

INDUSTRIAL WATER POLLUTION CONTROL IN DEVELOPING COUNTRIES

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Summary

This paper provides a general description of the differences in water use patterns and sources of pollution between developing and developed countries. Some of the international trade and investment trends which have resulted from generally stricter enforcement of pollution control measures in developed countries are considered. Specific instruments available to governments for dealing with industrial water pollution are discussed, including effluent charges, standards, permits and the requirement of environmental impact statements. Monitoring methods are also considered as essential elements of any pollution control method. It is considered important for developing countries, which have not already done so, to develop strategies to improve water quality in rivers and lakes and preserve the environment for future generations.

Resumé

Cet article donne une description générale des différences, en ce qui concerne les formes d'utilisation de l'eau et les sources de contamination entre pays en développement et les pays développés. On considère certaines tendances du commerce international et de l'investissement, qui ont résulté d'une application généralement plus stricte dans les pays développés, des mesures de contrôle de la contamination. Des moyens spécifiques, à la disposition des gouvernements pour traiter du problème de la contamination de l'eau par l'industrie sont discutés, y compris les charges en effluents, les normes, les permis et l'obligation de préparer une estimation de l'impact de tout nouveau projet sur l'environnement. Des méthodes de vérification sont aussi considérées comme des éléments fondamentaux de toute méthode de contrôle de la contamination. On considère qu'il est important, pour les pays en développement qui ne l'ont pas encore fait, de développer des stratégies pour améliorer la qualité des eaux dans les rivières et dans les lacs, et de protéger l'environnement pour les générations à venir.

Resumen

Este informe da una descripción general de las diferencias entre los distintos esquemas del uso del agua y las fuentes de polución entre países desarrollados y los países en desarrollo. Se consideran algunas de las tendencias del comercio internacional y de inversión que han resultado de la aplicación generalmente más estricta de medidas de control de polución en países desarrollados. Se discuten sobre medios específicos disponibles a gobiernos para tratar sobre la polución industrial del agua, incluso la descarga de efluentes, normas, permisos y la necesidad de proveer una declaración del impacto de los proyectos al medio ambiente. También son considerados medios de monitoreo como elementos esenciales de cualquier medio de control de polución. Se considera importante para países en desarrollo, que no lo hallan hecho todavía, el desarrollar estrategias para mejorar la calidad del agua en ríos y lagos y conservar el medio ambiente para generaciones futuras.

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Introduction

Industrial water pollution, until recently considered a lesser problem in numerous developing countries, has now been recognized as a serious one and a major health hazard. Developing countries have generally considered economic growth and industrialization as key development priorities, and preservation of the environment has not been given the same weight. However, it has become clear that urgent pollution control measures are necessary to avoid a major ecological upset, even though this may mean slower economic growth in certain industries. The objectives of this paper are to describe some of the aspects of industrial water pollution peculiar to developing countries, to suggest some alternative policy instruments for dealing with them and hopefully to provoke some discussion on existing and potential pollution control measures in developing countries.

Part I gives a general description of the differences in water use patterns and sources of pollution between developing and developed countries. Some of the international trade and investment trends resulting from stricter enforcement of pollution control measures in developed countries are then considered. Part II discusses some of the instruments available to governments for dealing with industrial water pollution within the framework of a national strategy or a regional water plan. These instruments include effluent charges, standards, permits and the requirement of environmental impact statements. Monitoring methods are also considered as essential elements of any pollution control programme. Some of the measures and methods presented in Part II may provide opportunities for discussion or technical co-operation among developing countries.

It has now become urgent for developing countries to recognize the rapid deterioration of the environment that can occur, particularly in the quality of water flowing through rivers and streams, and therefore in the quality of life in rural and urban areas. It will not be possible to sustain long-term growth, development and an improvement in the standard of living if the water courses carry toxic chemicals, phenols and other pollutants which endanger human and animal life. Action should be initiated immediately to prevent further deterioration and preserve the environment for future generations.

I. GENERAL PERSPECTIVE

Water use patterns differ markedly between industrialized and developing countries. In developed countries, industrial water use generally accounts for at least 40 per cent of the total water use, and in some eastern European countries may reach more than 80 per cent (33). In developing countries, on the other hand, by far the main consumptive use is for irrigation, while industry seldom accounts for as much as 10 per cent of total use. Therefore, water use in industry, waste-water treatment and recycling are much more important issues in the developed than in the developing countries.

Since industrial water demand is generally relatively small in developing countries, most of them have not been too concerned with increases in industrial water demand. Industrial development has been encouraged and infrastructure in the form of water supply has often been provided by the government of the developing country as an incentive to business. If not made available by the government, industries are often allowed to develop their own supplies (from surface or ground water) without much interference from the host government.

