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Evolution of Integrated Approaches to Water Resource Management in Europe and the United States

Some Lessons from Experience

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ACRONYMS AND ABBREVIATIONS

CAMS	Catchment Abstraction Management Strategies
CBC	Chesapeake Bay Commission
CFR	Code of Federal Regulation
CIS	Common Implementation Strategy
CSOs	Combined Sewer Overflows
CWA	Clean Water Act
DOE	Department of Energy
DRBC	Delaware River Basin Commission
DWR	Department of Water Resources
EA	Environmental Agency
EC	European Commission
EEA	European Environmental Agency
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FMfE	Federal Ministry for Environment, Nature Protection and Nuclear Safety
FWS	Fish and Wildlife Service
GDR	German Democratic Republic
ICPR	International Commission for the Protection of the Rhine against Pollution
ICPR	International Commission for the Protection of the Rhine
ICWE	International Conference of Water and Environment
IHE	International Institute for Hydraulic and Environmental Engineering
IWRM	Integrated Water Resources Management
LAs	Load Allocations
N	Nitrogen
NCWCD	Northern Colorado Water Conservancy District
NP	Nitrogen Phosphorus
NPDES	National Pollutant Discharge Elimination System
NPK	Nitrogen Phosphorus Potassium
NPS	Nonpoint Source
OECD	Organization for Economic Cooperation and Development
Ofwat	Office of Water Service
OTA	Office of Technology Assessment
RAP	Rhine Action Plan
RBA	River Basin Authority
RBMP	River Basin Management Plan
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
TMDLs	Total Maximum Daily Loads
UN	United Nations
UNECE	United Nations Economic Commission for Europe
USDA	United States Department of Agriculture
USFR	United States Federal Register
USGS	U.S. Geological Survey
WFD	Water Framework Directive
WLAs	Waste Load Allocations

CHAPTER 1: INTRODUCTION

This report is designed to highlight some of the key policy, legal and institutional issues encountered in the management of water resources, drawing primarily upon experience in Europe and the USA. The objective is to identify issues and lessons that are most relevant for the situation now existing in China, where, despite legislative and institutional reforms, water scarcity and deteriorating quality clearly pose a growing threat to continued economic growth.

Countries throughout the world have wrestled with these problems for many years. Major difficulty lies with the fact that conflicting interests are typically involved, and lack of policy, institutional and financial mechanism to address and sole these issues.

Nevertheless, significant progresses have been achieved in water resource management in Europe and the Unites States and some other countries over the past 10 to 15 years. Water policy and management are experiencing a transition of from sector to an integrated manner.

International experience indicates that there are certainly many experiences that can be taken to improve the situation in China, where there is prima facie evidence that water resources are being used in wasteful way, as judged by indicators such as economic efficiency or equity. Thus the widespread concern that major rivers are drying up implies acceptance of the view that the diversion of upstream resources for various uses is unjustified in terms of productivity or fairness.

In reviewing some international experience, this report first outlines the nature of the issues, and then considers key institutional, legal, and regulatory approaches, followed by a review of economic instruments and finally the role of public participation. Some general lessons from this experience are then drawn.

CHAPTER 2: PRESSURE FOR CHANGE

Growing Scarcity

Europe and the United States made significant progress in economic and social development from the end of World War II to the 1960s, but by that time it was becoming increasingly apparent that this had come at a price, namely the rapid deterioration of the environment. Water resource management was already, and continues to be, one of the most urgent environmental issues needing attention as scarcity and the declining quality of water threaten economic growth and public health. The major causes of the problem are highlighted below.

Urbanization: Urban expansion and population growth requires increased water supply and sanitation capacity including both collection systems and treatment plants. Increasing abstraction from surface and groundwater is accompanied by an increase in the amount of wastewater discharged into aquatic systems. Flooding results from increased runoff.

Industrialization: More chemicals, many of them toxic and non-biodegradable, eventually flow into surface, ground, and marine water. Air pollutants also contribute to deterioration in water quality.

Modern Agriculture: More and more chemical fertilizers and pesticides are being utilized to increase productivity. A significant amount of these chemicals enters rivers, lakes, reservoirs and soil, resulting in eutrophication and groundwater pollution and threatening the safety of the water supply. Erosion causes sediment issues. Livestock has become another source of water quality deterioration. Abstraction of irrigation water can affect river flow and aquatic environmental conservation.

Poor water quality is a direct consequence of inappropriate economic activities. Eutrophication due to nutrient discharge leads to an algae boom in lakes and reservoirs. Nitrate and pesticides coming from agriculture pollute ground water, and treatment is expensive. From the 1950s to the 1970s, the Rhine River, the largest in the Western Europe and the supplier of drinking water to many bordering countries, was heavily polluted by industry, agriculture, transportation, etc. In some sections, certain species of fish became extinct. Catastrophic water-related events occurred frequently; one example was the disastrous 1986 fire in Schweizerhalle, Switzerland, which led to serious pollution of the Rhine. For several days, fisheries and drinking water production had to be stopped as far as 1,000 km downstream in the Netherlands. The Rhine River was labeled a "European sewer." A similar situation occurred in the 1980s in the United States. The deaths caused by *Giardia Lambia* in the water-supply system indicate that drinking water is no longer safe even though sophisticated processes and technology have been developed and applied.

Flood Control and Power Generation: More and more dams and reservoirs have been built for flood control or power generation. However, these physical infrastructures can impair the self-purification capacity of the river systems and lead to ecological disasters. Power generation uses enormous amounts of water, reducing environmental flow and affecting fish and other wildlife.

Engineering Infrastructure: Engineering approaches have been applied to satisfy various types of water demand for many years. Along with increasing abstraction and wastewater discharge, aquatic systems are becoming more and more vulnerable. Free water extraction and unreasonably low prices of water service further accelerate this tendency.

Huge *investments* have been made in sewage collection and treatment plants, at times not always yielding expected results. Moreover, non-point (diffuse or area) source pollution plays a major role in overall pollution and is difficult to address. The shortage of funding has become more and more acute in light of the need to implement stricter standards and to upgrade aging infrastructure.

Institutions and Administrations respond slowly in the face of various challenges. This is due partly to the fact that in most cases, they do not have jurisdiction over the area of the basin in which the water problems occur. As a consequence, sectoral operations tend to work independently of each other, causing conflict among various administrations, up- and down-stream, reducing water supply and quality. These human activities and management approaches lead to river-flow reduction, falling groundwater tables, and saltwater intrusion. Eventually, the scarcity of clean water threatens all aspects of human activity, and not merely the rate of economic growth.

An Integrated Approach

Growing problems worldwide toward the end of the 20th century provided the impetus for many governments to adopt a more systemic approach to water resource management, based largely upon research and policy analysis done many years earlier. Major shortcomings in implementation still exist, but the shift from sectorally fragmented to integrated water resource management, the corresponding creation of new institutions and regulatory frameworks, more emphasis on non-point controls, demand management, and public participation and stakeholder involvement mark major departures from traditional practice (Box 1).

General acceptance of a systemic approach has been illustrated in recent years by new water policies and themes presented in several international conventions such as the UN Declaration on Sustainability Agenda 21 in Rio de Janeiro (UN, 1992) and the Dublin Conference on Water and Environment (ICWE, 1992). Celebrated statements made in these conventions asserted that:

- Users, planners and policy-makers at all levels should participate in water development and management (UN, 1992)
- Fresh water is a finite and vulnerable resource (ICWE, 1992)
- Water has an economic value in all its competing uses and should be recognized as economic goods (World Bank, 1993).

Water policies in Europe, the United States and other industrialized countries have also changed in parallel to these new initiatives. For example, *The Water Framework Directive (WFD) (EC/2000/60)* of the European Commission (EC, 2000), promulgated in 2000 after a series of consultations from mid-1995, marks a milestone of water policy. This "river-basin-based water

policy" sets up a common integrated approach and an ambitious target for Member States to achieve "good water quality" by 2015 (Section 3.1.1).

Similar changes have been observed in the United States' *Clean Water Act (CWA)* (CWA, 1972), the major water quality framework law. It shifts from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. This management approach emphasizes protecting healthy waters and restoring impaired ones on a watershed basis.

Box 1: New Approaches

From Sectorally Fragmented to Integrated Water Resource Management (IWRM). Conventionally, water-related sectors operated entirely independently of each other, and often with conflicting interests in making use of the limited water resources they all shared. In contrast to this fragmented management situation, integrated water resource management plans consider water supply, pollution control, agriculture, hydropower, flood control, and navigation together. The major objective is to improve the allocation of increasingly scarce water resources where costs of water are defined in terms of opportunities foregone, or the highest value of alternative uses.

New Regulatory and Institutional Frameworks. To apply new policies and approaches, new regulatory frameworks, including regulations, standards and guidelines, have to be formulated and promulgated. Integration requires that water resources be planned and managed on a basin or watershed basis, so new institutions have to be created to facilitate this.

Non-point Control. Point-source pollution has been largely under control in Europe and the United States although sewer overflow and storm-water pollution remain unsolved. Nowadays non-point sources such as agricultural run-off, much more difficult to control, tend to be the main contributors to water pollution.

Demand Management and Use of Market Based Instruments. Traditionally water resource management consisted essentially of construction and expansion of ways to meet growing demand. This purely engineering approach resulted in wasteful and inefficient use. Recent years have witnessed an increasing role of demand management, which emphasizes efficient water usage and conservation. Instruments include pricing, taxation, water rights security and transferability, as well as a growing role for the private sector in water resource management.

