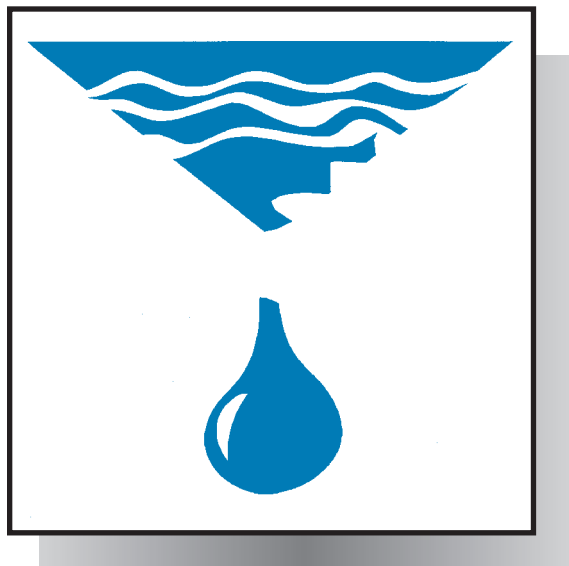




PROCEEDINGS

WATER CONSUMPTION AND SUSTAINABLE WATER RESOURCES MANAGEMENT



OECD PROCEEDINGS

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FOREWORD

The global demand for freshwater for human consumption has increased over four fold in the last 50 years (for comparison, world population roughly doubled in the same period). Water for irrigation and industrial production is the major component of this increase, but the demand for water in municipal areas is also increasing, particularly in countries undergoing rapid urbanisation. The sustainability of these trends varies according to a combination of environmental, economic and social factors. Projections from the World Resources Institute put the number of people living in water-scarce countries (less than 1000 cubic meters/capita/year) at roughly 13-20% of the global population by 2050. Most of these countries will be in the Middle East and Africa, but four of the five continents will be affected. Even in countries with adequate total water resources, there will be areas which are affected by drought and restricted supply; this will be the case, for example, in the United States, China, India, Pakistan and Mexico. The potential impact of climate change on hydrological systems and food production adds an additional element of uncertainty to future projections.

The stress put on water supplies depends on how they are used. Despite efficiency gains in many sectors and in many countries, water supplies continue to be undervalued, mismanaged and wasted. The symptoms of this mismanagement include overpumped groundwater sources, depleted river flows, salinisation, and thermal, chemical, and biological contamination of water supplies. Rising human demands for water are compounded by concerns that the water needs of the environment are not being met adequately. The consequences of the failure to ensure that there is enough water to sustain aquatic life and ecological systems are manifested in major losses of wetlands, decimated plant and animal populations, and degraded land resources and ecological functions in places as diverse as the Western US, the Aral Sea, and the Ganges. For many countries, the availability of water may become a major determinant of economic growth, industrial structure, and the national trade portfolio.

More efficient and ecologically sustainable water consumption patterns can only be achieved through significant changes in the pricing, allocation, and management of water supplies. To support countries in their efforts to better manage their water resources, the OECD Programme on Sustainable Consumption and Production, in collaboration with Environment Australia, organised a workshop in February 1997 to examine approaches which can lead to the sustainable consumption of water. Workshop participants discussed policy options not only to improve the sustainability of water consumption in the agricultural, industrial, and commercial/residential sectors, but also to more effectively manage demand between competing uses, including meeting the water needs of the environment. The discussion covered experiences in OECD Member countries, selected countries in the Asia-Pacific region (Malaysia, Indonesia, China, Taiwan, Thailand, Vietnam, Laos, Cambodia, India), and Brazil.

The workshop adds to a range of work in the OECD on water resources management, including current studies on water pricing and the environment, biotechnology and water quality, and policies for sustainable water management in the agricultural sector. It also built upon earlier OECD work on water, and in particular on the 1989 OECD Council Recommendation on *Water Resources Management Policies: Integration, Demand Management, and Groundwater Protection*. This report is intended to contribute to current international debate on the management of freshwater resources, including those taking place in major international meetings and at the 6th session of the UN Commission on Sustainable Development.

This publication draws from presentations and written contributions from workshop participants as well as selected outside material. It has been written by Elaine Geyer-Allély, consultant to the Environment Directorate. It is published on the responsibility of the Secretary-General of the OECD.

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EXECUTIVE SUMMARY

OECD countries are not running out of water, but an increasing number are facing occasional or regional drought and/or scarcity. Over the last two and a half decades, freshwater withdrawals have risen in the OECD region from approximately 830 billion m³/year in the early 1970s to a current level of just under 1000 billion m³/year. Globally, the demand for freshwater for human consumption has increased over four fold in the last 50 years. Per capita rates of water withdrawal vary significantly among OECD countries.

Efficiency gains have been made in many countries across all sectors, due to improved production technologies in industry and agriculture, and water-efficient devices and practices in commercial and residential settings. Nevertheless, a number of factors continue to encourage the waste and mismanagement of fresh water resources, including low prices for water supplies and wastewater treatment, ageing or inefficient water distribution infrastructure, and slow-uptake of water-efficient technologies and practices. Lack of information on the state of water resources and specific use patterns hampers both policy development and action at the consumer level. In a growing number of countries, the misuse of water resources is evident in overpumped groundwater sources, depleted river flows, salinisation, and polluted water supplies. Rising human demands for water are compounded by concerns that the water needs of the environment are not being adequately met.

Globalisation, and with it the liberalisation of markets and investment structures, will have an impact on national economic structures and trade. It is not clear yet what impact liberalisation will have on the environment and on water resources in particular. Access to water is already becoming a determinant of the pattern and rate of economic development and trade in many countries.

The OECD Programme on Sustainable Consumption and Production, in collaboration with Environment Australia, organised a workshop on *Sustainable Water Consumption* to focus on approaches which will lead to more sustainable use of water. Under the Chairmanship of Dr. Mike Sargent, Chief Executive, ACTEW Corporation, policy makers from OECD countries and from several countries in the Asia-Pacific region examined a range of policies and measures to improve the sustainability of water consumption and integrated water resources management.

Some of the main conclusions emerging from this Workshop are:

- Countries are increasingly recognising, and acting on, the **need for an integrated water resources management approach**. Integrated water resources management considers both production and demand-side pressures, and has the multiple objectives of: minimising water waste; maximising the efficiency of water use; maximising water availability by limiting degradation of water supplies, and through reuse; optimising water allocation to competing users; and limiting withdrawals to sustainable levels.

- The optimal allocation of water resources requires full **recognition of the environment as a water user**, and the ability to identify the minimum water requirements to support aquatic eco-systems. It is in this context, for example, that a number of countries are devoting increased attention to defining minimum flow requirements for river systems.
- A number of steps are needed to **implement integrated water resources management**, including: developing more appropriate institutional structures, functions and responsibilities; and, strengthening the information base on available water resources, environmental pressures, and present and future demand.
- **Greater involvement of water users**, including private sector firms and communities, is a critical element of successful strategies for sustainable management of water resources. Explicit mechanisms are needed to promote user “ownership” of water issues, and involvement and responsibility in water policy planning and implementation, (e.g. partnerships in objective setting and joint implementation).
- **Governments have the responsibility of setting the framework for sustainable water resources management.** The mix of government policies and instruments to promote sustainable management of water resources will vary between countries and will depend on social, economic and environmental considerations, technological possibilities, and the specific end-use patterns in question. There are nevertheless some common priorities:
 - * *Establishing appropriate water pricing regimes* that over time reflect the full costs of supplying water, preserving water quality and maintaining the resource base. The exact structure of water pricing regimes will vary according to the capital, operating, environmental and social costs of supplying water in each region. In the transition to full-cost pricing, adequate provision will have to be made in many countries to guarantee that water requirements for basic needs are met in low-income groups.
 - * *Strengthening social instruments designed to modify user behaviour* to increase the efficiency of use and to conserve water: education, information, and partnership strategies are needed which foster both user "ownership" and responsibility in water resources management. Strengthening social instruments also requires a better understanding of the network of factors influencing consumption patterns (technological, institutional, economic, social) so that they can be coupled with mechanisms that allow water users to put new information to use (institutional arrangements providing for water user involvement in water policy planning and implementation; availability of alternative water delivery technologies; metering to control household water consumption, etc.).
 - * *Employing mechanisms to promote a faster and wider diffusion of available water efficient technologies* in industrial, agricultural and commercial/residential sectors, including through the identification of economic, technical and social barriers to technology diffusion.

This Report describes a range of policy considerations for total water resources management. It begins, in Section I, *Introduction*, with a perspective on the intersection of two policy arenas: sustainable consumption and production on one hand and water resources management on the other. These are two issues which have been moving ahead in isolation of each other, but which have several points in common. This section lays out some broad conceptual lines that run throughout the Report.

Section II, *Water Consumption Trends*, reviews trends in water consumption in both OECD countries and more globally, and explores the notion of “sustainable water consumption”. It underlines that although OECD countries are not “running out of water”, the current management of water resources is not sustainable.

Section III, *Promoting Sustainable Water Resources Management*, summarises Workshop discussions on Integrated Water Resources Management. It highlights the emphasis given to two new elements of what is understood by “integration” -- the recognition of the environment as one among many “users” of water; and the inclusion of a wider group of stakeholders in water policy development and implementation. This section outlines Workshop discussions on policies and instruments for sustainable water resources management through: (i) modifying water use patterns -- through water pricing and tariff reform, information, and technology and infrastructure; (ii) institutional reform and multistakeholder decision-making; (iii) allocating water between competing uses; (iv) improving the information base on water resources and use; (v) building stronger links between water resources management and socio-economic considerations; and (vi) rethinking monitoring, evaluation and the role of Government. A case study on water management in Australia illustrates how that country is employing a mix of policy instruments to reform water use.

Section IV, *Sector Specific Policies*, highlights conclusions from each of the four Working Groups convened to examine policies to promote sustainable water consumption in the industry, agriculture and commercial/residential sectors, as well as integrated demand management. Working Group discussions converged on a number of points, including the need for an integrated water resources management approach across sectors. Working Groups also came to similar conclusions on the key elements necessary to move water use patterns towards sustainability. Those have been incorporated throughout the document. As a result, this section highlights additional insights from Working Group discussions specific to policies on water resources management in each of the three different sectors and in the context of integrated demand management. This section also provides four case studies on: Demand-Side Management in the Commercial/Residential Sector In Japan; Water Quality Controls to Reduce Industrial Water Consumption in China; Agricultural Sector Reform in Australia; and Integrated Demand Management in France.

Section V, *Conclusion*, provides concluding thoughts on areas where OECD and non-Member countries might place their focus as they work to improve the sustainability of water resources management.



I. INTRODUCTION

The Sydney Workshop brought a new element to the water resources management debate, by highlighting the concept of the sustainable consumption of water. This is a response to the reappearance, in many OECD countries in particular, of water on the policy agenda as stresses on available water supplies, and the environmental impacts of past water management practices have become more pressing. As an introduction to this Report, the Keynote Presentation by R Roberto Lenton, Director, Sustainable Energy and Environment Division, United Nations Development Programme, provides one perspective on the intersection of the debate on sustainable consumption and production on one hand and water resources management on the other -- two discussions which have been moving ahead in isolation of each other but which have several points in common. The excerpt lays out some broad conceptual lines that run throughout the Report.



Sustainable Consumption and Water Resources Management

Keynote Presentation (excerpt):

Roberto Lenton, Director, Sustainable Energy and Environment Division

United Nations Development Programme

“This is an opportunity to bring together two debates that clearly are very closely linked, and yet have been following separate paths for far too long. One is the debate on demand-side approaches to sustainable water resources management. The other is the debate on sustainable consumption and production patterns...Both debates have largely missed out on the potential benefits of cross fertilisation and the shifts in thinking and action that such cross-fertilisation might engender.

“Considerable progress has been made in defining the concept of sustainable consumption in general and much could be gained by attempting to establish more precisely what the concept of sustainable consumption means in the context of water resources.... Such a definition should focus on *meeting needs*, while at the same time protecting aquatic ecosystems. In particular it should define these needs in terms of water services for food security, human and ecosystem health, and for social, economic and political stability, rather than on specific levels of water quantity and quality. A focus on water services would begin to capture the distinction between levels and patterns of consumption, which has been so much a part of the sustainable consumption debate. In particular it would highlight the need to meet needs without a disproportionate increase in the levels of water use. This would help crystallise the goal, although it does not help us much in identifying the formidable, technological, managerial and institutional changes we will face to achieve this goal.

“[There are] three other aspects of the sustainable consumption debate that open up interesting implications for water resources management. One is the concept of *end use*, which is closely related to the concept of water services. [Although] making practical use of this concept is full of difficulties...developing the concept of end use would facilitate a focus on a second key ingredient of a sustainable consumption debate, and that is the *behaviour of individual consumers* as a major determinant of overall patterns of consumption. This perspective holds promise to open up exciting new ways of examining old problems since the traditional approach in the water resources area has either been supply driven or based on a very aggregate view of consumption. One particular avenue for new exploration would take into account that water for agriculture consumes an overwhelmingly large proportion of total water use...This suggests that attempting to achieve more sustainable water consumption through a focus on the behaviour of individual consumers requires concentrating to much greater extent than before on two specific groups: the first is the very large numbers of small farmers, especially in developing countries... and the second [is people world-wide and their food habits], taking into account that some foods, meat and rice in particular, require much higher levels of water use than others.

A key instrument for moving towards sustainable consumption patterns is to ensure that resources and ecosystems are given economic value and that external costs are internalised into market prices. . . The challenge in the water area, lies not in the principle, but in the practice.