However, it is estimated that the demand for water from industrial and other non-agricultural uses will increase rapidly over the next two decades in the developing countries, causing basic water use conflicts over the allocation of water among agricultural, industrial and domestic uses. For example, it has been estimated that in India irrigation will claim only 84 per cent of consumptive use in the year 2000 as compared to 92 per cent in 1975 (41). It is likely that water use patterns in other developing countries will reflect those of India. While in the future irrigation will still represent the major use of water, the demands of industry are becoming increasingly important. Rising demands from all sectors in terms of both quantity and quality will make it necessary for all countries to consider conservation and pollution control measures in anticipation of future shortages.

A. SOURCES OF INDUSTRIAL WATER POLLUTION

Despite the relatively small demand for water from industry in developing countries, pollution from industry has had a significant effect on the water supplies of those countries. Industrial water pollution can be found in both

modern and traditional sectors in developing countries: in the traditional factories processing primary products and in the factories of the major cities, which often use technologies imported from developed countries.

Although pollution has often been assumed to be a minor problem in developing countries, it is in fact fouling rivers and streams in Asia, Africa and Latin America. Untreated waste from agro-industrial processes and effluent from new factories have destroyed fisheries, reduced available water supplies and impaired agricultural productivity (37). Water bodies in almost all major urban areas are polluted by untreated organic discharges from human and industrial activities.

1. Primary Product Processing

The major industries in the traditional sector which are causing widespread water pollution are those which process primary products (often for export), such as sugar and oilseed mills, mineral extraction and processing facilities, coffee factories and tanneries. Agro-industries can become a major source of pollution when an increasing proportion of the population becomes involved in production of cash crops and industries begin concentrating in growing areas.

In Africa, agro-industrial activities present some of the most serious environmental problems in terms of industrial pollution. For example, in Nigeria the brewing, slaughtering and sugar refining industries have few or no facilities for either air or water pollution control. Waste water is discharged directly into rivers, other receiving waters or open drains. In Kenya there is a wide range of organic effluents containing soluble substances, of which coffee wastes are the most widespread and the most serious (37). The problems of organic loads from hair and fats as well as chromium and sulphide pollution from the tanning industry in Kenya are documented in Mr. Mwelesa's paper for this Meeting. Although Kenya now has a Pollution Control Division, it has not been able to reduce pollution effectively from long-established plants.

In Asia, localized pollution from agro-industrial operations such as sugar and palm oil processing mills adversely affects water supplies and fisheries and has become a major problem in some areas (37).

The disastrous effects of the concentration of agro-industry were evident in the increase from 6 to 17 sugar mills along a 20 km stretch of the Mae Klong River in western Thailand. When there were only six mills, the aquatic ecosystem continued to be very productive. By the mid 1970s, however, the increasing price for sugar had resulted in a more than doubling of Thailand's productive capacity. The result was that several sections of the river became so heavily polluted that the fisheries were nearly destroyed (37). The Government invoked the seldom-used water pollution control provision in its Factories Act and forced several of the plants to construct sedimentation ponds. Since that time fishery resources have been largely restored.

One of Malaysia's most successful economic developments has been the establishment of palm oil plantations and processing mills, which have made Malaysia the world's major exporter of the oil. However, the effluent from the processing plants has a high organic concentration and is rarely treated, thus polluting water supplies, damaging fisheries and adversely affecting the health of people in the countryside. The total organic waste loading from oil palm wastes in 1975 was equivalent to the total wastes from a community with a population slightly larger than the population of West Malaysia (37).

Pollution resulting from the concentration of traditional industries in local areas must be recognized, especially its damaging effect on the health of the people in rural areas.

2. Concentration in Urban Areas

During the last two decades, concentration of modern industry, population and government in larger metropolitan areas in the developing countries has led to disequilibrium in the ecological balance and widespread deterioration in the quality of air and water. In Latin America, rapid industrial development based on petroleum refineries and large petrochemical and steel complexes in urban areas of Venezuela and Mexico, and on metallurgical industries in Peru and Chile, has resulted in high levels of suspended particulate matter in water courses in those countries. In Mexico City foundries, metal processing, ceramic and paint manufacturing, cement production, smelting and other industrial operations

contribute to the total pollution burden in the enclosed valley of the city (37). Latin America will have many of the largest urban complexes in the world within the next decade, which, combined with large-scale industrialization, can be expected to result in increased environmental degradation.

