ECONOMIC INCENTIVES FOR A RATIONAL WATER USE IN INDUSTRY

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SUMMARY

The different aspects related with the application of economic incentives to industrial water uses are analysed, mainly from a pragmatic point of view. Economic incentives are compared with other instruments for a rational industrial water use. The main features of abstraction charges and pollution charges are described, based on actual examples of economic incentive systems that are in use in France, The Netherlands, Federal Republic of Germany and Czechoslovakia.

Legal, financial and administrative aspects of the implementation of economic incentives are described and public and users participation in this implementation is also analysed.

The effectiveness of abstraction and pollution charges as economic incentives is questioned and the factors that condition this effectiveness are referred to.

Taking in consideration the different aspects referred to, it can be concluded that abstraction charges and pollution charges may be effective as economic incentives for a rational water use, particularly as regards industrial water use. The experience of application of abstraction and pollution charges in some countries that have adopted them shows that this effectiveness depends largely on the actual values of the charges and on the existence of a water management framework that is able to correctly implement the charges policies in their legal, financial and administrative aspects and to ensure an adequate participation of the public and of the industrial water users.

RÉSUMÉ

Les différents aspects de l'application d'instruments d'incitation en ce qui concerne l'usage de l'eau dans l'industrie sont analysés, surtout du point de vue pragmatique, en faisant la comparaison avec d'autres instruments pour rationaliser l'usage de l'eau.

On décrit les principales caracteristiques des redevances de prélèvement d'eau et de pollution prenant pour base des exemples réels de systèmes d'incitations économiques employés en France, dans les Pays Bas, République Fédérale d'Allemagne et Tchécoslovaquie.

On décrit les aspects légaux, financiers et administratifs de l'application des instruments d'incitation, et on analyse la participation du public et des usagers dans ce procédé.

L'efficacité des redevances de prélèvement et de pollution en tant qu'incitations économiques est analisée et les facteurs qui conditionnent cette efficacité sont mentionnés.

Tenant compte des différents aspects mentionnés on peut conclure que les redevances de prélèvement et de pollution peuvent être efficaces pour stimuler l'usage rationnel de l'eau, en particuler en ce qui concerne l'utilisation de l'eau dans l'industrie.

L'expérience d'application des redevances dans les pays où elles ont été adoptées montre que leur efficacité dépend largement de la valeur de ces redevances et le l'existence d'un système institutionnel d'administration de l'eau capable de promouvoir la politique d'application de redevances dans leur aspect légal, financier et administratif et d'assurer la participation effective du public et des usagers industriels de l'eau dans cette politique.

RESUMEN

Los diferentes aspectos de la aplicacion de medidas de estimulo en lo que se refiere a la utilizacion de água en la industria son analizados, sobretodo de un punto de vista pragmatico, haciendose la comparacion con otros instrumentos para racionalizar la utilizacion de la água.

Se describen las principales caracteristicas de las tasas de toma de água y de poluicion tomando como base ejemplos reales de sistemas de estimulos economicos empleados en Francia, en los Paises Bajos, en la Republica Federal de Alemania y en Checoeslovaquia.

Se describen los aspectos legales, financieros y administrativos de la aplicacion de instrumentos de estimulo y se analiza la participation del publico y de los utilizadores en este proceso.

La eficacia de las tasas de toma y de poluicion en su calidad de estimulos economicos es analizada y los factores que condicionan esta eficacia son referidos.

Teniendo en cuenta los diferentes aspectos mencionados se puede concluir que las tasas de toma y de poluicion pueden ser eficaces para estimular la utilizacion racional de la água, en particular en lo que se refiere a la utilizacion de água en la industria.

La experiencia da aplicacion de tasas en los paises en que han sido adoptadas pone en evidencia que su eficacia depende fuertemente del valor de dichas tasas y de la existencia de un sistema institucional de administracion de la água capaz de promover la politica de aplicacion de tasas en su aspecto legal, financiero y administrativo y de garantizar la participacion efectiva del publico y de los utilizadores industriales de la água en esta politica.

1. INTRODUCTION

Economic incentives have been adopted by an increasing number of countries as an instrument for application of environment policies. Economic incentives usually concern different kinds of environmental problems related to water, air and soil, including water withdrawal and pollution, air pollution, solid wastes, land use, traffic congestion, noise and energy conservation.

As regards water, economic incentives concern the different water uses in the framework of natural water management policies.

The purpose of this paper is to analyse the different aspects related with the application of economic incentives to industrial water uses. The presentation will be focused mainly on the pragmatic aspects, leaving out the theoretical fundaments of economic incentives that have been the object of considerable attention. (e.g. KNEESE and BOWER 1968, KNEESE and SCHULTZE 1975, OCDE 1975 and BAUMOL and OATES 1979).

