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Effluent Trading to Improve Water Quality: What do we Know Today?

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ABSTRACT

Watershed based trading or effluent trading, allows pollution sources to buy controls that will reduce the amount of a problem pollutant elsewhere in the watershed or drainage basin. By buying such controls, factories do not need to install abatement technologies to lower the discharge of that pollutant for their own plants. Parties involved in the trade want to either: (a) trade directly with each other; or (b) create a market of 'credits' that represent a specific amount of pollutant reduction. The intent of trading is to achieve an expected reduction of a particular pollutant at a lower cost. The challenge with trading is to allow for innovative, market-based reforms without compromising the existing safeguards in environmental protection. In this paper we provide an overview of the benefits and considerations associated with designing an effluent trading program. We end by formulating some policy recommendations.

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Emissiehandel per stroomgebied of afvalwaterhandel, laat vervuilers toe om rechten te kopen die de hoeveelheid vervuiling in een ander deel van het stroomgebied zullen verminderen. Door het kopen van dergelijke rechten, moeten bedrijven geen of minder investeringen doen om hun eigen emissies van de vervuilende stof te verlagen. De partijen die bij de handel betrokken zijn, willen ofwel (a) direct met elkaar handel drijven; ofwel (b) een markt van 'credits' creëren die een bepaalde vermindering van de hoeveelheid vervuilende stof vooropstelt. Het doel van verhandelbare rechten is om aan lagere kosten de verwachte daling van een bepaalde schadelijke stof te bereiken. De uitdaging die met een dergelijke handel gepaard gaat, is om innovatieve, marktgeoriënteerde hervormingen door te voeren zonder de bestaande waarborgen in het milieubeleid te compromitteren. Dit artikel maakt een overzicht van de voor- en nadelen die samengaan met een programma om afvalwater te verhandelen en eindigt met enkele beleidsaanbevelingen.

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I. INTRODUCTION

As a response to growing ecological concerns, the need for an appropriate environmental policy arose. The two most prevalent approaches in environmental policy today are the command-and-control approach, which advocates direct government regulation of all activities affecting the environment and the market-based approach, which relies on government guidance to shape environmental policy but on market-based incentives to implement it.

Our current environmental laws depend overwhelmingly on top-down bureaucratic mandates to prevent pollution. Command-and-control regulations have one major advantage: more flexibility in regulating complex environmental processes. This implies much greater certainty on how much reduction in pollution will actually result from green policies. Another advantage of this approach is the ease with which compliance can be monitored. However, there are widely recognised problems with a top-down, command-and-control approach to environmental issues. Firstly, the information costs are high, which causes command-and-control regulation to be slow moving and very susceptible to errors. Secondly, this approach provides weak incentives for innovation. The motivation to find better ways to control pollution is clearly reduced. A third, and probably the biggest, disadvantage of command-and-control is the difficulty in satisfying the equimarginal principle (explained in section II). It is almost impossible to ensure that the marginal abatement costs are equalised among the different polluters. A final problem is that the polluter only pays for pollution control and not for the residual damage caused by the legally allowed emissions (Kolstad (2000)).

Dissatisfaction with command-and-control regulation has led many to look for more creative, market-based solutions to environmental problems. Market-based incentives can be one of three basic types: fees, marketable permits and liability (Kolstad (2000)). Emission fees or taxes imply the payment of a charge per unit of pollution emitted. It then becomes in the polluter's interest to reduce emissions. A marketable permit allows polluters to buy and sell the right to pollute. This trading induces a price or value on a permit to pollute, thus causing firms to see polluting as an expensive activity. Thirdly, liability is based on the idea that the person who causes harm, will have to compensate the injured party for the damage. The government does not tell firms what to do, just that they will be held responsible for any consequences of their actions. In this paper we focus on tradable permit systems.

The market-based approach relies on incentives to change behaviour. Regulators set the overall price or quantity of pollution, but individuals and businesses determine how best, and most efficiently, to abate emissions. As a consequence, a market-based approach tends to be more flexible and less adversarial. It also encourages innovation and the development of least-cost technologies. Market-based schemes also have the distinct advantage of making pollution-control costs more visible so that an informed public debate about costs and benefits is possible. Moreover, economic incentives make the polluter pay for control costs as well as pollution damage.

We now turn to discussing tradable permit systems related to water. Three fundamentally different fields of application can be identified. Firstly, tradable permits for water, or tradable water abstraction rights, can be used for quantitative water resource management. Secondly, tradable discharge rights, or tradable water pollution rights, can be use to protect and manage (surface) water quality. Thirdly, there are tradable permits to use or consume water-borne resources, such as fish or the potential energy of water (Kraemer and Banholzer (1999)). In this overview we concentrate on the second case; i.e. the use of tradable water pollution rights.

Watershed based trading or effluent trading, allows a pollution source to buy controls or permits that will reduce the amount of a problem pollutant elsewhere in the watershed or drainage basin. By buying such controls, the factory does not need to install abatement technologies to lower the discharge of that pollutant for its own plant. Parties involved in the trade want to either: (a) trade directly with each other; or (b) create a market of 'credits' that represent a specific amount of pollutant reduction, as is currently done with trading air emission reductions. The intent of trading is to achieve an expected reduction of a particular pollutant at a lower cost. The challenge with trading is to allow for innovative, market-based reforms without compromising the existing safeguards in environmental protection (National Wildlife Federation (1999)).