In the Middle East the main industries are oil and gas processing facilities. Industrialization is progressing rapidly in Algeria, Egypt, Iraq, Saudi Arabia and Turkey, where pollution is mainly confined to large cities, ports and resource processing areas such as oil fields and mines. Although most countries recognize the need to combat pollution, controls are generally inadequate.

In the rapidly industrializing developing countries of Asia, the same phenomenon is evident. Toxic substances are found in concentrations exceeding natural levels in the Republic of Korea. The presence of cadmium, mercury, copper and lead in the rivers and coastal waters of Korea exceeds water quality standards of Japan, the United States and those suggested by the World Health Organization (37). In India, heavy industries such as steel processing and petrochemical complexes have brought about a serious deterioration of water supplies in Bombay, Calcutta and Madras (1). In China, with the rapid expansion of the energy, chemicals and metallurgical industries and the growth of cities, there is widespread water pollution. All major rivers have been seriously contaminated in the stretches of and downstream from large cities that discharge large quantities of untreated industrial and urban wastes (30).

Most studies that have been conducted in the more industrialized developing countries to measure toxic pollutants have found them to exist at levels which exceed accepted health standards. It is likely that industrial pollution in developing countries is more of a problem than has been documented. More monitoring and control of water pollution are urgently needed (37).

B. TRADE AND INVESTMENT EFFECTS OF POLLUTION CONTROLS

Despite the rising level of pollution in many developing countries, they have historically put lighter burdens on their environmental resources than have industrialized countries. As a result of differences in the environmental assimilative capacity between developing and developed countries and the relatively lower priority generally given to the environment in the former, certain trends in international trade and investment have emerged.

1. Comparative advantage of developing countries

First, the relatively less stringent environmental standards so far imposed by numerous developing countries have given them a comparative advantage in the production and export of certain commodities subject to stricter environmental controls in developed countries. An industry which is allowed to discharge effluents directly into the water course saves on the costs of treatment and can therefore in principle produce more cheaply than the same industry subject to stricter controls. Industries which can take advantage of the lower costs of production may therefore be attracted by this circumstance which could in turn benefit the recipient country through industrialization, increased exports and a higher standard of living. This kind of consideration may be particularly attractive to light industries, such as textiles, food processing and plastics fabrication.

Second, extraction and export of minerals and other primary products may also have a comparative advantage when environmental controls are not too strict. Primary processing is increasingly being carried out within the developing countries. Exporters of minerals are smelting their ores and exporting refined metal; similarly, they are exporting vegetable oil rather than seeds. This increases the value added of exports and may have generated more favourable development linkages than those arising from the export of raw materials. At the same time, the pollution content of such materials is likely to be high. It should, nevertheless, be possible for developing countries which have not yet done so, to apply at least basic environmental safeguards without significantly narrowing their competitive advantage (42).

A third trade effect which works to the advantage of the developing countries is a shift away from "pollution-intensive" products, which have become increasingly expensive, to "natural" products, which are less damaging to the environment. During the post-war period there has been a significant displacement of natural fibres (cotton, jute and wool) by synthetic ones, rubber and lumber by plastics, soap by detergents, steel by aluminium and concrete, and returnable by non-returnable bottles (12). The synthetics, plastics and detergents have been responsible for a large proportion of the non-biodegradable and toxic substances which are polluting the water courses of the world. There has more recently been a shift in demand back to the

natural products. To the extent that the developing countries are major exporters of natural products which compete with synthetics, they should stand to benefit in terms of both price and quantity.

The view that they should take advantage of their competitive position in environmental terms had been voiced by many of the developing countries at the United Nations Conference on the Human Environment held at Stockholm in 1972 (recommendation 106 (b)). Such an advantage had arisen from the greater capacity of their natural environments, as yet unsaturated, to assimilate and dilute wastes (22). However, as discussed below, this view has now shifted in most developing countries, where the environment has already been strained beyond its assimilative capacity.

2. Establishment of polluting industries in developing countries

The comparative advantage of developing countries discussed above has led in some cases to the establishment of polluting industries in those countries. In particular, the processes of newly established basic industries such as steel, chemicals and metals smelting were not necessarily modified or treatment plants constructed to conform with environmental controls introduced elsewhere in the late 1960s and 1970s. This created industrial pockets in many large cities and reinforced the dualistic structure of economies with distinct modern and traditional sectors. Such investments were often supported because they promised new employment opportunities, development and higher standards of living. It was felt that there was still sufficient time to take care of environmental improvement at a later date and top priority was given to industrialization programmes.

However, it was soon revealed that the pollution-absorbing capacity of the developing countries was not large enough to prevent dangerous environmental disruption in emerging industrial complexes and over-crowded areas. Widespread water pollution in capital cities had caused disease, a decline in fishery resources and a reduction in the supply of water of suitable quality.