Public Participation and Stakeholder Involvement. Public participation and consultation are now seen as crucial to stimulating and pressuring governments and polluters to fulfill their responsibilities. Legal and institutional measures are increasingly being taken to ensure stakeholder involvement in planning and implementation of water-related policies and investment projects

CHAPTER 3: BASIN-BASED MANAGEMENT

The overriding institutional issue in water resource management is how to encourage an economically efficient and equitable allocation of water resources in view of the conflicting demands from various sectors, i.e.: agricultural, industrial and municipal water supply; power generation; flood control, navigation, and the disposal of waste water. This is complicated by the invariable presence of externalities, where for example upstream and downstream interests lie in different geographical or legal jurisdictions. It involves three key components, i.e, water quality, water quality and land planning. And even if economically efficient solutions which fully recognize opportunity costs can be identified for the relevant society as a whole, considerations of equity in allocation of resources may arise, and political considerations invariably do so. The heart of the issue is how to achieve sensible compromises between the multiple objectives and constraints that are involved in a sustainable manner i.e. that are based on integrated water resource management – or basin-based management plans.

To this end, many new institutional, legal and regulatory initiatives have been taken on Europe and the USA to facilitate a more holistic, cross-jurisdictional approach to water resource management. Some of these are summarized in this section.

Europe

The Water Framework Directive (WFD). This Directive, promulgated in 2000, represents a fundamental reform of the EU's water policy and legislation on both environmental and administrative terms. Not only does it make integrated river-basin planning and management compulsory for member states and candidate countries, it combines the overarching theme of sustainable water-resource use with the following environmental objectives:

- Expanding the scope of water protection to all waters, surface waters and groundwater,
- Achieving a status of "good" for all waters by a set deadline,
- Water management based on river basins,
- "Combined approach" toward both point and non-pointed pollutant sources,
- Setting price right ,
- More closely involving citizens, and
- Streamlining legislation.

The WFD establishes a framework providing a common approach, objectives, principles, definitions, and basic measures for water resource management in European countries. Covering both water quantity and quality, it stipulates that "for water quantity, overall principles should be laid down for control on abstraction and impoundment in order to ensure the environmental sustainability of the affected water systems (41)," and that "control of quantity is an ancillary element in securing good water quality and therefore measures on quantity, serving the objective of ensuring good quality, should also be established" (19). A timetable for implementation of various tasks has been set for member states (Box 2).

Box 2: Time Schedule for Implementation of Water Framework Directive

Water Framework Directive sets out a clear deadline for each of the requirements, adding up to an ambitious overall timetable. Key milestones are listed below.

Year	Issue
2000	Directive entered into force
2003	Transposition in national legislation; identification of River Basin Districts and Authorities
2004	Characterization of river basin: pressure, impacts and economic analysis
2006	Establishment of monitoring network; start public consultation (at the latest).
2008	Present draft of river basin management plan
2009	Finalize river basin management plan including programme of measures
2010	Introduce pricing policies
2012	Make operational programmes of measures
2015	Meet environmental objectives
2021	First management cycle ends
2027	Second management cycle ends, final deadline for meeting objectives

In order to address the challenges in a co-operative and coordinated way, member states, Norway, and the Commission agreed on a Common Implementation Strategy (CIS) for the Water Framework Directive. In the new Work Programme 2005/2006, the four Working Groups (Ecological Status, Integrated River Basin Management, Groundwater and Reporting will continue to address the key issues for implementation. In addition, new groups on "WFD and Agriculture" and "CIS" will share experiences in this area, and a new pilot river basin network will support the technical activities in all working groups.

Source: http://europa.eu.int/comm/environment/water/water-framework/timetable.html

The WFD has established requirements for instituting River Basin Management Plans (RBMPs) for each river-basin district in the EC's Member States and international river basins, whether they fall entirely within the EU or extend beyond the boundaries of the Community. Some details are as follows:

- The characteristics of the River Basin District, including maps of the location and boundaries of water bodies (surface and groundwater) as well as eco-regions and surface water body types found in the river basin should be defined. Reference conditions for the surface-water body types encountered should be included and economic analysis of water use should be conducted and summarized.
- Significant impacts on the status of surface water and groundwater due to human activity, including an estimation of point- and diffuse-source pollution, and a summary of land use should be analyzed. Pressures on the quantitative status of

water (including abstractions) are to be estimated and supplemented by an analysis of other impacts resulting from human activity on the status of water.

- For waters for which the objective of "good quality status" cannot be achieved, the River Basin Authority (RBA) must develop and submit for approval a program of corrective measures. The contents of the program are stipulated as well.

- The results of the monitoring programmes for the status of surface water (ecological and chemical), groundwater (chemical and quantitative) and protected areas should be presented, including a map of the monitoring networks. These monitoring results are the first indicator of the true state of the aquatic environment in the river basin.

- A list of the environmental objectives established under Article 4 for surface waters, ground waters, and protected areas. RBMPs should identify the water bodies where the authorities have to declare (and defend) for the first time the application of extensions and derogations under the directive's Article 4(4), (5), (6) and (7).

- A summary should be prepared of the program or programs of measures adopted under Article 11, including the ways in which the objectives established under Article 4 are to be achieved.

River basin management plans involve water quality, quantity and land planning and may be supplemented by the production of more detailed programs and management plans for sub-basin, sector, issue, or water type, to deal with particular aspects of water management.

Economic analysis of water service and water use is a major element of river basin management planning (Article 5). For the former, the analysis should reveal the present situation as well as the costs and benefits of proposed measures to restore water quality. This helps in the evaluation and selection of optional measures and provides a basis for pricing and other reforms and also contributes to greater transparency. Economic analysis of water use should aim at identifying the value of water in various uses and thus is indispensable for river basin management plans and water policy making ([1]EC, 2003).

The WFD sets out the legal requirements and general principles of basin-based institutions stating that such institutions should have clear legal and administrative status allowing them to fulfill their role in water resource management, and that there should be clearly defined institutional relationships with other institutions with water–related responsibilities.

Essentially, three models of water resource institutions exist in Europe (van Beek, 1997). These include river-basin (watershed) based management systems in the UK and France, whose administrations are centralized, and in Spain, whose administration is semi-federal (Barragué, 1999); administration-boundary-based systems adopted in many countries, whose administration is decentralized; and a co-ordinate model as adopted in the Netherlands (van Beek, 1997). Systems in the UK, France, and Germany, which all have rich experience in water resource management, are summarized below.

United Kingdom[1]

The major water institution in the UK most closely resembles that required by the WFD. The Environmental Agency (EA) is the leading central administrative body with responsibility for long-term water resource planning and the duty to conserve, augment, redistribute, and secure the proper use of water resources in England and Wales. The water resource policy is basin-based. The EA has offices at national, regional, and area levels. Its eight regional offices correspond to the eight big river basins in England and Wales.

The Agency's responsibilities cover a broader water-related spectrum: flood control, water quality, waste minimization in certain regulated industries (including minimization of wasteful use), fisheries, navigation, etc. This coverage provides favorable conditions for managing water in an integrated manner. While land use planning is not integrated naturally with water resource management in the UK as both spatial fit and policy priorities differ (van Beck, 1997), it is recognized that it is necessary to work increasingly closely with planning authorities to ensure that the water resource implications of new developments are understood and managed in a sustainable fashion. This not only covers the impact on water resources of new housing, but also industrial activities that dewater and otherwise affect local rivers and streams. (EA, 2001)

The EA has a decisive influence on water-resource policy formulation, as illustrated by some of the programs and activities under its jurisdiction (EA, 2001):

- Catchment Abstraction Management Strategies (CAMS), which set forth in 2001 the agency's plan for managing the abstraction regime of each catchment
- Drought plans, which set forth the agency's role in managing droughts
- Regular reviews of water companies' water-resource and drought plans
- Reviews of regional water-resources strategies, setting forth the agency's vision for the long-term management of water resources in each region and
- Water resource strategies, which set forth the agency's vision for the long-term management of water resources throughout England and Wales.

Private water companies in the UK play important roles in implementation of the EA's policies and plans (IHE, 1998). These companies are responsible for public water supply in England and Wales. Each water company has the statutory duty to develop and maintain an efficient and economical system for water supply in its area, and the Agency's duties in respect of water-resources management do not relieve the companies of that obligation. Water abstraction and effluent discharges fall under the authority of the Environmental Agency.

Economic regulation of water companies in England and Wales is carried out by the Director General of Office of Water Services (Ofwat). Water companies produce plans showing how they intend to manage and develop their supply systems. The Director General reviews water company prices yearly and determines prices to customers so that companies have sufficient income to carry out the parts of these plans that he considers justified.

[1] Part of the contents is taken from: http://www.environment-agency.gov.uk/.

France [2]

The Environment Ministry (more specifically, its Water Department) is responsible at the national level for protection, management and upgrading of aquatic environments and river systems, water quality, programming and coordination of state intervention in relevant sectors.

The National Water Committee, consulted by the Water Agencies, plays a key role in national water policy and drafts of legislative and regulatory texts. The Committee is chaired by a Member of Parliament and composed of representatives of the National Assembly and the Senate and of important institutions and national federations.

The Water Agencies (Agences de l'Eau) manage the water of six major hydrographic basins. There is a water agency in each basin. A River Basin Committee exists in each river basin as well. The Water Agency works as an executive organ for managing water resources, while the Committee acts as a 'Water Parliament' and is composed of between 60 and 115 users, elected representatives, specialists and state officials. Both organizations are involved in the preparation of the Water Resources Development and Management Master Plan (SDAGE). The six natural river basins in France are, therefore, each managed by two bodies—the River Basin Committee and the Water Agency. The Ministry of the Environment supervises both.

The Water Agencies are public bodies responsible for balancing economic development with respect to the environment by distributing aid and taxing users. A Water Agency's sphere of influence covers all the surface water, groundwater and territorial seawaters relating to each of the river basins.

