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WATER SUBSIDIES AND THE ENVIRONMENT

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FOREWORD

This publication examines the relationship between subsidies and water management in OECD countries. It was prepared as input to an OECD project on “Water Pricing”, which is expected to be completed in 1998.

The report was drafted by Andreas Kraemer and Matthias Buck (Ecologic Consulting, Berlin, Federal Republic of Germany). It also benefited from contributions made by the OECD Group on Economic and Environmental Policy Integration, as well as by the OECD Ad Hoc Group on Subsidies and Environment.

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WATER SUBSIDIES AND THE ENVIRONMENT

1. Introduction

1.1 Context

This paper on water subsidies and their environmental implications is prepared in the context of current OECD work on the more general relationship between subsidies and the environment. One of the main aims of this latter work is to identify subsidies that have adverse impacts on the environment. The reform, reduction, or elimination of these subsidies could lead to both environmental and economic gains (so-called "win-win" situations). To further the understanding of the relationship between subsidies and the environment, and to allow for sound policy advice regarding the reform or removal of existing subsidy schemes, the current OECD work programme has three broad objectives (OECD, 1996: 12):

- provide an analytical framework that allows for a qualitative and quantitative analysis of the relationship between subsidies and the environment;
- provide possible orders of magnitude of "perverse" subsidies, and their effects, on the environment;
- describe strategies to remove, reduce, or reformulate (decouple) "perverse" subsidies.

Water subsides have been identified as one of the priority areas of concern within this project. In this context, water subsidies are understood to encompass not only subsidies for water supply services, but all types of subsidies that contribute directly or indirectly to the *quality* of water resources available for use, or to the *quantity* of water resources actually used. This applies to a broad range of subsidies. Among the most prominent of these are subsidies to agriculture, or those in the municipal and industrial sectors.

This paper seeks to explain existing water subsidies in as many OECD countries as possible. However, the data presented here is drawn only from sources accessible within (limited) time and budget constraints. It therefore does *not* comprehensively cover all sectors of all OECD countries, and accordingly allows only for limited and cautious generalisations. The nature and type of subsidy schemes currently in use are first described. This includes an indication of their overall size, as well as where they are found. The consequences of identified subsidies for the aquatic environment and their economic context is then discussed, as are the fiscal and environmental implications of their potential removal.

1.2 The meaning of "subsidy"

Subsidies are only one of a wide range of economic instruments used in environmental policy. In general, policy instruments can be regarded as "economic" when they affect the cost and benefit structure of alternative actions open to economic agents (OECD 1994: 17). Different ways of classifying economic instruments have been proposed, each with different consequences for the understanding of the concept of "subsidy". For example, see OECD (1994); and Gale and Barg (1995).

In the context of the broader OECD project on linkages between subsidies and the environment, the working definition of "subsidies" that has been adopted here is: "...government interventions through direct and indirect payments, price regulations and protective measures to support income that favour environmentally-unfriendly choices over environmentally-friendly ones" (OECD 1996: 5). This definition includes, for example, *direct payments*, such as tax concessions or allowances; the provision of goods and services below market prices; as well as *guaranteed minimum prices; preferential procurement policies*; and *cross-subsidisation.*

With regard to the wide variety of possible forms of subsidy that influence water-relevant economic behaviour, this paper does *not* use a broad, all-encompassing definition from the outset. However, some characteristics and limitations of the concept of subsidy are reviewed in the following paragraphs, both to enhance the conceptual understanding of "water subsidies" as used here, and to limit the scope of the paper.

Subsidies and water pricing practices: The occurrence and calculation of subsidisation is fairly straightforward if identifiable monetary transfers are involved, whether these be in the form of direct payments, low interest loans, or debt reductions. On a more abstract level, however, the concept of "subsidy" implies that the actual price paid for a good or service does not cover for all of the "real" costs of providing that good or service. This conceptual perspective highlights the close relationship between water subsidies and water pricing practices. Even in the absence of "explicit" monetary transfers, one can speak of "water subsidies" if the system of water prices in place does not adequately reflect all of the costs involved in producing water services. In turn, the effective implementation of the principle of *full cost recovery* in the formation of water prices would eliminate water subsidies. Methodologically, the identification of "water subsidies" created by "underpricing" water services requires the establishment of benchmarks for correct prices. The concept of "correct pricing" in turn largely depends on decisions on the types of costs to be included in "correct" water prices.

Benchmarks for correct pricing: In principle, three types of cost need to be considered when discussing correct prices — direct economic costs, social costs, and environmental costs. The estimation of each type of costs involves a different set of problems:

1. *Direct economic costs*: In general, exact figures regarding infrastructure, operation, and maintenance costs for water services are available. Consequently, the "benchmark" for the economic costs of providing water services, and the amount of economic costs not recovered by operational charges but from other sources (e.g. the general state budget), can be calculated. Full recovery of the *economic* costs of water services will require the inclusion of (i) the costs of operation and maintenance of water infrastructure; (ii) the capital costs for the construction of this water infrastructure; and (iii) appropriate reserves for future investments in water infrastructure within the water price structure. However, even if calculated for only certain economic contexts, significant problems will arise if levels of subsidisation are to be *compared* (e.g. among OECD Member countries). Prices for the same good or technical device change over time, and will often be different in various economies. Furthermore, the particular regulatory requirements in place will result in differences in the applied

equipment, and consequently, in varying cost structures for providing comparable water services.[1]

2. *Social costs*: The establishment of subsidy schemes often aims to achieve a social benefit, or seeks to avoid some social hardship. With respect to water services, the direct or indirect social benefits (for instance, in the field of public health) will vary largely with respect to contextual settings. To calculate these costs, and to compare them across cases, is not generally feasible. Consequently, this paper does not include any monetary estimations of social costs and benefits in its concept of "subsidy". Where appropriate, however, a qualitative evaluation of subsidy schemes is undertaken by contrasting the social objectives pursued by a particular subsidy scheme with its actual achievement. Many of the subsidy schemes discussed in this paper involve a trade-off between *social* objectives (e.g. to maintain current levels of employment in the agricultural sector) and *environmental* objectives (e.g. to reduce environmentally-detrimental effects of subsidised fertiliser use). While the achievement of social benefits, or the avoidance of social hardships, may allow for debate about the acceptable level of negative environmental externalities (see below), it is more difficult to argue convincingly in favour of maintaining environmentally-detrimental subsidy schemes that do not even meet their own social objectives.

3. *Environmental costs*: The environmental costs of economic activities are not generally reflected in the prices established at the market-place, but appear as "externalities". Conceptually, the non-inclusion of negative environmental costs in price mechanisms can also be discussed under the label of "subsidies"[2]. In practice though, there are large difficulties in establishing benchmarks for the costs caused by environmental degradation, and in including these costs into market mechanisms. Still, the principle of *full cost recovery* requires that these costs be taken into account. Given the methodological problems involved in calculating environmental externalities, the inclusion of an environmental component into water prices will typically have to be supported by political, rather than economic, arguments. On the basis of the type of data available for this survey (see below), only a qualitative assessment of subsidisation via the non-inclusion of environmental costs was therefore possible. One exception to this were cases where the negative environmental effects of a given subsidy scheme entailed identifiable costs for other classes of water users. In these specific instances, the economic price of negative environmental externalities has been included in the quantitative assessment of water-relevant subsidies.

1.3 Structure of the analysis

In order to cover the full range of existing water subsidies in OECD Member countries, several water-relevant activities are examined below (agriculture, industry including mining, human settlement). For each of these areas, and where possible, the paper describes subsidies in three steps:

- *Subsidy scheme*: A description of the nature and type of support; the goals of the scheme; the amount of support; related water pricing practices; and the use of revenues;

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1. The analytical problems involved here are elaborated at length in (Kraemer *et al.*, 1997*a*).

2. From an environmental perspective, a "subsidy" consists of the value of uncompensated environmental damage arising from any flow of goods or services (Barg 1996: 28).

- *Incentive effect of subsidy*: An analysis of the behavioural implications; marginal costs and elasticities (if available); the degree of goal-attainment of the subsidy in its own terms; and its environmental impact;

- *Removal or reform of subsidy*: An assessment of potential behavioural and environmental implications, as well as fiscal consequences.

Using this model, a broad range of subsidy schemes is described. However, on the basis of the data available for this survey, no *generalizable* quantitative assessment of the environmental implications of existing water subsidies was achieved. As a “second-best” strategy, the analysis identifies typical patterns and “clusters” of water-relevant subsidies that seem to be of particular importance in OECD Member countries. From this base, some cautious generalisations about the fiscal and environmental implications of reforming water-related subsidies are then drawn.

1.4 Sources and quality of data

Limited resources and time constraints meant that no new case studies could be carried out specifically for the preparation of this paper. Therefore, the analysis is mainly based on available information and material. The data that was used originates from three different approaches:

- *A short-term survey*, in the context of which water administrators in most OECD Member countries were contacted;

- An evaluation of *existing published studies* in this area;

- *Personal communications* with various individuals, in both governmental and non-governmental organisations.

The published material gathered from environmental NGOs was especially useful, in that it provided a number of concrete examples of subsidies, tax rules, or regulations with economic consequences that are detrimental to the environment. Often, the examples cited include estimates of the budgetary impact, and of the consequences of altering or abolishing the measures described. These examples also enrich the taxonomy of subsidies and related issues developed in this paper, in addition to filling in some of the gaps which remained after the information provided by sources in OECD Member countries themselves was assessed.

The wide variety of sources, the varying quality of the obtained data, as well as differences in accounting approaches, posed significant problems of comparability and generalisation of results. These issues, and their implications for policy options and future research strategies, are further discussed in the conclusions below.

However, it is important to emphasise at the outset that the differences in the obtained data might create imbalances in perceptions about the range and type of “perverse” subsidies currently in use in OECD Member countries:

1. There are a number of countries or cases discussed here for which detailed figures have been reported, or where assessments of the environmental impact of existing subsidy and taxation systems have already been conducted. These well-documented cases should not be interpreted as proof that the budgetary systems of the countries involved are particularly

detrimental to the environment. In reality, the situation might be just the opposite: detailed accounting of the environmentally-detrimental effect of subsidies and taxation systems will often exist in those countries with a high degree of environmental awareness in their governmental institutions, and in those countries with active and well-organised environmental NGOs. The scientific review of the environmental implications of subsidy and taxation systems, and the presentation of studies like the ones used as background material for this report, frequently require strong public support and commitment to the goals of the research, both financially and administratively. Thus, one might argue that the availability of data as used for this report already indicates a relatively advanced state of discussions on the linkages between subsidies and the environment in the countries where this data exists.

2. For some water-related economic activities (e.g. river flow regulation in the areas of industrial water use; aspects of flood control; surface sealing and coastal protection; river development and inland shipping), it was not possible to obtain sufficient information to carry out a quantitative analysis of existing subsidy schemes. This may indicate that existing subsidy schemes are not of much importance. More likely, however, it may also highlight the lack of attention currently being given to these issues in most countries.

2. Subsidies to water-related activities

In principle, there are two ways in which the relationship between an existing subsidy or taxation system and the environment can be reviewed (OECD 1996: 10):

- *the economic perspective*: assess the behavioural effects of an existing subsidy or taxation system, and examine the relevance of that behaviour to the quality of the environment.

- *the environmental perspective*: start out from the environment, and describe different forms of environmentally-relevant behaviour; then assess the degree to which environmentally-relevant behaviour is being affected by the existing subsidy or taxation system.