“The third and final concept ... is the need to make the *linkage between consumption and production*. In the water resources area, there has been too much of a divide between those that espouse the need to increase the supply of water resources, and those that advocate improved efficiency in management. Clearly, both demand-side and supply-side approaches are needed, and they need to be considered together in an integrated fashion. Although the special attention given over the last several years to demand-side management may have been important to counteract the historical concentration on supply-side approaches in the water area, in the future concerted attention must be given to making the linkage between the two. Particular attention must also be given to the environmental and social sustainability of supply-side approaches which will require the development of imaginative options to increase water supply while protecting the aquatic ecosystem.

“The sustainable consumption debate has also yielded considerable consensus on the practical challenges that countries face in moving towards more sustainable consumption patterns. The first challenge relates to economic instruments... *getting the prices right*. There is virtually unanimous agreement in the environmental community that a key instrument for moving towards sustainable consumption patterns is to ensure that resources and ecosystems are given economic value and that external costs are internalised into market prices. Within the water resources arena this principle is now largely accepted. But the challenge in the water area, lies not in the principle, but in the practice. In many, if not most developing countries, the current price of water as charged to consumers, does not reflect even the economic cost of water, let alone the environmental cost. And pricing water generally entails finding practical ways of measuring water consumption, which for some water uses, particularly water for small holder agriculture in developing countries is not at all straight forward.

“The second challenge is *information*. In a sustainable consumption arena, it is largely accepted that much better information is needed to enable effective decision making on policies and instruments. This, in turn, requires improved environmental monitoring, better methods for environmental resource accounting and more practical sustainable development indicators. But in the water resources area there is a long way to go before these information needs are realised...A key information challenge...is based on the recognition that if consumer behaviour is to change, much better information on the environmental impact of consumption is needed to make these impacts visible and allow consumers to make more sustainable choices.

“The third challenge is *infrastructure and technologies*. The Oslo Ministerial Round Table in 1995 recognised that current capital stocks of physical infrastructure can lock societies into unsustainable patterns of consumption over which individual consumers have little influence. There is general agreement that the focus on the consumer needs to be tempered by recognition that infrastructure and technology have a key role to play in enabling or constraining individual consumer choices. In the water resources area, existing infrastructure will undoubtedly have a huge influence on consumption patterns for decades to come. Existing irrigation infrastructure in particular will constrain management choices. This re-enforces the need for imaginative managerial and technological innovation for future water resources infrastructure both for supply-side and for demand-side management.

“Several of the areas for action that have been identified through the sustainable consumption debate are very relevant to water resources. One is the whole issue of analysis, information and indicators...Much better information is needed to pinpoint the impacts that demand-side management has had on water consumption patterns in a variety of different settings and we need to make much more progress on the methods we can use to monitor our progress towards sustainable water management, which means developing and applying sharper and more widely agreed upon performance indicators of water demand and supply. Another area for further work relates to the development of better instruments for changing water consumption patterns. Since much of the work to date on water resources has dealt with regulatory instruments, particular attention needs to be given to social and to economic instruments...The third area that is particularly important relates to promoting dialogue and partnership amongst stakeholders...Promoting such partnership will require extraordinary levels of commitment and careful attention to capacity building since most water professionals are trained in their technical disciplines rather than in techniques of dialogue and participation. Action in this area needs to be linked to progress in the area of information, so that public participation in decision making and consultation with affected parties can take place with full and accurate information disclosure.”



II. WATER CONSUMPTION TRENDS

Since the beginning of this century, global water withdrawals have increased by over six times, more than double the rate of population growth.¹ The growing reliance on irrigation to meet global food requirements, a rapid expansion of the industrial base, increasing per capita use for domestic purposes, and energy generation have driven these increases. Ensuring adequate supply to meet rising demand has long been the focus of water resources management, implemented through huge investment programmes to dam, divert, channel and deliver water. Natural water flows have been engineered so successfully that the majority of people in OECD countries have in the past had access to as much water as they wanted.

Over the last two and a half decades, freshwater withdrawals have risen in the OECD region from approximately 830 billion m³/year in the early 1970s, to a current level of just under 1000 billion m³/year. The rate of per capita water withdrawal varies significantly among OECD countries (Figure 1). During the 1970s and 1980s, a number of countries, such as Norway, Sweden, the United Kingdom and the United States, appeared to have stabilised their per capita consumption. Others, including Canada, New Zealand, France, and Germany, have seen increases of 30 per cent or more, although this trend appears to have halted in recent years in France and Germany.²

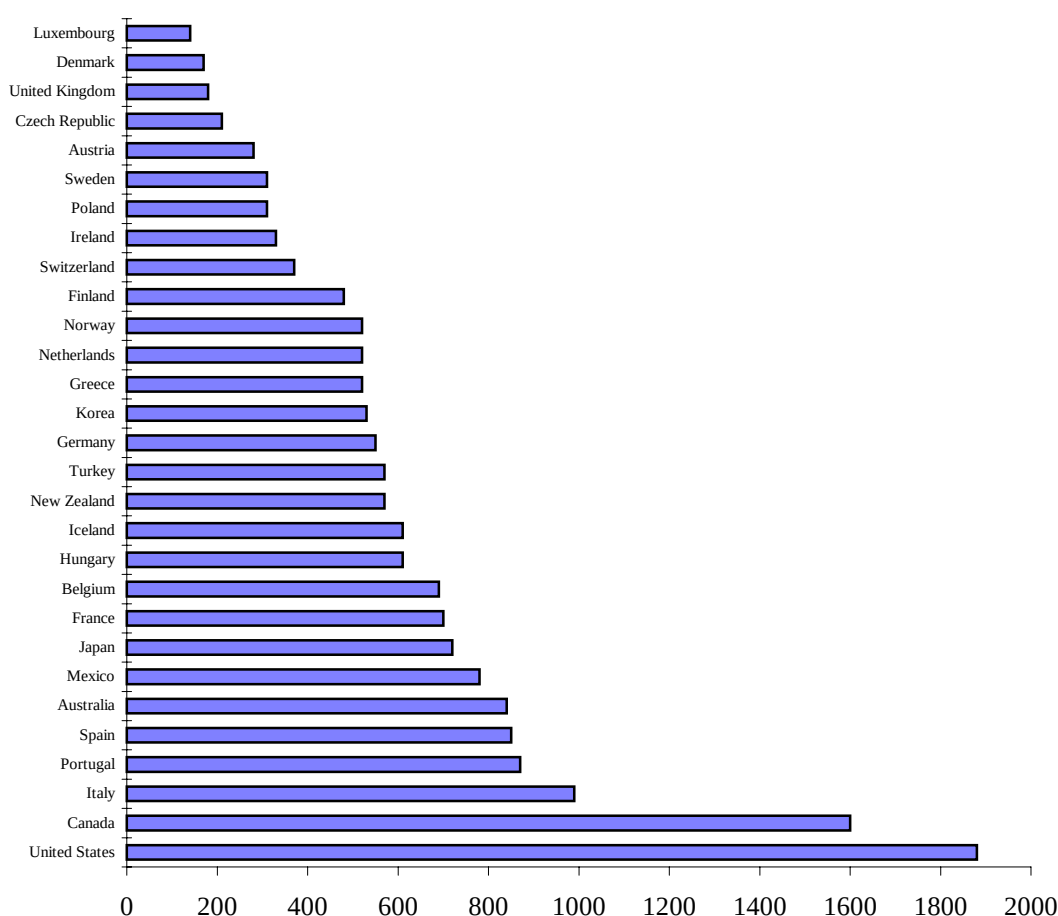
Water withdrawals in each of the major sectors are expected to continue to increase (see Figure 2):

Agriculture: In OECD countries water withdrawals for irrigated agriculture ranged from 1.2% in the Czech Republic to 83% in Mexico in 1995. Losses through evaporation and plant transpiration, however, usually make agriculture's share of total water *consumption* much higher. In the United States, for instance, agricultural withdrawals account for approximately 42% of total withdrawals, but 84% of consumption. In non-OECD countries the percentage of water resources drawn for agriculture is even greater, reaching as much as 90%. Rising population and increasing demand for animal proteins are expected to require a doubling of current global food production and greater trade in food.³ There is debate on the amount of water that will be needed to produce future yields. Estimates cited in the UN *Comprehensive Assessment* range between a 50% to 100% increase over 30 years, because the bulk of the increase in food production will need to come from irrigated land. In the majority of OECD countries, any expansion will have to come from water conservation to

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1. UN Economic and Social Council, Commission on Sustainable Development, *Comprehensive Assessment of the Freshwater Resources of the World* (E/CN.17/1997/9). Hereafter *Comprehensive Assessment*.
 2. OCDE, 1991. *The State of the Environment*.
 3. UN Department for Policy Coordination and Sustainable Development, 1997. *Critical Trends: Global Change and Sustainable Development*.

Figure 1: Annual per capita Freshwater Withdrawals (m3)

Source: OECD (see Annex 1)



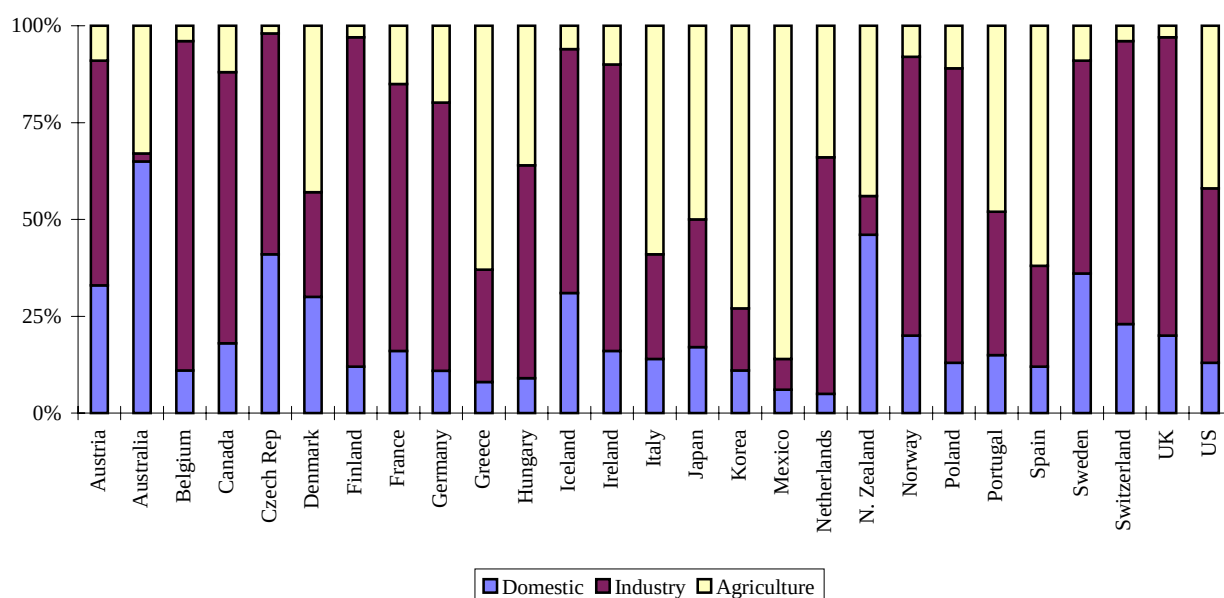
free “new” water or from ground water resources, as surface-fed irrigation appears to be approaching physical, and often financial, limits.⁴

Some countries have made significant reductions in the amount of water needed for irrigation. Increased efficiency has been achieved through price incentives, infrastructure refurbishment and improved agricultural management techniques, including greater precision in the timing and volume of water applied to crops, sustainable agriculture techniques (conservation tillage, crop selection). Still, water-efficient irrigation techniques have been adopted by an extremely limited number of agricultural producers: drip-irrigation, for instance, is employed in less than 1% of the world's irrigated area. The potential for efficiency increases is significant, but has not been realised.

Industry: On average, industry in OECD countries accounts for 49% of total water withdrawals. Globally, industry is the fastest growing user of freshwater: industrial demand is expected to increase over the next two decades between 2.7-3.2 times 1990 rates, driven

4. OECD Directorate for Food, Agriculture and Fisheries/Directorate for Environment, Internal Working Paper, 1996. “OECD Workshop on Sustainable Management of Water in Agriculture: Issues and Policies.”

Figure 2: Freshwater Withdrawals by Sector in OECD Countries (%)



Data from World Resources Institute, 1992, Sectoral withdrawal percentages estimated for 1987.

primarily by rapid industrialisation in many non-OECD countries.⁵ The projected growth in consumption is likely to be accompanied by more than a four-fold rise in industrial water pollution. Most of the water withdrawn for industrial purposes is used and then returned to the environment. As a result, industrial water use is most important in the impact it has on the availability and quality of downstream water supplies. In OECD countries, government-established water quality criteria and, to some extent, water pricing policies, have stimulated water efficiency and pollution prevention programmes. These have had demonstrable effects on reducing industry water use, increasing water use efficiency and improving the quality of cooling and wastewater discharged from industrial processes. However, water services for industrial purposes are still underpriced in the majority of countries and water conservation and efficiency gains have not penetrated industry world-wide.

Commercial and Residential: Commercial and residential withdrawals range widely among OECD countries, but in the majority of them commercial/residential withdrawals account for under 20%. In non-OECD countries, commercial/residential withdrawals average under 10%, although this figure disguises very wide variation among countries. Despite major investments of nearly \$100 billion during the 1980s, which gave 80% more sanitation facilities, the rapid rise in urban populations has meant that 220 million urban dwellers (13% of total urban population

5. World Business Council for Sustainable Development, November 1996. *Discussion Paper: The Role of Industry in the Sustainable Management of Fresh Water Resources.*

in developing countries) still had no access to a safe and reliable water source and 420 million (25% of the total urban population in developing countries) lacked access to sanitation services.⁶ Most of the projected population increase over the next 30 years will take place in the urban centres of the developing world. In these fast growing “megacities” pressures from growing domestic demand for water will be amplified by the rapid growth of industrial activities and increasing peri-urban agriculture.