The power of the Water Agencies rests on two principles:

- Solidarity: everyone has to pay charges to the Water Agencies for use of water. Everyone benefits from the construction of infrastructure.

- Decentralization: decision-making power rests upon the River Basin Committee and the Agency's Board of Directors. Both the Chairman of the Water Agency's Board and the Director of the Agency are government-appointed.

In contrast to the Environmental Agencies in UK, the Water Agencies have no power of policy formulation or construction that relate to water or sanitation. These duties lie mainly with local governments. This system is regarded as somewhat aligned to the basin-based institution as defined in the WFD (Barragué, 1999).

Germany [3]

The institutions in Germany show different features from those in the UK. Under constitutional law, the federal government has the right to enact general provisions concerning the framework for water resource management. The states must compile such general laws of the federal government by enacting their own laws at state level, and they may also make supplementary regulations.

[2] **Source**: http://www.lesagencesdeleau.fr/.

[3] This section is heavily drawn from [1]FMfE (2001).

The Federal Ministry for the Environment, Nature Protection and Nuclear Safety (hereafter, the Ministry for Environment or FMfE) deals with basic questions of water resource management as well as with transboundary cooperation at the central level. The Ministry for Environment is responsible for the Federal Water Act, the Wastewater Charges Act, the Detergents and Cleaners Act and the Federal Nature Conservation Act. Proposed legislation on environmental protection, projects, and programs are discussed with the Federal ministries such as The Federal Ministry for Consumer Protection, Food and Agriculture, The Federal Ministry of Health, and The Federal Ministry for Transport, Construction and Housing. The FMfE is the supreme authority in environmental and water resource issues at the federal level.

Implementation of water resources management regulations is solely the responsibility of the states and municipalities. Water management administration at the state level is mainly integrated within the general administration of the relevant state. Technical functions are carried out by authorities with various names (such as authorities for environmental protection, for water-resources management or for water and waste). Detailed responsibilities of these authorities with respect to fields such as hydrology, water-resources management planning, official technical advice, preparation of technical guidelines, education, and training vary from state to state.

In contrast to the United Kingdom and France, Germany's strong decentralized structure of federal, state, and municipality agents creates a cross-state water-resource management scheme that relies mainly on coordination through various organizations or more formalized co-ordination platforms for major rivers such as the Rhine, Elbe, and Weser. Coordination of course becomes an even more complex problem where international waterways are concerned, the Rhine River experience being of particular interest in this regard (Box 3).

Comparing the water institutions in the three countries, the common feature they share is that these institutions have a legal status and overall power concerning water quantity, water quality and hydrology (e.g. flood control) in river basins. River basin-based cross-jurisdictional institutions are in place in the UK and France while specific organizations are set up for managing cross-jurisdictional water issues in Germany.

United States

Federal Responsibilities. According to the U.S. Constitution the federal government formulates general policy and regulations for water resource management, while states are responsible for implementation. Correspondingly, there are two levels of water institutions. This section summarizes water resource institutions at both the federal and state levels as well as the interstate river basin commissions that manage cross-state water resources.

Box 3: Cross-Country Water Management: The Rhine River

The River Rhine, which was once referred to as "Europe's sewer," is a successful example of cross-country water management. Real international cooperation on River Rhine protection began in the 1970s. The International Commission for the Protection of the Rhine against Pollution (ICPR), consisting of Switzerland, France, Germany, Luxembourg, The Netherlands, and the European Union, plays an essential role in coordinating with other governmental agencies and institutions. Two Bern Conventions in 1969 and 1999 (ICPR, 1999) provide legal foundation for its operation, dispute solving, and financial responsibilities.

The tasks involved in international Rhine protection have changed over the course of this cooperation. Initially, chemical water pollution (through municipal and industrial wastewater, oxygen deficiency, oil, and chloride) and elimination of its causes were clearly priorities. After the introduction of an internationally concerted monitoring program and with the help of contractual and political agreements, the water quality of the Rhine visibly improved. Paralleling the decrease in chemical water pollution, biological ecological status assessment gained importance. The samplings performed in the five-year rotation record indicate a considerable improvement in biological quality components, such as fish, invertebrates, phytoplankton, and waterfowl.

Another consideration for Rhine protection is flood protection. Driven by the aforementioned flooding in the 1990s, the ICPR assessed and summarized flood-protection activities on the Rhine. A "Plan of Action – Flood" was set up in 1995. This plan centers especially on water retention in the river plains and the expansion of retention basins on the Rhine. The "Plan of Action – Flood" is to be implemented in phases until 2020 at an estimated cost of €12 billion. Its successful implementation presupposes interdisciplinary thinking and measures from the local to the international levels.

The water management problems of this multilaterally and intensely used river have been addressed with sustainable and increasingly efficient resolutions. This experience was used in drafting the European Water Framework Directive.

Source: Frijters et al., (2001).

The institutions at the federal level that have responsibility for water resource issues relating to their areas are (OTA, 1993):

- The Environmental Protection Agency (EPA): its duties include issuing permits for discharge of pollutants into aquatic systems, setting national drinking water standards, developing criteria that enable states to set water quality standards, administering state grant programs to subsidize costs of building sewage treatment plants, etc.

The EPA plays a leading role in regulating water quality. It has ten regional offices spanning the whole territory of the United States. Each office covers several states and one or more entire river basins, which cross several state jurisdictions (http://www.epa.gov/water/region.html). The authority of Regional EPA offices on the states is via empowering of approval of the state regulations and standards and approval of federal funding used in water.

- The Army Corps of Engineers: the most important federal water resource development agency in budgetary terms, responsible for projects involving flood control and flood plain management, water supply, navigation, hydroelectric power, shoreline protection, and recreation, etc.

- The U.S. Geological Survey (USGS) under the Department of the Interior: assesses the quality, quantity, and use of U.S. water resources. The Bureau of Reclamation provides municipal and irrigation water and operates hydroelectric facilities in the western states.

- Fish and Wildlife Service (FWS) under the Department of the Interior: the lead federal agency for conservation of fish and wildlife and their habitats; responsible for endangered species, freshwater and endangered fisheries, certain marine mammals, and migratory birds. Manages 700 national wildlife refuges; assesses environmental impacts of hydroelectric dams, stream canalization, and dredge and fill operations.

- Soil Conservation Service (SCS) under the Department of Agriculture (USDA): helps farmers develop soil and water conservation plans and arrange for cost-share funding for implementation of conservation practices in cooperation with other agencies, offers advice to farmers on pesticide and fertilizer use and land management, and is responsible for water improvement programs such as the Conservation Reserve Program, the Wetlands Reserve Program, the Agricultural Water Quality Protection Program, the Small Watershed Program.

- The National Oceanic and Atmospheric Administration under the Department of Commerce: deals with watershed management and non-point-source pollution in its coastal zone and fisheries management.

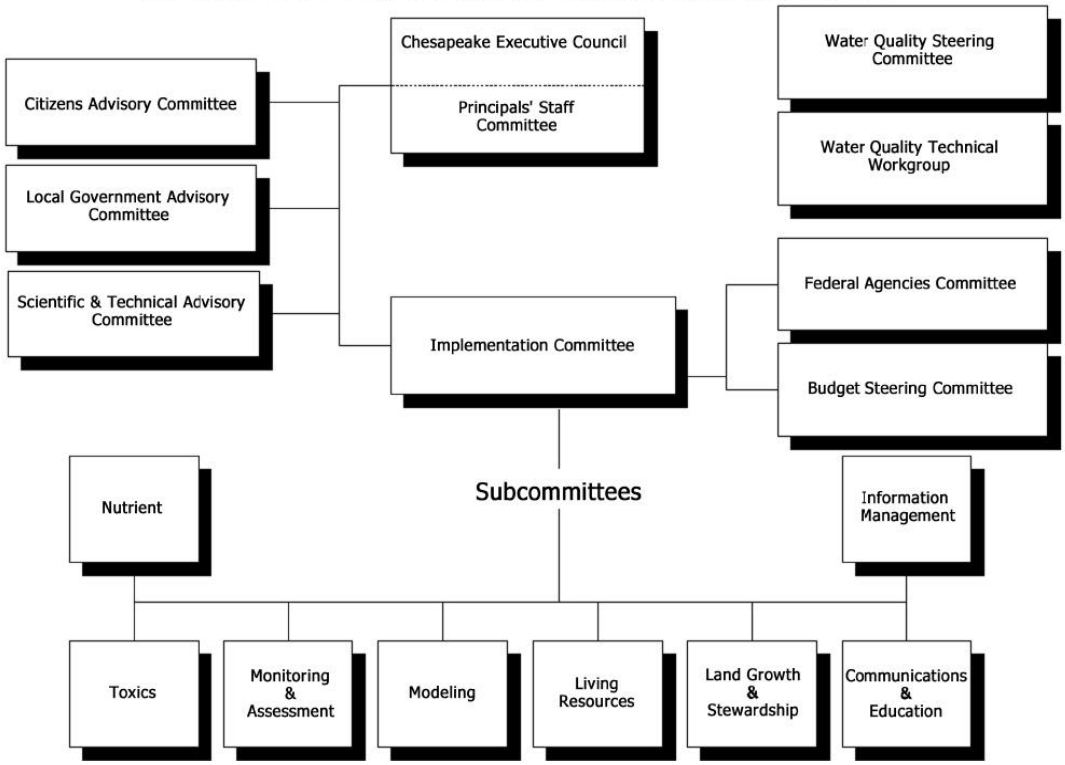
- Federal Energy Regulatory Commission (FERC) under the Department of Energy (DOE): issues licenses for hydropower projects, considers measures to preserve environmental quality, etc.