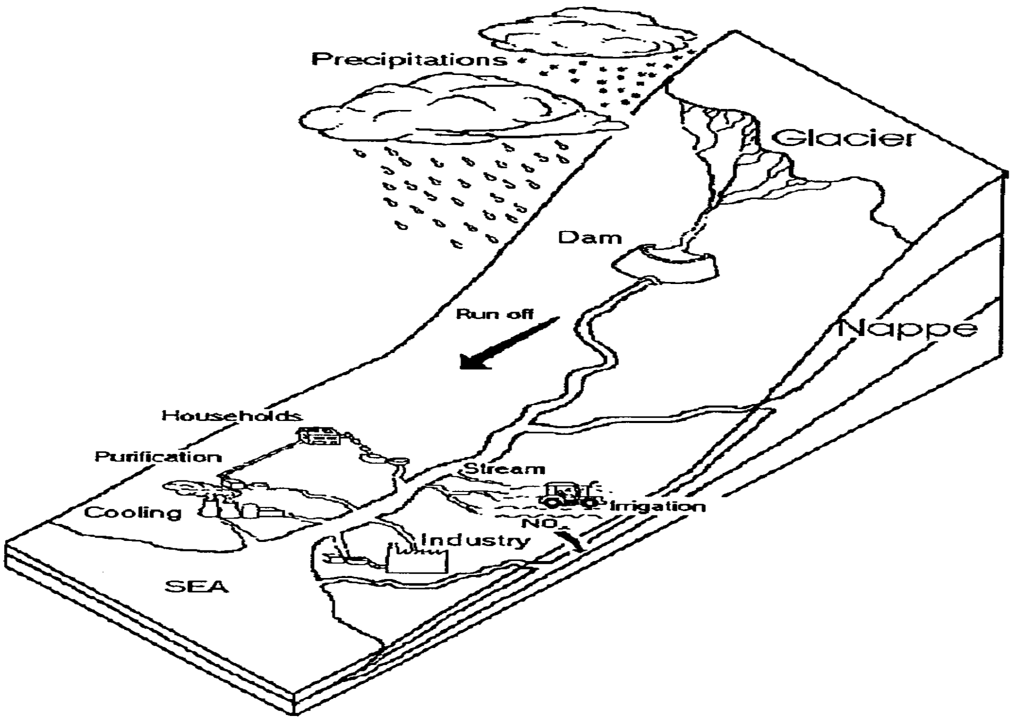
Water resources are essential for most human activities, and there are numerous ways in which human activities can be relevant to the quality or quantity of water. To structure this relationship, it is helpful to imagine an “economic” water-cycle (see Figure 1). The “economic” water-cycle highlights how existing water resources serve different economic purposes at subsequent stages in the natural and man-made water-systems. It also shows the main areas of economic activity, namely agriculture, industry, human settlement, and electricity generation, that are likely to influence the quality or quantity of water resources.

In order to obtain a relatively comprehensive picture of water-relevant subsidies, it is useful to assess how the identified water-relevant economic activities are being influenced by existing subsidy and taxation systems. This implies adopting an *environmental perspective* as outlined above.

When applying this particular analytical approach, some additional aspects are worth mentioning. Analysed from an environmental perspective, the relationship between subsidies and the environment needs to take the *multi-functionality* of water uses into account. “Multi-functionality” refers to the fact that in the natural water cycle, water often serves more than one purpose at a time or in subsequent uses. To account for this situation when analysing water-relevant subsidies, it is useful to distinguish between *in-stream* and *off-stream* uses of water. In-stream uses of water frequently serve a number of economic purposes. Dams, for example, may generate electricity and simultaneously be used for river flow control. The resultant artificial lakes serve as drinking water reservoirs and recreational sites. Regarding subsidies related to in-stream water uses, the multi-functional effect of these subsidies makes it difficult to specify the amount of subsidisation given to particular activities. Financial support may be aimed at furthering only one of the involved activities, but in practice, can benefit *all* activities.

In contrast, off-stream uses of water generally serve only one specific purpose at a time. This in principle facilitates the calculation of subsidies. However, off-stream uses of water typically require the construction and operation of a large infrastructure. In most instances, the costs for these infrastructure systems are only partly covered by tariffs. Consequently, in connection with off-stream uses of water, subsidies are likely to occur via the "underpricing" of water services. Thus, the identification of subsidies in this area is faced with problems of "correct pricing" that were discussed in the introductory section of the paper.

Figure 1. The "Economic" Water-Cycle



Source: (Eurostat 1996: 7).

Another aspect of the multi-functionality of water uses is relevant for the calculation of water subsidies. Since the same water serves different purposes at subsequent stages in the "economic" water-cycle, negative externalities associated with "up-stream" uses of water, such as pollution, are likely to generate additional costs for "down-stream" uses. Cases in which negative externalities of "up-stream" users are paid for by "down-stream" users or from public funds need to be regarded as a cross-subsidisation to the polluters (see earlier discussion).

On the basis of these preliminary considerations, the following sub-sections provide a description of different water-relevant economic activities (agriculture, industry, human settlement, electricity generation), and the existing subsidies and tax incentives that have an impact on each of these activities.

2.1 Agriculture

Agricultural activities account for an estimated 65% of global water use (Postel 1992: 19). Water extracted for agricultural purposes from surface waters or ground water is mostly used for irrigation. Whether irrigation is sustainable or not will dependent on local water availability; on the historical background of how irrigation systems have been developed; and on the particular irrigation techniques that are used. However, irrigation can lead to a depletion of water supplies, (i.e. where extraction exceeds the replenishment of the resource). Where land is converted to farmland use, or where farmland use is maintained in areas where water is scarce, water problems resulting from irrigation will be likely.

If wetlands are drained and converted to agricultural use, some species are likely to be threatened. Also, the reduced capacity for water storage will speed up water-run off and water-throughput, which may, in turn, increase flood levels, and reduce the self-cleaning capacity of aquatic systems. Intensive farming practices generally require the use of larger quantities of water, which can aggravate environmental degradation caused by irrigation. Intensive farming techniques also tend to require higher usage rates for pesticides and fertilisers, which can lead to diffuse pollution of surface water through run-off. High densities of animals can lead to large quantities of solid and liquid manure.

2.1.1 Water extraction, especially for irrigation purposes

Most water extracted for agricultural activities is used for irrigation purposes. The main function of agricultural irrigation in semi-arid and arid areas is to allow crop production in areas where water would otherwise be a limiting factor.

Irrigation can also involve pumping groundwater and using it locally. The net effect of such irrigation is an increase in transevaporation of water, leading to a net loss of water to the local or regional environment. As a consequence, water-based ecosystems, such as wetlands or forests, may suffer degradation. Irrigation water can also be made available to the farming sector by transferring water from one region to another. Environmental degradation associated with water withdrawal may then occur in one region, whilst other problems associated with irrigation itself may occur in the receiving region.

Irrigation water usually contains some minerals (in solution). Depending on climatic conditions, soil types, crops and irrigation patterns, these minerals can be deposited on the soil, reducing its reproductive capacity (salination). Similarly, water percolating into the ground can be high in salt content, leading to a deterioration of local groundwater resources.

Another consequence of irrigated farming in semi-arid and arid areas is that crops are often grown in areas (and in climates) to which they are not well suited. Where this is the case, the use of agro-chemicals that are dangerous to the aquatic environment may increase in order to regulate crop growth, and to provide protection from pests. These chemicals can run off into surface waters or percolate into the ground. This latter path of pollution is particularly prominent if irrigated agriculture takes place on light soils with little retention capacity of pesticides and fertilisers (see below). It should also be noted that irrigated agriculture exists in *humid* areas. Paddy irrigation systems, as traditionally developed in Asian countries, constitute a prominent example. Whereas irrigation in semi-arid and arid areas usually aims to ameliorate the consequences of temporal or regional *water scarcity*, irrigation systems in humid areas often seeks to regulate the *locally-available* amount of water corresponding to agricultural water use patterns. Paddy irrigation may even have some *positive* environmental externalities. Especially in Asian monsoon areas, paddy irrigation systems contribute to river flow control and to flood prevention, in that they provide water retention capacities similar to wetlands.

In **Australia**, for instance, agriculture accounts for about 70% of water use. Environmental externalities associated with agricultural activities arise particularly from the over-use of irrigation water, and the resulting salinity. In some areas, environmental degradation seriously threatens the continuation of agriculture. One major agricultural region of environmental concern is the Murray Darling Basin, which includes 75% of all irrigated land, and produces about one-third of total Australian output from rural industries. The environmental externalities (over-use of water, salinity, water-logging problems) are considered to be largely irreversible. Production losses have been estimated by the Murray Darling Ministerial Council to be over A$65 million per year, and the costs of the current level of salinity are estimated at A$37 million per year for agricultural and downstream urban and industrial water users (cross-subsidisation).

Water catchment, storage and distribution for agricultural uses is (among others) primarily the responsibility of public enterprises. In principle, these enterprises should meet expenses for the operation and maintenance of water supply systems through user charges. An 8% real rate of return has been estimated to be required to meet full cost recovery of capital and operating costs. However, in cases where revenues from water supply fail to meet the costs of operation and maintenance of water supply systems, governments are called on to cover these deficits (financial subsidy). In 1994, the failure to achieve an 8% real rate of return resulted in an estimated A$3.3 billion of financial subsidies to the water sector. In particular, *irrigation* systems failed to achieve a positive rate of return. As an example, the 1991-92 operating results of the Department of Engineering and Water Supply, South Australia (DEWS-SA), indicated a positive return only in the area of metropolitan sewerage services. The *highest* losses were reported in the irrigation and drainage sectors, where expenditures of about A$15 million were only partially covered by only A$6.6 million of total revenues. The estimated return on assets was *minus* 14% (Australia, 1996*a*).

Having recognised the need for the efficient and sustainable reform of the Australian water industry, the Council of Australian Governments agreed in February 1994 to implement a strategic framework for water industry reform. However, in the 1994 preparatory report by the Working Group on Water Resource Policy to the Council of Australian Governments, it was noted — with reference to rural water services — that "While the need for reform is recognised, the legacy of past investment and policy decisions, particularly in relation to irrigation schemes, means that there are very real constraints on the extent and pace of reform..."(Council of Australian Governments 1994). Following the estimation of the Working Group on Water Resource Policy, a period of five to eight years will be required to implement the proposed changes.

In the **Czech Republic,** irrigation systems are used on 154,000 hectares of farmland (3.6% of the total). The main irrigation equipment required to transfer the water as far as the stand-pipe is still in state ownership. The trusteeship of this property is provided by the Lands Fund of the Czech Republic, which has transferred its rights and obligations regarding operation and maintenance of irrigation system to the state-run organisation (SMS).

SMS is in turn financed by the Lands Fund. The annually transfer related is maintenance and repairs of the main hydromelioration equipment is about 100 million KCS (direct subsidy). Since 1992, no further subsidies have been given for the construction of new irrigation systems. To cover the costs of providing the irrigation water itself (operational costs), the SMS receives an additional 25 million KCS annually. The financial assistance for irrigation water abstraction helps private land owners build supplementary irrigation systems (leading to adverse environmental impacts). However, an Environmental Impact Assessment is now required before these new irrigation projects can be constructed. Due to reforms presently under way in agriculture, the use of irrigation water is also now being reduced. With the intended privatisation of the main irrigation equipment, this subsidy scheme is expected to eventually be stopped (Pavlík, 1996: 6-8).

In **Denmark**, water use (1992) for agricultural and irrigation purposes amounted to 400 million m^3, against a total annual water consumption of 1173 million m^3 (Andersen 1996). In January 1994, a national water consumption tax on "piped water" was introduced as part of "green tax reforms". This tax is being phased in gradually, with an annual increase of 1 DKK; it will reach its full rate at 5 DKK/m^3 in 1998. Despite its name, it also applies to water supplies from individual dwellings and wells. In principle, it therefore also applies to agriculture. However, farmers can deduct this tax from their VAT proceeds. Assuming, that the additional costs imposed upon consumers by the tax on water consumption still do not cover all environmental costs involved, this tax exemption, in principle, could be regarded as a subsidy. However, even though this would be methodologically consistent, it seems problematic to discuss exemptions from environmental taxation schemes that aim to include some environmental component into water prices under the concept of "subsidy". To do so would probably result in a distorted picture of the linkages between subsidies and the environment, since the non-inclusion of *environmental* costs into water prices is the norm in OECD Member countries, and full recovery of *economic* costs of water services is still the exception.