Most governments of developing countries have recognized deteriorating environmental conditions and in some cases have forced polluting factories to alter their production processes or construct treatment facilities, which has proved to be very expensive. Although the inclusion of treatment facilities at the time of construction of a plant is also expensive, it is less so than altering processes to repair damages once they have occurred.

It has become clear that the unplanned promotion of industrialization cannot be sustained on a long-term basis because of environmental damage, and that some controls included at the planning stage are necessary. It appears desirable that developing countries introduce and enforce general controls on water and air pollution before new industries are established in order to prevent the introduction of processes which may have a detrimental effect on the environment. Such controls may lessen the comparative and locational advantage of the developing country, but are essential to the attainment of long-term development goals.

II. POLICY INSTRUMENTS

A. LEGAL AND INSTITUTIONAL FRAMEWORK

As recommended at the United Nations Water Conference, the first step towards effective water management is the formulation of a national water policy. Policy is here considered to be a set of strategies or a plan of action drawn up by the government to guide water resources development, within which laws and policy instruments can be formulated to deal with specific problems such as water pollution. The water policy must allocate water among various competing economic sectors and should be linked to use, conservation and development of water resources in the different sectors. Although the overall policy should be drawn up at the national level, it will have to take into consideration differences in geographical regions and water basins, always recognizing the environmental dimension.

While a comprehensive water policy must be defined with the co-operation of all entities concerned with water, the responsibility for implementation of that policy should ideally be entrusted to a single authority which co-ordinates the activities of those entities in the water field at all levels (13). Such an authority should be capable of gathering and assimilating data and of basing long- and short-range planning on the resulting body of empirical information. In the water field, as in other areas of administration, the government must have the ability to implement programmes effectively. This calls for rational budgeting, inter-agency co-ordination, efficient delivery of services to the field, continuous monitoring and evaluation, enforcement mechanisms and the establishment of a meaningful dialogue with the public.

1. Environmental law

Unless environmental and water resources management efforts rest on a solid legal foundation, they are almost certain to fall short of achieving their objectives. While virtually all developing countries have basic legislation empowering government agencies to control some forms of water pollution, the laws may be of questionable suitability to prevailing political, economic, and cultural realities. For this reason and others, they may not be as effective as would be desirable.

Close co-ordination with carefully-designed social and economic programmes, especially those related to water and environment, is thus essential to an equitable legal framework.

In most African countries environmental laws dealing directly with water pollution are in the early stages of development, although many of the colonial governments had left general public health codes which prohibited nuisances such as water pollution and authorized its regulation. In Asia, laws on water pollution vary widely; in some cases water pollution is covered by general statutes (Bangladesh, Pakistan and Thailand). In others, there is specific water quality legislation (India, Indonesia, Malaysia, the Philippines and Singapore). However, legislation that does exist generally relates to drinking water quality, rather than industrial pollution. Regulations on the latter are more often found in industrial legislation (37).

In Latin America, three countries - Colombia, Mexico and Venezuela - have comprehensive laws and dominant institutions for environmental management, including water pollution control. Most of the other countries have at least established environmental units with a primary co-ordinating function; few of the Caribbean island nations have so far paid attention to environmental management.

All regulations governing water resources development can be drawn up to include an environmental dimension as part of the planning process if the relevant information is made available. Thus, for example, laws governing coastal developments, dam construction, factory licensing and fisheries might all incorporate provisions calling for the routine evaluation of environmental impact as part of the normal approval procedure. Such provisions are essential to the development of a genuine awareness on the part of government and yet they are absent from the laws of many developing countries. New legislation might include a provision calling for a mandatory examination of the feasibility of waste-water treatment facilities with the construction of any new factory, perhaps in co-operation with the government (37).

2. Policy Instruments

Within the unique institutional framework developed by the government, each country will have several policy instruments available to it for dealing with water pollution, among which are the following:

- (a) Direct charges on industrial effluents as an incentive to polluting industries to reduce waste loads;
- (b) Subsidies to promote pollution control using tax rebates or payments to industry to offset costs of pollution control;
- (c) Government standards on effluents from production processes, limiting discharge levels of certain substances into water courses;
- (d) Government licenses under which permits will only be issued to industries using "clean" processes;
- (e) Requirements of environmental impact statements from potential investors or new projects.

These instruments will be discussed in Sections B, C and D below. Each government must choose for itself the appropriate combination of measures which will maximize the effectiveness of anti-pollution expenditures. The necessary responses of governments and industries to environmental requirements will not be inexpensive. Industries will have to pay significant amounts for anti-pollution measures, while governments will contribute the substantial costs of administration, monitoring and research.

