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DISCUSSION PAPER

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Federal Government of Brazil

Secretariat of Strategic Affairs of the Presidency of the Republic
Minister Roberto Mangabeira Unger

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DISCUSSION PAPER

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SUMMARY

CURRENT STATUS OF WATER POLLUTION CONTROL IN BRAZIL*

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ABSTRACT

This paper attempts to discern the effectiveness of abatement policy and the status of current water quality in Brazil. It presents the results of a study on indicators of water quality for 13 states where systematic monitoring is undertaken. A regional, sectorial and sustainability analysis of water quality and policy will also be presented.

1. INTRODUCTION

Industrial sectors and households are two of the major sources of water pollution in Brazil. The former discharges organic as well as inorganic substances whereas the latter generates mainly organic matter. As shown in Table 1, remanescent industrial organic emissions, for the country as a whole, are 29% higher than domestic ones.

It is expected that the enforcement of environmental legislation varies in each Brazilian state according to the effectiveness of their respective environmental agency. The same occurs with sanitation companies concerning domestic sources.

Abatement and pollution intensity indicators are presented in order to make a comparative analysis, among industrial sectors and Brazilian states, on water pollution control and output composition. The aim is to show how successful environmental and sanitation agencies have been in performing their legal functions and how the state's industrial structure may influence this performance.

However, due to the number of observations extracted from this database, not many conclusions were reached to utterly explain the reasons for these distinct results. Nevertheless, further research efforts are possible in order to provide empirical evidences that improve the understanding of the water quality policies in Brazil.

The indicators presented suggest that industrial water pollution control is based mainly on BOD abatement and has a fairly positive relationship with state per capita income. In the case of domestic sources, however,income effects do not indicate a better water treatment service. Moreover, in both cases, no regional pattern emerges as a key parameter. The most interesting conclusion indicates that to a certain extent the most polluting sectors, particularly for BOD, are those where enforcement is more effective.

The last subsection will present water quality indicators for São Paulo and Paraná, two of few states where monitoring is carried on regularly and BOD control is more severe. It is observed that enforcement in these states was not effective enough to improve water quality. Moreover, these results suggest that ambient standards rather than emissions should be the target of water pollution control policies.

TABLE 1

Remanescent BOD Output in Brazil

STATE	BOD ABATEMENT LEVELS			REMANESCENT BOD OUTPUT						REMANESCENT
	TOTAL	INDUSTRIAL	DOMESTIC	TOTAL EMISSION		INDUSTRIAL SOURCE		DOMESTIC SOURCE		OVERALL INTENSITY
	%	%	%	[ton/yr.]	% of total	[ton/yr.]	% of total	[ton/yr.]	% of total	[g/US$]
SP	81.7%	91.0%	9.7%	908,748	26.0%	394,599	43.4%	514,149	56.6%	19.59
PR	68.4%	74.3%	18.8%	350,735	10.0%	254,755	72.6%	95,980	27.4%	52.34
Brazil	64.1%	75.2%	14.8%	3,497,305	100.0%	1,967,104	56.2%	1,530,201	43.8%	30.85
RS	49.7%	51.6%	31.5%	661,542	18.9%	578,349	87.4%	83,193	12.6%	83.23
PE	48.9%	66.6%	5.3%	173,145	5.0%	80,392	46.4%	92,753	53.6%	49.54
SC	45.7%	48.8%	37.8%	99,321	2.8%	67,510	68.0%	31,810	32.0%	31.19
MA	45.5%	69.4%	12.2%	45,094	1.3%	14,749	32.7%	30,345	67.3%	63.32
RJ	43.8%	60.3%	26.6%	284,972	8.1%	103,206	36.2%	181,766	63.8%	15.80
ES	32.8%	50.4%	10.9%	45,602	1.3%	18,611	40.8%	26,991	59.2%	25.12
BA	32.7%	70.9%	15.4%	119,617	3.4%	16,017	13.4%	103,600	86.6%	23.77
GO	30.2%	47.1%	2.5%	121,038	3.5%	57,044	47.1%	63,994	52.9%	35.21
CE	27.7%	24.0%	29.6%	77,769	2.2%	27,106	34.9%	50,663	65.1%	32.46
PA	20.4%	15.6%	21.7%	48,413	1.4%	10,748	22.2%	37,665	77.8%	16.94
MG	12.7%	19.0%	0.6%	561,310	16.0%	344,018	61.3%	217,292	38.7%	49.40

Sources: Pronacop (1989), Cetesb (1992) and IBGE (1992) and author's estimates

2. POLLUTION CONTROL INDICATORS

2.1. Database

Data on water quality in Brazil is available in non-systematic form. Only water pollution emissions from industrial and domestic sources are available, usually in sparse ways. Quality indicators of water bodies are even more scarce. Weak monitoring and database organization reflect the still incipient institutional capability of environmental agencies, with the exception of some more developed states.

The database on pollution emission and abatement was obtained from reports of a 1988 World Bank project denominated Pronacop (Brazilian National Programme of Pollution Control), which covered 12 states and was designed following another similar World Bank project in São Paulo. The Pronacop reports present the only information available on industrial emission covering many sectors and states in Brazil for a given year. They were part of the World Bank requirements for granting financial support for the programme and present 1988 estimates of potential and remanescent pollution levels of industrial sectors for biochemical organic demanding (BOD) and heavy metals.

The number of observations in most cases does not allow sophisticated statistical analysis. Hence, the analysis elaborated in this section is based on very simple indicators. Notwithstanding the results offer very interesting findings on water pollution control in Brazil.

Data were obtained in each state from EPA records based on files of controlled firms. Information on emission levels in these files are, in most cases, calculated from technical parameters based on the existing production and abatement technologies. These reports were undertaken by Cetesb, São Paulo's EPA, for 12 states[1]: Rio Grande do Sul (RS), Santa Catarina (SC), Paraná (PR), Rio de Janeiro (RJ), Espírito Santo (ES), Minas Gerais (MG), Bahia (BA), Pernambuco (PE), Ceará (CE), Maranhão (MA), Pará (PA) and Goiás (GO).

The state of São Paulo (SP) was not included in Pronacop since in 1988 it was already carrying on another World Bank pollution control project, called

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[1] The execution of the reports was under the responsability of former Secretariat of Environment but the coordenation was taken by Reinaldo de Vasconcelos and Arlindo Philippe Jr. from Cetesb.

Procop, restricted to that state. Thus São Paulo data was obtained directly from Cetesb relative to 1991.[2]

For the purposes of this analysis all national estimates will include only these 13 states, which cover almost 96% of Brazilian industrial output. Sectorial classification was also made comparable to IBGE (The National Statistical Office) classification. In the case of water pollution, the sectors contemplated in the reports are:

10 - Non-Ferrous Metals

11 - Metallurgy

12 - Mechanics

13 - Electric Materials

14 - Transport Equipment

15 - Wood Product

17 - Paper & Cellulose

18 - Rubber Products

19 - Leather & Products

20 - Chemical

21 - Drugs & Medicine

22 - Cosmetics & Soap

24 - Textiles

26 - Food Products

27 - Beverages

Other sectors were excluded because they were considered not relevant in water pollution terms. These exclusions for BOD and heavy metals emissions correspond, respectively, to 25 and 40% of the Brazilian industrial production.