In OECD countries, a growing number of cities face rising costs of supplying adequate water and sanitation facilities to urban residents. Human settlements are also increasingly entering into competition with agricultural and industrial water users for limited water resources. All over the world, municipal water supply networks face often serious water wastage due to leakage and distributional losses. In some OECD countries leakage has been reduced to 10-12%, although it remains high in others. In many industrialising world cities losses due to leakage or illegal connections run as high as 60%. High levels of human waste, untreated discharge from industry and non-point sources of pollution severely degrade urban water supplies. The economic costs of water supply and wastewater treatments services are generally not covered through current price and tariff structures, and a variety of related subsidies are in place.⁷ The importance of the public provision of water supply and sanitation services requires that a range of social and economic considerations, public health interests, and social policy objectives be weighed in the reform of pricing policies. Incentives to encourage more efficient water use are needed.

OECD countries are not running out of water. But even those with historically abundant water resources are increasingly facing at least seasonal or local water supply problems, including droughts, shrinking groundwater reserves, or lowering of groundwater tables. Pollution levels in some cases also limit downstream supply.

Sustainable Water Consumption

Whether withdrawal levels pose a problem for the sustainability of the resource depends on the availability and renewability of freshwater resources. Mean annual river run-off and annually renewable groundwater resources supply the bulk of water consumed. A range of human activities have various effects on the water regime, total annual flow and water quality. When human activities draw rapidly on slowly-renewed water resources (e.g. fossil aquifers, large lakes), they effectively become non-renewable. *Availability* depends on a number of factors, including the ability to capture annual flow of surface waters; economic, social and environmental feasibility of new infrastructure projects to dam and divert surface waters and pump groundwater; and minimum water flow threshold levels below which aquatic ecosystems are damaged.

The UN *Comprehensive Assessment* suggests that water *stress*, measured as the ratio of water withdrawal to water availability on an annual basis, "can begin as the use of fresh water rises above 10 per

6. World Resources Institute, 1996. *World Resources: 1996-1997* (Oxford University Press, NY).

7. OECD, 1997. *Water Subsidies and the Environment* (OCDE/GD(97)220).

cent of renewable freshwater resources, and becomes more pronounced as the use level crosses the 20 per cent level.”⁸ The *Comprehensive Assessment* distinguishes four categories of water stress:

- ◆ *low* -- use of less than 10 per cent of available fresh water. In general, there is no major stress on available resources.
- ◆ *moderate* -- use in the range of 10-20 per cent of available water. Availability is generally becoming a limiting factor, and significant effort and investments are needed to increase supply and reduce demand.
- ◆ *medium-high* -- water withdrawals are in the range of 20-40 per cent, and management of both supply and demand are required to ensure that use is sustainable. There is increasingly a need to resolve competing human uses, and to ensure that aquatic ecosystems have adequate water flows.
- ◆ *high* -- use of more than 40 per cent of available water. Serious scarcity is indicated, usually accompanied by an increasing dependence on desalination and use of groundwater faster than replenished. There is an urgent need for intensive management of supply and demand. Water scarcity becomes a limiting factor to economic growth.

By these definitions, the majority of OECD countries falls within the low and moderate stress categories: they are not “running out” of freshwater (See Annex 2). On the other hand, national averages obscure the fact that most countries, even those with historically abundant water resources, are increasingly facing at least seasonal or local water supply problems, including droughts, shrinking groundwater reserves, or lowering of groundwater tables. Pollution levels also seriously constrain downstream supply, particularly for high-quality uses. In the more arid regions, where water stress levels reach medium-high levels, resources may be so limited that the demand for water can be met only by exceeding the sustainable use of the resource in terms of adequate recharge rates, sufficient water flow for the ecosystem and quality considerations.⁹ In a growing number of countries, competition among diverse water users for shares of a limited resource has heightened the need to find effective water allocation mechanisms. Limited availability of water in many regions around the world is increasingly a major determinant of economic growth, industrial mix and goods traded. Access to water is already a significant point of tension between many nations in transboundary river basins.

The increasing frequency of problems related to water supplies explains the new preoccupation with water consumption and the ability of nations to meet their future water needs within environmental limits. As in many other domains, determining what is a “sustainable” level and pattern of water consumption is difficult at best. Recognising that water resources are best managed on a catchment level, Workshop participants identified several elements that start to form a definition of sustainable consumption. This begins with the basic tenet that current water consumption *should meet basic needs for water services without jeopardising the ability of future generations to meet their water needs and while protecting the water needs of the environment*. Water needs can be defined in terms of water services for food security, human and ecosystem health, and for social, economic and political stability. Determining sustainable limits requires recognition that although water resources are renewable, water systems can be so degraded that they are potentially lost, and that ecosystems dependant on water (aquatic flora and

8. UN *Comprehensive Assessment* (E/CN.17/1997/9) and presentation by Gunilla Bjorklund, Stockholm Environment Institute.

9. OCDE, 1996. *Environmental Performance in OECD Countries: Progress in the 1990s*.

fauna; river systems, wetlands, etc.) have a minimum quantity and quality threshold beneath which they are damaged. Sustainable water consumption is thus a dynamic concept which combines both quantity and quality considerations. Sustainable levels must be defined and refined within changing economic, social and environmental contexts and as information and understanding improves.

Current concerns about the sustainability of water consumption have provided new impetus to better understand what shapes water consumption patterns and levels, and to look behind the trends. In some cases, stabilisation or reduction of per capita water withdrawals has come as the direct result of efforts to rationalise the use of water and to increase the efficiency of water use. In many cases, however, reduced water withdrawals are a result of constraints on water supplies, either due to climatic conditions, such as periods of prolonged drought, for instance in Spain, or because of past water management practices which have reduced the amount of freshwater now available. This is the case in areas of the south-central and western United States, where decreasing water withdrawals for irrigation are due in part to a drop in agricultural activity and past water abstraction practices which have lowered water levels in several major aquifers.

A number of factors influence both how, and how much, freshwater is used for human purposes:

- economic (e.g. notably the price of water, and tariff structures);
- technological and managerial capabilities (e.g. the efficiency of water delivery technology; rate of uptake of efficient technologies; management techniques);
- socio-economic conditions (e.g. land-use patterns which determine agricultural and industrial activities: location of residential areas in relation to water supplies; land-use impacts on watershed conditions);
- cultural habits (e.g. landscape and gardening practices; domestic water use patterns);
- political, legal and institutional structures (e.g. water rights; institutional arrangements to manage water);
- regulatory controls (e.g. efficiency standards), and
- environmental conditions (variations in natural hydrological cycles).

This set of factors is linked together in an often complex set of cause-and-effect and feedback mechanisms, so that land-use patterns, rate of technology uptake, water quality controls, and the price of a cubic meter of water, for example, are often intricately tied together and jointly determine water use by industrial and agricultural consumers. These interconnections between different factors have strengthened the recognition that sustainable water resources management starts from an integrated, total water cycle perspective that draws on a combination of instruments and actions.



III. PROMOTING SUSTAINABLE WATER RESOURCES MANAGEMENT

Integrated Water Resources Management

A growing number of countries have recognised the problems inherent in current approaches to water resources management, and have taken significant steps to modify the regulatory, institutional, economic and social framework in which water resources policy takes shape. Many barriers still exist to achieving patterns of water use that meet human needs while protecting water resources. Nevertheless, a number of initiatives can be highlighted today that signal a shift toward a longer-term, integrated management of water resources which targets the total water cycle and includes environmental sustainability as a key consideration.

Integrated water cycle management considers both supply and demand-side pressures, and has multiple objectives, to:

- ✓ minimise water waste;
- ✓ maximise the efficiency of water use;
- ✓ maximise water availability by limiting the degradation of water supplies, and through reuse;
- ✓ optimise water allocation to competing users, including the environment; and
- ✓ limit access to sustainable levels.

Water resources policy development is changing in some countries -- reflecting an evolution away from top-down planning processes with a selected number of powerful players, to a more bottom-up process with a wider base of ownership, and which addresses a broader range of issues.

Achieving these broad objectives implies approaching water management from a number of different angles, and designing packages of measures targeted to the range of water users. A number of steps are needed to implement total water cycle management: institutional reform; reform of water allocation policies and mechanisms; influencing the behaviour of water users; restructuring of water pricing and tariffs; water-efficient technology development and dissemination; infrastructure maintenance to reduce waste; improved environmental management related to water use (e.g. land use; agricultural techniques); protection of ground and surface water quality; and improved information on water resources and use (metering, monitoring).

An integrated approach to water management is not a new concept in the water resources field. The 1989 OECD Council Recommendation, which stressed integration, stemmed from the need for reform of

scattered institutional arrangements governing water management, including administrative and legal structures. The focus at that time was essentially on the machinery of government water policy development and implementation.

The Sydney Workshop marked a further evolution in thinking and experience. Participants stressed that, although progress has been made in recent years to rethink water resources management, major steps must still be taken towards the basic reforms needed to create an institutional framework in which water resources are managed holistically. However, participants also broadened the concept of integrated management and gave stronger emphasis to two priorities in particular:

- full **recognition of the environment as a water “user”**, and the ability to identify the minimum water requirements needed to support ecological systems, as critical factors in determining the optimal allocation of water resources; and
- **greater involvement of water users**, including the private sector and communities, as a fundamental element of successful strategies for sustainable management of water resources.

Evident in the discussions was a perceptible shift in several countries in the framework around water resources policy development -- reflecting an evolution away from top-down planning processes with a selected number of powerful players to a more bottom-up process with a wider base of ownership and which addresses a broader range of issues. The focus of water resources management is increasingly not just basic economic interests related to water, but a broader set of considerations about the quantity and quality of water needed to fulfil human and environmental needs. The importance of ensuring that there is adequate water to protect watershed health is also placing greater emphasis on integrated and proactive environmental management in general, including land-use practices related to the protection of water resources.

Participants argued for a more refined use of policy instruments, and a better mastery of how packages of instruments can be applied, and where emphasis must be placed, to achieve the desired objectives. Although the mix of policies and actions for any country or region will be shaped by the natural conditions and human pressures influencing the state of water resources, and social, economic and environmental priorities, participants identified some important common components of an integrated approach. This chapter outlines these components and looks at a number of examples of the policy tools and strategies in place to move towards a more sustainable use of water resources. The Workshop did not evaluate each of these policies and tools exhaustively, but rather reviewed the range of actions required to move towards greater sustainability. It examined progress made in the areas long identified as ripe for reform, but also some of the more innovative attempts to put in place a wider vision of integration.

Policies and Instruments for Sustainable Water Resources Management

Modifying Water Use Patterns

A central theme in Sydney centred around the importance of stimulating changes in user behaviour and values regarding water resources in order to encourage water use efficiency, and where necessary, conservation. Participants agreed that the most effective approaches to stimulate changes in patterns of water use are likely to combine both top-down measures (i.e. regulatory controls; price signals), and bottom-up strategies (e.g. education, information, and dialogue), within a favourable context (i.e. technology and infrastructure). The particular points of emphasis for any set of policies will vary

according to the factors driving consumption, sectoral characteristics influencing the demand for water, and social, economic, and environmental objectives. Workshop discussions concentrated in particular on three key elements that help shape patterns of water use: water pricing and tariff reform, information, and technology.

Water Pricing and Tariff Reform:

Within the water resources policy arena, it is largely accepted that water has an economic value in all of its competing uses, and should be treated as an economic good. Full cost pricing -- which covers direct economic costs, social costs and environmental costs for supplying water -- is a necessary condition for sustainable water resources management and one which applies across all sectors. It is also widely acknowledged that this principle is rarely put into practice.

Currently, water is overconsumed and wasted in large part because consumers do not receive appropriate signals about the value of the resource. Real costs are masked by water subsidies, including not only underpricing and subsidies for water supply services, but all types of subsidies that contribute directly or indirectly to the quality of water resources available for use, or to the quantity of water actually used.¹⁰

Currently, water is overconsumed and wasted in large part because consumers do not receive appropriate signals about the value of the resource.

Reforms of water pricing regimes are taking place in some countries to remove cross subsidies and to raise sufficient revenue to fund operation, maintenance, administration and infrastructure renewal. In Germany, a groundwater charge (water resources tax) is levied on every cubic meter of groundwater abstracted. With the money collected the State subsidises technologies and measures to reduce water consumption in both the public and private sector, and funds pilot projects and programmes for water protection. There is resistance to this approach: the groundwater charges have been challenged before the Supreme Court. In China, historical subsidies to water supply are being phased out. Over the next five years, the price of water used for different purposes will be raised gradually until they cover the cost of supply and provide a small profit margin. Taiwan has plans to establish a price structure which reflects the cost of water use and to adapt a progressive tariff structure to encourage efficiency.

Tariff reform is also essential if maximum benefit is to be gained from pricing reforms. For example, in the Murray Darling River Basin in Australia, a horticultural district was allocated a relatively large water right for growing citrus and grape vines. 82% of the irrigators used less than the water right.

10. The price of irrigation water in particular has been heavily subsidised throughout the world, leading to overuse and the allocation of water to low-value crops. Pricing regimes for industrial water are most often of a flat- or bulk-rate type, or even include quantity discounts -- only rarely are prices structured to provide incentives to conserve. Water-relevant subsidies to industry are still frequent, usually in the area of water discharge and sewerage systems. Water services for domestic purposes are most often underpriced: although operating costs are generally covered by charges, the full costs involved in water supply and wastewater discharge are not. For a full discussion on water pricing see, OCDE, *Water Subsidies and the Environment* (OCDE/GD(97)220). For a discussion on water subsidies in the agricultural sector, see also OECD, (forthcoming) *Sustainable Management of Water in Agriculture: Issues and Policies, The Athens Workshop*.