In addition, a cross-subsidisation for agriculture in Denmark exists in the form of an annual payment of 65 million DKK under the Waterfund Law to waterworks and borings that have been especially hard hit by pollution, mainly from pesticides (Wallach, 1996). These costs reflect the negative externalities of past intensive farming practices, which are now being covered by the general taxpayer.

In **Germany**, three of the Western Länder (federal states) established water resources taxes in the 1980s (Baden-Württemberg in 1987, and the City States of Hamburg and Bremen in 1989). To date, 12 of the 16 Länder have adopted similar regulations. In Baden-Württemberg, the water resource tax was established in order to finance compensation payments to farmers for restrictions on fertiliser use in water protection zones. The tariff structure of the Water Resource Tax in Baden-Württemberg differentiates charges according to both the *origin* of the water (surface or ground) and its *use* (public water supply, heat pumps, cooling, irrigation, and other uses). Rebates of up to 90% are available for any water-intensive agricultural activity which might otherwise find its competitive position affected (subsidy via tax exemption). However, this rebate is conditional on taking all available measures to save water, and on using surface water instead of ground water. Part of the revenues go to farmers in the form of compensation for land use restrictions (environmental subsidy) (Kraemer and Jäger 1997: 62-65). Similar links between water resource taxes and environmentally-motivated subsidies also exist in the other Länder.

In **Italy**, an estimated 55% of total water use (approximately 23 billion m^3/year) is applied to irrigation purposes (Massarutto 1996). Regionally, irrigation takes place in only a few areas, especially in the Po Basin, and in the Provinces of Novara, Vercelli, Pavia, and Milano. Irrigation water often originates from *self-supply* systems. In these cases, water abstraction is (in principle) subject to regulations (requiring a license, which is accorded on a case-by-case basis). Until recently, these licenses have rarely taken account of water availability (Massarutto, 1996: 5). There are fixed charges for certain "units" of water abstraction, but these charges which remain negligible, relative to the overall costs of the irrigation service (e.g. irrigating one hectare of land is charged 640 Lira; there is a 50% reduction if the residual water is left to percolate into the groundwater).

In the case of water drawn from the public water supply system in Italy, prices are determined by the municipalities. According to law, a two-part tariff system with increasing-block rates should be in operation, with agricultural water supply being charged on a basis of cost recovery (for further details about this charging system see Section 2.3.1). A recent study of pricing practices in the Po Basin revealed that almost all municipalities had made exemptions for agricultural water uses (subsidy through charges lower than operation costs), although exact figures are not available. For the Po Basin, a significant reduction in water demand for irrigation can be expected in the future. Factors accounting for this reduction include technological improvements (spray irrigation and drip-feed), in addition to the impact of a general decline of the agricultural sector and moves towards less intensive agriculture in the European Union's Common Agricultural Policy (Massarutto 1996).

In the **Netherlands**, agricultural water extraction accounts for 30% of all ground water usage. Farmers are temporarily exempted from the existing groundwater extraction tax (subsidy via tax exemption). While the occurrence of excessive use of water depends largely on local circumstances, taxation normally generate a positive incentive to use less water (Ernst & Young, 1996: 60).

In **New Zealand**, water consumed for irrigation purposes in 1993 accounted for an estimated 55% of all withdrawals. Before removing the subsidies for irrigation in 1988, the majority of the costs for the development, maintenance and operation of irrigation systems had been funded by the government, even after including delivery costs and water charges to irrigators. Today, all irrigation systems have been privatised, and must be financed from private sources. As a result of this restructuring of costs, water abstractions for agriculture have stabilised. However, the demand for irrigation water has been increasing again in recent years (Shepherd 1996: 15/16).

In **Portugal**, agriculture accounts for 77% of the total water used, mainly for irrigation purposes (Correia *et al*. 1997: 526/527). With new legislation passed in 1995, all licensed uses of water are subject to a tax directly proportional to the amount of water used (and to the economic value of that water for each specific sector), and inversely proportional to water availability. The legislation will be implemented gradually, with 20% of the tax being paid in the first year, 40% in the second, etc. until 1999, when 100% will be paid. Agricultural withdrawals for irrigation purposes will be exempted for the first five years. (subsidy via tax exemption) (Correia *et al*. 1997: 508/509).

In **Spain**, water is a scarce resource, because the Mediterranean climate is characterised by irregular rainfall and high evaporation rates. Water abstraction for irrigation purposes constitutes 80% of total water use (11% for urban use; 5% for independent industrial use). However, 22% of irrigation water is abstracted from groundwater resources. Concurrent demands for water supply already lead to periodic regional water scarcities. As of 1994, there was an estimated water deficit of 3,030 Hm^3. This situation is expected to continue to deteriorate in the future. In the area of irrigation alone, an additional 2,317 Hm^3 will be needed by 2012, if current consumption trends continue (Maestu 1996: 2).

In Spain, abstraction from public waters requires a permit and the payment of a levy to the Basin Authorities. In most cases, the prices paid for agricultural water withdrawal are not related to the volume of actual water use, but to the size of the irrigated area. Furthermore, they constitute only a small fragment of total costs (e.g. in Almeria, a price of 0.16 ptas/m^3 means that, on average, only 0.03% of the total costs of water supply are covered). Thus, agricultural water prices do *not* provide an incentive for the efficient use of (scarce) water resources. The price charged for irrigation is mainly used to cover infrastructure expenses (amortisation, conservation, maintenance), as well as for administrative costs. However, in the case of the Basin Authorities which charge local irrigators for the abstraction of water from public water supplies, the levied charges are not even sufficient to cover the operational budget. In 1994, these shortcomings amounted to 5.4 billion pesetas, which had to be covered by subsidies from the central budget. (These shortcomings do not originate from "underpricing" of administrative services, but from the administrative incapacity to effectively collect the charges that ought to be paid.) In cases where the infrastructure has been amortised, or where irrigation projects are not integrated into the public infrastructure, very little (or nothing) is charged for the water (Maestu, 1996: 13).

Overall, the present situation in Spain is characterised by regional and temporal water scarcities, the need for subsidisation of the water industry, emerging large investment needs for agricultural irrigation projects, budgetary constraints, and underdeveloped administrative practices. Considering that 80% of all water consumed in Spain is used for irrigation, there is a significant potential for mutual budgetary and environmental gains if administrative and regulatory measures were to be backed with water-pricing practices that provide incentives for a more efficient use of available water resources, while simultaneously generating higher revenues for the maintenance and improvement of water supply systems.

In the **US**, the subsidisation of agricultural water and irrigation activities is particularly well-documented for water projects that reclaim arid and semi-arid land in the West of the country (see for example, Wahl (1989), Chap.2; and Harden, 1996). The federal government has been involved in financing and building water projects in this area since 1902. Under the federal law that governs the reclamation water projects (the so-called Reclamation Law), agricultural irrigators that participate in a federal water project can receive three types of financial assistance: (i) interest-free financing of a project's construction costs; (ii) shifting of part or all of their repayment obligations to other beneficiaries of a project, (iii) relief of part or all of their repayment obligations through specific legislation in special circumstances, such as economic hardship or drought.

As of September 1994, US$ 16.9 billion of the federal investment in water projects was considered to be reimbursable. US$ 7.1 billion of reimbursement obligations originally had been allocated to agricultural irrigators. However, as a result of adjustments and special legislation granting repayment relief, the amount was reduced to US$ 3.4 billion, or 47% of the irrigators' share of the construction costs. Of the 133 projects assessed by a report of the United States General Accounting Office, 15 projects relieved irrigators of 50% or more of their repayment obligation. In 41 projects, irrigation assistance and charge-offs accounted for 70% or more of the costs allocated to irrigation, and 39 projects were reported where irrigation assistance and charge-offs accounted for 10% or less of the costs allocated to irrigation (GAO 1996).

2.1.2 Conversion to farmlands or maintenance of farmland use

In the past, the drainage of wetlands (see below) and the clearing of forests for conversion to agricultural land have been directly subsidised, or have been carried out as a state activity financed by general taxation in many countries. This was normally in response to growing demands for food for expanding populations. Such schemes have recently lost their importance, since agricultural production in many industrialised countries now exceeds demand. Policies are therefore being adopted, most notably in the European Union, to reduce agricultural production in OECD countries by setting land aside. It appears that there are currently no subsidisation schemes for the *conversion* of land to farms. In future, however, this situation may change if the cultivation of (renewable) bio-fuels becomes more widespread.

The situation is different, however, in relation to *maintaining* farmland use. For instance, the **Netherlands** exempts the sale of agricultural land from the capital gains tax, if the agricultural usage of the land is continued. Furthermore, farmland is exempted from the local real estate tax (i.e. subsidy via tax exemption) (Ernst & Young 1996: 80). These tax exemptions are aimed at encouraging the maintenance of agricultural activity. Depending on local circumstances, adverse environmental effects are thereby prolonged. Similarly, **Ireland** has exempted the transfer of agricultural land from the capital acquisitions tax (gift and inheritance) (Ernst & Young 1996: 81).

2.1.3 Land drainage

The primary agricultural reason for land drainage is the removal of excessive soil moisture from the land, in order to improve its agricultural potential: a longer growing season leads to higher yields, higher stocking densities, fewer diseases and pest problems, and greater freedom to use agricultural machinery (Baldock, 1984). These gains in agricultural productivity are usually accompanied by environmental losses:

- the increase of negative externalities related to more intensive agriculture;
- the loss of biological diversity, as a result of changing characteristics of the wetland habitats;
- the loss of absorptive capacity and water retention capacity of wetlands changes water flow regimes. Faster water run-off and throughput will lead to higher flood levels. Furthermore, there is often a loss in the waste assimilation and nitrogen-reducing capacity of aquatic systems. Also, changes in sediment loads and discharge of rivers will occur.

In the **Czech Republic**, an area of 1.1 million hectares (25.4% of total farm land) has been drained. The drainage systems, built mainly in the 1970s and 1980s, are still in state ownership. As with irrigation systems, trusteeship of this state property is provided by the Lands Fund and the SMS. Annual receipts for maintenance and repairs of the main hydromelioration equipment amounting to about 100 million KCS (i.e. direct subsidy). Since 1992, the further development of drainage systems is no longer being financially supported from the state budget (Pavlík, 1996: 6-8).

2.1.4 Intensive farming

In addition to the effects of irrigation and drainage on water resources, water pollution by agro-chemicals is another main effect of agricultural practices. Taxation and subsidies, as well as price guarantees for agricultural products, can promote chemical-intensive farming practices, with attendant effects on the aquatic environment. Some subsidisation schemes have (or can be expected to have) a more direct impact on farming practices.

In the **Netherlands**, for instance, agricultural inputs such as pesticides, animal fodder and concentrates, manure, and fertilisers fall under a low (6%) VAT-rate (subsidy via tax reduction). No incentive effect of the VAT is anticipated for firms that recover their VAT charges. Other users might respond to the incentive effect of a higher VAT (Oosterhuis and De Savornin Lohmann 1994: 25), but this incentive effect would probably be low, since pesticide demand typically shows a very low elasticity. For the Netherlands, this elasticity is estimated to be only about 0.12 (Ernst & Young 1996: 82).

Eutrophication is still a major problem in surface water pollution in the Netherlands, although an environmental charging system on the basis of the Pollution of Surface Waters Act (WVO) has recently been introduced. When discharging into the sewer system or into surface waters, one has to pay a charge to the public body responsible for water quality management. This charge is based on the discharged quantity of "population equivalents". The resources needed to pay for the expenses of water quality management originate from these levies. In 1992, the revenues from this levy amounted to Dfl 1.2 billion for discharges into non-state waters. As of 1993, the WVO did not cover *diffuse* water pollution from agriculture (subsidy via exemption from charge); instead, preference was given to direct regulation and to other economic disincentives (van den Bergen 1993: 8 and 12). The fact that the quality of surface waters is still degrading probably indicates some fundamental undervaluation of the water resource.