The most common type of economic incentives that are presently applied in relation with industrial water use are charges applied to water withdrawal, currently called abstraction charges, and charges for waste water discharge, currently called pollution charges. These charges are based on the payment, by the user, of an amount that is proportional to the quantity of water withdrawn or pollution discharged. The reason why charges act as economic incentives is very simple: the obligation to pay for harm caused to other water users or to the environment provides an incentive to reduce this harm. Therefore, if a charge is to act as an economic incentive it must have values that are high enough to effectively condition the user.

Ideally, the purpose of economic incentives is to ensure that the different polluters are made to withdraw water or to treat waste water in measures that benefit the overall interests of the community, ensuring the interiorization of external costs caused by water withdrawal and, chiefly, by water pollution. In practice it is not possible to attain this ideal aim completely and one is led to be somewhat less ambitious. Thus, for instance, as regards pollution charges, some countries established as the goal of the application of charges the respect for certain water quality standards of receiving water bodies. In other cases the charges fixed are aimed at creating an income for financing the control of residual pollution. Charges may also contribute to make up a fund to pay damages to the entities affected by pollution. These different aims are frequently combined in some of the charge systems put into practice.

Such actions as government loans at low interests or the reduction or exemption of taxes for the installation of treatment systems are sometimes also considered as economic incentives to the control of industrial pollution. However, these actions are not in fact true economic incentives, because although they stimulate investment in pollution control equipment, they do not correspond to efficient forms of reducing pollution. After all they are merely grants awarded to the polluting entities or to the consumers of the goods produced by these entities. Besides, this type of grants, which are awarded in many countries, are usually only given to finance treatment units, which are also no means to encourage economic efficiency, since it is often preferable to spend additional amounts in changing the production process or in recuperating by-products than in the improvement of systems.

In what concerns pollution control some countries have adopted direct regulation systems instead of pollution charge systems. These are based on the setting of standards defining the maximum limits for pollution load in the effluents. These systems may be called regulatory systems and together with the economic incentive systems above referred to they may be considered as economic instruments for favouring a water management policy.

It is generally assumed that charges are more cost effective than standards, costs being therefore smaller for the community. Actually it would in principle be possible to reach the same degree of efficacy with standards as with charges but only at the cost of extremely high administrative expenses which would have to be supported by the community. The system of charges is also more easy to implement than the standards since with the charge system the polluter has every advantage in installing his pollution control system quickly so as to stop paying the charge. This is not so with the standards, for in this case the polluter will benefit from trying to drag the discussion about the best system to be installed.

Disregard for a standard must be punished with a <u>fine</u> the amount of which must be on the basis of the degree of infringement. The fine is usually proportional to the pollution load discharged in excess of the value laid down by the standard.

A combination of both charges and standards is often resorted to. This is for instance the case with problems such as the control of toxic substances, which must be governed by strict standards. Also the maximum pollution levels are sometimes limited by standards and then charges only apply to lesser pollutions.

Attention should also be called to the difference between pollution charges and the fees for sewage collecting, usually called <u>user fees</u>.

The charges are intended for changing the behaviour of the users and to control water pollution and at the same time to provide some compensations for inconvenience that cannot be avoided. They are calculated on the basis of social costs, of the marginal benefits they provide or of the marginal costs of treatment.

User fees are usually considered as the price to be paid for a public service or for the use of resources. They are calculated on the basis of the services rendered with pollution control.

The differences, in conceptual terms, between charges and fees are important. The object of the charges is to reduce pollution, while the object of the fees is reimbursement for services rendered. Revenue is the principal object of fees and only a secondary object of charges.

Abstraction and pollution charges, as other environment related charges should be both effective and equitable.

<u>Efectiveness</u> presumes that the charge systems are simple and clear for being easily understood and applied, and provide an incentive that in fact induces water users to change their behaviour in order to approach the economic and social objects of the water management policy, and also provide the funds necessary for the implementation of this policy.

<u>Equity</u> presumes that the charge systems are fair, give equal treatment to equal situations and are socially acceptable.

The interest taken in economic incentives for industrial water use has not finished to grow both in developing countries that are establishing for the first time their water management systems, and in developed countries that are shifting from standard systems to charge systems. The interest in these problems shown by international organizations such as the United Nations (UN 1976, UN 1977, UN 1979, UN 1980) or the organization for Economic Co-operation and Development (OCDE 1974, OECD 1975, OECD 1976, OECD 1977, OECD 1980a, OECD 1980b) has also been considerable.

2. ABSTRACTION CHARGES

Abstraction charges consist in a payment per unit volume of water withdrawn. In some systems of charges it is accepted that the user may receive a bonus per unit volume of water returned.

The unit charge may be constant, i.e. independent of the volume of water withdrawn, or else increase or decrease with the intensity of water use. If it increases we have progressive charging schemes that in principle are more effective as an economic incentive for saving water. If the value of unit charges decreases with the consumption we have regressive charging schemes that may be recommended only in special cases when water is not scarce and consumption must be encouraged in order to achieve economies of scale.

The abstraction charges are only used in certain countries, licensing systems without involving payment for water consumption being more widely used. Abstraction charges are even less frequent for ground water than for surface water.