State Institutions. By constitutional law, state governments hold most of the authority to allocate water, apply water rights, trade water, ensure and protect water quality, etc., within the state jurisdiction. State water institutions, as agencies of state governments, are in charge of water resources and quality within the state's jurisdiction. They are well established at the state level in the United States (http://www.epa.gov/water/region.html).

Interstate Institutions: River Basin Commissions. In the United States some river basin-based water commissions are responsible for cross-state water resource management. The Delaware River Basin Commission (DRBC), which involves Delaware, New Jersey, Pennsylvania, and New York, and The Chesapeake Bay Commission (CBC), which involves Maryland, Virginia, Pennsylvania, and the District of Columbia, are two well-known examples. The Commissions are legal entities rather than purely administrative institutions.

Box 4: Chesapeake Bay Program

The Chesapeake Bay Program was created in 1983 to reverse decades of man-made decline in the estuary. Signatories of the Commission are the States of Maryland, Virginia and Pennsylvania, the District of Colombia, and the U.S. Environmental Protection Agency. An organization chart of the Commission is shown below.



Experience in the Chesapeake Bay region illustrates the complexity of integrated basin management, in particular in relation to the vast number of interests involved. For example, the Federal Agencies Committee referred to in the chart has responsibilities with regard to formally designated "Partners", namely 11 Federal Departments, and about 30 sub-agencies, and these are in most cases paralleled by departments with similar responsibilities in the three States and the Washington DC Government. And other Partners include 20 foundations, watershed organizations and NGOs, and 16 Universities, as well as the headwater states of Delaware, New York, and West Virginia.

The experience however also demonstrates the necessity of integrated basin management. In particular the multitude on non-point sources of pollution combined with decreasing natural buffers cross jurisdictions and sectors and can only be addressed by a regional approach. This applies in particular to the management of forests and protection of wetlands as well as programs to control agricultural run-off, which is largely responsible for a major and growing problem in the Bay, namely the growth in nitrogen pollution.

Source: http://www.chesapeakebay.net

Establishment of these two Commissions was initiated by the federal government. The members of the Commissions include the governors of the states involved and the federal representative, who is an officer appointed by the President in the case of the Delaware Commission and the Administrator of the USEPA in the case of the Chesapeake Bay Commission. This ensures the Commissions' overall power and authority on basin-water related matters including setting policies, regulations and codes. The massive administrative and institutional complexities associated with large interstate basin management are illustrated in the case of the Chesapeake Bay Program in Box 4.

The Clean Water Act

The holistic approach to water resource management in the US at the federal level is perhaps best illustrated with respect to the issue of water quality, as enshrined in the The Clean Water Act (CWA). This, the United States' water-quality framework law, was first enacted in 1972 and sets out national water policies as follows (Section 101):

- The discharge of toxic pollutants in toxic amounts is prohibited
- Federal financial assistance is provided to construct publicly owned waste-treatment works
- Area-wide treatment, management, and planning processes are to be developed and implemented to assure adequate control of sources of pollutants in each state
- A major research and demonstration effort is to be made to develop the technology necessary to eliminate the discharge of pollutants into navigable waters, waters of the contiguous zone and the oceans, and
- Programs for the control of nonpoint sources of pollution are to be developed and implemented expediently so as to enable the goals of this act to be met through the control of both point and nonpoint sources of pollution

The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States. The statute employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater-treatment facilities, and manage polluted runoff. Many regulations based on the CWA are introduced in this chapter.

The CWA stipulates that "It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State (Section 102(g))."

There are several other water-related initiatives not covered by the Clean Water Act that significantly impact water resource management in the United States.

- *Safe Drinking Water Act (SDWA)*: This act, originally passed by the Congress in 1974 and amended in 1986 and 1996, aims to protect public health by regulating the nation's public drinking water supply. The act authorizes the United States Environmental Protection Agency (EPA) to set

national health-based standards to protect against both naturally occurring and man-made contaminants that may be found in drinking water.

- *Endangered Species Act (ESA)*: Enacted in 1986 under the authority of the Fish and Wildlife Service (FWS), the act requires each state to set up a minimum stream flow to protect specific species of fish and the overall environment. This act has important repercussions for irrigation, hydropower, navigation, and like projects.

Important initiatives under the general framework of the CWA include Total Maximum Daily Loads (TMDLs) (CWA, 1972), water-quality planning and management (USFR, 1999), and Nonpoint Source Program and Grants Guidelines ([1]EPA, 2003).

- *Total Maximum Daily Loads (TMDLs)* . Early in 1972 the CWA (section 303d) stipulated TMDL provisions, which set a limit to the amount of a pollutant that can be discharged into a water body. It required states to develop a list (303d List) of water bodies for which existing pollution-control activities were not sufficient to attain applicable water quality and to develop Total Maximum Daily Loads (TMDLs) for pollutants, including both point and nonpoint sources (NPS) or stressors causing impairment and an allocation of that amount to the pollutant's sources. The current operating TMDLs program is under 1992 TMDLs regulation contained in *CFR 40, part 130* (USFR, 1999) and consists of three key components: Waste-Load Allocations (WLAs) for point-source discharges, Load Allocations (LAs) for nonpoint sources (NPS), and a Margin of Safety (MOS). By law, the EPA must approve or disapprove the lists and TMDLs established by states, territories, and authorized tribes. If a state, territory, or authorized tribe submission is inadequate, EPA must establish the list or the TMDL.

- *Water Quality Management Plans.* US Federal Regulation CFR 40 Part 130 (USFR, 1999) mandates basin-based principles and components of water-quality management plans, and the TMDLs is one such component.

- *Non-point Source Program.* In 2003, EPA enacted the new Nonpoint Source Program and Grants Guidelines ([1]EPA, 2003) for States and Territories under Section 319 of the Clean Water Act. The document recommends that, whenever feasible, watershed-based plans be developed and implemented for all watershed projects, whether they are designed to protect unimpaired waters, restore impaired waters, or both. The guideline stipulates that a watershed-based plan contain the following components:

  a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan). Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to

which they are present in the watershed.

b. An estimate of the load reductions expected for the management measures recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time.

c. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated of the critical areas in which those measures will be needed to implement the plan.

d. An estimate of required technical and financial assistance, associated costs, and/or sources and authorities that will be relied upon to implement the plan.

e. An information/education component to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing the NPS management measures to be implemented.

f. A reasonably expeditious schedule for implementing the NPS management measures identified in this plan.

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and whether substantial progress is being made toward attaining water-quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS or TMDL has been established, whether the NPS or TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time and measured against the criteria established.

CHAPTER 4: ECONOMIC INSTRUMENTS

Water Rights and Trading

Most aspects of this topic are addressed in some way in the United States, which encompasses a variety of approaches to the allocation of water rights and trading in those rights.

Water Rights. There is no national water-rights law in the United States; and water resources fall mainly under the authority of states (Andreen, 2005). Most states have water code(s) or law(s) that outline the rights of public water and wastewater utilities as well as the state's authority over investor-owned utilities and rates setting. State laws or codes define the allocation of the rights of private parties and government entities to use such water. The doctrines which are referred to in approval of water-rights applications are different depending upon whether the water in question is surface or ground water as well as its geographic location (OTA, 1993; Andreen, 2005).

Doctrines addressing surface water in the 31 eastern states are dictated by proximity of land ownership (riparian rights). Riparian water rights occur as a result of land ownership. A landowner who owns land that physically touches a river, stream, pond, or lake has the right to use water from that source. This water right, however, is only a usufructuary right and not a property right in the water. The riparian right is part of the riparian land and cannot be transferred for use on other lands (OTA, 1993).

In the 19 western states water is usually allocated according to a "grandfathered" system of "first in time, first in right" (appropriative rights). An appropriative right exists without regard to the relationship between the land and water. These rights are entitlements to a specific amount of water, for a specified use, at a specific location with a definite date of priority. An appropriative right depends upon continued use of the water and may be lost if the water is not used. Unlike riparian rights, these rights can generally be sold or transferred, and long-term storage is not only permissible but common. There are four essential elements of appropriative rights application and transfer: Intent, Diversion, Beneficial Use, and Priority (OTA, 1993).

"Beneficial use of water" is the basis of a water right. Many state water laws define the contents. The goal in beneficial use is to avoid water waste, so that water is available to as many water-rights holders as possible. Return flow is water that returns to streams and rivers after it has been applied to beneficial use. It may return as a surface flow or as an inflow of tributary groundwater. Many water rights depend on surface and subsurface return flows. Under Colorado law, native basin water is subject to only one use, and thus return flow belongs to the stream system to fill other appropriations (Quinn, 2004).

For groundwater, water rights applications are considered according to one of three doctrines: absolute, reasonable use, or appropriation permit. The absolute doctrine, used exclusively in Texas, gives rights to the overlying owner and does not restrict usage. The "reasonable use" doctrine, used in California and most eastern states, gives the rights to

landowners, but with the added provision that their use of the water cannot interfere with other users. The third doctrine, used in the western states, is based on priority, meaning that prior users of groundwater have the greatest legal rights (OTA, 1993).

State governments impose interventions on the usage of water rights. The constitutions of all western states declare water to be a public resource. Some states, such as California and Washington, have started to enforce the public interest requirement. In these states, any transfer (sale, lease, or exchange) of water rights is subject to approval by the State Water Board through the application process. In the Eastern part of the country, about half of the states of the one-hundredth meridian have supplemented, since the 1950s, to one extent or another, the riparian rights system with an administrative permit scheme (Andreen, 2005).