2.1.5 Payments for environmentally-friendly farming

These financial transfer schemes generally refer to policies that, rather than *regulating,* actually offer *incentives* to farmers and other landholders to achieve a desired environmental outcome. It has been questioned whether these measures can be regarded as subsidies, because they are usually made in return for the provision of an environmental benefit. In other cases, payments are intended to compensate farmers for the costs of complying with environmental prescriptions (Baldock 1996: 123).

However, there *are* valid reasons for including this type of payment into an analysis of subsidy schemes, such as the one conducted in this paper. A number of these subsidies specifically address the protection of the aquatic environment. Thus, subsidies for environmentally-friendly farming are part of the overall incentive structure that influences water-relevant behaviour of farmers. Therefore, "perverse subsidies" and environmentally-friendly subsidies interact in their environmental effects. In addition to these environmental considerations, budgetary linkages also exist between subsidies that encourage environmentally-detrimental behaviour and payments for environmentally-friendly farming practices. A number of cases have been reported in which some subsidies schemes stimulate the growth of surplus crops, often on marginal lands, while at the same time the environmentally-detrimental effects of these intensive farming practices make farmers eligible for other subsidy programmes to cut back production.

In the **Czech Republic**, financial compensation is given to farmers that experience losses due to cultivation limitations in protection zones for drinking water abstraction (Pavlík 1996: 7).

The Department of Agriculture, Food and Forestry in **Ireland** operates a Rural Environment Protection Scheme (REPS), under which — among other purposes — grants are provided to farmers who adopt nutrient management plans for the purpose of protecting water quality (Egan 1996: 2).

To supplement existing regulations regarding the limitation of the amount and the practices connected with the use of pesticides, fertiliser, and manure, **Sweden** initiated (1988) a variety of compensation programmes to farmers (i.e. direct subsidy). In 1989 and 1990, for example, compensation payments for the cultivation of nitrogen-fixing crops was granted in Götaland and Svealand. In order to reduce the use of pesticides by introducing more efficient active ingredients and by lowering dose-rates, farmers were encouraged by this compensation to test improved field crop sprayers. Also in 1989, a temporary compensation scheme was introduced for farmers who a converted all or part of their acreage to organic production (Bergvall 1996).

In the **UK,** the Ministry of Agriculture, Fisheries and Food operates a group of subsidy schemes that aim to protect or enhance the quality of the rural environment. Some of these schemes are closely related to the protection of water resources. Among the most important of these are the Nitrate Sensitive

Areas Scheme (NSA), the phased implementation of the European Union Nitrate Directive (91/676/EC), and a programme that offers free farm visits to provide either a pollution risk assessment, or assistance with the preparation of farm waste management plans.

The NSA aims to reduce the loss of soil nutrients from agricultural practices. It compensates farmers which voluntarily change their farming practices in ways which significantly reduce the leaching of nitrates. Under five-year agreements, a total of £3.6 million was paid in 1995/96, with payments ranging from £55 per hectare for restrictions on nitrogen fertilisers, to £590 per hectare for the conversion of arable land to native species grassland. 26 of 32 NSAs covered by a recent monitoring report showed reductions in nitrate leaching, in comparison with pre-scheme levels (Ministry of Agriculture, 1996).

The implementation of the European Union Nitrate Directive requires the designation of Nitrate Vulnerable Zones (NVZ), in which farmers are obliged to change their farming practices. In order to help farmers comply with the restrictions on the spreading of livestock manure in NVZs, the MAFF reintroduced (in 1996) farm waste grants for the installation or improvement of farm waste facilities (Ministry of Agriculture, 1996).

The Agri-environmental Regulation of the **European Union** (Council Regulation 2078/92) "on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside" requires all European Union member states to introduce a programme that is compatible with the European Framework. Many of these schemes aim to reduce water use and water pollution from farms, by promoting improved farming practices, or by encouraging the introduction of new technologies (Baldock 1996: 126).

In **Sweden**, water-relevant programmes under this EU Regulation mostly seek to reduce the effects of nitrogen and phosphorus-losses to surface- and groundwater. They include measures for the Restoration and establishment of wetlands and ponds on arable land, the establishment of permanent grassland to prevent nutrient leakage and erosion, and the promotion of specific crops which inhibit these processes. The total annual payment for these programmes is presently estimated to be about 6.8 million ECU (Bergvall, 1996).

New Zealand reports that there are currently no government subsidies to farmers to improve environmental performance. Instead, it is considered necessary to remove distorting price signals that lead to environmental "bads" before introducing measures to assist farmers for the provision of environmental "goods" (see box).

2.1.6 Main conclusions and policy options regarding water-relevant subsidies to agriculture

On the basis of the preceding examples, some general observations about the environmental and budgetary impact of water-relevant *agricultural* activities in OECD Member countries are highlighted below. Furthermore, policy options are briefly discussed that would result in budgetary and/or environmental gains.

- In most OECD Member countries, agricultural activities account for the largest share of overall water use, with irrigated agricultural activities comprising the largest portion within the agricultural sector.

Case Study: Environmental Effects of Removing Agricultural Subsidies -- Experiences in New Zealand

In 1984 and subsequent years, New Zealand removed virtually all direct and indirect support for agriculture. Affected measures were:

- output price assistance for agricultural products;
- input subsidies for fertiliser and pesticides;
- subsidies for irrigation and drainage schemes;
- land development loans and subsidised credits;
- tax concessions;
- free government services to farmers; and
- subsidies for soil conservation and flood control.

While these measures were largely taken for *economic* reasons, it was also considered necessary to remove distorting price signals, and to address *environmental* "bads," before offering governmental assistance to farmers for the provision of environmental "goods".

The resulting decline in incomes caused difficulties for rural communities. Farmers reacted by cutting back on all discretionary expenditures (fertiliser use, non-essential repairs and maintenance, new land development, new equipment). They also laid off labour and did more work themselves. Credit mediation and writing off about 20% of the total farm sector debt helped to limit the number of farms being sold to about 5%.

The removal of government support had a number of environmental implications:

- in some cases the financial stress of farmers led to short-term exploitation of the resource base;
- the development of marginal lands virtually ceased;
- livestock numbers declined;
- the use of fertilisers and other agricultural chemicals decreased;
- forestry plantings continued to increase;
- the previously constant increase in demand for irrigation water stabilised.

Overall, the New Zealand experience implies that the removal of subsidies may be a *necessary*, but not a *sufficient*, condition to redress the environmental impact of agriculture. The remaining externalities still have to be targeted through domestic environmental policies.

Source: (Shepherd 1996).

- Where intensive farming practices are employed, agriculture has a high environmental impact, especially in cases when practices take place in areas not suited for agriculture (marginal lands).

- In a number of cases, environmental degradation caused by agriculture produces identifiable economic costs. Most of these economic costs are to be found in the form of decreasing agricultural productivity or a shifting of cost-burdens to other classes of water user (industry, human settlement).

- In most OECD Member countries, there are some historically evolved “traditional” patterns of subsidies to agriculture. Overall, agricultural subsidies are widely used, deeply entrenched, and often large.

- The construction of agricultural water supply systems usually takes places in large areas with low population densities. In practically all cases, the necessary financial resources exceed the financial capabilities of the local population, requiring some form of subsidy for infrastructure construction. These subsidies are either paid by public funds or via cross-subsidisation from urban to rural water users. Regarding the operating costs of agricultural water supply systems, in most cases prices paid do not reflect the full *economic* costs involved. Only in a few cases do agricultural water prices include (estimated) costs of any environmental externalities at all.

- The *structure* of agricultural water prices rarely provides adequate price signals to farmers to encourage less water use, or to use the same amount of water more efficiently.

- Most OECD Member countries operate countervailing subsidy schemes that aim to promote less intensive agricultural practices, seek to establish environmentally-friendly farming practices, or encourage the re-cultivation of marginal lands.

- In *most* OECD Member countries, the high *economic* costs of agricultural subsidies have led to discussions about subsidy reform. In *some* countries the reform of agricultural subsidies is on the political agenda, and experience with the reforms is starting to accumulate.

The preceding observations allow for some general remarks concerning policy options for subsidy reforms:

- Currently, the effectiveness of subsidy schemes that aim to promote environmentally-friendly farming practices is being somewhat obstructed by “perverse” subsidy schemes that favour intensive farming methods. Thus, the removal of environmentally-detrimental subsidies would simultaneously improve the efficiency of subsidies for environmentally-friendly farming schemes (over the longer-term, it may even render them unnecessary).

- Considering the high environmental impact of current agricultural production patterns, coupled with the considerable economic cost effects of agricultural subsidies in most OECD Member countries, the reform or removal of subsidies to agriculture, (particularly in the case of irrigation subsidies) would probably result in environmental and economic improvements at the same time.

- Regarding the social and political problems associated with changes in agricultural production patterns, the removal of either input-oriented or output-oriented agricultural subsidies, and their replacement by direct income supports, may constitute a "first-step" towards capitalising the potential for *environmental* gains associated with subsidy reform. Subsidies in the form of income support would result in the higher political "visibility" of agricultural subsidies to all groups involved. This may shift the burden of proof away from those that would like to remove certain subsidies to those who want to maintain them.[3] Even if the maintenance of financial transfers to agriculture does not generate immediate budgetary savings, the *economic* costs of dealing with the negative environmental externalities of agriculture would be reduced, leading (*ceteris paribus)* to considerable economic gains in the medium- or long-terms.

- In each case, it should be assessed if the establishment of "correct" or "better" water prices can be accompanied by support for measures that raise the efficiency of agricultural water use. If adjusted properly, the financial losses caused by higher prices should be balanced by savings due to efficiency gains.

2.2 Industry

In many countries, industry is the largest (or one of the largest) user and/or polluter of water resources. Its impact on the aquatic environment can vary considerably. In the case of water *extraction*, the environmental effects will be similar to those related to extractions for other uses. In the case of water *pollution*, the types of substances involved will also differ according to sub-sector. Because of their often large operational scales, industrial sites can be important point sources of pollution that endanger the water environment, even if the substances involved are not particularly dangerous in themselves. Industry (e.g. thermal power generation) can also result in environmental degradation through thermal pollution. Heating aquatic ecosystems (normally rivers) reduces dissolved oxygen, while accelerating oxygen-demanding biochemical processes. In extreme cases, the combined effect can result in large losses of fish life. Below acceptable levels, changes in aquatic flora and fauna can be expected.

There are many subsidies to industrial sectors that have no specific impact on the water environment, other than expanding the scale of industrial activities beyond what would otherwise have been the case. However, direct impacts on water systems can be expected where incentives are given to expand water withdrawal by industry, or where pollution control costs for industry are reduced as a result of subsidies or taxation measures.

In relation to pollution control, mention must also be made of measures to regulate the flow of water courses that act as receiving waters for industrial effluents. Flow control measures can be designed to ensure that sufficient water is available at all times to remove the pollution loads emitted by industry within a particular river basin. However, no specific information about indirect support of this kind has been included in this study.

2.2.1 Industrial water withdrawal

In **Canada**, thermal power and manufacturing account for the largest share of industrial water withdrawals. The greatest proportion of industrial water (83% = 6.100 million m^3) is derived from *self-*

3. It would also allow for *other* types of arguments to be employed in the policy debate, especially regarding the positive social and/or environmental values of various forms of agricultural production, as a way of legitimising the maintainance of income supports to farmers.

supply systems. The 10% of industrial water supply that stems from *public* utilities is mostly used by small industrial plants (for which public water supplies are cheaper than the costs of self-supplied water systems), and by firms that need potable water for their own production purposes (food and beverages). Industries which use municipal supplies either pay flat rates, or pay on the basis of the lowest block of increasing-block tariffs. Virtually no volume-based charges exist for water withdrawals from publicly-owned surface or groundwater sources. Instead, municipalities often offer "promotional" water rates to industry, and thereby seek to enhance the local economic base (direct subsidy). If licence fees are levied, these are primarily aimed at raising revenue, instead of at promoting economic resource management. All user demands are met, regardless of their water-using practices. The necessary *infrastructural* measures for the provision of water have been accomplished through large subsidies (Tate and Rivers 1990; Tate and Scharf, 1995).