It is important to distinguish between two types of pollution sources: point and nonpoint sources. Point sources discharge from a defined route, such as a pipe. Nonpoint source, on the contrary, have diffuse discharges that enter a river or lake as runoff from a wide geographic area. Examples of this last category include runoff from agricultural fields, roads and parking lots.

In section II we discuss the basic economic theory concerning tradable permit systems. In section III we turn to water trading systems. We distinguish different advantages as well as disadvantages of water effluent trading. The major elements to consider while developing such a system are also highlighted. In the fourth section, we describe existing effluent trading projects. Next, in section V, we provide some specific recommendations for Belgium. Finally, we conclude with some general guidelines.

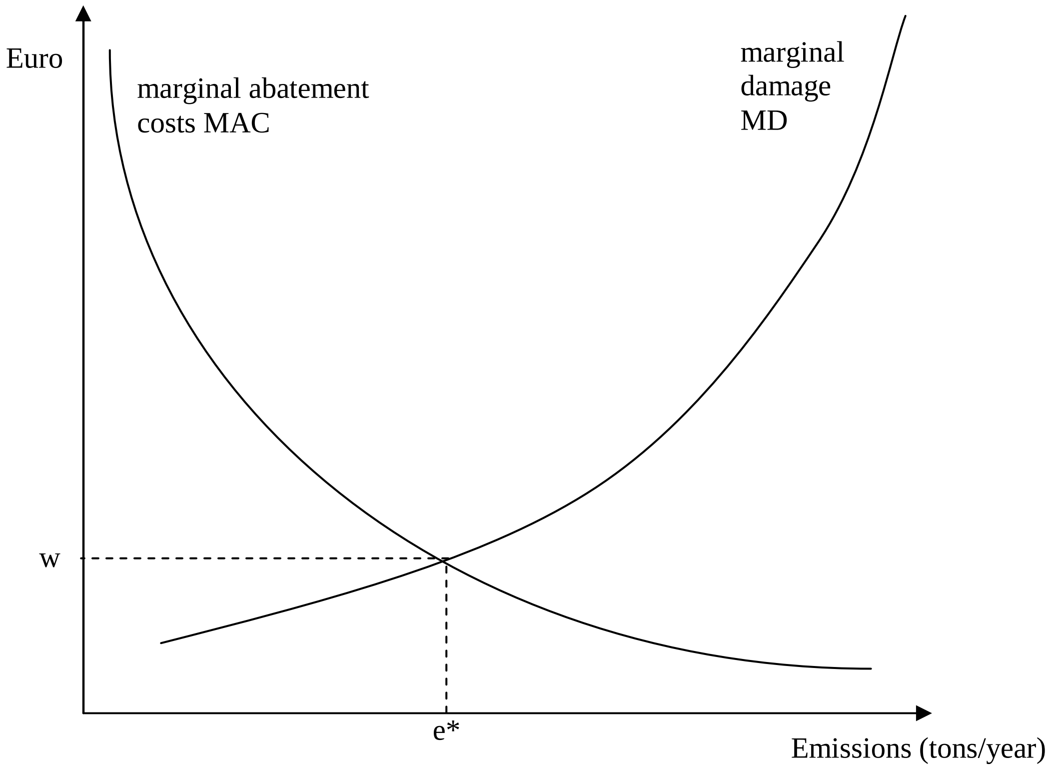
II. BASIC ECONOMIC THEORY

We begin by defining what is meant by an optimal allocation of a resource and by describing the principles that can be used to design economic incentive policies that fulfil the optimality conditions.

What is meant by the optimal allocation of a resource depends on how a 'policy target' is defined. Several possible targets have been considered in the literature. Traditionally, instruments were designed to obtain economic efficiency. In partial equilibrium terms, an economically efficient allocation maximises the net benefits to society. Ignoring corner solutions, efficiency is obtained when the marginal benefit of the last unit used equals the marginal cost of its provision.

The efficient level of effluent in the economy is thus the level where the costs stemming from environmental damages exactly offset the resources devoted to abatement activities. That is the point where marginal damages (*MD)* and marginal abatement costs (*MAC)* are equal to each other. This is overall efficiency. In figure 1 the efficient emission level is *e**. The marginal damages and marginal abatement costs equal the value *w* at his level of emissions. Since abatement is costly, firms do not voluntarily reduce emissions to the efficient level. Therefore, the government needs to develop environmental regulation. Using tradable permits, it is clear from figure 1 that the efficient solution can be obtained by setting the total amount of permits issued equal to *e**.

FIGURE 1



As Tietenberg (2000) points out defining optimality in terms of efficiency imposes a heavy informational burden on those who model and implement regulation. Not only does an efficiency target make it necessary to track the physical relationships underlying the use of the resource; it also requires monetary valuation of the consequences (both human and nonhuman). Each of these steps is subject to data limitations and uncertainties. Moreover, the efficiency criterion is not universally accepted as an appropriate criterion outside the discipline of economics. Other possible criteria are distributional or ethical concerns.