B. ECONOMIC INCENTIVES

The first group of policy instruments available to developing countries is based on economic incentives, which should induce industries to reduce discharges of pollutants simply because it is in their own best interest. In a market economy, prices perform the key function of allocating all types of resources to their most efficient use. However, many environmental resources are still unpriced and remain outside the market. Such environmental assets are "used up", but their use is not accurately reflected in the price system. Economists describe the harm caused by such use as "externalities", because the burden of resources consumed falls on society at large, not just on the consumer who uses them (2).

Externalities frequently lead to a breakdown in the performance of the market mechanism. The producer does not factor their cost into his profit-maximizing computations. Economic theory states that if the producer had to

pay for the costs of pollution, he would discharge less. An effluent charge levied by government on the quantity of pollutants in the discharge of an industrial firm should have the same effect as the market price on the firm's decision to consume environmental resources. Externalized costs should be internalized by the firm to some degree. The concept of effluent charges levied against polluters has come to be known as the "polluter pays principle". The introduction of such a policy presupposes the existence of a system and facilities for measuring and assessing the quantity of water used and of effluents discharged by each user.

1. Effluent charges

Effluent charges have been introduced successfully in several European countries, and are generally considered by economists to be the most effective means to reduce water pollution. Ideally, the government should set the charge at the level at which the cost of increasing pollution by an additional unit is slightly greater than the cost of treating the additional unit. The objective of effluent charges is to induce individual firms to take pollution control steps, the over-all result of which will be attainment of prescribed water quality goals. Studies have shown that with the imposition of such a charge, much of the pollution is eliminated immediately. After the initial reduction, however, it is more difficult to reach higher levels of water quality.

Czechoslovakia provides the best example of a working system of effluent charges. The country has been using such a system to maintain water quality at predetermined levels since 1967 (2). A basic charge is placed on biochemical oxygen demand (BOD) and suspended solids (SS). A surtax of from 10 to 100 per cent of the basic charge is added, depending on the extent to which the discharge increases the concentration of BOD or SS in the receiving waters.

The incentive effect of the scheme seems to be directed at inducing proper operation of existing treatment facilities. Charge amounts are based on the operating costs of available treatment systems, and do not reflect capital costs of pollution control treatment. Thus, they are too low to induce investments in treatment systems or process changes. However, the Czech system does allocate revenue from effluent charges to subsidies for such investments.

Self-monitoring, regulated through random checks by government inspectors and penalties for false reporting, provides information on discharge levels. The charge for each source is calculated on the basis of total yearly discharges, but is paid in equal monthly installments. A penalty of 0.1 per cent of the charge is levied for every day the payment is late.

The Federal Republic of Germany, Hungary, France and the Netherlands have also developed versions of effluent charges with varying degrees of success. Furthermore, the "polluter pays principle" has been accepted by the Organization for Economic Co-operation and Development (OECD) as the most appropriate implementation framework for dealing with pollution (42).

Various programmes of effluent charges geared to the achievement of water quality goals have been advocated in the United States since the 1960s. Under the programme developed by Allen Kneese and Blair Bower, charges would be set on one or a few pollution indicators, such as BOD. The rates would be set separately for each river basin to achieve the desired level of water quality for that basin. Initial charge rates would be calculated using marginal control cost data on classes of sources in the basin and approximate hydrological models so as to come as close as possible to the "correct" charge. The charge scheme would be supplemented by regulatory controls where discharge prohibitions were more appropriate, as with toxic substances (19).

Under Malaysia's Environmental Quality Act, the Division of Environment in 1978 introduced license fees and pollution fees. For palm oil mills, license fees are to be calculated on the basis of the quantity of crude oil processed, while effluent fees are based on predicted levels of BOD discharged. These are innovative measures which are to be used in conjunction with standards, and their initial results are not yet known. However, other developing countries may benefit from the Malaysian experiment (36).

For developing countries, one of the most important advantages of an effluent charge system is that it brings in revenue which can be used for regional or local pollution abatement programmes. As in Czechoslovakia, revenues earned can be allocated as subsidies to industries for construction of wastewater treatment facilities.

Finally, a system of charges has the advantage of requiring less information than other approaches and therefore lower costs associated with water quality management. This should be particularly appealing to developing countries which generally lack funds and comprehensive information networks. The major administrative costs are for monitoring, rather than for legal and enforcement measures.