The perceived abundance of water resources in Canada has led to costs for water supply being "cheaper than dirt", and to consistent growth in industrial water use overall, from 18.045 million m^3 in 1972 to 36,003 million m^3 in 1991 (Tate and Scharf 1995). As a result of this policy, degradation of water quality has been observed (Tate and Rivers 1990: 466).

To achieve the sustainable use of water in Canada, it would seem essential to put a price on industrial water withdrawals from *self-supply* systems. One such approach has been discussed by Tate and Rivers (1990) in a case study of Ontario industry, where they proposed to recover the full costs of water management for this region from industry through charges on (metered) water withdrawal. Overall, these charges would amount to some 0.5 billion dollars per year. They would also have a substantial effect on industrial water use.

In **Denmark**, municipal and private water works generally seek to cover the full amount of capital and operational costs via water tariffs and charges. As of 1993, the average price of water was 3.10 DKK/m^3 (see section 2.3.1.). Generally, the water price per m^3 is the same for all types of consumers, and remains constant regardless of amount consumed. However, there are some examples of quantity discounts for industrial users. In the context of the tax on water consumption recently introduced as part of the "green tax reform", industrial water users can deduct this tax on water consumption from their VAT proceeds (Wallach 1996; Andersen 1996). Assuming that the additional costs imposed upon consumers by the tax on water consumption does not cover all of the environmental costs involved, this tax exemption could be regarded as a subsidy. This structure is identical to that facing Danish *agricultural* water consumption (see Section 2.1.1).

In **Norway,** there are some subsidies for the building of new (of the upgrading of existing) water plants. Water supply management and waste water treatment fall under the responsibility of the municipalities, which levy a local tax ("water and wastewater tax") to cover for the costs of water supply. Industrial water use is usually metered, and the water tax is adjusted accordingly. The municipalities are not allowed to give discounts to large industrial users (Sjoholt, 1996).

2.2.2 Industrial water discharge and sewerage systems

In **Canada,** surface waters exist in abundance and the largest part of industrial water withdrawal originates from *self-supply* systems. Similarly, industrial plants mostly discharge their waste waters directly to surface waters. As shown by a recent survey, between 50% and 60% of these discharges occur in an untreated form, and just over 40% of discharges are treated by primary mechanical methods. Only a relatively minor portion of waste water is discharged to municipal treatment systems (760.6 million m^3/year, out of 35,486.1 million m^3/year). As reported by Tate and Scharf (1995), current practices have succeeded in minimising private sector costs, but have created serious and persistent water pollution problems, despite very expensive regulatory efforts (1995: 43). The money required to regulate the environmental externalities of industrial waste water discharges is generated from the general state budget, and not from the polluters themselves (cross-subsidisation). It has been proposed, in order to put an adequate price on the water originating from industrial self-supply systems, that these water prices should reflect the administrative costs of dealing with the negative externalities of current discharge practices. Discussed in the context of Ontario industry, the full costs of this type of measure would have amounted to some 0.5 million dollars per year (Tate and Rivers, 1990: 471).

In the **US**, a 1996 survey of industrial pretreatment plants revealed that, in most cases, only limited information was available concerning the costs of providing services to specific classes of customers. As a result, multiple levels of cross-subsidisation within the pretreatment programmes, and between pretreatment and other municipal activities, was the norm rather than the exception. Without providing exact figures, it was concluded that the cross-subsidies in place generally resulted in underpricing services to industrial users of waste water services, which in turn led to under-investments in source reduction and pretreatment by these users (Koplow, Clark *et al.*, 1996).

2.2.3 Main conclusions and policy options regarding water-relevant subsidies to industry

On the basis of the preceding examples, some general observations about the environmental and budgetary impact of water-relevant subsidies to *industry* are highlighted below. Furthermore, policy options are briefly discussed that would result in budgetary and/or environmental gains.

- In OECD Member countries, industrial water use constitutes a large share of overall water use (largest or second largest).

- The water-related environmental impact of industrial production patterns can not be generalised. It depends on the type of activity involved, and on the environmental regulation regime which is in place.

- The overall level of subsidies to *industrial* water use is considerably lower than it is for *agriculture.*

- In most OECD Member countries, as regards the pricing of water services, the principle of “full cost recovery” is either already in place, is in the process of being implemented, or is under discussion. However, water-relevant subsidies to industry are still frequent. Industrial water prices therefore tend to depart from the principle of full cost recovery, and revenues lacking from tariffs or charges are covered by state budgets.

- When discussing the principle of full cost recovery and “underpriced” water services, one has to distinguish between three different dimensions of this principle: (i) operation and maintenance costs; (ii) capital costs and reserves for future investments; and (iii) environmental and resource costs. In general, industrial water prices cover the operational costs of providing industrial water services, whereas in only few cases the full amount of infrastructural costs is yet reflected in water prices. Only a few countries that have environmental taxation or similar instruments aim to include environmental costs into existing water prices. However, in these cases, exemptions for industrial water users often exist.

- Subsidies through water prices tend to be higher in the area of water *discharge* and *sewerage* systems than they are in the area of industrial water *supply* systems.

- In most OECD Member countries, industrial water price systems are of a flat- or bulk-rate type, or even include quantity discounts in their price structure. Only rarely are prices structured in ways that provide incentives to use less water, or to use available water more efficiently.

- In a number of cases, accounting problems have been reported that disguise the use and amount of cross subsidies between different classes of consumers and between public funds.

The preceding observations allow for some general remarks concerning policy options for subsidy reforms:

- Implementation of the principle of “full cost recovery” would raise industrial water prices significantly, and would provide an incentive to use water more efficiently. However, given a high enough water price, industry might switch to self-supply systems (if appropriate water resources are available, and their use is not inhibited by legal barriers). For those cases in which industrial self-supply is in accordance with the principle of “full cost recovery” regarding the *economic* costs of water services, a shift from public to industry-run water supply systems would render the “sunk-costs” of the public water infrastructure useless. In these situations, an *economic* threshold level for maximum water prices therefore exists. In practice, however, raising industrial water prices up to this level would significantly reduce the level of subsidy, and would reduce environmentally-adverse incentive effects accordingly.

- A higher price paid for industrial water is likely to result in more efficient water use. Apart from saving water resources, this shift would in effect reduce the vulnerability of industrial production processes to changes in the aquatic environment, be it in the form of relative water scarcities, or water quality degradations. This in turn will provide an additional potential for economic gains (e.g. capital-intensive measures of river flow control might be rendered unnecessary).

- At the moment, most OECD Member countries do not exploit the potential for structuring industrial water pricing to encourage the saving of water resources. Therefore, the inclusion of an environmental component into water prices would provide additional incentives to save water. These incentives would be even more pronounced if they were accompanied by measures that encouraged the introduction of technologies that use water more efficiently.

- The negative externalities of industrial water uses are much harder to specify economically than they are in the case of agricultural externalities

- There is a need for more transparent accounting, in order to identify the size and extent of cross subsidies currently in use. Only if the question of “who pays what to whom?” has been answered will political arguments about *why* some types of cross subsidies should be maintained be resolvable.

2.3 Human settlement

The concentration of human populations that characterise modern urbanised industrial societies would not have developed (and could not be sustained) without the regular provision of clean water for human consumption, and the prompt removal of human and other wastes from settlements. Water supply and sewerage systems together can be referred to as “urban water services” (understood to include central water supply and sewerage systems in rural areas). Because of the importance of these services, subsidies are often given for the construction of the necessary infrastructure, or for its operation. Such subsidies benefit (directly or indirectly) all users.

Urban water services are primarily aimed at the protection of human health, but also have significant impacts on the water environment. This is the case where large quantities of water are abstracted from the natural environment in order to supply population centres, and where water-borne wastes evacuated from such centres are subsequently released into aquatic ecosystems.

The operation of water supply and sewerage services are segments of the water industry that fall into the category of *public services*, even in cases where they are provided by private enterprise. The reason for this lies not just in tradition. There are good reasons to regard these water management functions as being “in the public interest”, the most important of which is the existence of “externalities”-- the positive and negative effects on the population of a city as a whole which are not (or cannot be) captured by market mechanisms.

In the past, such externalities relating to urban water services have been associated with public health. If sewerage services are ineffective in removing human wastes from an urban area, epidemics of communicable diseases could follow. Such diseases would affect not only those without access to normal sanitation facilities, but by reason of their infectious nature, would go on to affect the larger community. Therefore, it is in everyone's interest to have effective sanitation measures and sewerage systems in a city.

The water supply system involves similar externalities, especially if local wells carry a risk of infection and if the population depends on proper the functioning of flushing toilets. In effect, for reasons of public health, it is impractical to exclude anyone from access to sewerage, even if this were technically feasible. Moreover, for political and social reasons, it is often not beneficial to exclude users from the water supply system, even though this would be technically possible in many cases.

Today, environmental externalities have gained political prominence, especially in relation to sewage treatment. Effective and stable treatment of urban waste waters is necessary to reduce water pollution. Nutrient removal (phosphorus and nitrogen) must also often be carried out to avoid eutrophication. Environmental externalities of water supply occur, for instance, when the water table in a catchment area is lowered, affecting vegetation cover and surface water flows.

In addition, the provision of urban water services is largely indivisible.[4] The technical systems involved are complex and need to cover long distances (either to the source, or to the recipient, water course). The capital expenditure involved is large in comparison with the operating costs and the (marginal) cost of connecting an additional user. It is therefore uneconomic to build separate water supply or sewerage systems for only a small number of inhabitants of a city. It is more economic if everyone is

4. In rural areas and in suburbs, autonomous water supply, and especially, sewage treatment, is often a viable option. Preconditions include a ready supply of good quality water, and a reliable and effective treatment system respectively. Public health concerns also apply in relation to the contamination of natural waters and the removal and treatment of sludge.

connected to the same system. Furthermore, once the technical systems are put in place, it can become physically impossible to build a second system, and in many cases, there is no real choice among sources or points of discharge. In consequence, urban water services are natural monopolies and, in this respect, are similar to other public services.[5]

Electricity, gas and, to a certain extent, district heating can substitute for each other, while they also compete with liquid and/or solid fuels. Public transport exists in many forms which compete with each other, and with individual transport modes. Thus, the user has a choice. In practical terms, no substitutes exist in many cases for water supply (private or public wells, bottled water, rainwater cisterns) or sewerage (septic tanks). Every user and citizen thus has an interest in these services being provided effectively and efficiently, and in monopoly power being brought under collective (and democratic) control. This can be done in several ways, and with different institutional structures.

Irrespective of ownership and control over the operation of urban water services, regulation is therefore required to ensure that these natural monopolies are exploited under supervision, and that no abuse of monopoly powers occurs. Economic regulation of water supply or sewerage always needs to address the conditions of supply (access and possible exclusion), water tariffs and prices, as well as water quality (of drinking water or effluent and natural water courses respectively). Additional objectives of regulation include investment and profits, and returns on capital. Technical standardisation and operational rules also play an important role.

The practical design of tariffs and the setting of unit rates, as well as the imposition of regulatory conditions on access to (and exclusion from) urban water services, can result in discrimination in favour of (or against) certain water users or classes of users (subsidies through redistributive effects of regulating public services). Some examples of such subsidies are described in the following section.