To respond to both the informational and moral concerns with an efficiency approach, the tradable permit approach starts from a sustainability perspective (this refers to an outcome in which the resource itself is preserved). A tradable permit program begins by defining a sustainable target. This target may or may not be efficient, but it does provide a good opportunity to achieve sustainable outcomes.

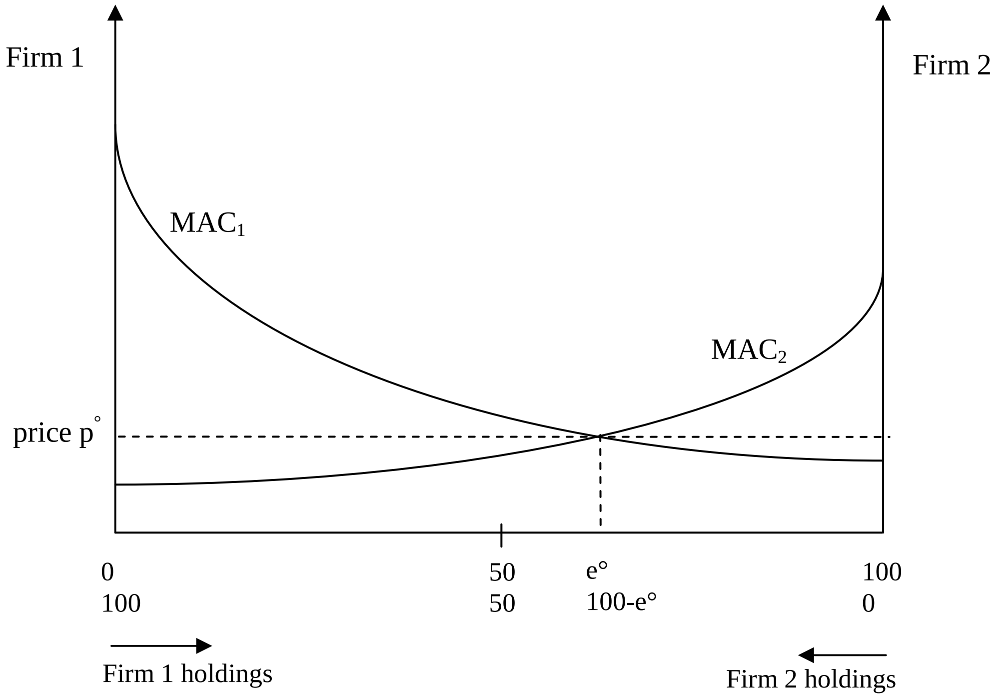
Baumol and Oates (1988) state that one of the principal theorems of environmental economics demonstrates that under specific conditions an appropriately defined tradable permit system can maximise the value received from the resource, given the sustainability constraint. In a perfectly competitive market permits will flow toward their highest valued use. Those that would receive a lower value from using the permits (due to higher costs, for example), have an incentive to trade them to someone who would value them more. The trade benefits both parties.

A rather remarkable corollary (Montgomery (1972)) holds that this theorem is true regardless of how the permits are initially allocated among competing claimants. It is true regardless of whether permits are auctioned off or allocated for free. It implies that with tradable permits the regulator can use the initial allocation to obtain other goals (such as political feasibility) without sacrificing cost effectiveness.

Previously, we determined the efficient level of emissions for the economy as a whole. However, the effort to abate emissions will be divided among the different polluters. For tradable permits, this is illustrated in figure 2 for a situation with two polluters. Assume that we are interested in allowing 100 units of pollution in total. Initially the permits are allocated equally among the firms (50-50). Both firms have a different abatement function. Firm 2 can abate emissions at a lesser cost than firm 1. This opens up possibilities for trade. Trade will occur until the marginal abatement costs are equal *(equimarginal principle or cost efficiency)*. In equilibrium firm 1 holds $e°$ and firm 2 holds $100\text{-}e°$ permits. The equilibrium price of a permit is $p°$.

It is important to note that an emission fee of $p°$ would achieve exactly the same outcome. However, suppose there is some uncertainty. With a tradable permit system, we would know exactly the resulting pollution but we would be less sure of the marginal cost of control. For an emission fee, the opposite holds.

FIGURE 2
Equilibrium after permit trading



Source: Kolstad (2000)

It is also noteworthy that command-and-control regulation in general does not satisfy this equimarginal principle. In our example, we have that by limiting emissions to, for example, 50 units, the marginal abatement costs for the two firms will diverge (see Figure 2). The same emissions total (100 units) will, therefore, be achieved at a higher cost through an emission standard than through a tradable permit system.

III. WATER TRADING PROGRAM

First we consider the benefits associated with permit trading. Next we look at some disadvantages and preconditions that need to be fulfilled in order for the tradable permit system to maximise its full potential. Finally, several, potentially problematic, considerations associated with effluent trading are looked at more closely.

A. *Benefits of trading*

Benefits of trading over more conventional approaches, such as command-and-control, include:

(a) costs savings,
(b) incentives to reduce pollution beyond current limits,
(c) incentives for technological innovation,
(d) an emphasis on water quality rather than the installation of a particular abatement technology, and
(e) the possibility for independent groups to participate.