The disadvantages of the charge system arise mainly because of difficulties in defining the "polluter" who is to pay. In some cases, pollution is "old" or a factory discharges from many outlets, some of which cannot be located. In other cases, the sources of pollution are so numerous it is difficult to determine the appropriate level of effluent which should be allowed to each. Some minimal amount of pollution may be unavoidable, although it seems to be only a small fraction of the amount many industries would discharge without regulation. It should be possible to determine that amount and allow firms to discharge it when river flow is great enough to assimilate it. Finally, assessment of effluent charges has been attacked as a "license to pollute at a fee". Where marginal charges are less than the marginal cost of treating effluents, the industry will prefer to discharge pollutants rather than treat the wastes.

For developing countries considering the introduction of effluent charges, some of the following suggestions (35) regarding favourable ingredients of such a system might be useful:

- (a) When an effluent charge system is introduced, initially low rates can be established, with dates for specified rate increases indicated;
- (b) The charges can be related to a few pollutants which are comparatively easy to measure by techniques which yield consistent results;
- (c) The administration of an effluent system is greatly simplified by a table of pollution coefficients, establishing levels of pollution per unit of output or per employee. Provisions must be made for sampling and for basing payments on actual discharge of pollutants;
- (d) An effluent charge system should emphasize regional differences, including the assimilative capacity of the water course.

2. Tax incentives

Other economic incentives which have been introduced in some developing countries are tax concessions or low-interest loans for the construction of treatment facilities. In the Philippines, for example, one half of the tariff

duties and compensating tax on imported pollution control equipment is to be waived for five years from the effective date of the Environment Code (June 1977). Similar rebates are available for domestically-produced equipment. Moreover, tax deductions are available for research aimed at improving pollution control technology (36). In other countries, industrial promotion boards offer tax incentives to new industries to locate away from urban concentrations or permit industries to amortize or write off investment in treatment facilities in a short term (accelerated depreciation).

Although such measures may be beneficial for developing countries, many economists consider them subsidies which should be avoided. They argue that such "subsidies" are mainly for treatment equipment and do not encourage alterations in production processes, recovery of materials, utilization of by-products or changes in raw materials. In developing countries, however, promotional measures could be applied to new industries utilizing "clean" production processes and recovery methods. The developing countries have an advantage in that many of the industries have not yet been established, whereas in developed countries, old industries using obsolete processes must be induced to change. Subsidies may be an important means to bring about pollution abatement in countries which have only recently become serious about water quality improvement.

C. POLLUTION CONTROL STANDARDS

The method that many countries, particularly the United States, have used to carry out their programmes in water pollution control is direct regulation. Under the direct regulatory approach, the appropriate level of government sets maximum allowable limits on discharges for particular pollutants or industries, and establishes the administrative and judicial means used to enforce these standards. In the United States and the United Kingdom, this approach has yielded important gains in the struggle against environmental harm. The growth of environmental pollution and environmentally-harmful activities has slowed and in some cases has reversed (2).

1. Stream and effluent standards

Two types of standards are typically involved in water pollution control regulations. First, ambient or stream standards are the legal specifications of the minimum conditions which must be met for a given indicator of water quality at a specified location along the stream. For example, a stream standard may require that dissolved oxygen, averaged over a 24-hour period at a selected river mile point, must not fall below 4 parts per million (ppm) more than one day per year. Second, effluent standards are those which specify the mean or maximum permissible discharge of a pollutant, such as SS or BOD, from one particular source. Effluent standards are requirements (either by weight of materials or concentrations) set on the quality characteristics of actual discharges, while stream standards refer to the quality requirements for the receiving watercourse (2).

Stream and effluent standards coexist in control programmes today and must be viewed as potential complements in a rational programme of management. In a situation where there are numerous waste dischargers, achieving a stream standard through several independent decisions will be impossible. Therefore, a central agency must provide information and incentives which will produce co-ordinated behaviour. Effluent standards will be meaningful only in the context of water quality goals or standards in the water course (20). Sometimes a combined approach of stream and effluent standards may be used by setting individual effluent standards which reflect the size and location of the discharge relative to the waste assimilative capacity of the river stretch.

When setting water-quality standards in developing countries, factors such as technological feasibility and cost must be considered as well as the possible effects of pollutants on human health or aquatic organisms. Such standards should minimize all the known environmental and health hazards and should be regularly reviewed in light of new knowledge. Since water quality must be considered in relation to the intended use of water, there is no unique set of standards for streams, lakes or ground water, and the problem cannot be solved in a general way (34). Standards on water intended for drinking will generally be higher than those for most industrial uses.