A two-part tariff was introduced with a fixed component designed to recover 50% of the required revenue. A volume-based component recovered the remainder and irrigators were given a benefit if they used the water more efficiently. Anecdotal evidence suggests that the new tariff structure is accelerating the introduction of modern, more efficient irrigation technology. In Japan, differentiated tariffs are applied for urban water users, with the largest consumers paying a rate per cubic meter eight times higher than small-volume consumers.

The move to full cost pricing raises a number of important issues in terms of both the speed with which price increases are made and how “full costs” are calculated. Participants agreed that price reforms in general needed to include economic, social and environmental costs of water “production” and consumption and to incorporate a conservation signal so that big consumers have an incentive to increase their efficiency. The discussion on price reforms, however, also underlined the need for a real exploration of basic water “rights” at the individual level, and the importance of ensuring that the water needs of the poor are met as water prices are set to rise. OECD countries must sometimes make distinctions between basic human needs for water and sanitation, for example, and secondary uses of water (e.g. gardening; recreation). In the industrialising countries, additional factors must be considered, including the fact that currently urban poor often pay a price 10 times higher (or more) to private water vendors than wealthier populations hooked up to a water distribution system.¹¹ The historical perspective on water as a social and “free” good has helped to shape the water consumption patterns in most societies. Full-cost pricing and volume-based tariff structures will help distinguish between “basic” and “secondary” needs, although participants observed that the challenge often comes in determining the “right” price.

Information

The information available to individuals on their real consumption patterns is another important factor influencing water use. Currently, information is insufficient, or unavailable in a format which links individual consumption patterns with wider resource management questions. Individual consumers, agricultural producers, and small- and medium-size enterprises (SMEs) often have little feedback concerning the impact of their water use patterns on water supply systems. The lack of information is tied in general to the need for both better water resources monitoring and evaluation capacities and for indicators of sustainable levels of water use and consumption (see below). However, there is also the issue of making existing information accessible to consumers so that it motivates a change in consumption behaviour towards greater efficiency, and where appropriate, conservation.

Metering can be an important tool to achieve this. Measuring the volume of water drawn is the only means of directly providing information on water consumption and relating charges to that consumption and the cost of supply. This creates direct financial incentives for consumers to use water more efficiently. A recent study in the United Kingdom, building on earlier work by the OECD in 1987 on the effect of charging by metering, observed that peak consumption can be reduced by between 25% and 35% in relatively hot summers.¹² The actual effect of meter-based charging depends on a combination

11. UN Centre for Human Settlements, (no date). “Habitat Press Release: Water Crisis to Strike Most Developing World Cities by 2010”.

12. Herrington, 1996 cited in *Water Resources and Supply: Agenda for Action*, UK Department of Environment, 1996.

of factors, including the tariffs applied. A long history of metering in Germany -- where nearly all residences and businesses are metered -- has paved the way for using water pricing as an instrument to directly influence consumption. Metering will now also be applied at the household unit within apartment buildings following studies which have shown that individual metering can lead to savings of approximately 15%.¹³

Metering is not always widely employed in OECD countries. A 1992 water law in France, for example, stipulates that pumping devices must be equipped with appropriate assessment tools to measure the volumes of both surface and ground waters abstracted. In the Loire-Brittany river basin, the installation of a meter is subsidised by the River Basin Agency at a rate of 75%. Despite this assistance, only 50% of the total irrigated surface of the river basin is currently equipped with meters. The cost of meter installation and subsequent meter reading operations are a barrier to higher metering rates. One option to increase metering effectiveness without ensuring total coverage is selective metering to aid demand management among customers with an actual or potential high use of water. This is one of the steps the United Kingdom Department of the Environment's 1996 *Water Resources and Supply: Agenda for Action* suggests is an appropriate and urgent step for UK water companies to take. Developing more easily managed metering systems is another.

Many countries have conducted *information and awareness campaigns* to help consumers reduce their water consumption. These typically include information about the water consumption of household appliances and other activities (e.g. gardening) as well as advice and demonstration projects to provide concrete suggestions on ways to reduce water use. Raising the awareness of school children has often been part of these campaigns. In France, Australia and elsewhere, education strategies have targeted children as those who will be most affected in the future by water resources problems. These strategies seek not only to influence the current and future behaviour of youth, but also, through them, their parents (See Case Study 5). The Canadian government has published a series of informational leaflets providing concrete water-efficiency tips for households. Under the banner "Be Water-Wise: It makes Cents!" the leaflets cover: simple measures to reduce water use in the bathroom, kitchen and garden, water-saving household technology, and how to conduct a household water audit. Consumers are encouraged to use the sample "Water Log" to calculate water and dollar savings as they learn to use water more wisely.¹⁴ In the Netherlands, information and education campaigns are part of a package of measures under consideration to influence residential consumers, including the introduction of a new system for residential water rates (including a consumption-based component); introduction of 100% individual metering, mandatory installation of water-saving devices by builders; and product testing and ecolabelling.

Water's long history as a social good suggests that a good deal of new learning has to take place before the range of consumers begin to use water with the sustainability of the resource in mind.

13. H. Nowell-Smith and R. A. Kraemer, 1996. *International Comparison of the Demand for Water: Report on Germany*, and R. A. Kraemer and W. Kahlenborn, *Sustainable Water Management: The Experience in Germany*, 1997. (Ecologic: Gesellschaft für Internationale und Europäische Umweltforschung, Berlin, Germany).

14. See also Environment Canada, 1995. *Water: No Time to Waste -- A Consumer's Guide to Water Conservation* (Ottawa, Ontario).

Workshop participants discussed the intended impact of providing information to consumers on their water consumption patterns. Both values and behaviours can be shaped by new information, particularly when the consumer has an opportunity to put that new information to use. Other OECD work related to this question has shown that a change in values often comes after individuals change their habits and develop a new perspective on what is actually an acceptable change for them.¹⁵ Workshop participants also considered that information obtained through a sustained dialogue between relevant actors was likely to have a longer-term effect on the evolution of values than one-off education and awareness campaigns. This suggests that governments need to be more transparent and sophisticated in the way they handle information: both in terms of how well they incorporate what different water users are saying about their water needs and how they tailor new information on water resource conditions to specific user groups. It took nearly twenty years of information on smoking to begin to have an effect on consumer behaviour. Water's long history as an abundant social good suggests that a good deal of new learning has to take place before the range of consumers begin to use water with sustainability of the resource in mind.

Technology and Infrastructure

Information is only a powerful instrument of change if available technology and infrastructure enable water users to put that information to use. Participants identified a number of technological and infrastructural barriers to improved consumer management of the water resources they draw upon, such as irrigation systems that deliver water according to a set schedule, regardless of whether plants need watering or not, and household and commercial technology with poor efficiency performances.

A number of countries have voluntary efficiency rating systems for household appliances, but participants were uncertain as to the real impact of efficiency labels on consumer purchasing decisions. Efficiency is just one consideration among a broader set of consumer concerns. Where water prices are artificially low, it is likely to be a minor consideration. For these reasons, several participants argued the merits of setting longer-term goals for minimum efficiency standards for all water-using appliances combined with a rating system to give products that do better than the minimum a competitive advantage in the market.

In some cases, countries have established mandatory technology standards to decrease water consumption rates. This is the case in Australia, where very substantial volumes of water were saved through the introduction of 6/3 litre dual-flush toilets in new and replacement installations (standard toilets consume 11-18 litres). Several states in the United States have also mandated low-flow plumbing fixtures. In Australia, a number of conditions facilitated this approach, including a tradition of government regulation of sanitary fittings and a process of stakeholder consultation with manufacturers and community groups to discuss the planned regulation. The proposed change also came on the tail of a severe drought which left consumers with a strong sense of concern about wasting water. Germany has extended the application of efficient and ecological water use to a new construction law. Under this law, homeowners can be required to integrate cisterns in their houses, to let rainwater from roofs seep into the ground, or to even to have "green roofs". The objective of these measures is to keep the rainwater out of the sewage system and to promote re-use of rainwater.

15. See OCDE, 1997, *Sustainable Consumption and Production*; and the Reports of the OECD project on Individual Travel Behaviour: *Report of the OECD Policy Meeting on Sustainable Consumption and Individual Travel Behaviour* (OCDE/GD(97)144); *Final Report: OECD Workshop on "Culture, Choice and Technology"*, (OCDE/GD(97)1); and *Final Report: OECD Workshop on "Values, Welfare and Quality of Life"* (OCDE/GD(96)199).

More efficient water delivery infrastructure and technology is available in all sectors. Modern information technology, for example, including monitoring systems and precision irrigation technologies, has the potential to improve the sustainability of water use in the agricultural sector. Efficient shower heads, sanitary facilities, and other household appliances are available for domestic use, and industry has made important advances in reducing water use. In Japan, for example, the recovery rate of industrial water has been increasing steadily from 36.3% in 1965 to 76.8% in 1994. Industry initiatives continue to look for ways to improve water management practices and technologies, including conservation and “zero emission” technology.¹⁶ In general, however, water-efficient technologies have not been adopted on a wide scale. This gap highlights the close relationship between the price of water, tariff structures, information/education and technology. More efficient water technology is most likely to be put in place when there is an economic incentive (and perhaps a regulatory mandate) to do so and when water users understand how to put that technology to work to help them change their consumption behaviour. Greater information exchange on existing technologies and those under development is needed globally.

In many non-OECD countries, there are additional barriers to faster diffusion of efficient and effective water supply and wastewater facilities and technologies. India, for example, has found that conventional wastewater treatment technologies are not suitable because they are highly energy intensive. The ability of small and medium-size enterprises and low-income populations to pay for water services are also limited in many cases. Refurbishment or replacement of existing infrastructure is needed in many OECD and Asia-Pacific countries where many water distribution networks have been in place for several decades, or where networks are rudimentary. In some cases, it is counter-productive to broach demand-side issues until supply-side problems are resolved. This is the case for agricultural water management in South Korea, for example, where there is an insufficient supply of irrigation water, most irrigation facilities are old and small scale; most irrigation canals are open and unlined; there is no water measuring equipment, and the average farm is little more than one hectare. In these cases, a different set of issues must be addressed before the potential for demand management can be exploited. The link was drawn between technical and financial assistance and the ability of the industrialising countries to adopt or develop more efficient technologies and practices, and to strengthen infrastructure. In both OECD and non-OECD countries, greater investment in education and on-the-job training is also needed if the potential of modern water delivery and monitoring technology is to be realised.

“It was always remarkable [to me] how international the electricity business was and how “uninternational” the water business was in terms of case studies and the like.

The International Energy Agency produces voluminous documents of new technologies and case studies... I think that those are the types of documents [the water] business has to produce in the end.”

**Dr. Mike Sargent, Workshop Chair
Chief Executive,
ACTEW Corporation**

16. World Business Council for Sustainable Development, 1997. “Outline of Current Activities on Water Issues by the Working Group of the WBCSD.”

BOX 1: Alternative Water Supplies: Re-Use

The increasing stress on available water resources, rising costs for new supply infrastructure, and concerns over the quality of water available for extractive and environmental uses are leading some countries to explore the potential of alternative water sources, including effluent re-use, greywater and stormwater use. The development of these alternatives will be shaped by a number of factors, including economic, environmental, public health and scientific/technical considerations.

Many water utilities around the world have been successful in promoting the use of non-potable recycled water. In Japan, for instance, treated wastewater is re-used for municipal works (public parks, restoration of abandoned canals) at a rate of 100,000 m³/day in 1994 and paddy irrigation has been organised to allow water used in upstream fields to be re-used in fields downstream. In several OECD and non-OECD countries, industrial firms, green space locations (parks, golf courses) and agricultural/horticultural areas have been using treated wastewater for some time.

As part of a site visit organised by Sydney Water, participants visited a water treatment plant servicing a new residential development area outside of Sydney. The Rouse Hill project is significant -- it is the first large-scale project to incorporate a dual piping system in a greenfield project. Households in the area have two sets of pipes -- standard pipes supplying water for indoor uses (drinking, cooking, bathing, cleaning) and a second set supplying re-use water suitable for outdoor uses, such as gardening. With outdoor usage estimated to account for 25% of total household use, the average household could be substituting 50 cubic metres or more of re-use water for potable water per year.

Sydney Water is also looking ahead at potable water re-use. Analysis of the potential market for recycled water has shown that non-potable re-use of effluent, in isolation, would be insufficient to meet the target set for a 35% reduction of the per capita draw on stored water by 2010/11. A combination of other demand management options, and potable re-use, will be needed to achieve the target reductions. Sydney Water's 1996 Annual Environmental Report points out that potable reuse is technically feasible (using existing technology such as activated carbon adsorption, microfiltration, ultrafiltration, reverse osmosis and ozonation). It also notes that many countries in the world already rely on "indirect potable re-use" -- taking water from rivers where treated effluent has been released and then treating the merged water flow to drinkable standards. The development of re-use markets will depend heavily on consumer and regulator acceptance. In a 1995 survey, only 7% and 9% of the population surveyed strongly supported the use of potable re-use for cooking and drinking respectively. To demonstrate the potential of re-use, Sydney Water will construct a potable re-use demonstration plant at a cost of approximately 15 million \$AUS. Community education strategies will also be developed to further familiarise the public with this alternative water source. (Source: Sydney Water, October 1995, *Demand Management Strategy*; Sydney Water, 1996. *Sydney Water -- Good Enough to Bottle: Annual Report 1996*)

OECD work on biotechnology for water use and conservation has addressed some of the issues related to the re-use of wastewater. This work has examined the potential role of bioremediation/biotreatment techniques for aquifers, surface waters and for marine and coastal waters, as well as for the rapid detection of waterborne bacterial pathogens and certain contaminants in industrial effluent. For a full discussion, see OCDE 1997, *Biotechnology for Water Use and Conservation: The Mexico '96 Workshop*.