With market-based instruments there will be cost savings associated, since it always pays a firm to clean up a bit if a sufficiently low-cost method of doing so can be identified and adopted (Stavins (2000); Milliman and Prince (1989) and Jaffe and Stavins (1995)). The main reason underlying these cost savings is the equimarginal principle. Instruments, such as marketable permits, that equalise marginal abatement costs across different polluters will always involve lower costs than instruments that do not. Faeth (2000) performs an empirical study calculating the cost effectiveness of programs including nutrient trading. His findings confirm that trading is a cost-saving instrument.

However, in reality cost savings are smaller than predicted by theory. Atkinson and Tietenberg (1991) discuss one possible explanation. They claim that the actual trading process is sequential and bilateral and, hence, differs considerably from the implicit process modelled in the existing empirical studies. Simulations of this more realistic trading process suggest that the resulting equilibria deviate considerably form cost-effective allocations of the control responsibility.

A tradable permit system encourages firms to innovate and reduce pollution beyond current limits. Tradable permits give firms an incentive to invest in abatement because, once the tradable permit system is installed, they can sell permits and gain some revenue. As Gersbach and Glazer (1999) indicate this can solve the regulatory hold-up problem. A time-consistent equilibrium exists with all firms investing and the government imposing regulations, even if no permits are traded and their market price is low.

With tradable permits the emphasis is on water quality rather than the installation of a particular abatement technology. This implies that, even under uncertainty, the regulator is sure to reach the environmental objective. However, he cannot be as sure about the cost of achieving this goal. The permit price is determined by the market and cannot be set directly by the government.

Finally, a tradable permit system also allows independent groups to participate. The regulator has the option to distribute permits to environmental interest groups, neighbours or city councils. It is also possible to allow these groups to buy permits at the market thus influencing the equilibrium permit price.

B. *Preconditions and disadvantages*

Tradable permit systems may not maximise the value of the resource if market conditions are not right. Unfavourable market conditions are the possibility of market power, the presence of high transaction costs (McCann (1996)) and insufficient monitoring and enforcement. Another important precondition involves the absence of large uninternalised externalities. They would imply that maximizing net benefits of permit holders would not necessarily lead to maximal net benefits for society as a whole. The regulation could serve to protect one environmental resource at the expense of another (Tietenberg (2000)). For example, if limiting waterborne pollutants implies a large increase of solid waste, the environmental gain from emission trading could be more than offset by the ecological damage caused by the disposal of the solid waste.

Other conditions include, among others, the availability of several control technologies or methods and the identification of more than one source discharging the problem pollutant in the same watershed (NWF (1999)).

Further, it is important to notice that pollution regulation is complicated by the physical environment that interposes itself between polluters and consumers. The polluter generates emissions that are transformed to ambient concentrations of pollution. Emissions do not cause damage; but ambient concentrations do. Ambient concentrations are, for example, the concentrations of pollution in river water. However, ambient concentrations are imperfectly connected to emissions and emissions are what firms emit and what needs to be regulated. It is possible to develop a system of tradable ambient permits. An ambient pollution permit for a receptor j gives the holder the right to emit at any location, provided the incremental pollution at receptor j does not exceed the permitted amount (Kolstad (2000)). This system implies, for a situation with two firms, that marginal abatement costs, normalised by the transfer coefficient, should equal the permit price. The transfer coefficient between the source i and the receptor j is defined as the ratio of the change in pollution at j to the change in emissions at i (Kolstad (2000)). However, this concept is only really useful when the relationship between emissions and pollution is linear.

Remember that water pollution in a river basin is a directional pollution problem. We need to take spatial effects into account. Consequently, discharges further upstream have more impact on the river's water quality than discharges further downstream. Ideally, a tradable water pollution scheme should take this into account and discount the value of the permits in function of the location of the pollution source. However, this would make the system administratively more complicated. On the other hand, this would provide the assurance that trading would not cause adverse environmental impacts, such as the creation of 'hot spots' or highly degraded localised areas in the stream or lake.

Finally, it is important to mention that water pollution is stochastic. For example, non-point pollutants, such as agricultural nitrate emissions, have proved difficult to control (Kampas and White (2000)). This is due to the diffuse source of the pollutant and the complexity of its transportation pathways through the hydrological system. Moreover, the variability in rainfall means that daily emissions of nitrate in water percolating through the soil into groundwater is highly variable. The inherent stochastic nature of the levels and composition of environmental discharges makes it difficult for the firms to assess their compliance with regulations. This has also important implications for the way environmental quality objectives are defined. The regulator can use average or median quality standards or even minimal quality standards that should never be violated. A policy that targets average emissions is liable to give pollution concentrations in excess of the standard on a number of days. A more realistic option is to specify policy in terms of the probability of the standard being exceeded. Even if this is not stated formally in the legislation, the inspection agency often uses such rules-of-thumb to determine whether the firm was really in violation or not.

C. *Considerations*

1. Governance structures

The academic community has emphasized the importance of co-management of environmental resources with users playing a substantial role. In reality, however, users seem to have only a limited influence and representation in existing water trading programs (Tietenberg (2000)).

Traditional means of informing the public – through public notice, hearings, and opportunity for appeal – forces the public to respond to an already fully developed proposal. This makes it more difficult to understand the assumptions underlying the proposal and to influence the specifics (NWF (1999)).

2. Baseline

We can distinguish two categories of tradable permit programs: credit programs and cap-and-trade programs (Tietenberg (2000)).