2.3.1 Water supply systems

The **Canadian** system of public water supply is characterised by a perceived abundance of this resource (see Section 2.2.1). This situation has led to a *supply*-oriented, water management approach, and to very low unit prices for water (usually less than $1 per cubic metre; retail prices of water and wastewater services averaged just under $23.50 per month at the 35 m^3 level of usage). About half of the rate schemes are of the flat-rate type, about 19% of a declining-block-rate type, and only about 30% of the pricing schemes relate the amount of water used to a constant or increasing unit-price, thereby providing an economic incentive to limit the use of water. While, in theory, marginal prices are seen as the key benchmark to determine consumer decision-making, it is doubtful if this concept can be effectively applied in the Canadian context. With a very low price for water, marginal prices are also very low, and the costs of water will rarely be perceived as an economic factor that is relevant to the consumer´s decision (Tate and Lacelle, 1995). Despite low costs for the provision of water services, approximately CDN$ 3.3 billion is raised annually through municipal water rates (Tate and Lacelle 1995: 25). On the other hand, the estimated additional annual costs for the operation, maintenance, and improvement of the water (and wastewater) system are in the range of $ 4.5 billion between 1993 and 2003. Without adjustments of the prices for water and sewerage services, either the infrastructure of the current system is bound to degrade, or considerable subsidisation from other government sources will be ultimately required.

5. The common feature here is the existence of physical networks that cannot be duplicated economically. Other examples are electricity supply, gas supply, district heating and public (rail) transport. Telephones were another case, until radio communication made it possible to construct parallel systems.

It has been shown that, through more realistic pricing, the funds required for infrastructural measures could be raised in a way which would not cause undue financial hardship to municipal water customers (Tate and Lacelle 1995: 23). The resulting higher prices for water related to pricing schemes that provide economic incentives to use less water are likely to have positive environmental side-effects.

In the **Czech Republic,** drinking water supply before 1992 had been ensured by regional state-run enterprises. The prices to consumers for drinking water supply and sewerage services were fixed (until 1990) at 0.60 +0.20=0.80 KCS/m^3 for domestic use, and at 3.70+2.35=6.05KCS/m^3 for industrial and trade use. The operation was subsidised from the state budget with more than 2 billion KCS. Through a step-by-step increase, (implemented since 1994), prices now cover production costs of water services (prices include actual operation expenditure and "standard" profits). The average price for drinking water supply and sewerage in households is now 18.07 KCS/m^3. For other uses, it is 26.03 KCS/m^3 (Pavlík 1996: 1/2).

No subsidisation of the *operation* of water companies exists in the Czech Republic, except in a few small municipalities where it is used to eliminate a heavy social impact on household water users. Investments in the water sector are supported (to a maximum of 80% of the investment cost) by the state budget. In 1995, the state subsidy was reduced to 67% for water supply systems. Another subsidy is given in form of interest-free loans, with a 7-10 year repayment period (22% in 1995). State financial support for water supply represented 1.4 billion KCS in 1995, and 1.7 billion KCS in 1996. Overall, the support for water supply and waste water treatment (subsidy + return financial aid) comprised 3.0 billion KCS in 1993; 3.6 billion KCS in 1994; 2.9 billion KCS in 1995; and 2.7 billion KCS in 1996. Taking the inflation rate into account, state financial support has therefore actually been *declining* (Pavlík 1996: 2). The revenues generated from customers are used for maintenance or operations, as well as for investment purposes and loans repayment.

The increasing prices have led to substantial decreases in the production and consumption of drinking water. This trend is expected to continue in the future (Pavlík, 1996: 3 and 5). Measured by its own goals (elimination of inequality among those regions still lacking the financial resources in the municipalities for investment and maintenance of water supply systems; improvement of drinking water quality), the current subsidy scheme appears to be meeting its objectives — water pricing practices *are* discouraging overconsumption.

Water supply systems in **Denmark** are characterised by an abundance of groundwater resources, and a highly decentralised institutional structure. Approximately 305 municipal water works and 2881 private water works exist (Andersen, 1996). Furthermore, there are approximately 115,000 private wells and borings that mostly serve one house, typically a farm (Wallach, 1996). 99% of the water extracted by water works for water supply purposes stems from groundwater sources. Consumption of water supplied by water works declined by 20% between 1982 and 1994 (616 million m,^{3} to 493 million m^3/year). Under the Water Supply Act of 1978, municipalities are responsible for approving the local water supply tariffs that are proposed by the water works. The annual expenses for the water works are supposed to be covered entirely by tariffs or charges. Generally, there is a fixed charge, supplemented by a variable charge which depends on the consumption of water (Wallach, 1996). As of 1993, the average fixed tariff was 229 DKK, which on average made up 32% of the total tariff. The variable charge increased from an average of 2.65DKK/m^3 in 1984, to an average of 3.10 DKK/m^3 in 1993, with variations between 0.94 and 6.31 DKK/m^3. The fee per m^3 is normally the same for all types of consumers, and remains constant, independent of consumption. These prices do not include, but are subject to, VAT at a rate of 25% (Andersen 1996). As of January 1994, a national tax on piped water has been introduced as part of "green tax reforms". This tax is being phased in gradually, with an annual increase of 1 DKK -- it will reach its full rate at 5 DKK/m^3 in 1998. As of 1996, this rate was 3 DKK/m^3. However, the tax applies only to households. Industry, and agricultural activities can deduct this tax from their VAT proceeds (Wallach, 1996).

In Denmark, counties and municipalities are allowed to subsidise waterworks, principally for investment purposes. They are also permitted in some instances to subsidize operating costs. The extent of this subsidisation is not known, but is estimated to be limited (Wallach, 1996). As part of an effort to deal with the consequences of water pollution (especially from pesticides), the Minister of Environment and Energy intends to pass a law — the "Waterfund" — which will provide approximately 65 million DKK annually to affected waterworks for expenses related to new borings (especially small waterworks and single borings that extract their water from reservoirs close to the surface of the earth). This measure is effectively a cross-subsidisation to agriculture, since it deals with the negative externalities associated with intensive farming practices.

In **Ireland**, the capital costs of providing public water supplies are usually entirely met by the central government, with substantial assistance being provided by the European Union from Structural or Cohesion Funds. In cases of significant industrial use, some contribution from industry may sometimes also be required. With respect to pricing of water, a flat-rate domestic service charge is the norm. This charge ranges between £34-£150 per annum nationally (Egan, 1996). A 1996 report to the Irish Department of the Environment indicated that the water and sewerage charges levied in 1995 only covered about 75% of the costs of operating and maintaining water and sewerage services, (£86.95 million of charges levied, against total costs of £118.16 million) — i.e. subsidy through underpricing of services (KPMG Consultants 1996: 41). Without any information about local conditions regarding the quantity and quality of water available, it is difficult to make assumptions about the environmental impact of the existing charging scheme. However, it would seem both economically and environmentally advantageous to link the level of charges to the level of water consumption. In the absence of water meters, and given the anticipated high costs of metering all existing households which are connected to domestic water services (estimated costs of £200 million for installing water meters and of £8 million for maintenance, reading, billing and collection of metered charges), the pricing of water should probably be linked to the estimated level of consumption. Furthermore, the linkage between the level of water input and sewerage output could provide another approximation to be used when charging for sewerage. For the Greater Dublin area, a charging scheme has recently been proposed that would ensure that all categories of customers contribute on a fair and equitable basis towards the full financial costs of supplying water services (General des Eaux, 1996).

In **Italy,** with a net average rainfall per capita of about 5.200 m^3/year, water is generally abundant. However, there are considerable regional and seasonal differences that lead to large disparities between available water resources and water demand. (More than half of the potential water resources and more than 2/3 of the available outflow are concentrated in the North, while large parts of the South suffer from consecutive 100-150 day periods without rain (Massarutto, 1996 #82: 6).

Actual water use is not measured, but can be derived from various estimations about water needs. Overall, water needs are estimated to be 40.9 billion m^3/year, with domestic water use accounting for about 15%, or 5,8 billion m^3/year. The largest share of domestic water consumption is provided for by public waterworks, which in 1987 served 98.2 % of the Italian population.

In Italy, there is a deeply-entrenched system of financing public water works from government budgets (direct subsidy). Until the early 1980s, water services had been provided virtually free, but a worsening of water quality, overexploitation of underground catchments, as well as growing budgetary constraints, have each contributed to a process of reorganising these water supply patterns. As one consequence, charges have increased significantly, and are expected to continue to rise in the future.

However, municipalities still face political constraints in setting the level of their charges to reflect their cost structures. As a result, they remain largely dependent on subsidies to cover investment and maintenance costs. It is estimated that at least 70% of the capital expenditure for water supply is financed by public budgets (Massarutto, 1993). In absolute numbers, approximately 3 billion ECU have been transferred via grants or favourable loans for water supply purposes during the last decade. Furthermore, an additional 10-25 billion ECU is deemed to be necessary to meet the investment needs of maintaining and improving the current water supply infrastructure (Massarutto, 1996: 14).

Since 1975, a common framework for the charge structure has been in existence. It outlines a two-part tariff, with an increasing-rate in each block. The lower charges in the first block (civil uses) are subsidised from the upper blocks, and partially from the second block (cross-subsidisation), while charges in the second block (industrial/commercial uses) are calculated from average costs. However, for political reasons, this pricing scheme was never fully implemented, and the cost coverage obligation was alternatively relaxed and tightened until 1990. Nevertheless, from 1980 to 1985, prices did increase by an average of 87% (Massarutto, 1996: 18/19). As of 1992, the average annual cost for all water services, including sewerage and sewage treatment, are estimated to be 180 ECU per capita, which corresponds to a rate of 0,65 ECU per m^3 (approximately 0,43 ECU of which are used for water supply).

Due to a lack of transparent accounting by Italian municipalities, there is no reliable information about the use being made of the revenues from these charges. However, evidence does exist that some local administrations are using the charges as a fiscal policy tool, by trying to integrate costs into the water bill that are not related to the service being provided (Massarutto, 1996: 20).

In the past, pricing practices in Italy have mostly been oriented at questions of equity and inflation control. They have largely ignored aspects of allocative efficiency or environmentally-sustainable consumption patterns. In effect, this lack of incentives for an economic use of water resources has contributed to severe water shortages in the south (an average number of 36,07 days with critical situations, due to insufficient supply has been reported by Federgasacqua, a public water supply network comprising 55% of all water supply firms). Furthermore, groundwater pollution emerged as a very serious problem during the 1980s and early 1990s. In most distribution systems, drinking water could only be supplied by means of temporarily derogating European Union standards (Massarutto, 1996: 9)

Reform of current pricing schemes for water supply seems almost inevitable from the budgetary perspective, and reform efforts are already underway (Massarutto, 1996: 23). While allocative efficiency certainly would be enhanced (preventing overprovision of supply infrastructure in the future), the low price elasticities associated with public water supplies do not promise considerable changes in domestic consumption patterns unless a critical “visibility” threshold were to be exceeded. However, for industrial and irrigation purposes, significant water-saving and efficiency-gaining capacites are likely to be realised. At least the overexploitation of groundwater and surfacewater resources in some areas of Italy would be slowed down.

In the **Netherlands,** water pricing is based on the principle of cost recovery (“polluter pays” and “user pays”). A *fixed* fee is applied to cover the standing costs; a *variable* fee is related to the amount of water consumed (consumption is mostly metered, otherwise there exists a “subscriber tariff”). As of 1993, prices per cubic meter ranged between Dfl 0.85-2.50, depending on the origin of the water and regional circumstances. Purified and processed surface water results in prices twice as high as those for processed groundwater. Fixed fees vary between Dfl 37-150 per cubic meter, with a mean price of approximately Dfl 70. It is expected that this price will increase by 10% annually, at least until the year 2000, because preventive measures against source-pollution, the removal of nitrates, pesticides and chemicals (among others) will require further investments into the water supply/water treatment system (van den Bergen, 1993: 5). Despite “full cost recovery”, however, the resource base is still slowly degrading (increasing fees for investment purposes constitute cross-subsidisation to polluters, mostly to agriculture).