Water quality standards are usually issued on the national level based on the water quality goals of the country. International stream and effluent standards are only applicable where a common water resource is shared by two or more countries such as the great lakes or large river systems. The Lake Chad Basin Committee has drafted a regional convention on uniform water quality standards which is to be legally binding on member states. A very detailed description of water quality parameters and sampling techniques for different types of water bodies, which is extremely useful for developing countries, can be found in the UNESCO/WHO manual, entitled Water Quality Surveys, 1978 (34).

The major disadvantage to a system of regulatory standards alone is that it does not provide an incentive to the sources of pollution to treat their wastes or alter their production processes. Enforcement is generally carried out by random checks on factory effluents by government agencies followed by fines or warnings to those industries not complying with regulations. The delinquent industry may prefer to delay compliance with standards and to engage the government in long legal battles. The charge on effluents, on the other hand, provides an immediate incentive for the industry to reduce its waste discharges.

Furthermore, the administrative and enforcement expenses needed to make the system function effectively are enormous. In practice the political and economic costs of a fully effective programme of direct regulation are simply too high for most governments to bear (2).

2. Mixed systems: charges and standards

Effluent charges may be used in conjunction with effluent standards in mixed systems, which demonstrate that the two instruments are not mutually exclusive. These systems may be viewed as either regulatory programmes in which charges play an enforcement role or as bona fide charge systems in which specified discharge levels have been exempted from the charge.

The German Democratic Republic and Hungary have enacted water pollution control programmes which combine charges and standards. Both levy charges on

all discharges in excess of fixed effluent standards. Charges in Hungary are based on costs of attaining the discharge standards, taking into account the condition of the receiving water and other factors. Revenue from the German Democratic Republic charge is directed at abatement, environmental improvement measures and compensation to some pollution victims. The Hungarian system seems to rely solely on discharge sampling by the government for its monitoring data. The charges in Hungary initially had little effect but, after they were raised, there was an upsurge in the installation of treatment systems (2).

Starting in 1978 Malaysia attached broad standards for palm oil effluents onto licenses which were to be issued to all existing and proposed palm oil mills. The guidelines were to serve as interim effluent standards to be met by all mills until more specific standards were developed for each one. Effluent fees are to be charged on BOD concentrations above a certain level. Standards for rubber, tapioca and other industrial effluents have also been proposed, based on temperature of effluent, pH and metal concentrations (36).

3. Other forms of government control

Licenses or permits are other important forms of direct government control which may be used in conjunction with effluent standards or charges. Licenses are an essential tool for prevention of environmental damages; in Malaysia guidelines on effluent standards are annexed to the license. In other countries, a permit may be given only to a plant using a process which is relatively safe to the environment or which discharges less than a set amount of harmful substances.

Effluent permits may be preferable to charges in certain situations, such as when waste dischargers have historically had a right to discharge material into a river and there is no desire to take this right away from them. The permit would allow an industry to discharge a specified amount. If the main goal is to improve the quality of a stream quickly, then it might be wiser to begin by granting effluent permits rather than to impose charges. Effluent permits could be granted to industries for a given period, say five years. After that, charges could gradually be introduced (35).

Finally, where adverse external effects are too large, neither standards nor permits would be sufficient to restrain polluters. Prohibitions would then be the only instrument available to the government to eliminate the hazardous waste.

D. ENVIRONMENTAL IMPACT ASSESSMENT

Many developing countries have already become aware of the necessity for predicting the impact a new development or industry will have on the environment before it is implemented. Such a prediction is called an environmental impact assessment and is often required by governments from investors in the form of an environmental impact statement. The concept of environmental impact assessment has been adopted by several Asian countries. The Philippines has a strongly worded statute, modelled on the United States National Environmental Policy Act, requiring the submission of environmental impact statements in connexion with all major project proposals. Recent legislative provisions in Malaysia and Thailand furnish an ample legislative basis for requiring similar information. Several other nations, including India, Indonesia, Pakistan, Singapore and Sri Lanka, state that even in the absence of statutory legislation, they conduct such an analysis as a policy matter (37).

The legislation in the Philippines empowers the National Environmental Protection Council (NEPC) to require environmental impact statements from all projects likely to have an effect on the ecological and environmental balance. Guidelines for the implementation of environmental impact statements were formulated by the NEPC, and provision was made for Philippine officials to receive training in environmental impact assessment techniques.

Environmental impact assessments have not yet been widely introduced in Latin America and Africa. The importance of such analyses will become more apparent as national and international funding agencies require consideration of environmental impact as a condition to loans or grants for development projects.