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[2] To be more precisely "around 1991", since it is very difficult to know when updating of files took place. Moreover, 1992 data are also expected to be counted due to very recent versions.

2.2. Estimation Procedures

The abatement indicator is the ratio of the remanescent pollution level to potential pollution level.Potential pollution level is the load level discharged by a plant or housing unit without any treatment. Remanescent pollution level is the actual discharge after treatment.

Industrial abatement indicators were estimated for BOD and heavy metals, and represent the pollution reduction observed in these sectors.

In the case of industrial plant, potential level will vary according to production process and technology. Remanescent level will be the level of pollution still emitted despite the abatement equipments installed in the plant.

For households the potential level is estimated using the average BOD emission per person while remanescent pollution was that resulting after treatment in public stations and septic tanks.

The recent IBGE Sanitation Survey presents, for each state, 1989 data concerning sewer services and serving population from public stations to septic tanks.

Multiplying an average BOD per capita domestic emission of 54 g/day by population, a potential domestic water pollution level is estimated for each state. Remanescent domestic water pollution level is determinated adjusting potential level by treatment efficiency level resulting from the type of sewer service a person is being supplied.

Treatment levels were derived from the conventional literature on treatment efficiency, as follows:

Primary Treatment - 30%

Preliminary Treatment - 10%

Conventional Treatment Station - 40%

Stabilization Pond - 50%

Aerobic Pond - 80%

Oxidation Ditch - 90%

Others - 40%

Inadequate Septic Tanks - 30%

Adequate Septic Tanks - 80%

The abatement indicator will represent how much pollution is cut at the source point. For the industrial sector, this indicator will reveal the ability of environmental protection agencies (EPA) to induce control of emission. In the case of households it reflects the state water and sanitation companies' performance in the management of public treatment stations.

Abatement indicators explain only environmental and sanitation management performance, they do not, however offer an indication of the environmental intensity of the output produced in each state. That is, how much additional pollution is bound to generate an additional unit of income?

To create this type of indicator one must determine the relationship between potential and remanescent pollution levels, and output. Two intensity indicators were calculated for each state for BOD and heavy metals: potential and remanescent intensities.

The potential intensity indicator represents the polluting dimension, due to the composition of the product and vintage of capital stock, of the economic structure of each state. A higher indicator means that state's output is structurally upward biased to generate more pollution, i.e., is based on highly polluting - intensive sectors.

If output composition and capital stock embodied technology are kept constant when production is expanded, then this economy is likely to generate a potential threat to environment. These economies require more active environmental management in order to mitigate their higher potential pollution intensity. If this management performance is not effective, the resulting pollution impact may be high. On the other hand, a potentially low polluting economy may emit high levels of pollution if sanitation and environmental control is not effective.

Pollution intensities for industrial sectors were determined dividing potential and remanescent pollution level by industrial output. This output was measured as the industrial manufacturing value (VTI) obtained from 1985 Industrial Census corrected to 1988 values with indexes obtained from IBGE (1988 and 1989) and FGV (1989).

The remanescent intensity is simply a measure combining polluting potentiality and environmental performance. If output composition and capital stock embodied technology are kept constant and the effectiveness of pollution control is unchanged, then production expansion will generate a pollution level consistent with the remanescent intensity indicator. Therefore, states with low (high) remanescent indicators are those where an additional unit of income can be produced with lower (higher) pollution level. That is, in those states economic growth is clearer (dirtier) due to the economic structure and pollution control actions.

Remanescent pollution intensity is calculated by dividing remanescent pollution level by state income. State income was measured from IBGE (1991) multiplying urban per capita average earning by urban population.[3]

2.3. General Indicators

Following the procedures previously mentioned, Table 1 presents estimates of overall BOD pollution control indicators for both industrial and urban domestic sources in each state in the sample. Due to their restriction to industrial sources, heavy metal emissions were not incorporated in this aggregated form. As it will be seen later, in the industrial indicator's analysis, the control of heavy metal emissions has not been effective and, consequently, is significantly affecting water quality in Brazil.

The estimates in Table 1 shows that industrial pollution is much stricter controlled than domestic one. For the country as a whole, 75.2% of industrial emission is abated whereas in the case of urban domestic sources this level is 14.8%.

In terms of absolute values, the proportions of industrial and domestic discharges also vary among states, though for the country as a whole, remanescent industrial emissions are nearly 30% higher than domestic ones.

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[3] Note that a domestic potential pollution intensity following these procedures would end up in measure of urban per capita income, therefore, it does not make sense to built up this indicator as did for industrial sectors. The per capita income used is that relative to people older than ten years old.

Table 1 suggests that in regard to both sources of pollution, the states of São Paulo and Paraná have the most effective BOD pollution control enforcement with overall abatement level of 81.7 and 68.4%, respectively. The least effective states are Minas Gerais, Pará and Ceará with abatement levels not exceeding 30%. The other states present levels from 30 to 50%.

Remanescent intensities presented in Table 1 show that the states of Rio de Janeiro, Pará, São Paulo and Bahia are the least polluting intensive economies in terms of BOD emissions. That is, where economic growth would generate less pollution per additional unit of income.

Inversely, the states of Rio Grande do Sul, Maranhão, and Paraná are those where economic expansion is based on pollution intensive industrial sectors and inadequate sewer services.

It may be helpful to decompose these overall indicators in terms of sources and, in the case of industrial emission, by sectors.

2.4. Industrial Indicators

2.4.1. Sectorial Analysis

A - BOD

Sectorial analysis reveals that, for the country as a whole, as shown in Table 2, the BOD abatement level is 75.2%. Food and Beverages are sectors with almost 86% abatement. The abatement levels for Metallurgy, Chemical and Paper vary from 70 to 80%. Transport Equipment, Non-Ferrous and Leather, and Wood have levels of 63.9, 55, 54.8%, respectively. Except from Cosmetics and Mechanics which abate 33.6 and 5.5%, respectively, all other sectors abatement levels range from 43.4 to 47.9%.

When compared with potential pollution intensity in Table 2, these BOD abatement indicators point out that highly intensive sectors, such as Food and Beverages, are well controlled. Leather is the exception and shows a very low abatement control.

In Graph 1 it becomes clear that sectors with higher BOD emission level are those with higher abatement level, with Leather again as an exception. Metallurgy, with low emission levels, presents abatement above national average level.