The simplest and most traditional form of conditioning water abstraction is through water property regulations. However, when water is scarce these regulations either following the riparian rights doctrine or the appropriative rights doctrine have proved to be inefficient as automatic instruments for a rational use of water. It is to respond to this inefficiency that abstraction charges have been introduced.

The criteria adopted in some Basin Agencies in France to estimate abstraction charges is a good reference criteria for this purpose.

In the Loire-Bretagne River Basin Agency[1] the charges for withdrawal of surface waters are determined according to the formula.

$$T = T_g - B$$

with

$$T_g = T_f \text{ for } V < V_o$$

$$T_g = T_f + (V - V_o)\, t \text{ for } V > V_o$$

$$V = \sum_i (V_i\, t_{B_i})\, C_r$$

in which: T - yearly net charge (francs); T_g - yearly gross charge (francs); B - - yearly bonus for recirculation of water withdrawn (francs); T_f - fixed charge corresponding to withdrawal volumes $V < V_o$ (francs); V - total volume withdrawn (m^3); t - unit charge (francs /m^3); V_i - volumes of water withdrawn in the i consumption class (m^3); t_{Bi} - bonus unit charge corresponding to the i class (francs/m^3); C_r - coefficient of recirculation given by the ratio between volume recirculated and volume withdrawn.

The unit charges t and t_{Bi} may have different values according to the region and time of the year. In some months t or t_{Bi} may be zero, which means that the abstraction charges are not applied in these months but only in the part of the year in which water is more scarce.

The volume V_o establishes the value below which there is a fixed charge independent of the amount withdrawn. If V_o is null the abstraction charge is always

(1) - See CUNHA et al. 1977 (Appendix 9)

variable with the amount withdrawn.

The coefficient C_r may have different values according to the type of water use. For industrial water use values of C_r are as follows: without recirculation $C_r = 0$; with recirculation by spreading $C_r = 0.3$; with direct recirculation $C_r = 0.993$.

The values of unit charges <u>t</u> and <u>tBi</u> are periodically updated, the rationale for establishing their values being the optimization of water users or simply the reimbursement of the costs of making water available to users. In this last case the abstraction charge is usually called a <u>user charge</u>.

These criteria of estimating abstraction charges are only applied in France for surface water. In the case of groundwater use there is no bonus for recirculation, the charge being calculated only by the first term of the above presented equation.

Payment of charges per volume unit of water withdrawn, and the possible institution of a bonus per volume unit of water returned, calls for measurement of the quantities of water withdrawn and returned. Though such measurement does not, in principle, raise special problems, it may be accepted that in the case of some small consumers the volume of water should not be measured but fixed on the basis, for example, of the maximum withdrawal capacity, the industrial output of the consumer, or the number of workers of the industrial plant.

The actual values of the abstraction charges vary very much from country to country. Based on a comparative study of seven river basins in different contries OECD 1980b give values of surface water abstraction charges between 2.5 and 0.08 US$[1] per thousand m^3 per year respectively in Seine-Normandy (France) and Severn-Trent (United Kingdom) river basins, with intermediate values found in basins studied in Australia, Japan and the USA.

3. POLLUTION CHARGES

The systems of charges so far applied in practice have two distinct aims:

a) to induce polluters to reduce the pollution loads discharged, down to levels that are low enough to allow to meet the legally established quality standards of the water of the receiving water bodies.

b) To raise funds that make it possible to finance actions of water pollution control at regional and local levels.

The system of charges adopted in Czechoslovakia, which will be mentioned later on in this section, is a typical example of situation a). A good example of situation b) is the system of charges which has long been used in the Ruhr, in the Federal Republic of Germany. The systems that have been used for some years in France and in the Netherlands, and which have also been adopted by the Federal Republic of Germany in 1981, are an attempt to fulfil both a) and b). These systems are also briefly described later.

Pollution charges must be paid per unit of pollution load discharged, and must, in principle, be established according to the nature of type of pollutant. In the case of industrial users the range of pollutant substances to be considered is very wide, and in order to simplify the charge systems, it may be of interest to define sets of representative pollution parameters or criteria allowing the conversion of the pollution caused, into terms of an equivalent pollution, expressed for example in population-equivalents.

(1) The conversion of currency is made acording to the rates of change in May 1981

Examples of these two different procedures are given by the systems of pollution charges adopted respectively in France and in the Netherlands, which are presented later on in this paper.

The parameters taken as a basis for establishing pollution charges are usually selected from the biochemical oxygen demand (BOD), the chemical oxygen demand (COD), Nitrogen, suspended matter, salinity, temperature and toxicity.

In principle the charge must be established on the basis of the damage caused by the pollutant activity, but assessment of such damage may be hampered in many cases, due not only to the complex analysis of a system in which there may be various pollutant and various polluted users, but also due to the difficulty in establishing criteria for an objective definition of the damage.