One international forum (5) suggested that the pattern for evaluation of the environmental impact of a foreign investment project in a developing country could be adopted as follows : (1) natural resource linkage; (2) processes in the plant; (3) site assimilative capacity; (4) waste management; (5) operation and

control; (6) health aspects; (7) social aspects; (8) ultimate disposal of wastes. The examination of potential foreign investment must be intensified by recipient countries, international financing institutions, multinational corporations and donor countries, to make sure obsolete and dirty processes are not being introduced to developing countries. The more a firm is required to make an advance disclosure of its project and environmental control plans, the more likely it will consider in advance the potential environmental impact objections that might be raised later.

Many developing countries have gained good experience in preparing environmental impact statements through submitting project proposals to development assistance agencies. Although environmental considerations may increase the total cost of a project, developing countries are increasingly required to prepare impact statements in support of projects for which external financing is sought. Such statement greatly reduce the environmental uncertainty and minimize unforeseen consequences.

Environmental impact statements are required by the World Bank as part of any project appraisal (42). As early as 1971 leading officials of the World Bank were alerted to the environmental repercussions of projects financed by that institution. The appropriate organizational changes were instituted with a view to helping the developing countries avoid some of the adverse environmental consequences of industrial development. The general feeling was that the costs of prevention were far smaller than the costs of environmental reparation later on - if then it would be possible at all (42). Other international development assistance agencies in 1980 declared their intention of requiring appropriate environmental measures in the design and implementation of economic development activities (32).

International development assistance agencies have thus provided a framework within which developing countries can learn to prepare and require of others environmental impact statements prior to the implementation of projects. The international agencies, including the United Nations, should be able to provide training in the preparation of such statements. Developing countries would benefit in the long run if new industries were required to reveal their potential impact. Such a requirement should encourage them to begin with cleaner processes.

E. MONITORING

Any system of charges, standards or impact assessment presupposes the existence of a system for monitoring changes in effluent or stream conditions periodically or continuously. Monitoring and information-gathering are essential elements in any pollution-control system and should be given priority by governments of developing countries.

Obviously, there is no single measure of water pollution. Whether a substance discharged into a waterway "pollutes" it depends on a number of factors, including the way in which the waterway is used, the location of the discharge and the time of day or year. Keeping those factors in mind, parameters must be selected to measure pollution, based on harmfulness to human health, among others. Under an effluent charge system, it is also necessary to identify the party responsible for payment of the charge. Finally, an acceptably accurate and reliable means of measuring the selected parameters over time must be chosen (2).

In developing countries although many government agencies may have some experience with monitoring of limited scope, few have developed comprehensive monitoring systems. Many African countries do not have a clearly defined water quality control programme, and have not yet established monitoring systems. A few, like Zambia, do have a systematic monitoring programme to control effluents from factories, mining, textiles and canning industries. Zambian factories are required to pre-treat their wastes. Despite the monitoring system, however, Zambia does not have sufficient resources to maintain the required levels of pollution control (10).

Many other developing countries monitor pollution only in their major rivers, without regard to actual discharges of individual factories. Even in the most scientifically advanced Latin American states, comprehensive water quality monitoring systems have not yet been established. The methods and equipment required to identify the presence and level of certain pollutants are considered too expensive and sophisticated. Only a few research centres, often limited to one in each country, have the capability to perform the complicated analyses needed to identify the level and presence of specific residuals. In most cases, residuals are first noted when an effect has already been produced, such as the death of fish or vegetation (37).

Efficient management of wastes and water quality requires adequate systems of data acquisition and a scientific understanding of the assimilative capacity of receiving waters. The development of such an information base is one of the first steps to be taken in the effort to control water pollution by developing countries.

Conclusion

Many of the developing countries still retain an advantage over developed countries in environmental terms since their use of highly pollutive and non-biodegradable substances has not yet reached unmanageable proportions. With the new treatment technology available, they may be able to avoid the worst pollution and move into cleaner processing methods. As the developing countries become more aware of the dangers posed to their environments by the discharge into rivers and streams of dangerous industrial wastes, they can incorporate preventive measures into their planning processes. Such measures include requiring environmental impact statements for any new projects and the setting of water quality and effluent standards to which existing factories should comply. The planning of water supplies for urban and industrial purposes must be accompanied by consideration of requirements for disposal of liquid wastes from human, industrial and other sources. Monitoring of effluents discharged by factories and fines for polluting industries will be essential for enforcement.

If the developing countries were to meet the targets of industrial growth envisaged in the Lima Declaration and Plan of Action on Industrial Development and Co-operation, first formulated in 1975, their share of global manufacturing output would reach 25 per cent by the year 2000. That would mean a substantial increase in industrial water requirements for developing countries over the next two decades. Their ability to meet the challenge will depend on planning for efficient use of water by industry, anticipating adverse effects on the environment before they occur and taking immediate steps to establish standards and monitoring systems to ensure water quality.

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