TABLE 2

Sectoral Pollution Abatement and Intensity in the Brazilian Industry

BOD						HEAVY METALS					
AI		PI (g/US$)		RI (g/US$)		AI		PI (g/US$)		RI (g/US$)	
27	86.1%	19	1,931.0	19	878.9	26	95.8%	19	78.9	19	30.3
26	85.1%	27	1,000.9	27	139.1	17	85.8%	11	3.0	11	1.3
11	78.9%	26	215.8	21	59.9	15	85.0%	BRAZIL	1.0	BRAZIL	0.4
20	77.8%	20	123.5	26	32.1	20	73.8%	12	0.3	12	0.1
BRAZIL	75.2%	21	114.6	20	27.4	14	62.5%	20	0.3	13	0.1
17	71.0%	BRAZIL	73.2	15	20.6	19	61.6%	14	0.2	14	0.1
14	63.9%	17	58.6	BRAZIL	18.2	BRAZIL	59.9%	13	0.1	20	0.1
10	54.8%	15	43.6	17	17.0	11	57.6%	24	0.1	24	0.1
19	54.5%	22	15.0	22	9.9	12	57.4%	26	0.0	26	0.0
15	52.8%	24	14.0	24	7.3	24	2.5%	17	0.0	17	0.0
24	47.9%	12	2.6	12	2.5	13	2.4%	15	0.0	15	0.0
21	47.8%	11	2.1	11	0.5	10	0.0%	10	0.0	10	0.0
18	46.3%	14	1.0	14	0.3						
13	43.4%	18	0.1	18	0.1						
22	33.6%	13	0.0	13	0.0						
12	5.5%	10	0.0	10	0.0						

Notes:

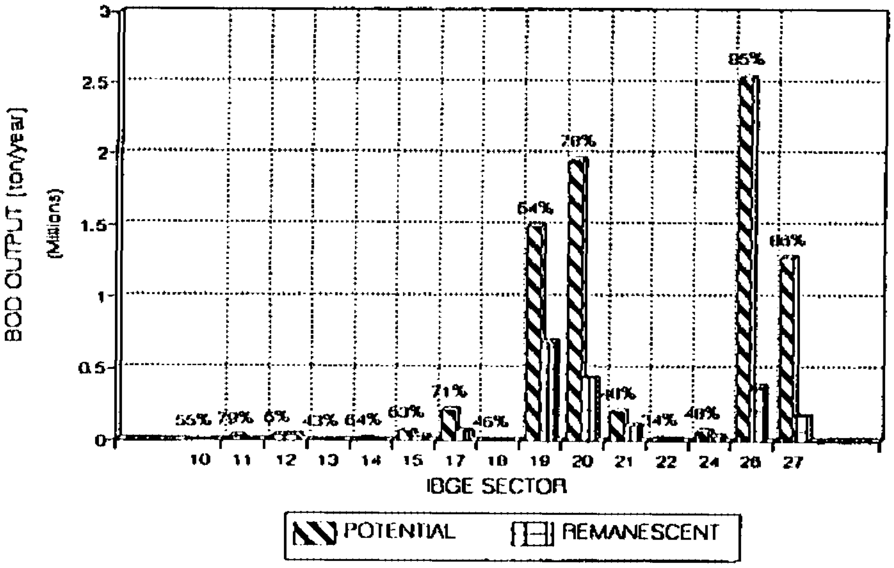
AI - abatement indicator, PI - potential pollution intensity, RI - remanescent pollution intensity

See indicators' definitions and sectoral classification in the main text.

Sources: Pronacop (1989), Cetesb (1992) and author's estimates

GRAPH 1

INDUSTRIAL BOD OUTPUT BY SECTOR
BRAZIL 1988



Note: See definitions and sectorial classification in the main text; numbers above columns are pollution abatement rates.
Sources: Pronacop (1989), Cetesb (1992) and author's estimates

The potential intensity indicators in Table 2 suggest that the three sectors with the most BOD potential intensive polluters, Beverage, Food and Chemicals are well controlled, but two others -- Leather and Drugs -- are not.

The remanescent BOD pollution intensity indicators in Table 2 indicate that Leather is the highest polluting sector with remanescent intensity level of 878.9, followed by Beverage with 139.1 and Drugs & Medicine with 59.9. Food, Chemical and Wood have, respectively, 32.1, 27.4 and 20.6. Paper and Cosmetics have intensities of 17.0 and 10.0, while Textiles and Mechanics have intensities of 7.3 and 2.5. Metallurgy, Transport Equipment, Rubber, Electric Materials and Non-Ferrous, are the less intensity sectors with values ranging from 0.5 to nil.

B - Heavy Metals (HM)

Table 2 also shows that the national average HM abatement level is 59.9%. Food is the most controlled sector in HM abatement with 95.8%. Following, with approximately 85% are Paper and Wood. Chemicals present a level of 73.8% and Transport and Leather approximately 62%. Metallurgy and Mechanics fall to 57% and Textiles, Electric Materials and Non-Ferrous to almost nil control level. When looking at the pollution intensity levels one easily visualizes that abatement control is looser in more highly potential intensive sectors such as Leather and Metallurgy. Inversely, the most controlled sectors are those where intensity is much lower such as Food, Paper and Wood.

Another interesting feature is that in some sectors where BOD is greatly abated, such as Food, Metallurgy, Paper and Transport Equipment, HM abatement is also great, even if they are not intensive or important in HM output. That pattern suggests that HM abatement seems to be a by - product of BOD control, i.e., in controlling organic substances EPA are consequently forced to do the same for HM.[4]

Graph 2 shows that the highest abatement levels do not occur in the sectors with more emission levels, though Leather and Metallurgy -- the highest heavy metal polluters -- showing approximately 60% abatement control.

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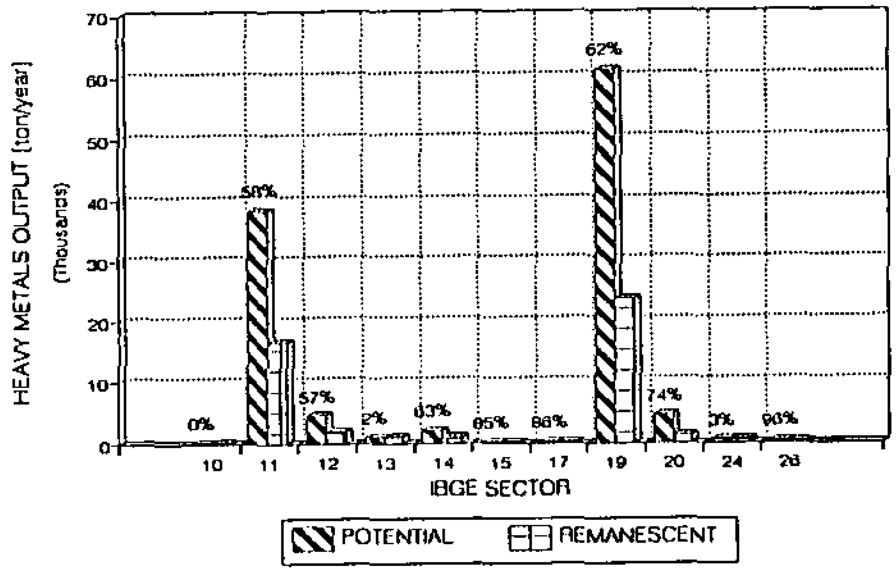
[4] Since organic pollution is more evident and easier to assess in laboratories than heavy metals, EPA try to control first BOD-intensive plants.