In **Norway**, water management does not face a *quantity* problem, but does to some extent face a *quality* problem. With the opportunity costs of water being close to zero, the costs of supplying household and industry with water hinge largely on investment costs in waterplants and pipelines. The building of new or upgraded water plants is, to some extent, subsidised by state authorities. As of 1995, the rate of subsidisation was 7.3% (89,980,000 NOK of 1,235,176,743 NOK. The amount of the subsidy is calculated on the basis of projects which have *applied* for the subsidy, the *real* amount will be slightly smaller). Based on a framework regulation adopted by the Ministry of Environment, costs for providing water services (water supply, waste water discharge) are collected by municipalities through a local tax (“water and wastewater tax”), that is divided into a connection fee and a yearly payment. In general, municipalities are supposed to set the price of water at a level where the revenues equal the costs of water supply. However, the municipalities are not restricted from subsidising the water supply if they want to lower the tax-level for their citizens (Sjoholt, 1996).

Since 1985, the **Spanish** water supply system has been undergoing transformation from a system where water was considered to be a public good, to one where costs are increasingly been internalised. Urban water use currently accounts for about 11% of the total water use (agriculture for 80%, independent industrial uses for 5%). Institutionally, the management of water services is divided between two levels of government. The 11 *Basin Authorities* (covering catchment areas of specific rivers or groups of rivers) are responsible for water resource development. They plan and manage the water supply to municipal water supply agencies and Municipal Authorities. The *Municipal Authorities*, in turn, are in charge of purification, secondary distribution, as well as the collection and treatment of waste water (Maestu, 1996: 5).

In Spain, an estimated 50% of infrastructure costs for water supply is provided via subsidies from various sources (Maestu, 1996). In 16% of municipalities, operational costs are also subsidised (Maestu, 1996: 18) The municipal water supply agencies and Municipal Authorities have to pay an average of 0.48 ptas per m^3 of received water to the Basin Authorities. The revenues are supposed to cover the Basin Authorities´ capital and operational costs attributable to specific waterworks. However, in 1994, the Basin Authorities experienced a deficit of 5.4 billion pesetas, which was covered through subsidies from the central budget. It is reported that this shortfall originated from ineffective levying of the water abstraction charges. The municipal water supply agencies and Municipal Authorities, in turn, each charge domestic users for their water services. Normally, two-part tariff systems are used, in which one part is determined by a fixed standard charge (67% of tariff systems) or a minimum consumption quota (33% of tariff systems), and the second part of the tariff is determined by the actual volumes used. Regarding the latter part of the charge, (as of 1992), 86% of municipalities used an increasing-block tariff, 13% applied a uniform rate, and 1.5% of the tariffs were of a decreasing-block type. The resulting average price for water supply in Spain was 68.08 ptas per m^3 in 1992 (Maestu, 1996: 10 and 14).

In the **UK** (England and Wales only), two types of water industry exist: 10 water service companies which provide *both* water supply and sewerage services, and 19 companies supplying *only* water supply. The latter companies provide approximately 25% of the drinking water. In general, water companies are liable to corporation tax. For qualifying capital expenditures, tax relief in the form of capital allowances is granted (subsidy via tax exemption). Water companies have to cover both their operational and infrastructural costs from the charges taken for their services, and from money borrowed on the open capital market, since there are no favourable government loans available. However, the prices charged for water services are regulated by the Office for Water Services (Ofwat), at a level that is supposed to ensure that the water companies themselves are able to fulfil their functions from the generated revenues. Within the overall price limit, the structure of the charging schemes is set by the water companies themselves. Prices are supposed to be set so that they reflect the costs of the services provided, and that no undue discrimination occurs among classes of different customers occurs. For *metered* households, the amount charged is related to the volume of consumption; for *unmetered* households, the charges are set on the base of the rateable value of the property. Except for some business customers, water supply is not subject to VAT (subsidy via tax exemption) (Zabel and Orman, 1996).

2.3.2 Water discharge and sewerage systems

In **Australia,** impaired water quality in streams and in sea water (due to inadequate treatment of wastewater and excessive flows into streams and oceans) is reported to be a major environmental problem (Commonwealth of Australia, 1996*a*). The overall level of subsidies is substantial and these subsidies mainly occur through non-recovery of costs by public sewerage and drainage authorities, and from fiscal practices which encourage, (or do not discourage), liquid waste production. A survey of metropolitan areas conducted by the Australian Resource Management Committee of Australia and New Zealand shows that, as of 1993-94, subsidies comprised between 4 and 8% of the real costs — only Melbourne Water achieved full cost recovery. Overall, however, recovery of the *economic* costs of waste water treatment has been improved, in comparison with the period before 1994.

Despite the gradual achievement of full-recovery of the economic costs of constructing and maintaining water discharge and sewerage systems, the existing negative environmental externalities will still require large investments in the future. In 1990, the Australian Water Resources Council estimated that new investments of over A$2.5 billion would be required for urban sewerage treatment assets in order to provide limited improvements in nutrient removal. This survey also indicated that the planned investments at that time amounted to only about 20% of the sum estimated to be required (*ibid*.).

In reaction to some of the environmental problems associated with waste water treatment, the Sydney region initiated a comprehensive programme as part of its Clear Water Programme (CWP), with planned expenditures of around A$7 billion over the 20 years between 1989 to 2009, in order to improve marine and inland water quality, to reduce odours, and to restore bush and wetland areas in the region.

In **Canada,** charges for sewer collection and treatment are typically billed together with water charges. Flat-rate sewer charges are the most frequently-used type, while a second frequently-used type is the fixation of a certain portion of the customer´s bill for water supply. The sewer charge portion of the water bill is often over 40% of the total, and sometimes exceeds 100%. Because sewerage costs are frequently integrated into the water bill, the summary financial data related to these amounts is also typically integrated (Tate and Lacelle, 1995: 14). For that reason, the same information reported in Section 2.3.1 also applies here.

In the **Czech Republic,** 73.2% of the population is now (1995) connected to public sewerage systems, and 89.5% of the waste water released to public sewerage is being purified (Pavlík, 1996: 4). The task of sewerage collection and disposal, formerly performed by regional state-run enterprises was entrusted to the municipalities in 1992. (For recent developments in these pricing regimes, see Section 2.3.1.)

While the *operation* of sewerage/waste water treatment is no longer being subsidised, subsidies for *investments* covered 77% of costs in 1995 (56% via direct payments, 21% via returned financial aid). This amounted to 1.5 billion KCS in 1995, and will reach 1.0 billion KCS in 1996 (Pavlík, 1996: 2). The main source of financial support is the State Environmental Fund, administered by the Ministry of Environment. The revenues generated are used for operation and maintenance of the waste water and sewerage facilities, as well as for loan repayments and investments in new infrastructure (Pavlík, 1996: 3).

In the Czech Republic, large inequalities exist among regions, and the municipalities do not yet have enough financial resources for required investments in network renewal and/or enlargement. Therefore, existing subsidy schemes will still be necessary for the immediate future. To meet water quality requirements for public water supply, as well as to improve the quality of water in catchment areas for water abstraction, the subsidised construction and modernisation of waster water treatment plants and sewerage facilities seems necessary from both a public health and an environmental perspective (see also Section 2.3.1).

In **Denmark,** the average waste water charge per cubic metre has increased from 2.80 DKK in 1984, to 9.43 DKK in 1993. This is more than three times higher than the price for one cubic metre of fresh water supply, and therefore largely determines the total water price. As of January 1997, a national tax on waste water, which applies to direct discharges from municipal sewage treatment plants and industries, will be introduced as part of "green tax reforms" (Andersen, 1996). Taxation will depend on the waste water´s content of nutrients. It is estimated that the average charge will be DKK 0,75 per cubic metre. Reportedly, certain (pollution-intensive) industries (fishing, cellulose production, sugar-production and certain chemical industries) are partly exempted from this tax (subsidy via tax exemption) (Wallach, 1996).

In **Italy,** capital expenditures for sewerage, and sewage treatment are financed entirely out of the public budget (Massarutto, 1993). During the last decade, approximately 7 billion ECU have been transferred via grants and favourable loans for sewerage and sewage treatment purposes (Massarutto, 1996: 16).

In the **Netherlands,** sewer construction, operation, and maintenance are the responsibility of municipal governments. The pumping stations, the pipework needed to transport the waste water to treatment plants, and the treatment plants themselves, are generally owned and operated by regional water boards. 97% of households are connected to the sewer system. In the past, there had been several subsidies available for speeding up the connection of waste water discharges to the sewer network, and to the Publicly-Owned Treatment Works (PTWs). Apart from a general flow of state money to municipalities (the "Municipality Fund"), which is used to finance a wide variety of municipal tasks, as of 1993 there were no programmes in force to transfer money for the operation, maintenance or expansion of the sewerage/water treatment systems. Current policy requires municipalities to strive for 100% coverage of sewerage management expenses from their own resources, preferably by levying a sewer tax. Only in dedicated soil protection areas are some (very limited) subsidies available (van den Bergen, 1993: 6).

In **Norway** (see Section 2.3.1), the municipalities are responsible for water and waste water management. The costs for providing water services are collected through a local tax. In principle, the municipalities are supposed to set the price of water at a level where the revenues equal the costs of water supply in practice. However, the *costs* of wastewater treatment are 12% higher than those paid in the waste and wastewater fee, which results in a 12% subsidisation to the households from the municipalities (subsidy via underpricing) (Sjoholt, 1996).

Traditionally, the **Spanish** water supply and waste water system was almost entirely subsidised. Since 1985, Spain has sought to transform its water services system from a system which considered water as a public good to one where costs are internalised. However, in order to meet the objectives set out by European Union Directive 271/91, an estimated 1.9 trillion pesetas (12.101 billion ECU) of investments in new connections and infrastructural improvements will be necessary (Maestu, 1996: 4). Raising such large sums will require massive subsidisation from various sources: the Central Government will contribute an estimated 25% of these costs. In the period from 1995 to 2000, an estimated 2010 million ECU will need to be spent (an average of 402 million ECU annually). Regional Governments will provide about 10.286 million ECU through their general budget. These payments will be partially covered by European Union Cohesion Funds (in 1995, 235 million ECU were available) and by Regional Funds (between 20 and 40% of the total investment in the sector). Furthermore, water utilities, municipalities, and regional governments can apply for favourable loans with subsidised interest rates from the European Investment Bank. As of 1993, there were 79 billion pesetas available in outstanding loans of this type.

Wastewater collection and treatment in Spain is paid for through three types of charges. The *discharge tax* is levied by the Basin Authorities to the Municipalities and private water utilities for discharging into lakes and rivers. The *sanitation tax* is levied by the regional governments and local authorities, to recover the costs of wastewater treatment, and municipal sewage charges. There are also *other taxes*, levied by the municipalities, to recover the costs of the municipal sewage network (Maestu, 1996: 14/15).

A 1994 study calculated the average charge of Basin Authorities to Municipal Organisations at 0.48 ptas per m^3 of water used. In 1992, the highly complex discharge tax led to a situation in which only 1,600 million of the charged 6,500 million pesetas were actually received. As a consequence, subsidies from the central budget were needed to cover the operational costs of the Basin Authorities (Maestu, 1996: 16). The pricing practices of the municipal authorities and water utilities are subject to regulation by the Regional Governments. As of 1992, the average price charged for municipal waste water treatment in Spain was 19.35 pesetas per m^3 (Maestu, 1996: 10).

Switzerland is currently discussing the reform of its system of subsidising the construction of sewerage and waste water treatment from the central budget. To date, subsidies to the Cantons (regional political units, similar to federal states) have ranged between 15-45% of the construction costs. Total annual payments have amounted to approximately 110 million SFR. Despite drastically reduced contributions from the central budget to future projects in this area, outstanding obligations of the central budget still amount to 1,370 million SFR (Eidgenössisches Departement des Innern, 1996).