One current assumption is to consider that there is a linear variation of the charge with the pollution load, which corresponds to accepting a linear relationship as well between the pollution load and the damage to third parties. This assumption of linearity is accepted as an advantageous and sufficiently accurate simplification, provided that the three following conditions simultaneously occur:

- damage is proportional to the concentration of pollutant matter in the water;
- pollutions caused by various pollutants are cumulative;
- there is not advantage in using treatment procedures that simultaneously treat pollutant matter of different origins.

Should any of these conditions be missing, the particular circumstances of each must be examined, in order to establish a suitable criterion for establishing charges. If, for example, the first condition is lacking, it is necessary to define the nonlinear concentration-damage relationship for each pollutant element and each injured user. If, moreover, the pollutions caused by the various pollutants are not cumulative, the definition referred to above must be made for various combinations of pollutants.

In these cases it is impossible to provide users with very precise information as regards the variation in charges in terms of the streamflow. Provisional charges must be established on the basis of a certain number of initial assumptions, and adjustments progressively made.

Any significant changes in the streamflow of the receiving watercourses may have great influence on the damage caused by effluent discharge. Not only do pollution load concentrations increase when the flow is low, but also the self-purification capacity per unit discharge of the watercourse generally tends do diminish. In fact, low-flow periods often coincide with periods of high temperatures that reduce the saturation level of dissolved oxygen in the water.

Waste water discharge is therefore more harmful in periods of low streamflow and consequently unit values of pollution charges must be correspondingly higher. This increase in the unit value of the pollution charge, in order to act as an optimizing factor, must aim at reducing the effluent discharge by offering an incentive to interrupt or limit the industrial activity, or temporarily to raise the degree of treatment or store the waste. Obviously solutions of this kind can only be considered if they involve costs which are lower than the savings in charges that are not being paid and some of them would only be feasible if the low-flow period is not too long.

This system of charges that increase as the streamflow decreases is, actually, an incentive to use the natural self-purification potential of the watercourse when its values are higher.

A system of charges varying with the streamflow naturally requires knowledge of streamflow variations. This requirement means that the monitoring system, which would be needed in any case, must be extended to the streamflow of the receiving with watercourse. There is thus the risk of having to set up a control system that is economically unjustifiable.

Pollution charges must be set according to the characteristics of the effluent, and it may be accepted that the charge shall depend only on the quantity of the effluent or also on its nature.

Charges based only on effluent quantity, for example in terms of volume discharged, do not seem adequate since the pollution load concentration is more significant than the volume of waste. In order to reduce the charge due, a user might concentrate the waste, thus reducing the volume but maintaining the quantity of pollution load discharged.

The system in which charges are a function of the quantity and the nature of the pollution load discharged seems the most rational. This system calls for measurement of volumes discharged and monitoring of the water quality parameters that are considered most important. Usually, in order to simplify the inspection procedure, the observations are made as simple as possible, as referred to in section 4.

To illustrate the application of systems of charges three examples of pollution charges adopted in France, the Netherlands and Czechoslovakia are presented below. These systems of pollution charges only concern surface water and they do not apply to groundwater pollution.

a) France (Loire-Bretagne)[1]

The gross pollution charge is based on the pollution load of the effluent, and this can be arrived at by direct measurement of the pollution load discharged into the receiving waters and/or public sewers, or else fixed on a lump sum basis.

In the case of direct measurement, the pollution load relates to one day of normal effluent discharge during the course of the month of greatest discharges, and is defined by the amounts of suspended solids M_s (kg), of oxidizable matter M_o (kg) and, of inhibiting matter M_i (kg equitox). Both the oxidizable matter and inhibiting matter are determined after separation of solids settleable in two hours.

The amount of oxidizable matter is determined by the formula:

$$M_o = \frac{M_{COD} + 2\, M_{BOD5}}{3}$$

in which M_{COD} and M_{BOD5} are the oxidizable material corresponding to the chemical oxygen demand (kg) and to biochemical oxygen demand in 5 days at 20°C (kg).

In the case of the pollution load being fixed on a lump sum basis, use is made of tables relating such loads to characteristic parameters (number of workers, amount of raw materials consumed or of products manufactured, etc.).

The pollution loads determined by direct measurement or fixed on a lump sum basis are multiplied by the corresponding yearly unit charges and also by a coefficient of zone with which an attempt is made to take into consideration, for the various discharge points, the particular conditions of the receiving waters.

(1) See CUNHA et al. (Appendix 10)

If the effluents are treated and the treatment facilities meet certain standard requirements of design and operation, the gross pollution charge can be reduced by aplication of suitable coefficients of bonus.