GRAPH 2

INDUSTRIAL HM OUTPUT BY SECTOR
BRAZIL 1988



Note: See definitions and sectorial classification in the main text, numbers above columns are pollution abatement rates.
Sources: Pronacop (1989), Cetesb (1992) and author's estimates

In Table 2 it also becomes evident that Leather is by far the highest HM polluting sector with remanescent intensity of 30.31, followed by Metallurgy with 1.27. Mechanics, Electric Materials and Transport Equipment present intensity values of 0.13, 0.11 and 0.09, respectively. Chemical and Textiles show approximately 0.07 and Food, Paper, Wood and Non-Ferrous show no abatement.

2.4.2. Regional Analysis

A - BOD

According to Table 3, only São Paulo exceeded national level with 91.0% of BOD abatement. Paraná follows with 74.3% and Bahia and Maranhão with approximately 70%. Pernambuco and Rio de Janeiro have 66.6 and 60.3% abatement rates, respectively. Rio Grande do Sul, Espírito Santo, Santa Catarina and Goiás have approximately 50%. Ceará has 24% and Minas Gerais 20%. Pará abates only 15.6%.

There is no regional pattern that emerges in describing BOD abatement levels.

Graph 3 suggests that there exists a weak relationship between state potential pollution and abatement levels, though states with low pollution levels, such as Bahia, Pernambuco and Maranhão, are showing high BOD abatement control while others with low BOD output (Minas Gerais and Rio Grande do Sul) present lower levels.

TABLE 3

Regional Pollution Abatement and Intensity in the Brazilian Industry

BOD						HEAVY METALS					
AI		PI (g/US$)		RI (g/US$)		AI		PI (g/US$)		RI (g/US$)	
SP	91.0%	PR	156.8	RS	59.3	MA	99.7%	RS	4.5	RS	1.9
BRAZIL	75.2%	MA	146.7	GO	58.5	BA	87.3%	PR	1.8	MG	0.6
PR	74.3%	RS	122.4	MA	44.9	GO	79.2%	GO	1.5	PE	0.5
BA	71.0%	PE	113.4	PR	40.3	PR	75.9%	RJ	1.2	PR	0.4
MA	69.4%	GO	110.6	PE	37.9	RJ	74.0%	MG	1.1	BRAZIL	0.4
PE	66.6%	SP	86.6	MG	31.3	BRAZIL	59.9%	BRAZIL	1.0	CE	0.3
RJ	60.3%	BRAZIL	73.3	CE	24.4	RS	58.5%	PE	0.6	GO	0.3
RS	51.6%	MG	38.6	BRAZIL	18.2	SP	57.5%	MA	0.5	RJ	0.3
ES	50.4%	CE	32.1	SC	13.7	MG	42.1%	SP	0.5	ES	0.2
SC	48.8%	SC	26.6	PA	10.9	ES	40.4%	CE	0.4	SP	0.2
GO	47.1%	ES	21.8	ES	10.8	PA	33.8%	ES	0.4	SC	0.1
CE	24.0%	RJ	18.8	SP	7.8	CE	19.2%	BA	0.2	BA	0.1
MG	19.0%	PA	12.9	RJ	7.5	PE	12.5%	SC	0.1	PA	0.0
PA	15.6%	BA	12.3	BA	3.6	SC	5.8%	PA	0.1	MA	0.0

Notes:

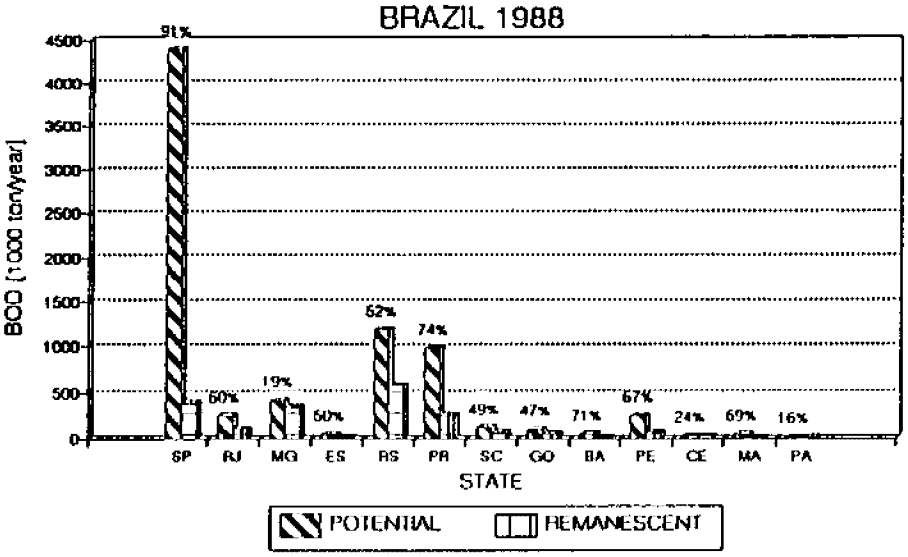
AI - abatement indicator; PI - potential pollution intensity; RI - remanescent pollution intensity

See indicators' definitions and state abbreviations in the main text

Sources: Pronacop (1989), Cetesb (1992) and author's estimates

GRAPH 3

INDUSTRIAL BOD OUTPUT BY STATE
BRAZIL 1988



Note: See definitions and sectorial classification in the main text; numbers above columns are pollution abatement rates
Sources: Pronacop (1989), Cetesb (1992) and author's estimates

In Table 3 there is no correlation between the level of potential BOD pollution intensity and abatement control. Remanescent pollution intensity indicators presented in Table 2 reveal that, in BOD terms, Rio Grande do Sul is the most BOD polluting - intensive state with remanescent intensity of 59.3 followed by Goiás with 58.5. Maranhão and Paraná with values ranging from 44.9 and 40.3. Pernambuco and Minas Gerais are 37.9 and 31.3. Other states do not exceed 25. Bahia, Rio de Janeiro and São Paulo are, however, the least BOD intensive states with intensity values of 3.6, 7.5 and 7.8, respectively.