Institutional Reform and Multistakeholder Decision-Making

The institutional arrangements that have been erected to manage water in OECD countries are a critical part of both the problem and of the solution for more sustainable water resources management. In many countries water supply and wastewater treatment are the policy responsibility of separate government departments, or they are run by separate organisations with isolated environmental departments. Participants stressed the importance of making institutional reforms that will promote integrated management and allow long-term planning. In many countries this is entailing a move away from a “franchised” approach by different water services agencies to water resource acquisition and supply to holistic water resources management to ensure the sustainability of the resource.

In Australia, the principal features of institutional reform for rural water use have been initiatives to clarify the accountability of the irrigation authorities, to decentralise decision making, to improve commercial skills and to give user groups a greater say in decision making. In the Western United States, changing the mission of the federal Bureau of Reclamation in the early 1990s (after nearly 60 years with a mandate to promote irrigation in arid areas) to a new role as a water manager, brought a significant shift in the balance given to competing water uses, including water needed to maintain river ecosystems and fish populations.¹⁷

A central focus of discussion at the Workshop was the growing number of instances where water resources management is moving out of a narrow government institutional framework into a broader multistakeholder process. Participants drew a clear distinction between these types of initiatives and more familiar processes of “public consultation” -- which in the past has often meant little real public impact on the decision-making process. Involving water users in the development and implementation of water management policies, including setting objectives and choosing appropriate implementation tools, was considered to be key to making wide-reaching reforms in the way water resources are drawn upon and used. Early experiences with user-based decision-making have been encouraging. They create both the conditions for stakeholder “ownership” of the problem and a broader spread of responsibility and manoeuvrability in finding effective solutions to water resource problems. Communities have proved to be effective integrators, often making up for government failure to bring all the right actors to the table.

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In a number of countries, the role of user-groups is being given increased prominence. For instance, in Japan and South Korea, farmers have organised themselves into user groups or “co-operatives” in order to manage irrigation water more efficiently. In some cases, these groups are informal water user associations, but elsewhere have been legally formalised. In France and Australia, user groups are major partners in efforts to reform water use. NGOs have often been active in facilitating multistakeholder and user-group processes.¹⁸

17. B. Harden, 1996. *A River Lost: The Life and Death of the Columbia* (WWNorton & Co, NY).

18. See also Programme Solidarité Eau, “Les ONG, interface nécessaire entre populations et pouvoirs publics,” in *La Lettre du Programme Solidarité Eau*, Novembre 1996 (Paris, France).

Country experiences have shown that user-based approaches to water management help encourage partnerships between different users and stimulate direct behaviour changes. They also facilitate a wider policy evolution by creating a social climate which is open to change. In France, for example, the price of water will have doubled between 1990 and 2000, with a 10% annual increase in each of the first five years and a 5% annual increase in the remaining years. The French Water Agencies believe that it would not have been able to apply such rapid increases without the widespread support of the major user groups. Through a multistakeholder process which carefully ensured that all interests were well represented, the Water Agencies engaged in a social debate to set water resources objectives for the next 10, 20 and 50 years. This debate provided not only a transparent process through which targets could be set and agreed upon, but also established a more conciliatory environment vis-à-vis the tools best suited to achieve the agreed objectives -- in this case, higher prices for water. In the United States, a major restoration programme has been initiated in the San Francisco Bay-Sacramento/San Joaquin Delta where development activities over the past 150 years, unscreened diversion, pollution and large-scale water projects have degraded the ecosystem. A formal state/federal planning effort is now in place to develop a long-range integrated management plan. This process brings together state and federal agencies along with a 34-member Advisory Council representing diverse stakeholders. This group is working, through an open public process, alternative scenarios for striking a fair balance between competing beneficial uses of Delta Resources. A short-list of alternatives will undergo detailed technical analysis and comparison against established objectives. A “preferred alternative” will emerge from this process and will undergo a final Environmental Impact Report for implementation.¹⁹

Achieving integrated water resources management in transboundary water systems presents a more complex set of challenges for current institutional structures and decision-making processes. Participants noted successful examples of international co-operation, including an initiative on the Rhine River, where multi-state collaboration has succeeded in restoring much of the economic and ecological quality of the River [See Case Study 5]. In other transboundary river systems, like the Mekong, the management of the resource still poses formidable challenges, in particular in terms of water supply and scarcity problems.

Allocating Water Between Competing Uses

A number of countries are reforming traditional systems for allocating shares of finite water resources. They are moving away from historical allocations based on land titles or administrative appropriations which have been unable to successfully address growing pressures from increasing demand.

Optimal allocation is a complex and difficult issue. Participants stressed that the process must begin with the recognition of the interdependence and legitimate claims of all water users, including the environment. Clear entitlements, in terms of ownership, volume, reliability, transferability, and where appropriate, quality, also depend on a sound knowledge of water resources and use patterns. Currently, our understanding of human impact on hydrological cycles and the water needs of the environment has serious gaps. Historically, the environment has typically received whatever water is left after agricultural, industrial, commercial and residential demand has been accounted for. The legacy of that approach has been degraded rivers and riverine environments.

19. USEPA, Region 9, (no date). “Meeting California’s Long-term Water Future: Solutions in the Bay-Delta Watershed - The Time is Now.”

A growing number of countries are attempting the difficult task of defining the water needs of the aquatic environment. In the Murray River Basin in Australia, environmental studies showing a negative impact of river regulation on the health of riverine Red Gum forests led the Murray Darling Basin Commission to allocate 100,000ml/year as a specific environmental allocation to the forest so that more natural flood regimes could be re-established. New Zealand's *Resource Management Act* enables minimum flows to be set in rivers to take account of aquatic eco-system needs. In some cases, defining the environment's water needs has been a contentious exercise: "minimum flow" issues have been at the centre of some of New Zealand's longest court cases -- and this despite plentiful, evenly spread rainfall which has not yet led to a supply problem. In the United Kingdom, competition between environmental flows and other uses has been of significance for more than 30 years, particularly in the drier regions of the country. During serious surface water droughts in 1995, 1996, and 1997, the Environment Agency, which now has the task of balancing these needs, had to accept otherwise unacceptable environmental impacts on water resources in order to maintain supply in critical circumstances.

Water trading must be carefully regulated to ensure that water is not traded into inappropriate uses or out of systems that are already stressed.

Experience with water markets and transferable water entitlements has also grown over the past decade, particularly in the United States and Australia. Temporary leasing and permanent trading of water rights have encouraged more efficient water use and the trading of water into higher value uses. Water trading must be carefully regulated, however. It can promote the immediate use of "sleeper licences" -- allocations not currently used, but to which the option to trade confers a new value. Water audits of available resources and withdrawals, followed by a definition of a cap on total

water use can prevent trading from leading to an unsustainable growth in overall water use. Controls are also needed to ensure that water is not traded into inappropriate uses, to areas with salinity or drainage problems for instance, or out of systems that are already stressed. Participants also raised questions concerning entitlements for the environment (and who should pay for them) as well as the permanency of water rights in an evolving supply and demand situation.

In countries where water markets have not been established, other water allocation mechanisms are being tried out. In Japan, for example, farmers are encouraged to voluntarily relinquish some of their water rights through the modernisation of irrigation systems. The costs of modernisation are borne in part by the new users. In Germany, in the State of Hesse, a new kind of water right is imposed whenever an old right comes to term. The new rights have shorter time limits and are divided into two periods: a first phase in which the supplier must ensure supply, and a second phase during which the license can be withdrawn - without compensation -- if monitoring shows that withdrawal patterns are causing ecological or economic damage. In China, the Government has set quotas for different extractive uses and uses a combination of economic instruments (fines and awards) to stimulate users to respect the quantities established. For users who exceed their consumption quotas, fees are collected on a progressive basis, or the water supply is reduced or even cut off. Taiwan has adopted a programme to develop water rights management, including defining standards of water use volumes for each industry and user groups, defining a water right fee; and formulating rules for compensation where rights are transferred, restricted or removed. In Malaysia, which enjoys abundant water resources in general, unevenly distributed rainfall and drought protection strategies are leading some states to look to inter-state or inter-basin transfers of water.

A number of difficult challenges are expected to surface in the next few years over the mechanisms of allocation. Many countries will need to find ways to release some water from current allocations to put it to other uses, such as repairing environmental degradation or allowing further industrial development. Discussions about caps on withdrawals and reallocations between users have not yet addressed the task of freeing up volumes of water. Compensation schemes, either monetary or in another form (e.g. funding more efficient technology) may have a role to play as catalysts in these cases.

Improving the Information Base on Water Resources and Use

Participants frequently cited the inadequacy of the information base as a key barrier to improving the sustainability of water resources management. Poor information is due in part to the complexity of the hydrological cycle, and of relationships between natural and human influences on the quantity and quality of available water. It is also due to the fact that in many cases countries have not put monitoring and evaluation infrastructure in place at the level at which it can be most effective. The German State of Hesse is moving to remedy this problem, by conducting an inventory of groundwater resources in the southern part of the State to allow a more differentiated, local approach to water management. Water suppliers are also called upon to provide the hydrological and hydrogeological data needed for authorities to make decisions about water rights. Suppliers must install a computerised monitoring system that records data on groundwater levels and flow, and monitors the impact of groundwater abstraction on habitats (especially wetlands), and the regeneration capacity of wetlands which have been affected by groundwater depletion.

Pressures to allocate fixed water resources among a competing set of uses have made the lack of information even more sorely felt as countries begin to try to determine “optimal” allocation levels, and, as part of this, the water needs of the environment. Workshop participants pointed to the need to move away from static evaluations of water bodies to more complex studies of water resources under dynamic conditions. But even basic information on withdrawals and use patterns is lacking in many countries. Filling this information gap is a critical factor of more successful strategies to manage water resources for long-term sustainability. Environmental impact assessment (EIA) was suggested by several participants as a tool that needs further development and application to integrated catchment plans. EIAs could provide a better baseline for the evaluation of catchment plans, but they may also help force people to think in appropriate spatial and time scales. The wider use of modelling techniques was also encouraged. Brazil has developed scenarios to identify watersheds presenting a high potential for conflict, and computer support technologies at the farm-level to help optimise water use.

Technical data on water resources must also be better translated into useful information. Better information dissemination and dialogue between stakeholders also means that information must be user-friendly and actively shared. On-going dialogue between all stakeholders was considered to be important in improving the quality and comprehensiveness of the data bases on water resource and use patterns. The effectiveness of dialogue in informing water resources policy development will be even greater where the State does not have the means to gather and disseminate information -- this is the case in many developing countries, but Workshop discussions suggested that this is generally applicable to OECD countries as well.

**Filling the information gap
on withdrawals and use
patterns is a critical factor
of more successful
strategies to manage water
resources sustainably.**

Building Stronger Links Between Water Resources Management and Sustainable Development

Workshop discussion highlighted the need for greater interaction between water resources policy planning and wider macroeconomic and social policies which, directly or indirectly, influence the use of the resource. Past industrial development and municipal land-use policies, for example, have had a direct effect on current water delivery infrastructure and patterns of water use. Similarly, national development policies related to settlement of vacant areas, and agriculture and food security, have stimulated the expansion of irrigation. Now, some countries are finding that restructuring irrigated agriculture must go hand in hand with rural adjustment policies, such as financial support not only for farmers with long-term prospects, but also for those that have no future in irrigated agriculture to leave the industry.

Globalisation, and with it the liberalisation of markets and investment structures, will have an impact on national economic structures and trade. It is not clear yet what impact liberalisation will have on the environment and on water resources in particular. Access to water is already becoming a determinant of the pattern and rate of economic development in many countries.

Rethinking Monitoring, Evaluation and the Role of Government

There was a general consensus at the Workshop that water resources planning lacks effective evaluation mechanisms. While there may be a shift underway towards more integrated management frameworks, participants stressed the need for an evolution in monitoring and assessment strategies as well towards results-based evaluation. Participants noted the growing use of environmental management systems, environmental audits, and reporting as steps in the right direction.

More generally, effective monitoring and evaluation fit into a discussion of the evolving role of Government in integrated water resources management. Participants made reference to the trend in many OECD and non-OECD countries of the State moving out of a direct role as water supplier. Participants agreed that increasingly the role of governments lay in defining the boundaries that create a framework for sustainable water resources management. Two essential parts of this responsibility are to ensure that water resources are managed, and water provision is guaranteed, with both the basic needs of consumers, and the sustainability of the resource, as a priority. Regulatory action will be part of any government strategy, but participants pointed out that Governments must make use of a range of other tools to promote the broad-based, integrated and dynamic management framework for action which is needed today. This includes a move away from purely a reactive, punitive framework to one that encourages innovation and doing better than the law requires.



1 CASE STUDY: Initiatives to Improve the Sustainability of Water Use in Australia

Australia is the driest inhabited continent on earth, with an average annual rainfall of less than 500 mm. Although low population density means that it is still relatively rich in water resources per capita, Australia's rainfall patterns are highly variable: it is a land of drought and flood. A generation ago, Australians were essentially concerned with "stopping water running to waste in the sea". Vast infrastructure programmes were initiated both to ensure a viable water supply for domestic uses and irrigation, and to facilitate the settlement of vacant areas of the country. The fruits of that period are over 300 large dams and perhaps the greatest water storage capacity per capita in the world.

But the heavy regulation of Australian rivers systems has also led to significant environmental problems. In the Murray Darling River Basin, which as Australia's largest covers an area the size of France and Spain combined, current patterns of water use are responsible for the diversion of 80% of the average natural flow. This river system now has periods of drought with low flows three out of every four years compared with one in twenty under natural circumstances. These changes, and related land-use patterns particularly for irrigated agriculture, have contributed to the poor ecological health of Australian rivers. The decline in native fish stocks, increased turbidity and salinity, waterlogging, the rapid growth of shallow water tables, and nutrient run-off are all symptoms of Australia's water resources dilemma.