The credit program involves a relative baseline based on traditional technologies. There is an individual access baseline defined for each user. Every user who does not reach its limit can have the difference certified as a tradable credit. A specific problem with this system is that dischargers may attempt to get credit for improvements that are already legally required to be in place in past legislation.

The cap-and-trade program involves an absolute baseline and trades allowances rather than credits. A total resource access limit is defined and then allocated among different users. The cap is defined a as the maximum amount of the pollutant that the water body can safely absorb while still meeting federal and regional water quality standards. The limits should have a large enough margin of safety to ensure that, once implemented, water quality standards will be achieved (NWF (1999)).

In the United States, states are developing 'total maximum daily loads' (TMDL) for polluted rivers within the framework of the Clean Water Act (CWA-section 303(d)). The development of these TMDL can take up to 12 years for the selected water bodies (NWF (1999)).

3. Legal nature of the entitlement

Although the popular literature frequently refers to the tradable permit approach as 'privatising the resource', in most cases it does not actually do so. One reason why in the US tradable permits do not do so, is because that could be found to violate the well established 'public trust doctrine'. This common law doctrine suggests that certain resources belong to the public and that the government holds them in trust for the public; they cannot be given away (Tietenberg (2000)).

In McCann (1996) we read that *'under most environmental regulatory regimes, ownership of the tradable permit generally is not a true* property *right, it is a* license *or* permit *right that does not have the same legal protection by the courts from being redefined or even revoked by the government'*.

The compromise used in reality between well-established ownership rights and flexible permits seems to work well even tough the legal foundations are rather weak.

4. Adaptive management

One of the initial fears about tradable permit systems is that they would be excessively rigid. Policy rigidity could prevent the system from responding either to changes in the resource base or to better information. Moreover, this rigidity could seriously undermine the resilience of biological systems (Tietenberg, 2000).

Several options to limit this rigidity can be considered. The lifespan of the permits can be fixed in advance by the regulator (see 3.2.8 Temporal dimension). Another possibility is that the permits may be revoked under certain predefined circumstances by the government.

5. Initial allocation method

Four possible methods for distributing the initial permits are:

- Random access (lotteries)
- First come, first served
- Administrative rules (e.g. grandfathering)
- Auctions

Both lotteries and auctions are frequently used in allocating hunting permits for big game. First come, first served was the traditional approach to water abstraction when water was less scarce. The most common method, however, for water pollution rights is allocating the rights based upon historic use. Reasons are twofold: firstly, it enhances the likelihood of adoption and secondly, it allocates permits to those who have made investments in resource extraction.

Grandfathering permits – i.e. distributing permits for free – has its disadvantages although it is politically the easiest path to sell to those subject to the environmental regulation. Firstly, in the presence of distortionary taxes, there will be no recycling effect (Goulder et al. (1999)). Revenue collected through regulation can be used to increase cost-effectiveness greatly by lessening existing distortions. Secondly, the system is very disadvantageous for new firms since they have to pay for all the necessary permits. Existing firms get a comparative advantage over potential entrants. Thirdly, since grandfathering creates rents for incumbent firms, firms will behave strategically in anticipation of a change in environmental regulation from standard setting to grandfathered tradable permits (Laplante et al. (1996)). Brandt (2003) found empirical evidence for this effect for the Mid-Atlantic surf clam fishery prior to the installation of tradable property rights.

Advantages of the free initial distribution of permits are – as mentioned before – the political feasibility and the observation that *‘the only departures with tradable permits from the direct regulation strategy would be voluntary ones, which would presumably improve the financial lot of both buyer and seller’* (Eheart et al. (1983)).

6. Trading rules

Many considerations need to be made in order to define trading rules. First one has to decide which pollutants are eligible to be traded. Combined with this the regulator has to decide about the units of trade and whether a minimum traded quantity is necessary to allow trading. Important is whether to trade emissions or damages. As Weber (2001) writes: *‘permit systems defined in terms of emissions generally are not efficient since they do not capture the spatial characteristics of damages from firms’*. However, informational demands of pollution rights defined in terms of damages are high. Incremental damages must be measured at each site. One possible policy option is a tradable ambient pollution right system (see section III.B).

Next one has to ask which parties are eligible traders. Who can generate credits and who can buy them? Is it anyone who discharges covered pollutants who can trade? Can third parties enter the market? One selection criterion can be the compliance records of the traders. Having a good record of compliance in meeting the terms of permits, including effluent permits, previously in force, can serve to assure the public that the proposed trade will not compromise water quality.

The size of the trading area also needs to be taken into account. Is it possible to trade between different watersheds? The problem with trading between watersheds is that abatement in one watershed will generally not affect water quality in another basin. Water quality will not improve in the watershed of the seller and it will therefore be difficult to find support for the trade in local communities. It is, therefore, not advisable to design one tradable permit program for both Maas and Schelde in Belgium. Closely related to this subject is the question of directionality. Must buyers always be downstream to the source that reduces its pollutants? If the buyer of the permits is situated upstream to the seller, there will be greater water quality benefits since a larger stretch of the river will be cleaner.

7. Transferability rules

Transferability not only serves to assure that rights flow to their highest valued use, but also provide a user-financed form of compensation for those who voluntarily decide to use the resource no longer.