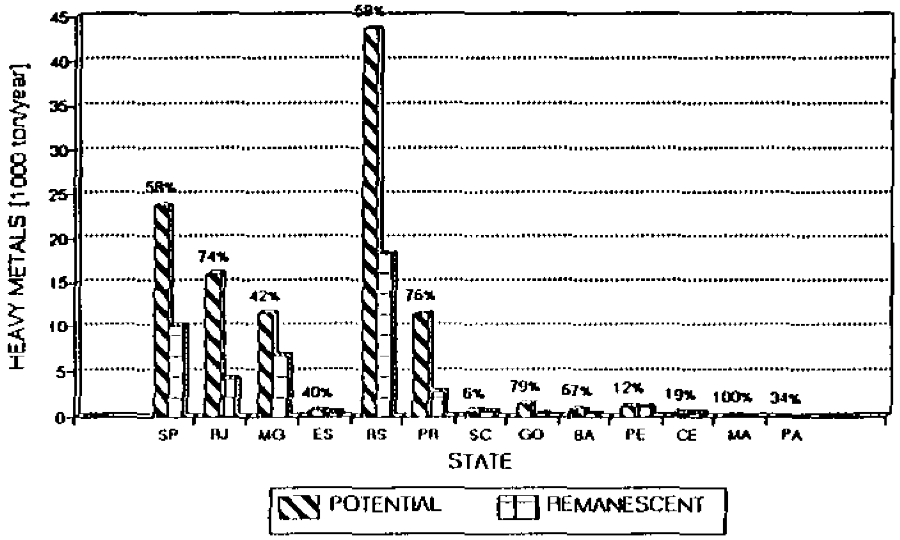
B - Heavy Metals (HM)

Table 3 shows that abatement levels are very high in Maranhão reaching almost 100%; these are followed by Bahia where the level is 87.3%. Goiás, Paraná and Rio de Janeiro have levels ranging from 79.2 to 74%. Rio Grande do Sul and São Paulo have nearly 58% abatement rates while Minas Gerais and Espírito Santo have approximately 40%. Pará has 33.8% and Pernambuco has 12.5%. Santa Catarina has the lowest level, 5.8%.

Graph 4 also shows that levels of emission do not explain abatement level since São Paulo and Rio Grande do Sul, with the highest levels, are not the most controlled and, others with low HM output are presenting high level of abatement.

GRAPH 4

INDUSTRIAL HM OUTPUT BY STATE
BRAZIL 1988



Note: See definitions and sectorial classification in the main text; numbers above columns are pollution abatement rates.
Sources: Pronacop (1989), Cetesb (1992) and author's estimates

State potential pollution intensity, however, has a weak relationship with state abatement control pattern. As shown in Table 3, states as Rio Grande do Sul with highest intensity value of 4.47 have abatement close to national average. Paraná, Goiás and Rio de Janeiro, the most intensive states following Rio Grande do Sul have values ranging from 1.81 to 1.15, also above the national average. Minas Gerais, with intensity of 1.06 shows very low abatement level whereas São Paulo is just the opposite with 0.47 intensity indicator. Other states are fairly sensitive to intensity values and present intensity values below 0.55, excepting Bahia with very high abatement, but a very low intensity of 0.20 .

Remanescent intensity values point out that Rio Grande do Sul is the highest HM intensive state with 1.86. Minas Gerais follows in second with a lower value of 0.61. Pernambuco and Paraná have approximately 0.45. Rio de Janeiro, Goiás and Ceará have approximately 0.30 and Espírito Santo and São Paulo have intensity values of 0.20. Santa Catarina's intensity value falls to 0.12 and Bahia and Pará to 0.07 and 0.04, respectively, whereas Maranhão is almost nil.

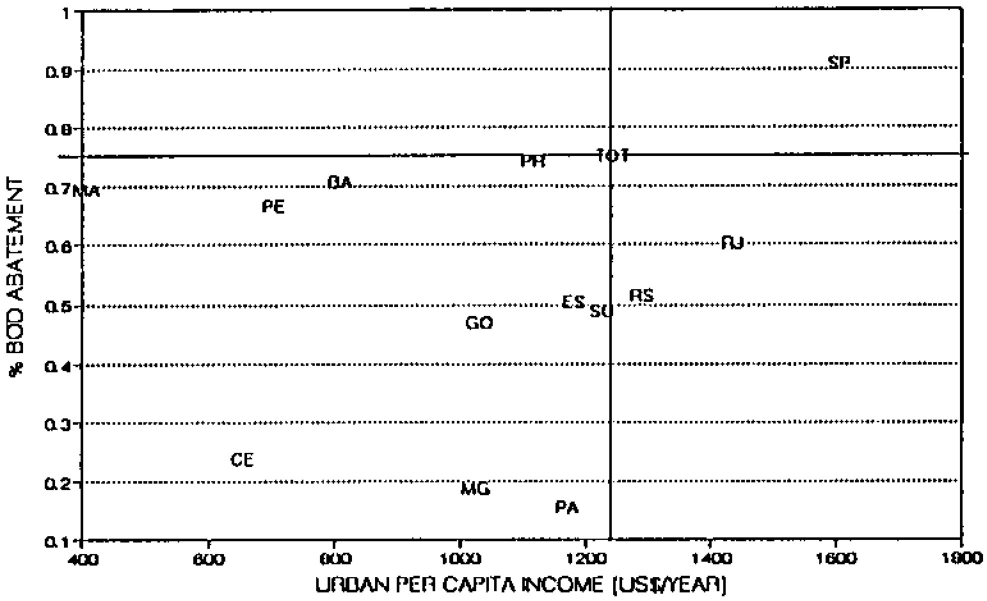
2.4.3. Income Effects

As expected, due to the small number of observations, it was impossible to estimate a regression using a cross-sectional technique to evaluate factors influencing state and sector performance on abatement level such as income, number of staff in EPA, capital stock vintage and so on.

However, the Graphs 5 and 6 show that, for most cases, there exists a fairly positive relationship between BOD and HM abatement levels and urban state per capita income, measured as earnings from those older than ten years old. In BOD abatement, Minas Gerais and Pará seem to be the states which have mostly diverted from this pattern, and for HM abatement, Santa Catarina and, to some extent, São Paulo. Both present much lower abatement levels when compared to other states with the same per capita income. States showing highest abatement levels above their standard income capability are Pernambuco, Bahia and Paraná for BOD and Bahia, Goiás and Paraná in HM.