In 1994, led by improved scientific understanding of the key factors contributing to the decline, increased community awareness, and concern over the likely effects of continued growth in demand for water, the Council of Australian Governments (COAG) agreed to reforms of the Australian water industry. The reforms are intended to create the framework for effective integrated catchment management. They involve a package of diverse, but inter-related, measures to improve knowledge, develop appropriate water management policies, and stimulate the practical actions and measures which must be taken by the range of water users in order to protect the nation's water resources. The framework provides a common strategic direction for governments across Australia to work together to address water resources issues in both rural and urban sectors.

The key elements of the reform focus on *water pricing*, *cross-subsidies*, and *water allocation policies* in both rural and urban Australia. To reverse a tendency to charge less than the full cost of providing water services, water prices are being developed which cover not only operating costs, but also provide for infrastructure refurbishment or replacement. In rural areas, full cost pricing will enable the irrigation industry to maintain or improve system delivery efficiency and will stimulate irrigators at the individual and district level to use water more efficiently. In urban areas, reforms have been focused on restructuring tariffs and reducing or eliminating cross-subsidies for metropolitan and town water services. The impacts on domestic consumers of water services are largely being offset by cost reductions achieved by more efficient, customer-driven service provision.

"Water isn't a trivial issue...This country nearly did not federate in 1901 because they couldn't agree how to share the waters of the Murray River."

**Dr. John Langford,
Director, Water
Services Association of
Australia**

More clearly defined property rights, formal water allocations for environmental purposes, and greater water trading are already strengthening demand management by encouraging more efficient water use and allowing water to be transferred to higher value uses. In the Murray Darling River Basin, striking a better balance between environmental and consumptive uses has also included putting a cap on diversions.

The reform process also seeks to achieve efficiency improvements through *institutional reform* and *better water delivery services*. Initiatives have been taken to clarify accountabilities for water management and to decentralise decision-making by allowing for greater local involvement in the management of water resources. Devolving responsibility for running irrigation schemes to local industry, for example, will create incentives for more commercial, customer-focused irrigation businesses which achieve more profitable and sustainable water use. Developing administrative arrangements in consultation with local communities has been one of the most important features in the integrated catchment management initiative led by the Murray Darling Basin Commission (MDBC). The Initiative brings together Ministers from the five Governments involved, senior managers from their land, water, agriculture, and environmental agencies of all the Governments, and a Community Advisory Committee which has harnessed the energy of grass roots and community groups. Involving water users and local communities has been critical in fostering community leadership and innovation to tackle water resources problems. The MDBC's Salinity and Drainage Strategy, for instance, involved working with upstream and downstream communities to establish drainage and salinity mitigation schemes that had failed to gain acceptance in the past. The integrated catchment framework allowed a system of salt credits to be developed and used pooled government funds to develop the most cost-effective schemes to achieve set targets without regard to their location within individual States. The overall result of the strategy will be a net reduction in salt concentration downstream.

In another example, the ACTEW corporation -- which meets the Australian Capital Territory's energy, water and sewerage needs -- worked in partnership with the communities it supplies to develop a detailed *Future Water Supply Strategy*. The Strategy describes where the communities want to be in the year 2040 and what steps will be needed to get there. ACTEW held numerous forums to achieve community involvement in, and ownership of, the Strategy, and documented the outcomes of the consultation at critical points in the process. It also commissioned market research to measure community reaction as the Strategy has developed. This process has made a difference. Earlier planning had indicated that, based on projections and consumption patterns, a new dam would have been required around the year 2005. In contrast, the community showed a clear desire to defer the need for a new dam by strengthening demand management initiatives. As a result, the Strategy recommends that, among other measures, water conservation targets of 15%, 25% and 35% of annual per capita demand be adopted by the years 2000, 2010, and 2020 respectively. Significant reductions in actual consumption have already been registered. Market research also showed that 97% of the community believed that ACTEW's education and awareness campaign needed re-orientation to focus on "how to save" strategies. If the current reductions in the ACT are maintained in the longer term, and staged water restrictions are implemented in more severe droughts, it is expected that the need for a new dam can be deferred well beyond the 2005 date.

Demand management strategies have also pointed to the need for *better water delivery technology* to increase the efficiency of water use in all sectors. For domestic appliances, more efficient designs are needed for shower heads, water taps and aerators, dish and clothes washers, domestic garden watering systems, and other devices. A "Water Efficient Appliance Labelling Scheme" has been introduced to help consumers make more water-efficient choices when purchasing household appliances. The Australian government has also applied regulatory measures to require the introduction of dual flush toilets in both new and replacement installations. Demand management strategies targeted on individual

consumers have been underpinned by public campaigns to provide information and incentives to adopt water saving devices and practices. Greater attention is being paid to water reuse technology (see above).

Australia is developing a rich experience in the sustainable management of water. The complexity of water resources management means that single initiatives will be unlikely to produce the desired results. There is fundamental agreement across the political spectrum about the need to work for a sustainable management system, even if controversy still exists on a range of issues. There is also broad acceptance that the environment is a legitimate “stakeholder” in this process. Developing the appropriate pattern of demand, and community acceptance of the premises which define what is acceptable and what is not, are essential if Australia is going to achieve the revolution in natural resources policy and practice which it is aiming for.

Based on the papers and presentations of Dr. John Langford, Water Services Association of Australia, and Mr. Don Blackmore, Murray-Darling Basin Commission, and Australian written submissions to the Workshop.

IV. SECTOR SPECIFIC POLICIES

Working Group Summaries

The Sydney Workshop was divided into both Plenary discussions and concurrent Working Groups which treated water consumption in the commercial/residential, industrial and agricultural sectors, as well as integrated demand management. Both Working Group and Plenary discussions evolved towards a focus on the need for an integrated approach to water resources management. Each of the Working Groups also came to similar conclusions regarding the central role of pricing, information, and technology and infrastructure as key elements of integrated water resources management. The advantages and challenges of multistakeholder or user-group decision-making processes were also discussed in all four Working Groups. As a result, many of the insights coming from the separate Working Groups are reflected in the preceding discussion. This section, therefore, does not comprehensively summarise Working Group discussions, but rather highlights additional insights from each Working Group specific to improving the sustainability of water use in their respective domains. Short Case Studies drawn from presentations made on the different Working Group themes are also included.

Working Group on the Commercial/Residential Sector

On average the commercial/residential sector uses about 10% of total water consumption. While this rate seems negligible compared to other uses, residential water use patterns derive from individual behaviour at the level of the household, and thus concern 100% of the population. As a result, government actions targeted at households and municipalities have a strong potential for broad awareness raising on water issues.

There is as much diversity between OECD countries as between OECD and non-OECD countries in the nature of water resources problems and the solutions needed to overcome them. Differences in standards of living, cultural habits and values, social, economic and political imperatives, and environmental conditions, determine priority orientations and activities. There was no agreement among Working Group participants, for instance, over whether saving water should be a goal in itself for this sector, especially in some industrialising countries where water supply does not yet cover basic needs. In these cases, it was widely agreed that water to meet basic needs, particularly health and sanitation, must be the focal point for water policy. Transparency in government policies (e.g. for equipment standards, subsidies and cross-subsidies, pricing, availability of technology) and an integrated, cross-media approach were identified as important elements of sustainable water resources management.

Participants identified a number of important considerations for policies to improve the sustainability of water use patterns in the commercial/residential sector:

- Information: Currently the information base on consumption patterns in the commercial/residential sector is inadequate: more specific information is needed on different

user groups and the different uses to which water is put. There was no consensus on whether comprehensive metering is needed, but Working Group participants did note that metering will be essential where volumetric pricing is introduced.

- Pricing Regimes and Tariff Structures: Reform of pricing regimes and tariff systems is important, not only for the incentives this would bring to commercial and residential consumers to rationalise their consumption, but also in terms of revenue-raising for water supply and wastewater treatment facilities. The move to full-cost pricing will need to be gradual in many countries because of the social and economic impact this would have on poorer segments of the population. Financial supports to the poor may be an appropriate measure to ensure that basic human needs for water services are met as prices are increased. Some participants felt that pricing may only be effective in the short-term as an influence on consumer behaviour if basic use patterns were not also altered (i.e. via technology, education).
- Infrastructure and Technology: The availability of water-saving appliances and water delivery systems have a significant effect on patterns of water use in this sector. Voluntary approaches to improving the efficiency of water delivery devices were advocated, although in some cases (e.g. Australia) regulatory approaches have been effective. Participants noted that *labelling* plays a role in improving the dissemination and use of more water-efficient appliances and technology, by increasing transparency and making information more accessible. Participants also felt that incentives and regulatory measures should be directed towards real-estate developers in order to stimulate water-efficiency in the design of new commercial buildings and housing. More generally, it was felt that water suppliers need to develop long-term water resources management strategies.
- User Participation: The objective of strategies to increase user participation in water resources management is to strengthen a sense of user responsibility and empowerment. Initiatives to increase the participation of users are on the whole in their infancy and there is a great need for effective mechanisms to achieve multistakeholder decision-making. Participants stressed that social instruments to facilitate user participation need more emphasis in government strategies to promote sustainable water consumption.
- Research: Participants identified issues which require additional research, including: the application of environmental impact assessments, including to measure the trade-offs between water and other inputs (such as energy use) in commercial and residential settings; new water saving and cleaner technology; meter accuracy; and wastewater management.

2 CASE STUDY: Demand-Side Management in Japan

Japan is located in the Asian monsoon region, with average annual precipitation around 1700 mm. Although this is about twice the world average, annual average per capita precipitation is only one-fifth of the world average and is insufficient to meet competing needs for freshwater. A number of factors have spurred efforts in Japan to use existing water resources as efficiently as possible: a series of severe water shortages, the most recent in 1994, which caused significant social disruption; long production cycles and difficult siting options for new water infrastructure (reservoirs, dams); the need to minimise the impacts to surrounding ecosystems from overdrawing on surface and groundwater; and the desire to minimise water quality problems by reducing pollutants and the total volume of effluent.

Japan has initiated a number of actions to reduce water consumption and improve the efficiency with which water is used in the commercial and residential sector. Freshwater consumption in this sector has increased 2.6 times from 1960s levels, reaching 16 billion m³ in 1992. 70% of that water is used by households, with the remaining 30% going to business and commercial uses. Average water use per capita was 335 litres/day in 1993, nearly twice 1965 levels.

A primary measure to reduce water consumption has been to reduce leakage from the municipal water distribution systems to 10% in 1993, down from 18.9% in 1975. Measures to reduce leakage have included replacement of old distribution pipes made of asbestos or lead and careful management of water pressure. Recycling and re-use of municipal wastewater reached 100,000 m³/day in 1994.

To influence consumption behaviour directly, urban municipalities have also established differentiated water rates through which large water consumers pay more per cubic meter than small-volume consumers. In one municipality, for instance, consumers using less than 10m³/month are charged approximately 60 yen per cubic meter (approximately .40 US\$) while consumers using more than 500m³/month pay rates per cubic meter almost seven times higher (i.e. 2.64 US\$). These economic measures are supported by information dissemination on water-saving practices, designation of water-saving equipment, and awareness raising events (e.g. Water Day).

An additional set of actions have been directed at business and commercial consumption. These include promotion of water recycling techniques both within one firm and among several plants in a business district. In these cases, wastewater receives secondary treatment, and in some cases additional chlorination and filtration before being recycled. By 1993, Japan operated 1963 recycling facilities for a total volume of .7% of freshwater consumed. Recycling has been promoted in response to both water quality and quantity concerns. Stored rain water has also been used for toilet flushing and other uses: one Tokyo baseball stadium has a 1,000 m³ storage capacity providing a daily supply capacity of 186 m³ when combined with recycled water.

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In a different context, the Government of Japan has taken action to reduce water consumption in its own day-to-day operations as part of the *Action Plan for Greening Government Operations*, adopted in 1995. The *Action Plan* sets targets for the introduction of water saving equipment and for water conservation in government office buildings, where (water consumption per unit of office space is to be reduced by more than 10% of 1995 levels by 2000). Government agencies and ministries are employing a number of different means to achieve this target, including sensor flushing in men's toilets and sound imitation devices in women's facilities to respond to cultural habits of flushing two or three times. Water-saving equipment is also slated for procurement in new and replacement situations (washing machines, air conditioners).

Based on the paper and presentation by Mr. Ryutaro Yatsu, Environment Agency of Japan

Working Group on the Industrial Sector

There is an improving trend in water efficiency in the industrial sector in OECD and some non-OECD countries, particularly in the production of paper, steel, and a number of other products (measured in product per unit of water). However, that improvement is a by-product of other strategies, for example to improve energy efficiency or the efficiency of other resources (processed chemicals). Efficiency improvements have also been driven by the export of technology from countries with fairly high levels of environmental regulation (e.g. for paper mills). Public perception of industry's environmental performance -- where it is tied to the license to operate -- may be another effective stimulus to sustainable water use.

Participants identified several elements of government's role in promoting sustainable water use in the industrial sector:

- Pricing and Tariff Reforms: Participants agreed that water supply and wastewater charges should reflect full costs, and that pricing and tariff structures should give industry an incentive to save water. Currently, government subsidies of water prices create a relatively low cost for water as an input to industrial processes. Combined with comparatively high costs for water-efficient technology, low input prices for water mean there is little incentive for industries to improve efficiency. Although the cost of wastewater treatment can be an important consideration, most industries are more concerned about their access to, and the quality of, water resources. Participants saw a strong role for market instruments to stimulate efficiency and high-value applications of water, including: water markets, trading between sectors, and allowing industry to gain access to new water supplies by making efficiency investments. They also pointed to the potential of water quality gradations linked to price (e.g. water discharged from one plant might be the input to another -- at a lower price). In general, participants emphasised that Government policies should focus on providing incentives to industry innovators, rather than subsidising those who waste water. Where subsidies exist, they should be transparent.
- Establishing clear institutional accountability and a predictable policy framework: Encouraging industry investment in new technologies requires providing a reasonable

planning horizon vis-à-vis policy guidelines (on water allocation, access to water, and environmental protection), and on tariff regimes.