Problems can arise if permits are concentrated in the hands of only a few users. Most tradable permit systems now include protections against ‘unreasonable’ concentration of quota. It is also possible to directly restrict transfers that seem to violate the public interest. This rule would also avoid the formation of ‘hot spots’, local concentrations of the pollutant exceeding water quality standards. This implies that we have to warn against using tradable permits to solve, for example, a typical Belgian pollution problem: the water pollution caused by Tessenderlo Chemie in the Laak/Winterbeek/Demer. There is basically only one big polluter in the Demer subbasin and the trading market would not work efficiently.

A second concern relates to the potentially adverse economic impacts of permit transfers on some communities. One common response to this problem is allocating quota directly to communities.

A third concern with transferability relates to possible external effects of the transfer. While in theory transfers increase net benefits by allowing permits to flow to their highest valued use, in practice that is not necessarily so if the transfers confer external benefits or costs to third parties.

Finally, for trading programs that include a nonpoint source as partner, there will be uncertainty surrounding the degree of effectiveness of the abatement practices. It is after all difficult to measure the success of emission reduction at non-point sources since

(a) the pollution is of a diffuse nature;
(b) performance is a function of weather conditions, soil type and permeability, slope and land-use practices;
(c) the watershed may be growing and
(d) contaminated sediments can re-circulate in the water if they are disturbed by storm or flooding (NWF (1999)).

We recall the problem of stochastic pollution, already discussed in section III.B.

8. Temporal dimension

Emission banking and borrowing allows firms to move emissions between time periods as well as between sources. The term ‘banking’ means saving emissions in one period for use in later periods and ‘borrowing’ means using more emissions than current standards allow in one period and paying back those emissions in the future (Kling and Rubin (1997)).

Few systems have included these banking and borrowing possibilities for several reasons. First there is the possibility of temporal clustering of emissions. A second concern, when imposing sanctions for non-compliance is difficult, is that borrowing is very hard to enforce over time (Tietenberg (2000)). Kling and Rubin (1997) show that allowing firms to freely bank and borrow emissions does not necessary lead to a socially optimal solution. In many cases firms will suboptimally choose excessive damage and output levels in early periods and correspondingly too few in later periods. The authors suggest a modified banking system to solve this problem. This modified system does not allow one-to-one trades of emissions between time periods but instead it penalises emissions borrowed against future savings by the discount rate. Thus forcing firms to pay back more emissions than they used.

Another temporal issue is the duration of the permits. Permits can be issued with finite duration or in perpetuity, though either type may be made contingent upon review and renewal by the authority (Eheart et al. (1983)). Permits with a short duration, would allow the regulator more flexibility in adapting the program to new information concerning abatement technologies or water quality. Long-term permits, however, would allow dischargers to plan capital investments with less uncertainty and might allow improved cost efficiency in water management.

Laffont and Tirole ((1996a), (1996b)) warn about the negative impact of stand-alone spot markets for tradable permits on the environmental pollution investment and innovation. Spot markets induce excessive investment and they enable government to expropriate an innovation by offering a competing ‘technology’ (pollution permits) that puts an arbitrary downward pressure on the licensing price. The introduction of a futures market reduces the incentive to invest but is not the optimal way to control pollution. A menu of options on pollution rights yields higher welfare. Moreover, options to pollution at a given striking price create private incentives to phase out pollution in the case of innovation.

9. Monitoring

Regardless of how well any tradable permit system is designed, non-compliance can prevent the attainment of its social, economic and environmental objectives. An empirical study of nutrient trading programs by Faeth (2000) stresses the importance of monitoring to be able to assess the environmental performance of policy. With the current levels of funding for monitoring, the US will never be able to adequately assess the effectiveness of environmental investments and make appropriate adjustments with confidence.

Every monitoring system must identify both the information needed to monitor the operation of the tradable permit program and the management component that will gather, interpret and act on this information. Data should also be collected on transfers so that monitoring and analysis of the market can take place. Effective monitoring systems are composed of data, data management and verification components (Tietenberg (2000)).

Implementation of a tradable permit program requires two kinds of monitoring data. First, periodic data on the condition of the environmental resource are needed to evaluate the effectiveness of the program. Second, managers need sufficient data to monitor compliance with the regulatory system. Monitoring compliance with the program, moreover, requires data on the identity of the permit holders, amount of permits owned by each owner and permit transfers.

Key to the success of the tradable permit program is to ensure that all data are input to an integrated information system that is accessible by eligible users on a real-time basis. This information system should provide easy and fast data entry.

Evidence suggests that making the information on-line to the public may further increase compliance. It also increases the possibilities for public pressure and even legal action from nongovernmental environmental agencies or citizens (Tietenberg (2000)).

As a typical example of how difficult monitoring water quality can be, we have a look at the Treaty to Protect the Schelde (April 26, 1994). It has taken over four years just to standardise the measures used for water quality in France, the Flemish Region, the Walloon Region, the Region of Brussels-Capital and the Netherlands.

10. Enforcement

To guarantee a successful implementation of the trading system, trading should only be allowed when the controls placed on participating sources are enforceable. To successfully enforce the tradable permit system we need to carefully construct a set of sanctions for non-compliance. Often predetermined administrative fines can be imposed by the enforcing agency itself for 'minor' or 'routine' non-compliance. More serious non-compliance could then trigger civil penalties. Criminal penalties should be reserved for falsification of official reports and the most serious violations (Tietenberg (2000)).