GRAPH 5

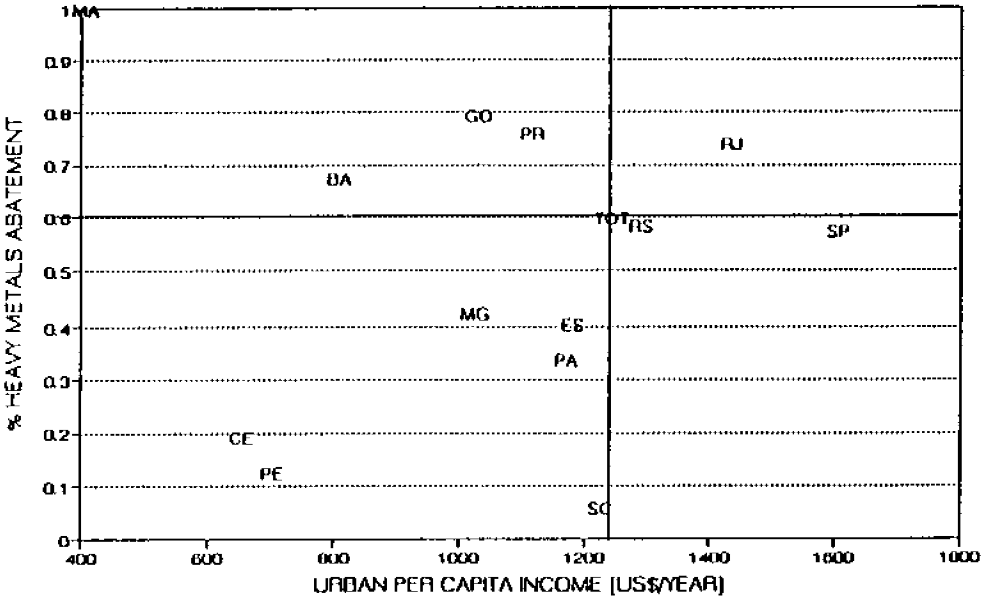
INDUSTRIAL BOD ABATEMENT BY STATE AND URBAN PER CAPITA INCOME: BRAZIL 1988



Ssources: Pronacop (1989), Cetesb (1992) and IBGE (1991) and author's estimates

GRAPH 6

INDUSTRIAL HM ABATEMENT BY STATE AND URBAN PER CAPITA INCOME: BRAZIL 1988



Ssources: Pronacop (1989), Cetesb (1992) and IBGE (1991) and author's estimates

2.4.4. Sustainability Analysis

Since data on plant emission per volume are not available, it was not possible to evaluate emission deviations from legal emission standards. In addition, the lack of well designed models to estimate assimilative capacity of water bodies in this study made estimates of total emission deviation from legal ambient standards unfeasible.

Therefore, in order to paint a picture of current deviation of water pollution from acceptable levels, the amount of industrial output produced with abatement levels below the best state's abatement level and below the national average abatement level were estimated.

The former gives an idea of how far abatement control is from a possible high abatement level and the latter shows how far abatement control is from an actual abatement level.

Table 4 shows that, for BOD, 53.1% of the total value added of sectors under EPA control in the country[5] are below the abatement level reached in SP and 47.3% below national average. For HM, these percentages are 99.7% when compared to MA, with the highest abatement level, and 76.1% when compared to the national average. That is, much more than half of production still requires better abatement enforcement.

The same procedures were adopted to assess value added produced with remanescent pollution intensity below states with the lowest intensity and below the national average. The percentages presented in Table 4 show 95.9% for BOD and 99.7% for HM under the best state and 29.2 and 27.0% below the national average. That is, almost all country's industrial production is higher polluting intensive than production that takes place in the least intensive states. Moreover, nearly a third of this production is higher intensive than the average intensity in the country.

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[5] Country here includes the sample of 13 states analysed in these studies.

Although these indicators are very crude, they seem point out that water pollution control and structural changes towards less polluting sectors must be promoted and fostered in Brazil.

TABLE 4
Proportion of Industrial Value Added
Diverging from Best and National Abatement
Levels and Remanescent Intensities

Parameters	Remanescent Pollution Intensities		Abatement Level	
	BOD	HM	BOD	HM
1st best state	BA	MA	SP	MA
below the best state	95.9%	99.7%	53.1%	99.7%
below national average	29.2%	27.0%	47.3%	76.1%

Sources: Pronacop (1989), Cetesb (1992) and author's estimates.

Note: Value added of sectors under abatement control estimated in the sample and considering the states: SP, RJ, MG, ES, RS, SC, PR, BA, PE, CE, MA, GO and PA.

2.4.5. Conclusions

A summary of the main indicators previously elaborated is shown in Table 5.

An analysis of these indicators results in the following conclusions:

1 - BOD control at sectorial level, with the exception of leather, is oriented to potentially high polluting sectors and emission levels seem to guide abatement enforcement.

TABLE 5
Indicators of Water Pollution Control in the Brazilian Industrial Sector

National average:
Abatement level
BOD - 75.2%
HM - 59.9%

Remanescent pollution intensity (g/US$)
BOD - 181.6
HM - 0.41

Proportion of value added under water pollution control with:
Abatement level below national level
BOD - 47.3%
HM - 76.1%
Remanescent intensity below national level
BOD - 29.2%
HM - 27.0%

First three industrial sectors with:

Highest abatement levels
BOD - Beverages, Food and Metallurgy
HM - Food, Paper and Cellulose and Wood Products

Lowest abatement levels
BOD - Electric Materials, Cosmetics and Mechanics
HM - Textiles, Electric Materials and Non-Ferrous Metals

Highest remanescent pollution intensities
BOD - Leather & Products, Beverages, Drugs & Medicine
HM - Leather & Products, Metallurgy and Mechanics

Lowest remanescent pollution intensities
BOD - Rubber Products, Electric Materials and Non-Ferrous Metals
HM - Paper & Cellulose, Wood Products and Non-Ferrous Metals

First three states with:

Highest industrial abatement levels
BOD - SP, PR and BA
HM - MA, BA and GO

Lowest industrial abatement levels
BOD - CE, MG and PA
HM - CE, PE and SC

(continues)

Highest industrial remanescent pollution intensities

BOD - RS, GO and MA

HM - RS, MG and PE

Lowest industrial remanescent pollution intensities

BOD - SP, RJ and BA

HM - BA, PA and MA

Sources: Pronacop (1989), Cetesb (1992) and author's estimates.

Notes:

[a] BOD - Biochemical Oxygen Demand; HM - Heavy Metals;

[b] State sample: Rio Grande do Sul (RS), Santa Catarina (SC), Paraná (PR), São Paulo (SP), Rio de Janeiro (RJ), Espírito Santo (ES), Minas Gerais (MG), Bahia (BA), Pernambuco (PE), Ceará (CE), Maranhão (MA), Pará (PA) and Goiás (GO);

[c] Ranking from higher to lower levels.

2 - For HM abatement, at sectorial level, there is no correlation to either potential intensities or emission output. Since some high BOD polluting sectors also present high HM abatement levels, it seems that HM control is a by-product of BOD control, i.e., BOD has been the priority in abatement enforcement. Therefore, any future changes in water pollution control must also emphasize HM abatement.