In addition to the interventions of state water administrations, federal environmental laws and regulations such as the 1972 Clean Water Act and the 1986 Endangered Species Act, which specify that water quality and biodiversity conservation objectives are to be granted priority over economic interests, are imposing more and more influence on existing water rights. Such laws have created federal regulatory rights to minimum flows and have the potential to require states to reconsider the allocation of water in order to improve instream flows and water quality (Andreen, 2005).

Water Trading. Water trading is useful in regulating water distribution. In some parts of the United States, there are well established active water-trading markets that aim to encourage the highest beneficial use of water, provide a source of adequate water supplies to beneficial new and supplemental water users, and provide a source of funding for improving water user facilities and efficiencies. A typical example is the Idaho Water Supply Bank (Box 5), which began in the 1930s. The Bank is operated by the Water Resources Board and has two program areas, the Rental Pool and the Water Supply Bank. The Rental Pool relates to stored flows from federal water projects and is administered by local committees within water districts. These committees establish the rules subject to the approval of the Water Resources Board (Camkin, 2004).

Box 5 Idaho Water Supply Bank

The Water Supply Bank relates to the management of natural stream flows and groundwater, and is administered through the Idaho Department of Water Resources (IDWR). It substitutes for a water-rights transfer process by removing some of the assessment requirements of transfers. Consequently, access to water sought through the Water Bank is generally provided within a couple of weeks, as opposed to several months through a water transfer. The IDWR keeps a list of water rights available for lease on the Internet; interested parties can call the IDWR to see if water may be available to them.

Water users who in any given year have rights to more water than they need can put the excess stored water or natural flow rights they will not use in the Bank. From there, the water can be sold or leased to people who do not have enough to meet their needs. This system helps make excess water available to other users for irrigation or other authorized uses. Water from the Water Supply Bank has also proven valuable in providing stored water for downstream-salmon-recovery efforts.

This Water Supply Bank approach helps put the maximum amount of water to beneficial use. There is also incentive for those not using their water rights to make them available through the Water Supply Bank as it stops the forfeiture clock. However, because the intent of the Bank is to make water available for beneficial use, a key policy question is whether the forfeiture clock should stop if the water placed in the Water Supply Bank cannot physically be taken by others, for example due to environmental constraints. Where possible, the IDWR is obliged to rent out the water rights that have been in the Bank the longest (i.e. first in, first out), which can restrict an open market exchange in some cases. The rules of operation of the Water Supply Bank are established in the State Water Plan. The Water Resources Board can amend the rules through the SWP planning process.

Large scale water trading also occurs in the western United States: water trading from agriculture to municipality and industry has made essential contributions to economic development in the region. A typical example of this type of economic boost is illustrated by the Northern Colorado Water Conservancy District (NCWCD). This local agency partnered with the federal government (Bureau of Reclamation) to construct the Colorado-Big Thompson (C-BT) Project, the largest trans-mountain diversion project in Colorado, which supplies supplemental water to 30 cities and towns, over 100 ditch and reservoir companies, and 600,000 acres of irrigated farmland in north-eastern Colorado.

It should be noticed that state governments maintain the right to intervene in trading, since unrestricted trading may very well change the use of the water. Several important factors, including physical infrastructure, variability of the large number of agencies that need to be involved in any comprehensive water-strategy agreement, critical property rights, and a conflict between established and newer users make unlikely the possibility of a market simply directing water to where its marginal productivity appears to be highest (O'Brien et al., 2001).

Water Quality Trading. Water quality trading aiming at cost-effective water-pollution control has been used in the United States for some time. The first EPA water-quality trading policy was issued in

1996, and the latest *Water Quality Trading Policy* was enacted on Jan. 13, 2003 ([2]EPA, 2003). Trading works well under the following conditions ([2]EPA, 2003):

- There is a "driver" to motivate finding approaches to reduce pollutants, usually a Total Maximum Daily Load (TMDL) or a more stringent water quality-based requirement in an NPDES permit

- Sources within the watershed have significantly different costs to control the pollutant of concern

- The necessary levels of pollutant reduction are not so large that there are insufficient potential surpluses in the watershed to be traded, and

- Watershed stakeholders and the state regulatory agency are willing to try an innovative approach and engage in trading design and implementation issues

EPA's Water Quality Trading Policy provides guidance to states and tribes on how trading can occur under the Clean Water Act and its implementing regulations. The policy discusses the Clean Water Act (CWA) (Section 301(b)) requirements that are relevant to water quality trading.

EPA's policy supports trading of nutrients (e.g., total phosphorus and total nitrogen) and sediment-load reductions. The policy recognizes the potential for environmental benefits from trading of pollutants other than nutrients and sediments but believes that these trades may warrant more scrutiny. The policy does not support any trading activity that would cause a toxic effect, take priority over human health, or impair water quality. EPA does not support trading of persistent bio-accumulative toxic pollutants at this time.

The policy supports trading to improve or preserve water quality in a variety of circumstances. For example, in unimpaired waters, trading may be used to preserve good water quality by offsetting new or increased discharges of pollutants; in waters impaired by pollutants, trading may be used to achieve earlier pollutant reductions and to make progress toward water quality standards pending the development of a TMDL; and trading may be used to reduce the cost of achieving reductions established by a TMDL. The EPA does not support trading that delays implementation of an approved TMDL.

The EPA's policy stresses that to be credible and successful, the trading programs should include the following general elements: clearly defined units of trade, use of standardized protocols to quantify pollutant loads and reductions, provisions to address the uncertainty of non-point source loads and reductions that are traded, accountability mechanisms for all trades, public participation and access to information, and monitoring and program evaluation.

Abstraction Fees

Most countries in Europe levy fees for private abstraction of groundwater. For example, in the Netherlands, the water abstraction charging scheme on groundwater comprises two different taxes: one charged by the provinces and another, additional national levy. The national groundwater abstraction tax was introduced in 1995 as one of several "green taxes." The main objective of this tax is to act as an incentive and to reduce groundwater use in favor of surface water

by narrowing or eliminating the price differential between ground and surface water. Ground water is cheaper in the Netherlands due to lower treatment costs; it amounts to 70 percent of the country's water supply.

The tariff is set per cubic meter and is determined mainly by political considerations. In 2000 the tariff per cubic meter was €0.166/m3 for public water-supply companies, €0.12/m3 for other users, and €0.025/m3 for infiltrated groundwater. The tax generated total revenue of €163.4 million, and as it falls under the general government budget, it is administered and collected by the Ministry of Finance and the Central Environmental Tax Unit in Rotterdam (Kraemer et al, 2003).

Taxes on the abstraction of water from the natural environment were introduced in Germany at the state level after earlier discussions at the federal level in the 1950s failed to bring about the imposition of a federal tax in the 1960s. Water resource taxes were introduced not as alternatives to command-and-control instruments but as their complement. On January 1, 1988, Baden-Württemberg became the first German land to establish a tax on water abstraction, the tax being established in order to finance compensation to farmers for restrictions on fertilizer use in water catchment areas. Similar links exist between water resource taxes and environmentally motivated subsidies in other states. (Kraemer et al, 2003).

In the UK anyone wishing to abstract water from a surface source (e.g., river, stream, or canal) or from an underground source will need an abstraction license according to the Water Resource Act of 1991. If the water is being abstracted from an underground source, such as a well or borehole, a groundwater investigation consent to construct and then test pump the source are required. The Catchment Abstraction Management Strategy (CAMS) for the related area will provide relevant information on the Environment Agency's approach to abstraction licensing in the catchment (EA, 2005). An application fee and abstraction charges are levied.

Prices and Taxes

Water Pollution: The Polluter-Pays Principle. Generally, in both Europe and the United States, pollution control relies primarily on the enforcement of standards – so called "command and control - rather than the use of economic incentives. However, in recent years the growing use of environmental taxes to address water pollution in industrialized countries has been extensively documented by OECD and others. Most European countries have introduced emissions charges for industrial wastewater, typically based upon volume, and varying according to the type of pollutant. In the USA, charges on emissions, levied by states, vary according to source, volume, and/or toxicity of the discharge.

In practice, due to the administrative problems inherent in monitoring to ensure compliance with standards, there appears to be an increase in the use of product charges or indirect instruments where taxes are levied on the sale of a potentially polluting substance rather than upon discharges of effluent into a river or other water body. While non-compliance still remains an important issue, this is clearly less of a problem for fixed, point sources of pollution as opposed to non-point pollution, where run-off from agricultural chemicals remains one of the most intractable problems.

Box: 6: Taxation of fertilizers in Europe

Summary of European experiences of nitrogen taxation

Countries	Dates	Tax base and rate (% of fertilizer price)	Tax product use
Finland	1976-1995 1992-1995 Since 1987	Fertilizer tax (less than 3%) →Specific tax on nitrogen fertilizer (70%) Fertilizer tax collected fertilizer producers and importers	Subsidies of cereal export Cost of administration and control regulation
Sweden	1985-1993 Since 1985	Tax on NPK fertilizer (around 20%) Environmental tax on NP fertilizer (increased rate) → In all: 20-30% of nitrogen fertilizer price	Support of agricultural exports Subsidies, expenditure, State budget since 1995
Austria	1986-1993	Tax on NPK fertilizer (increased rate) → 39% then 59% of nitrogen fertilizer price	Subsidies for export Subsidies expenditure for environmental protection
Norway	Since 1988	Tax on NP fertilizer → Around 20% of nitrogen fertilizer price	State budget

Source: Bel, (2004)

The practice of taxing fertilizers has been widely adopted in Europe in order to reduce nitrogen discharge into surface and groundwater (Box 6). The revenues generated are used as governmental revenues as well as for expenditures on water-pollution control. Such an approach has not been used in the United States. In that country agricultural policy is designed in regard to environmental consequences, and indeed some programs show that the Department of Agriculture is well aware of the environmental problems that agriculture can cause, but it prefers to tackle them through conditional access to subsidies, rather than applying the "polluter-pays principle" (O'Brien, et al., 2001).