Other possible sanctions are the loss of future allowances to compensate the excess emissions or even losing the right to participate in the tradable permit program at all.

Malik (1990) has examined the consequences of non-compliance for a system of tradable permits. The analysis reveals that when firms are noncompliant, permit markets only retain their efficiency properties under some fairly stringent conditions. The principal effect of non-compliance on the market is that it alters the equilibrium prices. Prices can be higher as well as lower. Keeler (1991) has extended the analysis by emphasising the importance of the shape of the penalty function facing firms as a key determinant of outcomes in a tradable permit system. He concludes that *'while it is still true that in all circumstances a marketable permit system imposes lower costs on the regulated firms, the uncertain control over quantities and compliance status should cause analysts to think more about the nature of penalties faced by firms for pollution control violations and about the importance of enforcement in the design of permit systems'*.

Montero (2000), however, shows that tradable permits (quantity controls) have an advantage over emission taxes (price controls) when there is incomplete enforcement and uncertainty about the benefit and cost curves. The reason is that under a quantity regime, the (effective) amount of emission control does not remain fixed but rather adapts to unexpected cost shocks.

D. *Evaluation criteria*

When evaluating a tradable permit system several criteria have to be considered: implementation feasibility, environmental effects, economic effects and equity effects.

An environmental policy proposal cannot protect water quality if it cannot be implemented or if its main protective mechanisms are so weakened by the implementation process that it is rendered ineffective. Or as Tietenberg (2000) puts it '*What matters is not how a policy regime works in principle but how it works in practice*'. The feasibility of implementing the permit system includes the possibility of water quality maintenance, the availability of abatement technologies and the certainty of moving into the direction of the desired outcome.

A recent positive trend is that introducing new tradable permit systems becomes easier because of the increased familiarity. Although not all past programs have been successful some of them have been. An example of a very successful US program is the lead phase-out program. Hahn and Hester (1989), who studied this trading program in depth, considered it to be quite successful. It resulted in the elimination of lead in gasoline within a short timeframe, and did so in a cost effective manner - it was estimated that the program saved refiners $226 million. The simplicity and clarity of the regulations, coupled with the fact that self-monitoring and reporting mechanisms were already in place, meant that transaction costs were minimal.

When looking at the environmental effects of tradable permit systems one has to consider more than the initially selected environmental objective (the baseline). The associated monitoring and enforcement policy can greatly influence the environmental quality obtained. Another important aspect is the working of the trading market. If the market is working efficiently the predefined goals may be obtained. However, this efficient working is far from obvious.

When reviewing an environmental policy it is also important to look at the effects on other pollutants. Policies aimed at the reduction of one pollutant may shift the problem to other substances.

When looking at the economic consequences of the permit programs, an important consideration is the evolution of employment in affected industries and communities. Another issue is the presence of market power and the concentration of quota on the permit markets.

Finally, one also has to consider the distributional consequences of the regulation. The groups who benefit or loose from the environmental policy have to be identified. These distributional effects can take place via, among others, recreation or employment decisions.

IV. EXISTING EFFLUENT TRADING PROJECTS

Trading in permits to pollute water resources copes with a high degree of uncertainty. Water can be polluted by a number of substances that have very distinct effects on water-based ecosystems. The presence of two or more pollutants at the same time can lead to synergies, both positive and negative. Furthermore, most sources of pollution contribute not only one substance that is dangerous to the water environment, but several. Water pollution permits can contain long lists of substances and parameters that have to be observed. It is not surprising, therefore, that there are no examples of trading systems in water pollution as such, but only in relation to individual substances or parameters (salts, organic oxygen-depleting substances and nutrients) (Kraemer and Banholzer (1999)).

In the US the national effort to allow for watershed based pollutant trading or effluent trading began as a result of President Clinton's 'Reinventing Environmental Regulation' program released March 16, 1995. The environmental protection agency (EPA) provided guidance to the states in 1996 to assist in evaluating and designing trading programs.

By now several effluent trading programs are in place. We summarise some basic information about the trading programs in a table. The projects are ordered according to the description of the activity. The table is based on several documents: Environomics (1999); Tao et al. (2000); Kraemer and Banholzer (1999) and several Internet websites. An overview of relevant websites can be found in the list at the end of the paper.

The projects summarised in the following table include watershed trading programs, watershed pilot programs, offsets for one discharger, trading studies and some other activities. We now discuss the obstacles that were most frequently encountered. Negotiations over trade ratios and trading rules were often complex and time consuming. Moreover, coordination between state and federal government regulation seems to be complicated. Furthermore, several programs reported a clear lack of interest by the (potential) participants of the trading system.

Some of the programs provide us with the estimated savings of the tradable permit system. These estimated savings are difficult to compare but appear to be quite substantial. However, we have no insight in the benefits that were truly generated by the programs; nor on their environmental impact. Therefore, it is not easy to conclude whether the tradable permit programs were successful or not. There certainly seems to be a potential of large benefits from trading.