3 - There is no regional pattern to explain state abatement levels. However, there seems to exist a weak relationship between potential BOD pollution levels and abatement levels as well as potential intensity. That is, states with output composition based on polluting intensive sectors do not necessarily show better enforcement capability. Therefore, many high BOD potentially polluting intensive states are also high remanescent polluting intensive states.

4 - Regional HM abatement has no correlation with state emission output, but suggests a weak interrelationship to potential intensity. Consequently, some high polluting intensive states succeeded in become low remanescent polluting states.

5 - Income effects seem to influence EPA performance, since high per capita income states tend to present higher abatement levels.

6 - Since emission and ambient standards fulfillment by sectors cannot be measured, it was estimated that almost 50% of the industrial value added being controlled by EPA in the sample is presenting BOD abatement levels lower than national average. For HM abatement level this proportion is 76.1%. Moreover, nearly a third of the sample industrial value added has

a composition below the national average remanescent pollution intensity, that is, industrial production with much higher pollution intensity than the national average measure.

7 - The same comparison made to states with the highest abatement level reveals that 53.1% of industrial production in other states have BOD control below that state's level and 99.7% in terms of HM. When compared to states with lowest remanescent intensity these proportions in both BOD and HM are 95.8 and 99.7%, respectively.

8 - These indicators suggest that there is a need to increase abatement levels in order to reduce remanescent water pollution intensities in the Brazilian industrial sector. Moreover, it can be assumed that there is a positive correlation between EPA performance and state urban per capita income, though no strong evidence that high potentially intensive sectors are the most controlled. That is, remanescent intensity of Brazilian industrial sectors could be greatly reduced, thus making industrial expansion environmentally more acceptable. Therefore, in the case of industrial water pollution in Brazil, it seems plausible to suggest that the use of market-based instruments can be successfully applied and offer a good opportunity to change pollution intensity of the industrial sector towards cleaner technologies and less polluting sectors.

2.5. Urban Domestic Indicators

The average abatement level in urban domestic waste water, for the country as a whole, is 14.8%. As shown in Table 6, SC has the highest abatement level, around 38%, while RS, CE and RJ follow it closely with approximately 30%. PA and PR are around 20%, MA, ES and SP are around 10%. PE and GO show 5.3 and 2.5%, respectively, and MG almost nil. As it can be seen, there is no regional trend in these estimates.

Graph 7 shows that abatement levels does not seem to be related to pollution levels. Thus, while São Paulo (with the highest potential level) treats only 9.7%, ES and MA for the same abatement level have the lowest potential levels. MG and RJ at almost the same potential level have, respectively, 0.6 and 26.6% abatement.

Moreover, no regional pattern is recognized when abatement level is considered.

TABLE 6

Urban Domestic Water Pollution Abatement and Intensity in Brazil

STATE	AI (%)	STATE	RI (g/US$)
SC	37,8	MA	42,6
RS	31,5	PE	26,5
CE	29,6	CE	21,1
RJ	26,6	BA	20,6
PA	21,7	MG	19,1
PR	18,8	GO	18,6
BA	15,4	ES	14,9
BRAZIL	14,8	PR	14,3
MA	12,2	BRAZIL	13,5
ES	10,9	PA	13,2
SP	9,7	SP	11,1
PE	5,3	RS	10,5
GO	2,5	RJ	10,1
MG	0,6	SC	10,0

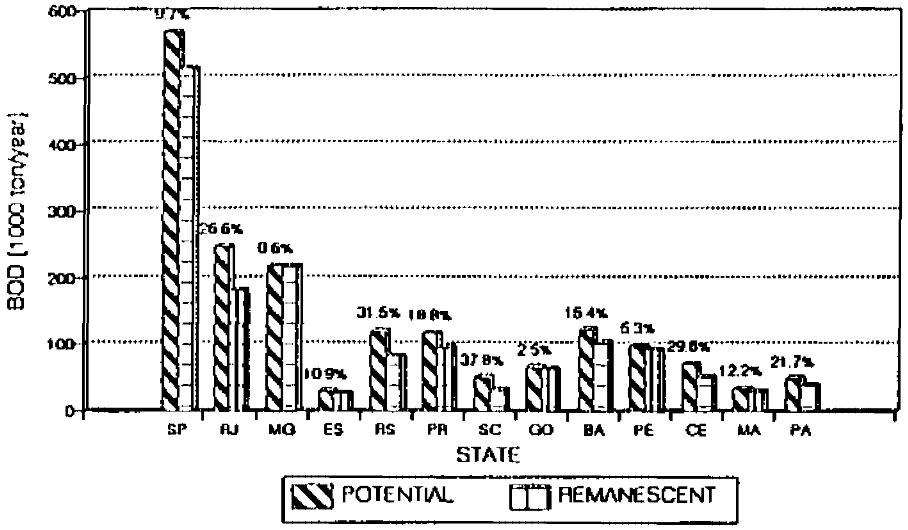
Note: AI - abatement indicator; RI - remanescent pollution intensity.

Sources: IBGE (1991, 1992) and author's estimates.

GRAPH 7

HOUSEHOLD BOD OUTPUT

BRAZIL 1988



Note: See definitions and sectorial classification in the main text; numbers above columns are pollution abatement rates.
Sources: Pronacop (1989), Cetesb (1992) and author's estimates

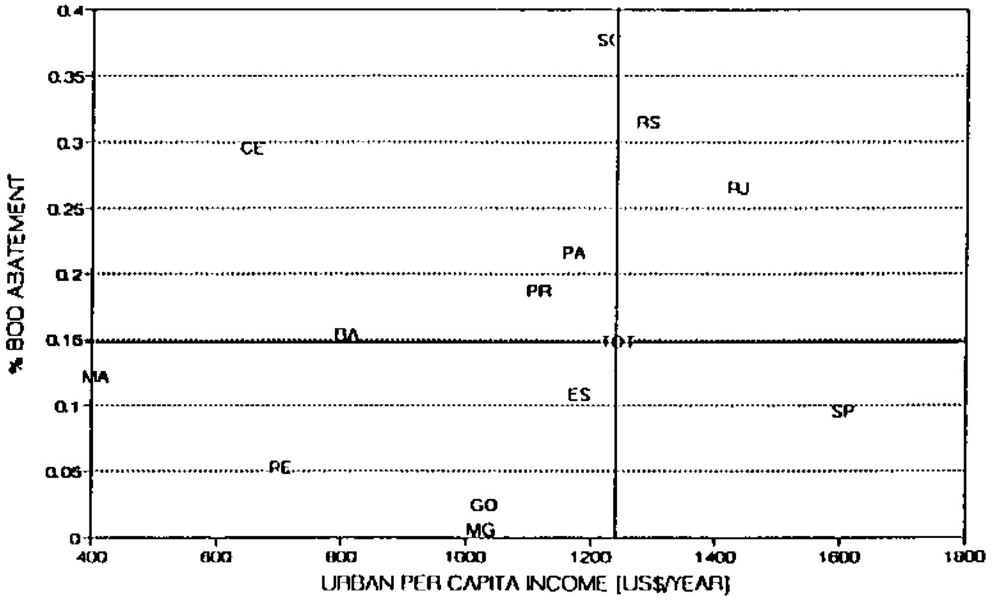
Observing remanescent pollution intensity in Table 6, SC, RJ, RS and SP present the lowest intensity values ranging from 10 to 11.1 whereas MA, PE, CE and BA have the highest ones, with values from 42.6 to 20.6. In the case of intensity a very clear regional pattern is recognized, though MG and GO are closer to northeastern standards and PA to southern standards. PR and ES, with a intensity of approximately 14 are in line with other developed states in the south.