Disposition of revenues from pollution taxes remains a controversial issue. Political realities often dictate that such revenues are earmarked for environmental improvements, or channeled back to the polluting sectors via a myriad of subsidy programs. Indeed, OECD experience indicates that the use of economic instruments for pollution control in the industrialized countries is small, but subsidies of one form or another are by far the dominant type of economic instrument observed in practice.

While they may be necessary for political purposes to ensure the cooperation of industry, or, in some cases, to compensate

for social problems caused by imposition of pollution control measures, subsidies are clearly inconsistent with the polluter-pays principle, impose a fiscal burden, invite corruption, and once established they are difficult to remove. Indeed, rather than subsidizing environmentally degrading activities, the trend should be to introduce "green taxation" to make a positive fiscal contribution, and to establish a "level playing field" in which, as far as possible, true costs are reflected in the prices charged for environmentally-related resources.

The above experience shows that despite an increasing use of economic instruments for environmental purposes, much still needs to be done to make the polluter-pays principle a reality, whether by means of requirements that waste generators pay for the cost the incur in meeting effluent standards, by directly levied economic instruments, or by indirect forms of taxation based upon the cost of environmental damage that is caused.

Domestic water supply

Traditionally, many European countries and the United States provided financial subsidies for public water supply, often in the name of protecting the poor, but such a policy has had perverse effects. The consequence has been that financially deprived utilities have been unable to generate sufficient funds to expand service to low income areas, typically leaving the poor with inadequate volume and quality of water even for their basic needs. Growing recognition of this problem has led, in recent years, to efforts to ensure the financial viability of water utilities, generally implying, inter alia, an increase in water rates.

Indeed, the increasing cost of water supply is becoming a major issue throughout the world, as demand grows and as sources further and further away from consumption centers have to be exploited; in other words, long run marginal costs of supply exceed average costs. An economically efficient price is one that equals long run marginal production costs including any environmental costs that may be incurred in the production process: valuation of incremental production is demonstrated by consumers' observed willingness to pay. Such a price would also yield financial surpluses; since invariably the bulk of the water consumed in a municipal system is consumed by a relatively small number of wealthy households, commerce and industry, there is generally considerable scope to generate enough funds to provide basic requirements to the poor at little cost to them. While in principle it is desirable that subsidy programs should be explicitly targeted and controlled by a central agency such as the Ministry of Finance, in practice inadequate fiscal administrative mechanisms mean that it will generally be more practical for the water authority to directly cross-subsidize the poor by a system of increasing block rates.

Tariff structures for public water consumption vary. The majority of industrialized countries, however, use a combination of the flat fees plus variable charges. Where flat fees or fixed elements are used in the tariffs, these may be charged at the same level for all households, or varied (depending on the lot, household, or garden size; the pipe or meter size; the number of taps; or the number of rooms).

A general shift of tariff reform of public water supply towards more economically efficient charging systems, and the implementation of incentives for water conservation, has been observed. A general moving tendency is away from fixed-price and decreasing-block tariff structures, and

towards volumetric charging and increasing-block structures (OECD, 1999). Ensuring affordable water to the poor is a key to successful price reforms. To promote affordable water supply and wastewater-treatment services, a range of innovative tariff structure and methods have been used to alleviate hardships caused by tariff reform while still providing incentives for efficient water use ([1]OECD, 2003).

Industrial Water Supply

The price structures for industrial consumers are generally fixed at the local (municipal) level and can vary widely within a country (e.g., in order to reflect differences in cost structures). The most common structures are two-part tariffs, including a fixed element, which generally varies according to some characteristic of the user, and a variable element, usually based on average cost pricing. The supply amount is an important factor to the price. Decreasing block (lower price is offered to the larger supplier) prices are in effect in the United Kingdom and part of the United States (Great Lakes). The block structure is increasingly being applied in Italy, Portugal, and the western United States (OECD, 1999).

Direct abstraction is another major resource for industry water supply in addition to public water supply. Lower quality requirement for some industry is one of the main reasons for direct abstraction. The physical source of industrial water abstractions can be either groundwater or surface water depending on the investment needs and charge levied by environmental regulators. Most countries levy fees for direct abstraction of water resources.

When distinctions by type of user are made, industrial uses tend to face higher charges than domestic ones. In Poland, for instance, abstraction charges for public supply are 6 to 47 times lower than those for industrial supply. On the other hand, water-intensive industries in Germany can obtain rebates. In the Netherlands, if surface water is injected into the aquifer before groundwater abstraction, the abstractor can claim a subsidy, which will then reduce the total charge. Similarly, in Italy, industrial users are all charged the same, but a 50 % reduction is given if water-saving techniques are employed (OECD, 1999).

Sewerage

Household Sewage. The tariff of household sewage is based largely on volumetric water supplied to households because of a close relationship to the volumes of sewage generated and water supplied. Thus, the structure of wastewater charging regimes tends to follow closely that of domestic water-supply systems in most developed countries (OECD, 1999).

Domestic sewerage fees in Europe vary considerably, with Germany being the highest at an annual rate of €113 per habit, Denmark ranks the second, France and the U.K. are moderate, while Ireland is the lowest (FMfE, 2002). This sequence is consistent with the technologies and processes adopted in the sewage treatment. Germany and Denmark have the highest portion of the tertiary biological-treatment plants in Europe. Generally, sewerage fees have increased steadily in recent years.

The structure of annual total sewage fees in Germany is made up of basic charges, regular wastewater charges, and connection charges. Basic charges are levied on about 11 percent of the people served, mainly low income groups. So, basic charges help to achieve a more reasonable distribution of the high fixed costs (some 75 to 85% of the costs) (FMfE, 2001).

The wastewater charge in Germany consists of a sewage charge based on the freshwater

scale (the charges are calculated on the basis of drinking water consumption only) and rainwater charge based on the size of the site to be drained. The average tariffs of households, sewage and rainwater are € 2.28/m^3, € 1.79/m^3 and € 0.77/m^2, respectively (FMfE, 2001).

Industrial Sewage. The volume and characteristics of industrial sewage vary considerably from one company to another. Thus, industrial water consumption levels do not represent a good proxy for industrial sewerage and sewage disposal costs. As a result and closely related to the shift toward more cost-reflective water tariffs for industry, the separation of sewerage and trade effluent prices for industrial sewage is a tendency. The number of countries in which the costs of industrial sewage services are included in the price of water supply (or in general local taxes) has therefore been decreasing steadily. Trade-effluent charges usually depend on the metered volume of pollutants and/or pollution contents. In other cases, the charging formula can defer the costs to the water-treatment company treating a particular effluent (OECD, 1999).

Trade effluent charges are levied in 17 OECD countries and are under consideration in a few others. Opponents are concerned about the competitive implications for local industry, or perceive that monitoring costs will be too high.

In countries where sewage service costs have risen significantly, industrial users have increasingly set up their own treatment and effluent re-use facilities. A permit is needed for direct discharge of treated industrial wastewater.

For domestic and industrial users of the public water system, wastewater charges are often insufficient to cover the full costs of providing these services. For agricultural users, although irrigation run-off can be quite polluting (particularly where minerals are leached), there are generally no facilities in place to reduce this "environmental subsidy."

The pricing of wastewater services for industrial users is generally based on accounting principles, which aim at covering some fraction of the *historic* costs of providing these services. However, charging systems based on historic costs will not typically generate sufficient revenues to finance *current* investment needs. For this reason, even if sewage tariffs are set to recover operating and maintenance costs, they would be insufficient to cover future investment costs. This is particularly true in some EU countries, where the implementation of the Urban Waste Water Treatment Directive (91/271/EEC) ([1]EC, 1991) has led to considerable investment needs in order to comply with more stringent standards.

Agriculture

In addition to volumetric pricing, various types of tariff structure are used for irrigation water in the OECD countries (see Box 7), although levels are very low.

Indeed, supplies are virtually free in parts of the United States and some European countries, with the Netherlands and Austria being exceptions to this rule. More commonly, irrigation prices are intended only to make farmers responsible for the variable costs of supplying water, whereas part or all the fixed costs are covered by public agencies, at taxpayers' cost. In many cases, water consumption is not metered, leading to difficulties in defining pricing mechanisms and choosing tariff structures.

Box 7: Irrigation Water Charges, OECD Countries

Area-pricing: charges for water used per unit of irrigated area. This structure may sometimes lead to area pricing discrimination depending on factors affecting water utilization such as crop irrigation, irrigation technologies, and the season of the year

Tiered-pricing (sometimes called "block-rate" pricing): different prices for the volumes of water expected to be used in different ways

Betterment levy-pricing: charges irrigated land based on the increased value of land, due to the provision of irrigation water

Water markets (including auctions): public agencies can elicit farmers' "willingness-to-pay" for marginal units of water and set prices accordingly

Passive trading: the district offers a price – presumably one which equates aggregate water supply and demand – and farmers make use of whatever amount of water they want. Farmers' consolidated rights to water are then charged at the average price, but those whose consumption is higher pay the offered price, and those consuming below their rights would receive a payment for their thrift

Volumetric pricing (of any kind), with a bonus: farmers are required to pay for any water that exceeds a certain volume and are financially rewarded if their consumption is below another threshold

Source: OECD (1999).