The yearly net pollution charge is given by

$$T = T_g - B$$

with

$$T_g = (M_s t_s + M_o t_o)\, C_{z_1} + M_i t_i\, C_{z_2}$$

$$B = m_s t_s C_{b_s} + m_o t_o C_{b_o} + m_i t_i C_{b_i}$$

in which: T - yearly net pollution charge (francs); T_g - yearly gross pollution charge (francs); B - yearly bonus (francs); M_s, M_o, M_i - quanties of suspended solids, oxidizable and inhibiting matter, calculated by direct measurement or defined on a lump sum basis; m_o, m_o, m_i - quanties of suspended solids and, oxidizable and inhibiting matter entering the treatment facilities (kg); t_s, t_o, t_i - yearly unit charges, for suspended solids, oxidizable and inhibiting matter (francs/year); C_{bs}, C_{bo}, C_{bi} - coefficients of bonus for suspended solids, oxidizable and inhibiting matter; C_{z1}, C_{z2} - coefficients of inhibiting matter

b) The Netherlands[1]

The estimation of pollution charges is based on the determination of the pollution load expressed by the number of population-equivalents.

The number of population-equivalents P_e corresponding to raw sewage is given by the formula

$$P_e = \frac{(COD + 4.57N)\,Q}{180} + A$$

In this case of biologically treated wastewater, the pollution load is given by the formula

$$P_e = \frac{(2.5\ BOD_5 + 4.57N)\,Q}{180}$$

COD is the chemical oxygen demand (mg/l), BOD_5 the biochemical oxygen demand (mg/l), N the Nitrogen, A the weight of toxic substances discharged and Q the waste water discharge (m^3/day).

In the case of small industries with a population-equivalent lower than 1000 and without wastewater treatment systems, where it is not economical to carry out measurements, the incidence basis of the charge, in population equivalents, may be calculated by the formula.

$$P_e = c\ n_1$$

in which c is a coefficient and n_1 may be, according to the type of industry, one of the following values: number of workers; number of units produced yearly; annual volume of water consumed; number of livestock.

The coefficients are established for use by industries that operate during

(1) - See CUNHA 1977 (Appendix 14) and GEUZE and VAN DE WETERING 1980

the whole year (250 working days), and their reduction is envisaged for seasonal industries. If a firm covers different sectors of activity, the basis of overall incidence is calculated by adding the bases of partial incidence.

c) Czechoslovakia(1)

Under Czechoslovakian legislation, the charges payable for effluents are divided into two parts: the basic charge and the surcharge.

The basic charge is calculated on the basis of the treatment costs of the discharged waste, by means of formulae of the type shown below, relating to biochemical oxygen demand (BOD) and suspended solids (SS):

$$T = tM$$

where T is the basic charge relating to BOD or SS (crowns/year); t the unit charge relating to BOD or SS (crowns/t); and M the quantity of BOD or SS in the effluent (t/year);

The unit charge for each of the two parameters referred to is determined by two processes, according to whether there exist or not preliminary technical-economic studies, or treatment plant designs that make it possible to calculate the yearly operation costs of the plants for eliminating the biochemical oxygen demand and suspended solids. In the first case, the unit charge is obtained by dividing, respectively, the yearly operation expenses by the yearly quantities of eliminated biochemical oxygen demand and suspended solids. In the second case, the unit charges are obtained by the formulae:

$$t_{BOD} = 5 - \log X$$

$$t_{SS} = 2.75 - 0.25 \log Y$$

where X is the yearly quantity of BOD discharged yearly into the watercourse (t) and Y is the yearly quantity of SS discharged yearly into the watercourse (t);

The surcharge is calculated, in percentage of the basic charge, by the formula

$$S = \frac{D}{U_d}$$

where S - is the surcharge relating to BOD or SS in percentage of the basic charges D the degree of deterioration caused in a watercourse by the discharge of wastewater (mg/l) and Ud the basic unit of deterioration (mg/l).

Calculation of the degree of deterioration is done by considering the quantity of pollutant discharged (BOD or SS) and the streamflow of the watercourse which in an average year is guaranteed for 355 days. By dividing the quantity of pollutant matter by this flow the degree of deterioration (BOD or SS) is obtained.

The basic unit of deterioration is 0.25 mg/l for BOD and 0.50 mg/l for SS, values which represent, respectively, fractions of the difference of standards between the quality characteristics of the waters of two consecutive categories in the water classification in force.

Besides these three examples of pollution charges systems that have been applied for a number of years, the new system applied since January 1981 in the Federal Republic of Germany, deserve a reference. In this country pollution charges

(1) See CUNHA et al. 1971 (Appendix 16)

were not implemented before on a national basis, but only in the Ruhr region.

In this system the charges levied depend on the harmfulness of the effluent, one unit of harmfulness being equivalent to approximately the pollution load of untreated water produced by one person in one year. The harmfulness is calculated on the basis of the volume of waste water, suspended solids, oxydisable substances and toxicity.

The law on which the charge system recently implemented in the Federal Republic of Germany is based was passed in 1976 to give dischargers enough time to build adequate waste water treatment works. The law includes a clause, which has caused some controversy, that establishes that the charges will be reduced by 50 % if legal minimum standards for the waste water discharges are met.

In the European Economic Community some thought has been given to the study of the introduction throughout the community of a system of pollution charges, that so far have been the object of expert group discussions without any submission of proposals to the Council.