This regional pattern means that for each unit of income generated in southern states there will be less domestic pollution than would occur if this unit was generated in northeastern states.

Due to the low number of observations, no econometric model was attempted to correlate urban average per capita income with abatement level. However, Graph 8 clearly reveals that this interrelationship is very weak. Therefore, a high urban state per capita income does not necessarily leads to higher state abatement levels, but total state income makes domestic pollution less affecting when economic expansion takes place.

GRAPH 8

HOUSEHOLD BOD ABATEMENT AND URBAN PER CAPITA INCOME: BRAZIL 1988



Sources: IBGE (1991), IBGE (1992) and author's estimates

Thus, urban domestic water pollution shows a very low level of abatement even in some high-income states. Hence, it is plausible to assume that in these cases sewer rates may be raised in real terms to finance investment expansion in sewer services. However, in low-income states -- particularly in the northeastern region -- economic expansion will be certainly more pollution intensive than in richer states. These findings may suggest that in these states sewer services can only be increased by subsidized rates.

3. WATER QUALITY INDICATORS

The purpose of this section is to provide indicators of water policy effectiveness. It was possible to obtain systematic monitoring and indicator measurements of water quality only in São Paulo, Rio de Janeiro and Paraná states, though the latter is not updated. In fact, the PRONACOP project previously mentioned was conceived, among other things, to foster EPA capacity in water quality monitoring in Brazil.

São Paulo and Paraná use composite indexes which are comparable and make a simple analysis of trends in water quality possible. In the case of Rio de Janeiro, quality indicators are much more sophisticated but do not have a composite form. Hence, the following analysis will be centered on figures from São Paulo and Paraná.

The indexes adopted in São Paulo and Paraná states follow the method proposed by the National Sanitation Foundation in USA.[6] This composite index (WQI) is a weighed product of water quality indexes of DO, BOD_5, Fecal coliforms, Temperature, pH, Total Nitrogen, Total Phosphate, Total Solids and Turbidity estimated from a sample of monitoring points in each river basin under control. Heavy metals are not considered since their concentration above certain levels mean zero quality.

Therefore, the following analysis do not incorporate toxicity parameters. This is the main reason why Feema, Rio de Janeiro's EPA, does not use these composite indexes. In this analysis the pollutants included in the composite index will be enough to fulfill our goals.

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[6] See Cetesb (1991) and Surehma (1987).

In order to make WQI measurement compatible in both states, the following classification was adopted:

WQI SCORE	CLASS
0-36	not acceptable
37-51	acceptable
52-79	good
80-100	very good

To carry on this analysis, the most important river basins were selected according to industrial pollution discharge which was the only emission data available by river basin. The selected sample represents almost 90% of industrial BOD emission in Paraná and about 80% in São Paulo.

Thus, 94 monitoring stations were considered for Paraná in the period 1982/86 and 55 for São Paulo in the period 1981/90.

Two indicators were then measured. One represents the average index observed in the respective periods given by the arithmetic mean of annual indexes. The other represents the temporal trend in quality, pointing out the station where WQI changes in the last year comparing to the first year of the period.

Table 7 reveals that 77 stations in Paraná show good water quality index and five show very good ones. There

TABLE 7

Water Quality Indicators in Parana State 1982/86 (1)

Class	Stations classification (2)		Temporal trend (3)		
	Stations	%	Upgraded	Stable	Downgraded
Very good	5	5.3%	3	2	0
Good	77	81.9%	5	48	3
Acceptable	7	7.4%	0	1	5
Not acceptable	5	5.3%	0	4	1
Total	94	100.0%	8	55	9

Notes: (1) Relative to the river basins: Iguacu, Ival, Tibagi and Paranapanema

(2) Annual average class

(3) Changing class from the first to the last year of the period. Note that 30 stations presented only one year index which did not make possible to estimate trend indicators for them.

Source: Surehma (1987) and author's estimates are seven with acceptable index and five with unacceptable. That is, 87.2% of the stations are indicating good water quality. Trend indicators show that eight stations presented index improvement while in nine index was down-graded. Since 39 stations presented only one annual measurement, they were not included in trend indicators.

These results, however, indicate that water quality has been stable in this state.

In the case of São Paulo, presented in Table 8, a smaller proportion of stations - 61.8% - are classified in good and very good classes. Also stations with index down-gradations (9) exceeded stations with index improvement (4).

TABLE 8

Water Quality Indicators in Sao Paulo State 1982/91 (1)

Class	Stations classification (2)		Temporal trend (3)		
	Stations	%	Upgraded	Stable	Downgraded
Very good	2	3.6%	0	1	1
Good	32	58.2%	2	26	4
Acceptable	14	25.5%	2	10	2
Not acceptable	7	12.7%	0	5	2
Total	55	100.0%	4	42	9

Notes: (1) Relative to the river basins: Jundiai, Mogi-Guacu, Paraiba do Sul, Paranapanema Alto, Pardo, Piracicaba, Tiete Medio- Interior, Baixada Santista, Tiete Alto-Cabeceiras and Tiete Alto-Zona Metropolitana

(2) Annual average class

(3) Changing class from the first to the last year of the period.

Source: Cetesb (1991) and author's estimates

Considering the water pollution indicators presented before, it seems that the high abatement level of 91% observed in industrial water pollution in São Paulo has not been sufficient to assume good water quality in this state; that condition can be partly explained by the fact that domestic pollution source presents a very low abatement level of 9.7%.

The state of Paraná also shows a high industrial abatement level of 74.3%. As for domestic sources the level of abatement, 19%, is higher than in São Paulo, but still rather low.

The differences in the periods under analysis in each state may influence the results by underestimating pollution level in Paraná and overestimating pollution level in São Paulo when comparisons are made with the 1988 water pollution control indicators presented in the previous subsection.

Nevertheless, these very rudimentary indicators of water quality suggest a need to introduce ambient standards as a key parameter in pollution control. That is, policy which considers both emission standards and assimilative capacity must be enforced. In doing so, concentration of pollution point sources vis-à-vis assimilative capacity of water bodies indicate the optimal control level. Consequently, such perspective will inevitably lead to river basin approach in the design of water policies.

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