Similar comments to those made earlier about municipal water supply also apply to irrigation water. Pricing at less than long run marginal cost (defined to include opportunity cost – or highest value in alternative uses) is an inducement to wasteful use. Moreover, failure to recover costs of operation and maintenance results in further inefficiency and waste, often with adverse environmental consequences as well.

Private investment

Private participation in water and sewerage sector in the OECD countries increased significantly in the 1990s ([2]OECD, 2003), but it is still estimated that only 10 percent of the world's population is supplied with drinking water by private operators. While the nature of private sector participation ranges from partial financing of investments to an increasing role in the operation of services, most countries have opted for the concession approach, in which the private sector participates in managing some services but the public sector retains ownership of the system. Views expressed by the OECD on lessons from experience of private sector operations in urban water and wastewater services are shown in Box 8.

Box 8: Private participation in Urban Water and Wastewater Services: Some Lessons

The following list outlines some of the key lessons from OECD experience with private-sector investment in urban water and wastewater services.

- If a government decides to involve private firms in meeting its responsibility, it also needs to shift from being the manager of the water system to being its overseer and regulator.
- Water fees are often too low to support major private investments.
- Water users are willing and able to pay for many water services.
- Addressing the social aspect of water provision is crucial to the success of private-sector participation.
- Costs and risks are often too high.
- Governments and users are often not willing or ready to address risks to investors' satisfaction.
- Private water-operating companies are limited in number and cannot do everything.
- Municipalities need to set infrastructure-performance standards to reflect local needs and demand.
- Local and central governments need to improve their regulatory capacity.
- Public awareness needs to be increased so that the form of private involvement best fits local needs.

Source: [2]OECD, (2003)

Private financing in water infrastructure takes the forms (1) capital investment: contractual options vary from Building Operation and Transfer (BOT) to Design, Building, Operation and Transfer (DBOT). The length of contracts may also vary from three to thirty years. At the end of the contract, assets are transferred back to the municipal or state authorities; and (2) direct financing: often called "full privatization," because hundred percent of the assets are owned by the private investors. It is the rarest form of private-sector participation, found mainly in the United Kingdom and in the United States. In Europe, the United Kingdom goes the farthest in direct privatization of the water sector.

Even where the public water supply system remains publicly owned, service management is increasingly being delegated to private operators. This approach seems particularly well suited to decentralized systems, in which municipalities see delegation as a useful way of overcoming their own lack of technical expertise and/or financial resources. In France, with regard to a growing number of municipally owned systems, service providers are permitted to decide whether they want to manage the service themselves (direct management) or to delegate management to a private operator. Currently, "concessions" (i.e., the delegation of authority to private concerns) in France involve 75% of public water supplies, but only about one third of wastewater services. A variety of such systems has also been adopted in Spain; 40% of the population is served by concessions. Direct (municipal or supra-municipal) or delegated public management remain the norm in Belgium, Canada, Denmark, Greece, Korea, and Sweden, and in some areas in Austria and Italy (OECD, 1999).

In Germany various enterprise models have been adopted in wastewater services as follows (FMfE, 2001):

- Municipality-operated enterprise: operated by the municipality within the framework of the general municipal administration.
- Enterprise in its own right: operated by municipality as special property with independent accounting.
- Company in its own right: enterprise under private law in the hands of the municipality.
- Operator's model: operating functions transferred to a "private" entrepreneur while responsibility for implementation of the functions remains with the respective municipality.

Germany's experiences illustrate that the poor performance are attributed to faulty incentive structures, the politicization of appointments and management, and other bureaucratic weaknesses rather than the types of ownership of water services.

Confronted with the demand increase, user competition on limited water sources, needs of upgrading of aging infrastructure, and budget constraints, the government's role in water management in many advanced countries has been shifted from a primary provider of water services to a more innovative creator and regulator of policy and reform ([1]OECD, 2004; [2]OECD, 2004).

Private investment enhances the financial in put to water service, but full recovery via user charges of capital costs seems unlikely over the near term (OECD, 1999). The public *subsidies* are still provided as illustrated by the fact that substantial special funding by the federal government and the EU was made available for the reconstruction of infrastructure in the new states in the former GDR and the EC's new member states especially on wastewater treatment infrastructure (FMfE, 2001).

CHAPTER 5: PUBLIC PARTICIPATION

Importance of Public Participation

Public participation is crucial to stimulating and pressuring governments and polluters to fulfill their responsibilities. Because of the various dimensions and sectors involved, stakeholder involvement is required at all stages of policy, planning, and implementation. Given the multiple dimensions and broad involvement of various groups and sectors with different interests in water-resource management, the benefits of extensive public participation, as a critical component to IWRM, are obvious. Experience illustrates that the greater the transparency in the establishment of objectives and implementation of plans and projects, the greater the care that will be taken to ensure efficient and equitable water resource management. Public participation imposes pressure on polluters and administrations that may be influenced by short-term economic gain, and opens the process to the scrutiny of those who will be affected to balance the interests of various groups through either consultation or other legal channels.

Both Europe and the United States have a tradition and accumulated much practical experience in involving the public in environmental matters, as evidenced by the Århus Convention and Water Framework Directive in Europe and the USEPA Public Involvement Policy.

Europe

The Århus Convention
The Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (the Århus Convention) (UNECE, 1998) organized by the UN Economic Commission for Europe (UNECE) and signed by the EU, took effect on October 30, 2001, and established three pillars for public participation (Box 9). Public authorities at national, regional or local levels are to contribute to these rights' becoming effective.

The Århus Convention was a major event: the EU has subsequently taken steps to update existing legal provisions in order to meet the requirements of the Convention by means of legislation directed at the Member States, but also for its own institutions, through its Water Framework Directive (WFD). This introduces the notion of public participation as defined by the Århus Convention as follows.

> "To ensure the participation of the general public including users of water in the establishment and updating of river basin management plans, it is necessary to provide proper information of planned measures and to report on progress with their implementation with a view to the involvement of the general public before final decisions on the necessary measures are adopted" (46).

Box 9: The Århus Convention: Three Pillars for Public Participation

The right of everyone to receive environmental information held by public authorities. This can include information on the state of the environment, but also on policies or measures taken, or on the state of human health and safety where this can be affected by the state of the environment. Citizens are entitled to obtain this information within one month of their request. Furthermore, citizens need not explain their motivations in making said request. In addition, public authorities are obliged to actively disseminate environmental information in their possession;

The right to participate from an early stage in environmental decision-making. Arrangements are to be made by public authorities to enable citizens and environmental organizations to comment on, for example, proposals for projects affecting the environment, or plans and programs relating to the environment; these comments are to be taken into due account in decision-making, and information on and justification of the final decisions are to be provided.

The right to challenge, in a court of law, public decisions that have been made without respecting the two aforementioned rights or environmental law in general.

Source: UNECE (1998)

Among the requirements of public involvement and consultation it specifies that Member States should encourage the active involvement of all interested parties in the implementation of the Directive, in particular in the production, review and updating of the river basin management plans. It requires that Member States should ensure that, for each river basin district, they publish and make available for comments to the public (a) a timetable and work program for the production of the plan, including a statement of the consultation measures to be taken, at least three years before the beginning of the period to which the plan refers (b) an interim overview of the significant water management issues identified in the river basin, at least two years before the beginning of the period to which the plan refers and (c) draft copies of the river-basin management plan, at least one year before the beginning of the period to which the plan refers. On request, access shall be given to background documents and information used for the development of the draft river basin management plan. Member States shall allow at least six months for interested parties to comment in writing on these documents in order to allow active involvement and consultation. The above also applies to updated river basin management plans.

Within a clearly defined timeframe the Water Framework Directive requires that when river basin management plans are established information on the river basin management plan in a draft version and the background documentation on which the decisions are based must be made accessible for consultation. Furthermore a biannual meeting in order to provide for a regular exchange of views and experiences in implementation will be organized. Too often in the past implementation has been left unexamined until it is too late—until Member States are already woefully behind schedule and out of compliance. The Framework Directive, by establishing very

early on a network for the exchange of information and experience between water professionals throughout the Community, will ensure this does not happen.

The WFD specifies the background documents including all the documents that are summarized in the river-basin management plan. The set-up of the centers, where public can access information, and the procedures for providing information, has to be decided on the river basin basis. Background documents can be provided in the form of inventories of pressures and impacts on water bodies or details with regard to the programs of measures or more detailed information on implementation levels under the river-basin district.

Taking the Århus convention as a reference, one month could be advised as a reasonable deadline for the response to the public request for information. The possibility of also placing background documents on the Internet, and of making relevant references, should also be considered. This would require a specific effort, as the same files must be prepared for inventories according to the Directive.

Three aspects relevant to access to information and to background documents should be considered to ensure a successful public and stakeholder participation ([2]EC, 2003):

- The public and stakeholders involved are from various sectors and with different interests,
- Information provided should cover broad areas and topics including progress in planning processes, results and outcomes of analysis, proposed measures and plans, arguments in decision making, etc,
- The way information is provided in an easily understandable manner. For the general public, the Internet, brochures, and television spots may be useful means. Organized stakeholders may most probably get all the relevant information from the steering groups or committees established.

The New Public Participation Directive

A new directive on *Public Access to Environmental Information (Directive 2003/4/EC)* ([3]EC, 2003) entered into effect on February 14, 2005, then becoming binding for all European Union Member States. The directive strengthens existing EU rules in environmental information disclosure, aligning them with the environmental information requirements of the 1998 Århus Convention. This Convention grants the public access to environmental information, provides for public participation in environmental decision-making, and ensures access to justice when environmental law is infringed.