- Information: Participants noted two ways that governments can use information-based strategies to stimulate good water management in industry. The first is by encouraging (potentially requiring) reporting and disclosure procedures on water efficiency performance, thereby creating external pressure on industry to improve their water use. The second is to facilitate information flows, technology transfer, and research and development in order to support industry capacity to change. Participants also recommended that governments help build linkages between domestic industry and trade and international organisations to widen the networks of information exchange
- Establishing greater and more effective consultation with industry: Participants stressed that policies to promote sustainable water use by industry need to give a greater voice to industrial users and to empower them to find innovative solutions to water management issues. There are several mechanisms for increasing industry ownership and action. Participants identified strategies to promote industry leadership, for example through self-regulation, documenting industry good practice; benchmarking; and rewarding good performance. Other mechanisms to give industrial users concrete responsibility include government/industry consultation through environmental impact assessments, policy and resource planning, the development of voluntary agreements, delegation of some water management functions (e.g. measuring the resource, etc.) and giving industry leaders a role in water planning process -- coupled with clear accountability.

Participants emphasised that special approaches are needed to promote sustainable water use in small- and medium-size enterprises (SMEs), which collectively have an important impact on water resources. Information-based strategies are particularly important, including demonstration projects and technical advice (audits). Metering tied to water and wastewater charges was seen to be a strong tool to encourage SMEs to get to know their water use patterns. Participants felt that training programmes to improve water management must address SME from a complete business perspective, rather than focusing on water issues alone.

3 CASE STUDY: Water Quality Controls Drive Reduced Water Consumption in China

Rapid industrial expansion is steadily increasing industrial demand for water in China. In 1997, industrial water consumption accounted for 18% of total consumption (agricultural activities account for 78%), exceeding 90 billion m³. The quantity of water consumed by village and township enterprises has increased sharply, making up 50% of this total.

Parallel to the growth in the demand for water, China is also witnessing growing conflicts between supply and demand, an excessive extraction of groundwater, and serious water pollution problems. The majority of China's rivers, lakes and groundwater resources have been contaminated to various degrees -- in some areas, water pollution is so serious that it has become a barrier to local economic development and a significant threat to human health. Industrial discharges are one of the major causes of high levels of water pollution, and have closely followed the increase in water consumption levels. Outdated and resource-intensive production technologies make China's industries highly inefficient: to produce 1 ton of coal, steel, nitrogen fertiliser and artificial fibre takes in some cases as much as 10 times higher the volumes of water used in the industrialised countries.

To strengthen water management, the Chinese government will focus on a set of initiatives to control water quality, and through this, problems of water consumption. These measures include:

- requiring industrial enterprises to meet national or local wastewater discharge standards. In some cases, heavy polluters and water consumers have lost the licence to operate: in 1996, for example, 1000 highly-polluting paper mills were closed, as were tens of thousands of SMEs, most of which were small village and township businesses with heavy pollution loads and high water consumption habits.
- controlling new pollution sources, by stipulating that any new industrial project which consumes water must meet national or local wastewater discharge standards as well as total pollutant discharge controls. In areas where water is scarce and pollution is serious, the construction and extension of oil refineries, paper mills, and iron and steel plants will be severely restricted. New or extended industrial installations in urban settings will also be given a water quota.
- reducing pollution and water consumption levels through cleaner production, improved production technology and equipment.
- charging wastewater discharge fees to adjust the price of industrial water and to encourage businesses to consciously implement water conservation and pollution control measures as well as to develop re-use of water used for cooling and temperature regulation and other industrial waste water. Price incentives are

Failure to meet government standards for water quality and consumption levels can mean loss of the licence to operate.

expected to stimulate significant savings (60% of current consumption).

To meet national water pollution control standards and to reduce their costs related to wastewater treatment, private enterprises are expected to increasingly move towards water conservation, re-use, and separation technologies and techniques. Many industrial enterprises have realised that low water consumption means lower wastewater discharges and lower costs of treatment. Because failure to meet government standards can mean loss of the licence to operate, firms that reduce their water quantity and quality problems improve their opportunities to survive and develop. In the medium term, water quality objectives are expected to facilitate industrial restructuring in China and to optimise industrial water use in the wider context of sustainable water resources management.

Based on the paper and presentation by Mr. Qiwen Qiu, NEPA, China

Working Group on the Agricultural Sector

The nature of agricultural water use and associated problems vary greatly between countries, thus the policy mix for correcting unsustainable water use patterns will depend on a range of social, economic, and technical factors. Working Group participants stressed that demand management strategies, as in other sectors, must be part of an integrated approach that also addresses supply-side issues which influence water use in the agricultural sector.

Participants highlighted some particular issues concerning the policies and tools governments can apply to encourage sustainable water use in the agricultural sector:

- Economic and Fiscal Instruments: There are cultural and political barriers to the implementation of full-cost pricing regimes in the agricultural sector, for example where full pricing comes on the tails of national policies to encourage irrigation for regional development or for food security reasons. The full identification of all the costs involved in supplying water is the subject of much debate: both governments and users must agree on the financial framework for the pricing mechanisms. Participants emphasised that the transition to higher prices will be smoother if the benefits of moving to full-cost pricing are clear to all water users.
- Technology and Infrastructure: Participants identified the absence of appropriate institutional arrangements and working infrastructure for water delivery as a severe constraint to the implementation of demand management, and water efficiency or conservation policies. Sending price signals to irrigators will not be effective if they cannot change their behaviour because water is delivered on a set schedule over which the agricultural producer has little or no control. As a result, rehabilitating supply systems is often a very important first step in encouraging a change in user behaviour. Participants also argued that there is more to be gained from the adoption of existing and appropriate irrigation technology than there is from inventing new “Geewizardry”. They also noted, however, that agricultural research is currently too heavily commodity and production-based; more emphasis needs to go into generic irrigation research.

- Information and Education: Participants stressed the need for an adequate knowledge base on irrigation systems, including the water resources they rely on, the physical, economic and social factors shaping agricultural production patterns, and the number of “players” involved. On a general level, greater exploration via models and geographical information systems are one way of beginning to fill in the knowledge gap on the condition and sustainable use levels of water resources in the agricultural sector. Education initiatives for agricultural users, including on-the-job training and more formalised training at higher education institutions are also needed to increase the ability of agricultural producers to use water sustainably.
- Institutional Arrangements and Allocation Policies: The ability of irrigators to plan over the long-term and improve the efficiency of their water use depends in part of the stability of the policy environment. This includes clear definitions of their water property rights in terms of volume, security (*under what conditions will the allocation be taken away?*), transferability, and duration. For agricultural uses, it is also important that the quality of the water allocated must also be defined. Participants stressed the importance of a catchment basin approach is needed for allocation policies, including a conflict resolution mechanism to enable allocation strategies to work effectively.
- Regulatory Measures and Social Instruments: “Command and control” measures (e.g. caps and licenses) should set the boundaries for sustainable water use and support shifts in behaviour. Where they exist, regulations on water quality and water efficiency should be based on best practice achievable. Agricultural water users need to have a voice in policy development process; social instruments should be designed to build a sense of ownership of water resource issues among users.

4 CASE STUDY: Agricultural Sector Reform in Australia

Although most of Australia's water consumers live in large cities, 70-80% of the water consumed is used by irrigated agriculture. 75% of that water is used in the Murray-Darling Basin (MDB). As a result, irrigation in the region is the key focus for the national rural water reform programme, which is part of the wider programme of COAG reforms (see Case Study 1).

The Murray-Darling Basin generates approximately 40% of the national earnings from agriculture. However, even though the non-irrigating group of stakeholders (which includes more than 3 million people and major industry and tourism sectors) use only 5% of the water diverted, the value of the economic and political interests they represent is very high: the financial returns that come from their activities substantially exceed those of irrigated agriculture. In comparison with a number of countries, such as Israel and the United States, investment in irrigation in Australia has traditionally provided a very low rate of return; in part because the bulk of irrigation water within the southern Basin is used to support mixed farming. Many of the irrigated areas in the Basin now have large numbers of people on small, uneconomic blocks -- this has caused financial stress for the people concerned and means they are not in a position to reinvest in their farms. Investment, to replace existing capital equipment and introduce new technology is essential to earning higher profits and reducing the volume of excess water.

Many of the programmes to reshape the pattern of demand for water in the Basin are concerned with preserving or improving water quality, and, in the end, with ensuring the sustainability of agricultural production in the region over the long-term. Poor agricultural management practices introduced over the last 150 years (overgrazing of semi-arid and arid pastoral lands; cropping of marginal lands; over cultivation of some croplands, inappropriate irrigation practices, extensive native vegetation clearance) have had negative impacts on river catchments and water quality. Added to these pressures has been the dramatic increase in the volume of water diverted. There are also now serious problems caused by rising water tables within irrigation regions which threaten their long-term viability.

Elements of Reform

As part of the COAG reforms, the national government, four State governments with territory in the Basin, and the region's communities have developed an unusual but very effective partnership designed to promote a comprehensive approach to national resources management, with particular attention to water. The reform touches every aspect of water management.

Institutional structure: The COAG reforms established a "water business unit" to put water supply in the MDB on sound financial footing, including ensuring that charges make provision for the large investment required to refurbish the Basin's ageing infrastructure over the next 15 years. The administration of water delivery and drainage services has devolved to regional corporate bodies: some of these organisations are privatised while others are State-owned corporate bodies of various types. These bodies receive a bulk water entitlement for distribution in their region. At the same time, regional land and water management plans were developed by the community, in collaboration with government agencies, to deal with issues such as high water tables, nutrient and salinity problems, poor drainage, or

the need to encourage faster uptake of more efficient irrigation systems. These plans must be implemented within an agreed timetable for the regional bodies to retain their water distribution licenses.

Water Allocations and Water Trading: An audit of water use in the Murray-Darling Basin was conducted in order to provide information which could be used to determine the appropriate balance that should be struck between off-stream diversions for human consumption, industry and agriculture, and in-stream levels needed to maintain riverine health. The audit found that the existing management regime was having an increasingly negative impact on the health of the river and related ecosystems. As an immediate response, the MDB Ministerial Council imposed an interim cap on any increase in diversions beyond existing (1995) levels. Detailed discussions are now taking place in order to define the long-term cap that should apply to off-stream diversions and the management regimes needed to achieve that target. That discussion is being supported by a wide-ranging program of scientific research to develop the basis necessary to make integrated catchment management effective. An improved system of water trading, particularly across State borders, is expected to enable the water currently used for inefficient irrigation practices to be traded to higher value activities. This will allow investment in better technology and reduce negative environmental impacts. Controls on trading will keep water from going into areas with high salinity (although it can be traded out of such zones).

The government is leading large-scale community consultation and education campaigns, both to help the public understand the reasons for water reforms, and to encourage wide participation in the development of the policy and management operations needed to achieve long-term environmental goals.

Pricing Policy -- Under the COAG reforms, pricing regimes are to be based on the principles of consumption-based pricing, full-cost recovery and the removal of cross-subsidies wherever practicable. In the State of Victoria, new agricultural customers and all urban water authorities are now charged for bulk water on a 4% real rate of return to equity after meeting business costs. Existing rural users such as irrigators and stock and domestic consumers also have a “renewals” component incorporated into their pricing structure which is used to finance the maintenance and renewal of existing long-term assets. In New South Wales, pricing reforms also include the introduction of a *resource management charge* for all categories of rural water users.

Environmental Management and Improved Public Consultation and Education: Environmental considerations have been incorporated into several elements of the reform programme: institutions are being reshaped to take account of environmental priorities; water allocations are being made to meet environmental needs; water pricing has to take account of the cost of meeting environmental criteria; and water trading is seen as a way of moving water away from areas with negative environmental impacts. In support of these activities, large scale community consultation and education campaigns are being undertaken to help the public understand the reasons for this approach, and to encourage wide participation in the development of the policy and management operations which are needed to achieve long-term environmental goals.

Multistakeholder, collaborative efforts involving state and federal governments and the community, have resulted in significant improvements in water use efficiency in the agriculture sector. For example, in the “Highlands” region in South Australia -- a large irrigation area (10,000 ha) irrigators have made significant savings in water use, including up to half of the water used in some districts. These

savings have been encouraged through the National Landcare Program, which has used public funds to refurbish deteriorating infrastructure, along with a range of complementary measures (water allocation, pricing reforms, structural adjustment measures) and implementation of improved land management practices. The initiative has also produced strong results in terms of reduced river salinity, reduced groundwater accession, on farm adjustment leading to more competitive and viable agricultural business, and improved water use and allocation.

Drawn from the presentation and paper from Mr. Don Blackmore, Murray-Darling Basin Commission, and "Achieving Efficient and Sustainable Water Resource Management: Australia's Approach", Australian paper submitted to the Workshop.

Working Group on Integrated Demand Management

The Working Group explored the multiple meanings of *integration* in the context of sustainable water resources management. Integration of the different uses for water and the different user groups has moved forward in water resources planning in recent years. The need now is to balance the ecological needs of the rivers, and aquatic ecosystems, with the demands of other users. Integration also means considering the relationship between surface water, ground water and, to a lesser extent, the role of wastewater and re-use in water availability and the impacts of coastal water conditions. Water policies must be integrated with broader national economic and food security issues. Finally, information and expertise from a range of disciplines and stakeholders (users, planners, managers, regulators, scientists) must also be integrated to build coherent strategies.

Achieving effective integration often requires a combination of specific mechanisms and external "shocks" (e.g. drought, flood, algae bloom) that focus the minds of politicians and other actors on the need to address a water resource problem from several different angles. Community groups are often well motivated and equipped to provide the sort of integrated thinking which top-down government structures have failed to provide in many countries.