For establishing the pollution charges the pollution load must be determined, measurement being the most efficient method. This, however raises problems and leads to costs that are not always justifiable, especially in the case of users with a relatively low pollution potential. In such cases it is best do fix the pollution loads on the basis of parameters such as the discharge of water withdrawn, the number of units produced or the number of workers employed.

Broadly speaking, the system should make it possible to determine with sufficient accuracy the volumes of water withdrawn and effectively consumed and the pollution loads discharged, but it must be simple enough not to make it too costly.

In principle the charges are a function of space and time, i.e. they may vary from one river basin to another or even within the same river basin, and may evolve in time. Variability of charges in space is justified by the fact that it is necessary in the optimization processes to take into account the variations in the economic value of water from region to region and the characteristics required of the water in every watercourse, according to the quality goals set by law for watercourses. Variation of charges in time is due to the fact that the economic value of the water grows as the water becomes scarcer, a rise in the cost of water use being thus justified regardless of any inflationary trends.

In practise, for easy application of the system, there should be charging schemes that are not too diversified, and revision of the charge values should be carried out yearly or at least every two years.

A forecast should be made of the evolution of charges over a period of five or ten years, in order to give consumers an idea of the amount of the expenditure for which, in principle, they must budget. However, it should be noted that although charges may increase over the years with the increase in the use of water, the overall amounts received by the river basin agencies may not increase, since the increasing value of the charges will, after a certain time, lead to a reduction in the volumes of water withdrawn and of pollution loads discharged.

The variation of charges in space is usually based on the establishment of constant values for each water management region as is the case in the Netherlands. However, in cases where the regions are comparatively large the charges may vary within each region in order to project certain parts of the water management region, as happens in certain Basin Agencies in France.

The values of pollution charges vary widely from one region to the other and also with time.

In the Netherlands for instance the maximum, minimum and average values were about 25 and 17 US$(1) per population equivalent in 1980. In France in the same year the corresponding values of the charges were 2.2, 1.2 and 1.7 US$ per population equivalent.

This shows a large disproportion between the values of the charges in the two countries, which may suggest that the values adopted in France are too low to act effectively as economic incentives.

The evolution of average values of pollution charges with time in recent years is shown for the two countries in the following table (also in US$(1)).

	The Netherlands		France	
	charge	rate of growth	charge	rate of growth
1977	12.9		1.22	
1978	13.0	8 %	1.45	18 %
1979	15.1	17 %	1.60	10 %
1980	17.2	14 %	1.68	5 %

This shows that in spite of the fact that the values of the charges are much lower in France than in the Netherlands the rate of growth is also smaller in France and shows a definite trend to decrease.

The values of the table above correspond to current prices. A comparison based on constant prices, taking into account inflation would of course show a much smaller growth in both cases.

4. IMPLEMENTATION OF ECONOMIC INCENTIVES

The implementation of systems of economic incentives involves some important problems of legal, financial and administrative nature. Adequate public and user participation is also a condition for the success of the implementation. The purpose of this section is to present some comments related to these aspects.

a) Legal aspects of the implementation of economic incentives

The legal definition of the concepts of abstraction and pollution charges is one essential aspect of the implementation of economic incentives related with water resources management.

Sometimes abstraction and pollution charges are assimilated to taxes. However, they are quite distinct legal instruments. In fact, taxes are mainly expected to collect a revenue to support governmental activities, whereas charges are expected to stimulate an optimal use of water and/or to finance water supply and water pollution control.

The differences between charge systems and regulatory systems based on pollution standards, whose disregard is punished with fines, has already been pointed out.

There is sometimes a tendency to consider charges and fines as instruments

(1) See note on page 6.

with similar effects, both comparable to criminal penalties intended to punish in fractions of a given law. However, this idea is not true. Charges are by no means criminal penalties whereas fines are. As said by ANDERSON et al. 1977 "the behaviours for which charges are carried are not evil in itself, as for example, are robbery and homicide"; the conduct "charged" is socially desirable and the conduct "penalized" is not, since in fact the application of charges may imply considerable social benefits, which is not the case with fines.

There are also differences in the application of charges and fines. Whereas fines are applied on an individual basis, case by case, and only attain a small number of transgressors, charges are applicable as a routine, to all water users.

The assessment of the value of the charges is usually done inside the water management framework and eventually approved by the government, this being usually preceeded by the hearing of legislative or advisory councils that are part of the water management framework at regional level.

In the implementation of the charging schemes that have recently been established a conciliatory attitude has prevailed over very rigid or technocratic positions. Enquiries, consultations and public hearings should be considered in order to smooth out possible difficulties in the application of the law, which should be applied wisely and only in the case of consistently serious infringements.

b) Financial aspects of the implementation of economic incentives

As previously referred to, one of the aims of pollution charges is to raise funds for financing water supply and pollution control activities.

This financing can be made through different types of measures such as payment for construction of collective works by the water management authorities, compensation to polluters, grants to regional or local authorities, and support of research and development programs or education and training programs.

The construction of collective works such as treatment plants that jointly handle the waste of various polluters, reservoirs for regulating the discharge of the watercourses receiving the effluents, reservoirs for storing the effluents of several polluters or works for watercourse aeration will obviously redound in benefit for the water users.