The main features of the new directive can be summarized as follows:

- It grants a right of access to environmental information (as opposed to freedom of access currently) and to ensure that environmental information is made available and disseminated actively to the public;
- It provides a broader definition of environmental information as well as a more detailed definition of public authorities;

- It establishes a deadline of one month (reduced from the current two) for public authorities to supply the information requested;
- It clarifies the circumstances under which authorities may refuse to provide information. Access to information shall be granted if the public interest served by the disclosure outweighs the interest served by a refusal;

- It identifies two types of review procedures for the public to challenge acts or omissions of public authorities relating to requests for environmental information.

United States

The USEPA recognized the importance of public participation in making decisions, policies, and procedures as early as 1979, when regulations at *40 CFR Part 25* (EPA, 1979) was promulgated.

This legal document sets forth minimum regulatory requirements and suggests program elements for public participation in activities under the Clean Water Act, the Resource Conservation and Recovery Act, and the Safe Drinking Water Act as follows.

Information, notification and consultation responsibilities: Each agency shall provide the public with continuing policy, program, and technical information and assistance beginning at the earliest practicable time. Each agency shall provide one or more central collections of reports, studies, plans, and other documents relating to controversial issues or significant decisions in a convenient location or locations such as public libraries.

Public Hearings: A notice of each hearing shall be well publicized, and shall also be mailed to the appropriate portions of the list of interested and affected parties required. This notice shall state the location, time, and presentation schedule, etc.
Other components include regulations for public meetings, advisory groups, enforcement of permits, financial assistance agreements, and assuring compliance with public participation requirements.

The fundamental premise of the *EPA Public Involvement Policy* ([3]EPA, 2003) is that the EPA should continue to provide for meaningful public involvement in all its programs and consistently look for new ways to enhance public input. EPA staff and managers should seek input reflecting all points of view and should carefully consider the input when making decisions. They also should work to ensure that decision-making processes are open and accessible to all interested groups, including those with limited financial and technical resources, English proficiency, and/or past experience participating in environmental decision-making. Such openness to the public increases EPA's credibility, improves the agency's decision-making processes, and informs its final decisions. At the same time, EPA should not accept any recommendation or proposal without careful, critical examination. This guidance is to help EPA staff and managers in implementing the seven basic steps for effective public involvement outlined in the Agency's Public Involvement Policy as follows:

- *Planning and budgeting* for public involvement activities.

- *Identification* — determining who needs to or should be informed of, interested in, or affected by a forthcoming action and performing associated actions;

- *Consideration* to provide technical or financial assistance to the public to facilitate involvement.

- *Provision of information and outreach* — conducting activities to provide information to the public;

- *Conducting public consultation* — ensuring opportunities for the public to provide input, comments, ideas, opinions, and information and to obtain feedback and information from the agency on a forthcoming action, decision, or other matter that may have an impact;

- *Reviewing and using input and providing feedback* — ensuring that public concerns and opinions have an impact on the decisions made by the agency; and

- *Evaluation of public involvement activities* — providing explanations for decisions and how the agency (or delegated program organization) used public input in the decision-making process.

CHAPTER 6: SOME LESSONS FROM INTERNATIONAL EXPERIENCE

From the experience briefly described above, some general lessons emerge about the role and challenges facing basin-based management, the actual and potential use of economic instruments, and the role of public participation.

Basin-based Management

An integrated, cross-sectoral and cross-jurisdictional approach as exemplified by the WFD and the CWA has been shown to be necessary if water resource management is to be efficient. This experience shows that river basin-based water institutions with unambiguous legal status and responsibilities for strategic water-related issues are essential to the administration and implementation of new policy and management strategy covering water quality, quantity and land planning. The financial responsibilities and dispute sovling among the partners are clearly defined legally. Such institutions should have sufficient autonomy to allow a flexible approach to be taken, which varies according to local social, economic and hydrological conditions.

However, basin-based management approach brings a series of challenges, including compliance with ambient or emission standards, with non-point discharges being of particular concern. For the latter agricultural pollution become the major issue and not much progress has been achieved although some regulation such as the EC's Directive on Nitrate control ([2]EC, 1991) has been issues many years ago. Basin-based management invariably involves issue of conflict of interest – and the advantages of decentralization have to be weighed against those of overall management, weighing the costs and benefits of strategic alternatives, which is often not possible at a much decentralized level. Decentralization may result in fragmentary decision making– and thus often inefficient or inequitable management. The core of the water resource management strategy is how to resolve the multiple tradeoffs involved in an efficient and equitable manner.

To some extent these problems can be addressed by improved information, facilitating a systematic approach to the identification of priorities by cost-benefit analysis. While many consequences of water development projects are not measurable in monetary terms, information required to improve decision making requires continued efforts in monitoring and data management; detailed information on geography, hydrology, water quality and pollution, social and economic development in a river basin requires comprehensive monitoring and characterization of surface and groundwater systems and present and potential future linkages to economic and social requirements. Such analysis may be costly, involving many disciplines and technologies such as hydraulic modeling, GIS application, and economics. Generally, education of stakeholders remains a problem everywhere.

The measures referred to in this report to improve water management, such as cost-reflecting prices, will, if successfully implemented, over time bring about strategic changes in water use, and thus have a beneficial effect on industrial and

agricultural output and locational decisions. However, for long term prospective water resources are so fundamental to economic development, that institutional and incentive mechanisms are required to ensure that water resource management is fully integrated into strategic economic planning (comprehensive water resource management, (van Beck, 1997)), including detailed proposals for systematic estimation of the opportunity costs of water required under various strategic policy scenarios.

It is important to ensure that – particularly in view of the rapidly escalating incremental opportunity costs of water resources – these costs are systematically factored into government's industrial, regional planning and other macro-level decisions. This in turn requires inter-agency coordination at the highest levels of government.

Economic Instruments

With regard to public water supplies, experience has shown that in many cases financial subsidies are counter-productive, and trends throughout Europe and the United States are to introduce more financial discipline – typically involving more cost-reflecting tariffs for both household and industrial consumers. Transferring responsibility from local authorities to private operators has been a characteristic of this trend. To a lesser degree this also applies to sewerage and sewage treatment.

The most commonly cited advantages of private-sector participation are that it brings technical and managerial expertise, improves operating efficiency, entails injections of capital and greater efficiency in its use, reduces the need for subsidies, and increases responsiveness to consumer needs and preferences. But experience shows that it is not a panacea – competent public regulatory institutions are required to oversee private operations, for example to ensure technical and financial efficiency and pay adequate attention to social and environmental objectives. And as German experience shows in the case waste water operations, inefficiency may stem from- many causes and apply whatever the form of ownership.

Nevertheless, the phasing out of subsidized financing for water and sewerage – one of the objectives of privatization - is justified on utility efficiency and fiscal grounds, and is in many cases a necessary condition for extending service to lower income or high cost areas. However, given that the costs of water are rising rapidly almost everywhere in the world (long run marginal costs are in excess of average costs), and that environmental costs are associated both with the supply of water and its disposal after use, it will typically be the case that standard financial norms for water and sewerage performance result in prices that are well below the true economic and environmental costs involved. Ensuring affordable water to the poor is a key to successful price reforms. Pricing according to long run marginal cost will in fact yield financial surpluses which allow a two part tariff with low rates for basic needs to ensure widespread access to service by cross-subsidization with minimal distortions in water use.

In a wider economic sense therefore, water and sewerage pricing continues to be subsidized by governments, thereby stimulating excessive and wasteful use. The same usually applies to private abstraction fees, which should ideally reflect the corresponding long run marginal cost of augmenting public supplies. Moreover, it is typically the case that irrigation water is particularly heavily subsidized.

Much the same can be said about pollution taxes, where they exist. Generally – as OECD reviews show – economic instruments for environmental protection are used primarily to generate revenue or offset costs of the environmental agency involved. As in the case of public water supply and sewerage, there is relatively little consideration given to the incentive effects of pollution taxes, and indeed, tax rates typically bear no relation at all to environmental damage costs. There are some exceptions to this rule, e.g. the fertilizer taxes used in some European countries, but in general the conclusion is that the potential for using pricing and taxation to create incentives to use water efficiently and avoid waste has far to go in Europe and the United States.

Water markets for water right transfer, including water quality trading, are playing an increasing role, and, where the opportunity costs of water are rising significantly, can be of major importance in encouraging the most economically efficient uses of water. However, questions of fairness invariably arise – in particular, as experience in the western United States shows - those relating to the initial allocation of water rights.

The government's role is shifting from a provider-only model to a provider-and-regulator model. However, it is still true that governments must be responsible for the provision of water services and making them accessible to the poor. Public funding spent on water, mainly on new sanitation infrastructure, should have a high priority in the governmental agenda. At the same time, governments should be more innovative in policy formation and system reforms to raise the efficiency of public investment and operation of water services, to assist private participation through legislative and institutional help, and to share the burden of risk.

Public Participation

European and United States governments have recognized the importance of ensuring public participation in water resource management and have taken legislative measures to facilitate this. The presence of a well-informed public has been shown to be a major driving force in improving the management of water resources, particularly in the case of their environmental aspects. For example, the growing significance of voluntary agreements between private industry and public authorities in European countries and Japan owes much to the environmental awareness of affected populations and the need by industrial operations to protect their reputation.

However, while sector-based legislative measures are useful, more fundamental issues are involved. A key problem with regard to environmental issues in all countries concerns asymmetry in information. Genuine uncertainties about the causes and consequences of environmental degradation or resource depletion allow powerful interests to manipulate information. To counter this, enabling factors for equitable water resource management include the basic elements of an open and transparent administrative system, such as technical education; legal rights of accessing information, expressing opinions, and transparent decision making process etc. These longer term measures are fundamental to the achievement of virtually all development objectives, but indispensable for water resource management, due to the need to reconcile inherent conflicts of interest that are invariably present.

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