WPS1597	Egypt and the Uruguay Round	Bernard Hoekman Arvind Subramanian	May 1996	F. Hatab 35835
WPS1598	Logistical Constraints on International Trade in the Maghreb	Francois Amiot Ovadia Salama	May 1996	L. Lewis 37369

Policy Research Working Paper Series

	Title	Author	Date	Contact for paper
WPS1599	Economic Implications for Turkey of a Customs Union with the European Union	Glenn W. Harrison Thomas F. Rutherford David G. Tarr	May 1996	M. Patena 39515
WPS1600	Is Commodity-Dependence Pessimism Justified? Critical Factors and Government Policies that Characterize Dynamic Commodity Sectors	Nanae Yabuki Takamasa Akiyama	May 1996	G. Ilogon 33732
WPS1601	The Domestic Benefits of Tropical Forests: A Critical Review Emphasizing Hydrological Functions	Kenneth M. Chomitz Kanta Kumari	May 1996	PRDEI 80513
WPS1602	Program-Based Pollution Control Management: The Indonesian PROKASIH Program	Shakeb Afsah Benoit Laplante Nabiel Makarim	May 1996	A. Williams 37176