Compensations to polluters may be due to those that are not expected to be able to support entirely the cost of pollution charges. In view of the adoption of different pollution charges for different regions, equity may not be ensured to all polluters and this may be corrected by compensations.

The attribution of grants to regional or local authorities is intended to help to support the expenses related with water supply or waste water discharge systems that are of the responsibility of these authorities. These grants may be in the form of subsidies, loans or advances.

Finally, an indirect type of financing is achieved through the support by the governments to research and development problems or to education and training programs in the area of pollution control, whose results are expected to benefit the polluters at medium or long term.

In some cases subsidies may be granted to encourage industries to develop new industrial processes and new systems of pollution control. Without this the users would prefer to invest in well proved technologies and not in new or non-traditional technologies. Special subsidies for testing new technologies should be available, these subsidies being only reimbursable if the new technology proves to be efficient. The results of these subsidized experiences should always be publicized, whether the new technology proves efficient or not.

c) Administrative aspects of the implementation of economic incentives

The authorities responsible for enforcing abstraction and pollution charges are usually placed at the national, regional and local levels.

At the national level are usually defined the general principles for the implementation of charge systems and some regulatory instruments. At regional level (with regions ideally based on river basins), the charges are defined and applied for the whole region, in order to ensure an integrated regional water management policy. At the local level there may be some regulations established by the municipalities, within the framework of the legislation established at the regional level.

For a smooth operation of the whole system an effective coordination between the three levels is essential. In particular the establishment of charges and the distribution of aid is often carried out in cooperation between the central and regional authorities.

An adequate system of monitoring of water consumption and pollution is very important for the implementation of economic incentives. In fact, as previously mentioned the application of both systems of abstraction charges and pollution charges entails the measurement of the rates of flow of water withdrawn or waste water discharged. In the case of pollution charges it is also necessary to measure the concentration of some pollutants or the level of some pollution parameters.

Flow measurements are unexpensive and easily made. It is also easy to apply proportional sampling techniques that make it possible to collect a composite sample representative of the average characteristics of the effluents. The determination of the concentration of pollutants and of the level of pollution parameters is far more difficult.

The Biochemical Oxygen Demand (BOD) is the most frequently used measure of the reduction of oxygen caused by most pollutants discharged in water courses. The BOD is a parameter difficult to measure and not suited for continuous monitoring, because its determination implies the observation of the reduction of dissolved oxygen in a sample of pollution after five days under controlled conditions in the laboratory.

To avoid these difficulties it is possible to do continuous monitoring of the Total Organic Carbon (TOC) and Chemical Oxygen Demand (COD) parameters, that are related to BOD. However, continuous measurements of TOC and COD are also expensive.

The amount of suspended solids (SS) is another important parameter to be measured when establishing charges. The standard procedure for the determination of SS is also carried out in laboratory but it does involve a delay as the BOD. For continuous monitoring of SS it is possible to measure the turbidity of water using comparatively unexpensive techniques, but the correlation of this parameter with SS is not always very accurate.

Other parameters of water pollution can also be the object of monitoring, some of them easily-like temperature and salinity (by measuring conductance)-, others--like several inorganic and organic compounds-through more difficult and expensive procedures including automatic laboratory analysis based on special techniques such as colorimetric and spectographic techniques.

The effectiveness of any charge system is definitely conditioned by the accuracy of the measurements of the pollution loads discharged.

The direct measurement of these loads by the agency in charge of water management would be extremely expensive and consequently impracticable. The solution usually adopted is to ensure that the polluters measure and report their discharges, and the agency only intervenes by means of surprise inspections. The agency should also specify the methods used for monitoring and approve the performance of the equipment installed.

The above solution is however adopted only in the case of major polluters. As was previously mentioned in the case of minor polluters it is currently admitted that pollution charges are proportional to the volume of water withdrawn, the number of employees or the volume of industrial output.

d) Public and users participation in the implementation of economic incentives

Up to a short time ago, decisions regarding the problems of water resources were taken chiefly by the public administration based on the judgement of its Technical Staff. Participation of the public in the decisions, when there was any, would only take place at an advanced stage of the procedure, after the fundamental decisions had all been taken. The only possibility left to citizens when they disagreed with a water resources project was to try and prevent it from being implemented. Frequent conflicts were thus created whose solution was in certain countries left to the courts.

This procedure has been very much criticized lately because of the delays it causes and consequent inconvenience. Therefore, as water resources problems are getting more serious and citizens are becoming more aware of these problems, there is a tendency to give the public a chance to intervene in the decision-making process, from the beginning.

The public participation in the decisions concerning water resources problems, particularly as regards economic incentives, entails actions to ensure that this participation is carried out in a way that ensures the effective protection of public interest.

Education institutions may have a very active part in public education process. As regards the actions to be carried out for senior citizens, public education may be achieved along several lines. The distribution of written information or the presentation of adio-visual information spread directly through official channels, different kinds of associations, or the press, are among the more passive actions.