2.3.3 Main conclusions and policy options regarding water-relevant subsidies and human settlement

On the basis of the preceding examples, some general observations about the environmental and budgetary impact of water-relevant subsidies in their relation to *human settlement* in OECD Member countries are highlighted below. Furthermore, policy options are briefly discussed that would result in budgetary and/or environmental gains.

- In OECD Member countries, the amount of water withdrawn for human settlement is generally smaller than for either agriculture or industry.

- The local and regional availability of water resources differs considerably among OECD countries. Negative environmental externalities associated with water supply systems are of importance, especially where large quantities of water have to be transferred from rural to urban areas.

- In a number of OECD Member countries, degrading local or regional water resources has required the introduction of more costly wastewater treatment facilities. The costs of wastewater treatment have therefore risen considerably in recent years.

- Since water supply and sewerage systems require large infrastructure facilities that are constructed, operated, and maintained by public or private agencies which sell water services to consumers, subsidies generally occur via "underpricing". In most of the observed cases, the *economic* costs involved with water supply and wastewater discharge are not fully covered by the generated revenues, and require compensating financial transfers.

- Tariff structures for water prices tend to include a *fixed* fee to cover standing costs, and a *variable* fee to cover operational costs of water-related infrastructure. In a number of countries, the structure of these tariffs is *not* related to the actual amount of water consumed. On the other hand, a number of tariff structures or charging schemes in operation *do* aim to provide incentives for the use of less water. Some OECD Member countries (e.g. Denmark, Germany, Netherlands) even seek to include an explicit environmental component into their charging schemes, through abstraction taxes that become part of the water price.

- In general, for both water supply and waste water discharge and sewerage systems, operating costs are covered by prices or charges. If exceptions exist (subsidy), these can often be justified by social reasons.

- There are considerably higher levels of subsidies involved in the *construction* of water infrastructure than for its *operation*.

- As regards the existing tariff systems, a large variety of subsidy patterns can be identified: subsidies from richer to poorer users; cross-subsidies from urban to rural (or among different urban) areas served by the same utility system; cross-subsidies between different types of users (human settlement, industry, agriculture); temporal subsidies; unintended subsidies to polluters (lack of administrative capacity to effectively collect due charges); hidden subsidies (non-transparent accounting of some municipalities). These financial transfers can be related to a range of social, economic, and administrative reasons.

The preceding observations allow for some general remarks concerning policy options for subsidy reform:

- Although some generalisations can be made about water-related subsidies in the area of human settlement, the important public function of providing water services requires careful assessment for each case in question, to decide if (and under what conditions) a significant rise in water prices can be justified. In effect, this means that the principle of "full cost recovery" has to be weighed against social and economic interests, public health interests and social policy objectives.

- Before generally raising the prices of water to encourage more efficient water use, *specific* incentives that promote the use of less water within existing should be used.

- More transparent accounting practices would seem to be an important step towards assessing who actually pays for the various components of the water services, allowing a proper evaluation of currently existing water subsidies in the area of human settlement.

- Increases in water tariffs might be coupled with programmes that encourage more efficient water use practices.

2.4 Electricity generation

The energy sector, (more specifically, the construction and operation of power stations) can have several important impacts on the water environment. This is obvious in the case of hydroelectric power with the *construction of dams and weirs*, which often significantly reduce fish passage in rivers. Environmental damage is less obvious, but no less significant, *where water flow regulation* is a necessary part of ensuring the safe/efficient operation of thermal and nuclear power stations. In such cases, upstream dams are designed to stock water from wet seasons, in order to release it during low-flow periods, so that sufficient water is available for cooling purposes. Both the construction of dams and changes in flow patterns can alter the characteristics of aquatic ecosystems. In addition, water extraction and the discharge of polluted water (including thermal pollution) both affect river ecology in ways that are similar to the consequences of abstraction for, and discharges from, manufacturing industry.

2.4.1 Thermal power plants

In **Canada**, 1991 water withdrawals for thermal power generation constituted by far the largest share of water use by the industrial sector (28,357 million m^3/year out of 36,003 million m^3/year for all industrial users). Electric power plants accounted for approximately 99% of water intake in this sector (28,288.1 million m^3/year). Close to 92% of this water was withdrawn from surface water resources (26,035.1 million m^3/year), and also discharged to these water bodies (25,929.0 out of 26,035.1 million m^3/year). In 1991, the total costs for acquisition and intake treatment of water amounted to $23.0 million, with costs for intake treatment accounting for well over 70% of this total. In contrast, expenses for public utilities and provincial license fees made up only $1 million of this sum ($0.9 million and $0.1 million respectively). With costs for water being determined almost exclusively by operating and maintenance costs, as well as by intake treatment costs, the thermal power generation industry has no incentive to employ intensive methods of water usage. As a consequence of these economic conditions, thermal power generation plants in Canadian industry almost exclusively employ “once-through” cooling systems, and recirculate no water at all (Tate and Scharf, 1995).

2.4.2 Dams

Dams typically perform a number of functions with regard to water uses. They generate electricity and at the same time are used for river flow control. The resultant artificial lakes may serve as drinking water reservoirs and recreational sites

In the **US**, more than 100,000 dams exist, 5,500 of which are more than fifty feet high. The changes in river flow regimes, and the resulting barriers to fish passage can have a significant impact on the aquatic environment. Notwithstanding these environmental consequences, the budgetary effects of dam building are even more important (Devine, 1995). Typically a number of subsidies are “clustered” around the construction and operation of dams. In most cases, *construction* costs are either completely or mostly subsidised by state budgets. Regarding *operating* costs, other types of subsidy are often in place. For example, navigating barges often do not pay for operation and maintenance costs of dams, including the servicing of locks. With regard to generated electricity, cross subsidies to irrigated agriculture are particularly well-documented. While irrigation water is frequently sold at prices below the economic costs involved (see Section 2.1.1), in many instances, these subsidies are complemented by electricity prices needed to pump the irrigation water that are below production costs. In at least one reported case, it was actually economically profitable for farmers to run irrigation water through their hydroelectric generators, and sell the resulting power at market rates (Harden, 1996: 133/134).

3. Conclusions

3.1 Subsidies and their environmental effects

As described in the Introduction, this study has aimed to identify so-called “win-win” situations in the relationship between water subsidies and the environment. In order to identify and evaluate such situations, one would ideally wish to be able to: (i) assess the incentive structure provided by a given subsidy; (ii) estimate the extent to which this incentive structure actually induces changes in economic behaviour; and (iii) evaluate how these changes in economic behaviour actually affect the aquatic environment.

On the basis of information currently available, however, no reliable *quantitative* assessment was possible of the fiscal and environmental consequences of subsidy reform in the water sector. (There are a few specific exceptions to this general statement, and some examples have been provided in the preceding sections.) However, it is possible to draw some *qualitative* conclusions about the relationship between effects on the aquatic environment and water-relevant subsidies, as well as about the environmental and budgetary consequences of the reform or removal of these subsidies. Three basic cases or types seem to exist:

First, some specific subsidies seem to have a direct negative effect on the water environment. Several examples are provided in this paper, including the situation where tariffs paid for water supply are kept below the economic costs involved, leading to overconsumption of water, and thus, to environmental degradation. Increasing the price of water would provide additional revenues for governments or reduce the need for subsidies for water services, while contributing to reduced water consumption or a better quality of the environment.

The second case refers to situations where the negative environmental effects caused by one subsidy scheme (the “perverse subsidy”) feed back on the economy and produce costly effects for *other groups of actors*. In order to compensate for these environmental externalities, *additional compensating subsidy schemes* (“compensating subsidies”) are then put in place, either in the form of cross-subsidies between different classes of water users, or in the form of direct financial support from public funds. An example of this type is the public support granted for the construction of new water works for public drinking water supply that have become necessary because of environmental pollution caused by (subsidised) intensive farming practices. In this case, the reform or removal of the original “perverse” subsidy is likely to result in *additional budgetary gains*, since improvements in environmental quality would automatically render the *compensating subsidies* unnecessary.

In the *third* type of “win-win” situation, environmental degradation can be related to a specific behaviour that is caused or maintained by the general nature of the socio-economic environment (e.g. absence or inadequacy of environmental regulations, nature of property rights regimes, etc.), and no strong causal relationship can be observed between any one subsidy scheme and the behaviour in question (i.e. there is no obvious “perverse subsidy”). If the negative environmental externalities “feed back” on the social and economic sphere, they frequently produce cost effects for *groups of actors other* than those actors which are responsible for the original negative environmental effects. Often, these groups will receive compensating subsidies from public funds. In such cases, the removal of the subsidy scheme would lead to *budgetary* gains. However, the *environmental externalities* that provided the justification for the compensating subsidy in the first place will only be reduced if the cost burden can be shifted from the group of actors *affected* by the environmental degradation (the "victims") to those actors *causing* it (polluter-pays-principle and resource-user-pays-principle). Thus, in this type of situation, subsidy removal has to be accompanied (or preceded) by regulatory reforms which would result in the effective internalisation of environmental costs, including those previously borne by others.

3.2 Reforming environmentally harmful subsidies: some policy considerations

A number of suggestions for policies aiming to address the subsidy-environment interface are provided below.[6] These suggestions might facilitate the development of this topic in the *political* sphere.

Subsidy removal or reform should come to be regarded as a necessary first step when discussing economic instruments in environmental policy. At present, the large variety of subsidy schemes in existence have a significant impact on the incentive structure of economic agents. Economic instruments of environmental policy that are introduced in the presence of (possibly countervailing) subsidy schemes with negative impacts on the environment will *not* be efficient policy tools, and thereby risk undermining the public acceptance of those instruments more generally.

- In many cases, subsidy removal will provide the potential for mutual budgetary and environmental gains. Nevertheless, changes in patterns of subsidisation need to be *phased in* in ways that allow for non-disruptive social and political adaptation.

- More *transparency* about subsidies needs to be achieved, in order to allow for a sound assessment of subsidy schemes in use, especially with respect to accounting practices in municipal services and in privatised public services. Enhanced transparency would also be beneficial for the carrying out of future analytical work in this area.

- To some extent, the existence of a large number of “perverse” subsidies reflects the lack of integrative assessment of the subsidy-environment-relationship in political decision-making. While overall responsibility for public finance typically rests with Ministries of Finance, particular decisions on subsidies are often taken by ministries or agencies responsible for specific economic sectors (e.g. agriculture, transportation, or for the environment). If environmental considerations were to be integrated in subsidy-relevant policy processes at an early stage of decision-making, the occurrence of “perverse” subsidies might be avoided in the first place. However, better integration of environmental and economic interests is currently being impeded because ministries of finance normally have no competence and/or responsibility to address *environmental* issues by themselves. Judging from the research underlying this paper, these ministries often appear reluctant to “take sides” in what could turn out to be an inter-ministerial conflict. At the same time, the necessary *economic expertise* might be missing in Ministries of the Environment. Or, there might be no clearly allocated responsibility for addressing subsidies and the environment as a priority policy area within these ministries. In such cases, there would be no-one in a Ministry of Environment to actively approach the Ministry of Finance, with a view toward building the appropriate strategic alliances. This stalemate may be overcome if the necessary competencies could be

6. For a more complete set of specific policy strategies suggested to policy-makers, see de Moor, 1997:54-56.

established (and the responsibilities defined) in the appropriate ministries of OECD member countries.

3.3 Suggestions for future research

The experience gained during this survey of “perverse” water subsidies suggests two basic observations concerning future research in this area:

- Currently, only a small number of studies *simultaneously* assess both the economic and environmental implications of subsidies. Methodologies for assessing these variables would therefore be beneficial.

- The evaluation of “perverse” subsidies has to deal with considerable political sensitivities. This is especially important for comparative studies of OECD member countries. These political sensitivities may be reduced by: (i) looking at past examples (e.g. the former German Democratic Republic); and (ii) evaluating actual experiences with subsidy *removal* (e.g. New Zealand).

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