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V. RECOMMENDATIONS FOR BELGIUM/FLANDERS

First of all, it is necessary that an emissions trading program for Flanders should be coordinated at an international, or even a European, level. Three out of four Flemish watersheds are transboundary: the IJzer, the Schelde (including the Leie) and the Maas. Only the Brugse Polders are situated completed within Flanders. At the very least cooperation among all countries through which the river under consideration flows, is necessary. Permit systems should be developed based on watersheds or basins rather than national frontiers. When pollution crosses national borders, polluting countries do not experience the full benefits of pollution control. As a result they may not exercise sufficient control from an international perspective. Sigman (2001) shows that free riding does take place in reality and that international spillovers cause degradation, suggesting that international cooperation is incomplete at best. This same study, however, concludes that the EU appears to have successfully decreased free riding within its borders.

The European Council Directive on water (2000/60/EC), in force since 22 December 2000, has provided an ideal framework for investigating the possibilities of tradable emission permits for the improvement of river water quality. Within this framework member states of the EU are urged to cooperate in order to improve and protect the environmental quality of joint watersheds. Most rivers in Belgium are shared with neighbouring countries; e.g. Schelde, Leie, IJzer and Maas, since it is only a small country.

Regulators in Flanders or Belgium also have to take the difficult constitutional context into account. Belgium, as a federal state, consists of three regions: the Flemish Region, the Walloon Region and the Region Brussels-Capital. The legislative competences are divided among the different regulators. Uncertainty about this division can lead to additional costs associated with environmental policies by bringing about more cases before the Court of Arbitration. Moreover, this division of competences also means that the regulators cannot use every available policy instrument. The competences to establish a tradable permit system according to the European Directive are partly with the federal government and partly with the regional government. This implies that a cooperation agreement between federal state and regions would be necessary in order to develop a tradable permit system in Belgium.

Finally, each region is inclined to ignore environmental effects in other regions. Obviously, this is not efficient when dealing with water pollution. As we mentioned earlier, only one watershed, i.e. the ‘Brugse Polders’, is enclosed fully in the Flemish Region. All other watersheds in Flanders are common with other regions or countries. Interregional and international coordination of water pollution regulations is, therefore, imperative.

Further recommendations for initiating a tradable permit system in Belgium are not country specific and are found in the next section

VI. GENERAL RECOMMENDATIONS

Summarising the points we previously made, we can give ten key focus points one has to consider when designing a tradable permit system.

- Before starting the design of the program, perform a very detailed study of the waterway you want to regulate. Pollutants cause different environmental damage depending on flow conditions, bio mass, weather conditions, land use, recreation, surrounding communities… Knowing what daily load a river can absorb without deterioration of the water quality is essential.

- Define the water quality objective you want to reach in a very careful way. Keep in mind that one pollutant often influences other pollutants. The inclusion of a safety margin is no luxury.
- Contact the communities, firms and people who are influenced by the program and seek their cooperation. A necessary condition to obtain this cooperation will, almost certainly, be the grandfathering of the permits rather than auctioning them.
- Incorporate the possibility to adapt the program without reducing the incentives for investment. One way of doing this can be through limiting the duration of the permits to medium-term or by allowing for governmental buy-back.
- Think about how you will handle new firms. If the permits are grandfathered, newcomers have a disadvantage because they have to buy all the necessary permits. Are you comfortable with that?
- Carefully design the trading rules. Who has to approve of trades? Administration and/or local communities? Are minimal trading amounts required? Can permits for one pollutant be traded for permits for another pollutant? Are trades across watersheds allowed? Which parties are eligible traders? Can third parties enter the market? Must buyers always be downstream to the sellers?
- Keep in mind that the formation of ‘hot spots’ must be avoided and that trades can have adverse economic impacts on local communities. Also one has to keep in mind the possible external effects of the trade.
- Decide on whether to use banking and borrowing. Few systems have actually incorporated these features for reasons we discussed above.
- Plan the monitoring of the program carefully. Without monitoring the program will be useless. Make sure enough resources are allocated to ensure sufficient monitoring. Key to the success of the program is to put all data in an integrated information system that is accessible by eligible users on a real-time basis. These data must include data on the condition of the river, data on compliance, data on emissions, data on the identity of permit holders, on the amount of permits owned by each owner, on past trades…
- Make sure the program is enforceable. Trades and abatement need to be enforced in order to guarantee the success of the permit system. Use a set of sanctions depending on the seriousness and the nature of the violations. Make sure monitoring and enforcement are linked together. This will create synergies.
- Finally, make sure to incorporate periodic evaluation of the program. When detected in an early stage, flaws and misunderstandings can often easily be solved. Moreover, evaluation allows one to learn and to avoid some misspecification in future tradable permit programs.

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www.epa.gov/owow

Watershed '96 Proceedings.
www.epa.gov/owow/watershed/Proceed/toc1.html

Great Lakes Trading Network.
www.gltn.org

Vlaamse Milieumaatschappij (Flemish Environmental Agency).
www.vmm.be

U.S. Environmental Protection Agency – Office of Water Trading Page.
www.epa.gov/owow/watershed/trading.htm

National Agricultural Library Water Quality Information Center.
www.nal.usda.gov/wqic

World Resources Institute.
www.igc.org/wri

River Watch Network (Citizen Monitoring)
www.riverwatch.org

Internationale Commissie voor de Bescherming van de Schelde (ICBS).
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