As regards education techniques of a more active kind we may quote those in which the population actually takes part in the decisions taken in connection with specific cases, by means of meetings, public discussions, committees with the participation of the public, etc.

The most direct type of participation as regards the establishing of charges consists in discussing the standards and criteria related to charges between the authorities and the users.

Other possible solutions consist in discussions, in meetings of representatives of water management authorities, users, citizens, regional bodies, and local interests affected by water use or pollution. Public hearings are also possible as wider forms of public participation.

A few instances of public participation referred to in OCDE 1980b are:

" - required formation and use of advisory committees to make inputs in the water quality management planning process;
- required publication and dissemination of water quality management plans for comment and discussion at public hearings;
- required publication (notice) of applications for permits to abstract or discharge, with specified time period for comments and objections;
- required publication of discharge standards for various industrial and other types of dischargers with specified time period for comments;
- permission for private individuals or groups to file court suits with respect to discharge standards, behaviour of specific dischargers, individual permits".

5. EFFECTIVENESS OF ABSTRACTION AND POLLUTION CHARGES AS ECONOMIC INCENTIVES

Abstraction and pollution charges will only be effective as economic incentives if their value is high enough.

The value of the charges must reflect not only the coast of pollution control measures but also the harm to other water users and to the environment. This involves some difficulties as it is often not easy or even possible to evaluate harm to the environment. As a consequence, the consideration of this harm tends to be neglected when establishing the charges, which may, for this reason, be fixed at too low values.

When establishing the charges the consideration of the harm to other water users, (quantified by external costs) has a consequence, allocation effects that consist in the modification in production and consumption patterns as a response to the modified price structure. The consideration of the harm to the environment creates regulatory effects that correspond to a reduction of certain types of pollution as a consequence of the modification of production and consumption patterns.

WERNER 1980 reasoning on the effects and implications of economic incentives in the countries of the Economic Commission for Europe (ECE) states:

" - In the economic field, among others, such effects can be stated, e.g.: economic returns and benefit of investments for water distribution, supply and treatment; development of valuable cost-benefit procedures and standard systems of calculation; higher production results per unit of water; use of more efficient technologies in industry and agriculture with higher profit and in this connexion lesser water demand and costs; a better function of the interaction between the state of the pollution of water resources and their rational use; better and more comprehensive management in water resources.

- In the social field such important problems are influenced as, for example, the state of pollution of water resources and their use for human consumption; growth of unemployment caused by dificulties for certain industries which use too much water; a rise in the level of prices by added costs resulting from the control of pollution.

- The application of economic incentives and instruments involved in the ECE countries have facilitated higher efficiency of capital investments in water management. Thanks to this application, it has become possible to compare the alternatives, to distribute investments between the consumer involved, to establish discounting norms, etc. That means also, the right application of economic incentives and instruments in time and space gives the opportunity to influence industrial technological processes under special consideration of rational utilization of water resources".

It is often claimed that the application of economic incentives may create difficulties to some industries which depend very much on the water use, and contribute to the growth of inflation by raising the level of prices. As previously referred to in some cases compensations or aids are used to solve these problems, in an attempt to ensure equity among the different users. These aids are of particular importance during transition periods in the first years after abstraction or pollution charges have been established.

In each country the effectiveness of charges as economic incentives should be periodically analysed through an adequate statistical analysis of the pertinent economic, social and environmental data, the results of this analysis influencing essentially the policy of charges to be implemented in the future.

One interesting aspect which conditions the effectiveness of application of economic incentives are the individual and collective reactions to the implementation of these incentives. These reactions may come mainly from the industry and the public agencies involved with water management.

The opposition of affected industries to the introduction of economic incentives is well known. The rationale for this opposition is that the industry will be better off without the introduction of such incentives.

As ANDERSON et al. 1977 refer "under a charge system, a firm is almost certain to have to pay the charge, or spend money to abate in order to reduce its charge payments. Under direct regulation, however, an industry might conclude that because the enforcement mechanism is so cumbersome and ineffective, it either will not have to pay for the most expensive kinds of abatement techniques, or will be able to gain the monetary advantages of years of delay past the official deadlines. Thus, all other factors being equal, the firm, in rational self-interest, would prefer the present system to an effective charge system".

The reaction from public agencies comes from the fact that public administration usually tends to react to inovation. This reaction has been very strong in several countries that have adopted charge systems to replace standard systems. ANDERSON et al. 1977 also explains this situation, stating that "agency personnel are used to working with standards enforced by direct regulation, while effluent charges are a new and uncertain program. The agency people usually have had a difficult time achieving whatever they have accomplished and are understandably reluctant to start the process over again under different ground rules. They think that a charge system will require more stringent monitoring procedures than are now in use, and doubt their feasibilty. Even when examining the monitoring procedures that might be used under different charge proposals, they tend to search for ways to "play the regulatory game" - to seek accommodations that would keep the regulated firms pacified and thus make life easier for the agency".

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