Participants identified some principles of successful integrated demand management:

- Public Empowerment in Water Resources Management: All interests (extractive/environmental, national/local, short-term/long-term) must be represented at the table in order to achieve an effective solution that will be acceptable to all: ownership of the process and its products is key to successful integrated planning. Participants noted that community involvement is becoming a powerful force in many countries, particularly where it has moved beyond traditional "public consultation" exercise. This highlights the need for a reconsideration of the way the public is involved in government policy development, beginning with the recognition that a commitment of resources and energy is needed to get all stakeholders to the table. Tools for strengthening the role of the public include better information flows about the nature of water resources issues, stronger two-way dialogue, partnerships in objective setting, and the joint implementation of projects and strategies. Participants observed that it may be difficult to achieve this kind of planning in cross-cultural or international situations, where ownership and accountability issues are often hard to

define, but they noted some instances, the Rhine River for example, where multistakeholder approaches are working (See Case Study 5).

- **Information and Learning**: Building a knowledge base to support integrated water resources planning requires a conceptual framework for thinking about the data, models, prediction and performance assessment needed. Participants emphasised the need for more comparative analysis and information on the various instruments to motivate sustainable water management, their effectiveness, and their intended and potential indirect effects. They identified environmental impact assessment as a tool which needs further development and application in this context. Information must be better targeted to improve its accessibility for different user groups (the general public, community groups, policy makers, politicians, landholders, children). Building a useful information base also involves helping people to develop their information seeking skills so that they know how to find the information they need.
- **Setting Goals**: Setting objectives and choosing appropriate implementation tools should take place via a dialogue between the different players. Participants observed that scenario building on future water supply and demand outlooks -- particularly the development of a range of scenarios from the different users' perspectives -- can be more useful in this context than a single analysis for public comment, and may stimulate debate which could lead to a stronger view of what is an acceptable outcome.
- **Integrated Decision-Making**: Integrated decision-making processes require some process management to put a timeline on the planning process, facilitate discussions between competing users, and ensure that the products are approved at the highest level of government appropriate in any particular context. Finally, participants emphasised the need for better evaluation and assessment of water management policies. In particular, they called for results-based evaluation of strategies to improve water resources management, including to determine whether integrated planning has made any difference to the sustainability of the resource.

5 CASE STUDY: Integrated Water Resources Management in France

In the last 15 years, water consumption in France has increased significantly, driven essentially by the expansion of irrigation during the 1980's in the large cereal-growing regions in the Loire-Brittany River Basin. Irrigation has brought with it the drilling of new bore holes, an increase in the volumes of water withdrawn, and an extension of the growing period. Coupled with severe droughts -- which in some areas brought the exploitation of water tables to their limits -- increasing demand has led to the drying up of outlet rivers and a drop in the productivity of hydraulic works. It has underscored the fragility of available water resources, particularly from groundwater.

In order to improve the management of the nation's water resources, France has strengthened its approach to river basin planning. The concept of water resources planning at the basin level has guided water resources management since the mid-1960s. A 1964 Water Law created an innovative and decentralised framework built around six river basin agencies: four of these manage the Seine, Loire, Rhône, and Garonne rivers, while the other two cover smaller areas or transboundary rivers (the Rhine). The 1964 law also established the principle of *user participation* in the water planning processes: within each Basin a River Basin Committee forms a "Water Parliament" made up of elected officials (33%), government officials and technical experts (33%), and water users (including cities, industry and agricultural producers) (33%). The River Basin Committees debate and provide support for the pluri-annual action programme of the Water Agencies and determine the water charges to be applied.

The increasing pressure on water resources in recent years has shown that this basic framework for water resources management needed to be strengthened to ensure the long-term sustainability of the resource. In 1992, a new water law introduced four innovations. These: (1) recognised the intrinsic value of water as going beyond its economic value; (2) created parity in the treatment of all water resources, whether surface or groundwater; (3) established a longer term planning horizon (15-20 years) and a strategic planning process; and (4) increased the powers and duties of local governing bodies. The planning process has resulted for each basin in the production of a long-term guidance document (le SDAGE²⁰) elaborated over several years and via wide consultation with all stakeholders concerned.

Actions to modify water use patterns vary by River Basin, but the primary tool is through financial incentives. This approach relies on the application of the polluter-pays and user-pays principles: charges are commensurate to the amount of pollution discharged or the volume of water abstracted. Revenues are redistributed via grants, loans or soft loans for initiatives to control pollution or increase the availability of water supplies. Charges are evolving quickly, but gradually, towards levels that are more representative of the collective costs generated by excessive withdrawals. At the same time, financed assistance is also increasing to help make local actors aware of their responsibilities and to redirect behaviour in a way that better corresponds to the public interest.

In the Rhine-Meuse River Basin raising public awareness of water quality and supply questions has been a key element in improving the management of water resources. In the early 1990s, attention focused on both the Basin's poor water quality and the almost complete lack of public awareness of water

20. Schéma directeur d'aménagement et de gestion des eaux (Guiding Framework for the Development and Management of Water Supplies).

issues. The public viewed water as a free gift flowing from pure natural springs: pollution was assumed to be the result of industrial activity. Building on the strengthened role of local communities in water policy development, the Rhine-Meuse Water Agency initiated an innovative education component dubbed “Long Life to Water -- Kids take Action!”²¹ The school campaign had two objectives. The first was to support teachers’ efforts to help 8-11 year-olds learn about the risks of pollution and the measures required to improve the quality of the water supply. Second, the programme sought to mobilise children as ambassadors for water in their own homes and communities. The programme worked through skits, plays, educational classroom materials, and field-projects to spread its message. Support from the Ministry of Education and elected members of local assemblies gave the Rhine-Meuse Agency a recognised role to contribute to this “citizen education.” Over a 6-year period, 7,000 classes (70% of primary school children) participated in the campaign. The results are encouraging: in a survey of households whose children had participated in the programme, many still had the information acquired still well in hand. New objectives have been set for the period 1997-2001, including activities to consolidate the learning experience, reinforce awareness and open the door to apprentices and students pursuing studies in the health and social sectors.

Through education programmes, students explore water resources issues and become ambassadors for sustainable water use in their own homes and communities.

Water Management in International River Basins: The Rhine

France has also been a partner in successful international efforts to restore the Rhine. As a central artery in the region’s economy, international agreements from as early as the late 19th century have focused on developing the Rhine’s potential for navigation, energy production and its contribution to industrial and urban development. Although a project to restore water quality has existed since 1972, the Rhine’s ecological value has been badly damaged.

The 1986 Sandoz Chemical accident, which caused significant ecological damage and disrupted water distribution for thousands of people, galvanised public awareness of the fragility of the resource and led to an important shift in policies. A Rhine Action Plan was defined in 1987 with four broad objectives: (1) to achieve a balanced ecosystem (salmon should be able to live there again); (2) Rhine water quality should enable water production (not the case in 1987); (3) sediment should not be the cause of damages in the future; and (4) the Plan should contribute to protection of the North Sea. The Plan is led by the ICPR (International Commission for the Protection of the Rhine²²), an international consultative assembly which develops unanimous recommendations to member States: Switzerland, France, Germany, the Netherlands, and Luxembourg. The EU is also a member. Each member provides on a voluntary basis the legal framework, technical guidelines and financial provision necessary to achieve the objectives set.

In 1993, an evaluation took stock of the results of the co-ordinated programme of actions: target values for 36 out of 45 pollutants were met; accident prevention was considerably improved, and the ecological health of the River was on the mend -- measured in part of the presence of salmon. To achieve these results, 20 billion dollars have been invested by Member States over the last 10 years in pollution control, especially in industry and urban wastewater sectors.

21. “Vive l’eau -- Les jeunes se mobilisent!”

22. Commission Internationale pour la protection du Rhin

Future initiatives are intended to strengthen integrated management. Emphasis increasingly is being placed on non-point source pollution, integrated management of the Rhine ecosystem to better manage flooding issues, and promotion of broader participation of target actors and environmental groups in setting and policy development processes.

Based on the papers and presentations by Mr. Jean-Louis Beseme, Director, Loire-Bretagne Water Agency and Mr. Bruno Verlon, Director, Rhine-Meuse Water Agency, France.

V. CONCLUSION

In the concluding session of the Workshop the Chairman and Workshop participants reviewed major conclusions emerging from Workshop discussions. These have been incorporated throughout the preceding text and are not summarised here. Participants also identified a number of key orientations for OECD and non-Member countries as they move to improve the sustainability of water resources management:

1. Developing integrated management structures, functions and responsibilities that will allow integrated water resources management. Participants noted that it will also be important to understand how current administrative, institutional, regulatory and other structures will evolve: these structures have their own built-in tensions and gaps which will need to be resolved in the transition to more integrated resource management.
2. Developing appropriate pricing concepts and methodologies -- There is general agreement that full-cost pricing regimes are needed, but there is debate over what constitutes full costs, and there is an absence of methodologies to support policy in this area.
3. Developing information exchange and education strategies that improve the dissemination of information, the results of demonstration projects, best practice, case studies, etc. Greater dissemination of efficiency benchmarks are also needed.
4. Promoting additional research on “environmental sustainability” and integrated management, including social issues, management considerations, and the decision-support systems needed to make decisions on water resources which support environmental sustainability.
5. Developing environmental assessment processes to contribute to the knowledge base on water resources management, and in particular, developing dynamic, iterative assessment methodologies which respond to evolving information needs.
6. Promoting community involvement, responsibility and empowerment in water resources planning and management. In particular, moving away from traditional public consultation processes which have given little real voice to community concerns or demonstrated little “effective listening” to community generated ideas.
7. Developing integrated policy mixes, monitoring and evaluation frameworks and a portfolio of instruments so that progress on water resources management is not piecemeal. Results-based planning and policy development -- linking policy and the evaluation of its effectiveness-- is essential to ensuring that the sustainability of water resources remains a central objective.
8. Researching the international trade and commercial aspects of water trading and use, including their political ramifications. Increasingly, the impacts of limited water resources will be felt outside national borders. It will be important to understand where and how those impacts will evolve.

ANNEX 1: Notes on Figure 1 -- Annual per capita Withdrawals

Data sources: OECD

- ◆ Abstractions: accounts for total water withdrawal without deducting water that is reintroduced into the natural environment after use.
- ◆ Freshwater abstractions data: refer to 1995 or latest available year.

LUX Annual average of the 1990-95 period.

DNK Data refer to groundwater only, represents the major part of total freshwater abstractions (e.g. 95-99% for 1995).

UK Partial totals. England and Wales only. 1994 data. Data include miscellaneous uses for power generation, but exclude hydroelectric power water use.

CZE Data refer to 1996.

AUT Partial totals. Irrigation and industry no cooling: groundwater only. Electrical cooling (includes all industrial cooling): surface water only. 1993 data.

POL Totals include abstractions for agriculture, which include aquaculture (areas over 10 ha) and irrigation (arable land and forest areas greater than 20 ha); animal production and domestic needs of rural inhabitants are not covered. CAN 1991 data

IRE 1994 data; totals include 1980 data for electrical cooling.

CHE Partial totals excluding all agricultural uses. 1994 data.

FIN Partial totals. 1994 data excluding all agricultural uses.

NOR 1983 data.

NLD Partial totals excluding all agricultural uses. 1991 data.

GRC 1980 data.

KOR Partial totals excluding electrical cooling. 1994 data.

DEU Excluding agricultural uses other than irrigation. Data refer to 1995 data which include 1991 data for irrigation.

NZL Partial totals excluding industrial and electrical cooling. Data refer to 1993 and are estimates.

ISL After 1985, fish farming is a major user of abstracted water.

HUN 1994 data.

BEL Secretariat estimates.

FRA 1994 data. Irrigation: Secretariat estimates; includes other agricultural uses, but irrigation is the main use.

JPN Secretariat estimates based on 1990 and 1994 data.

MEX Data include Secretariat estimates for electrical cooling.

AUS Estimated data.

ESP Excluding agricultural uses other than irrigation. Data refer to hydrological year average, except for electrical cooling (1995 data).

PRT 1991 data.

ITA Excluding agricultural uses besides irrigation. Data refer to 1987.

USA 1990 data.

ANNEX 2: OECD Freshwater Withdrawals as a Percentage of Resources (1980-95)

OECD N. America	1980²³	1985²⁴	1990²⁵	1995²⁶
Canada	1.4	1.5	1.7	2
United States	21.2	18.9	18.9	19
Mexico	..	..	15	22
OECD Northern Europe	1980	1985	1990	1995
Austria	2.4	2.4	2.4	3
Belgium	..	..	72	72
Czech Republic	..	..	..	5
Denmark	..	..	11	9
Finland	3.4	3.7	2.8	2
France	17.7	17.6	19.1	19
Germany	26.1	25.4	26.5[29.2]	27
Hungary	..	..	5	6
Iceland	0.1	0.1	0.1	0.1
Ireland	..	..	2	2
Luxembourg	..	1.3	1.2	..
Norway	..	0.5	<1	1
Netherlands	16.3	15.9	13.8	9
Poland	..	..	30	22
Sweden	2.4	1.7	1.8	2
Switzerland	2.2	2.3	2.3	2
United Kingdom	19.6	18.2	20.1	17
OECD Southern Europe	1980	1985	1990	1995
Greece	..	..	12	9
Italy	32.2	29.8	32.2	34
Portugal	2.3	2.8	10	10
Spain	34.1	39.5	31.5	28
Turkey	6.9	8.3	13.7	17
OECD Asia-Pacific	1980	1985	1990	1995
Australia	..	..	5	4
New Zealand	0.4	0.6	<1	1
Korea	..	..	17	42
Japan	16.1	16.3	16.3	17

²³ Data for 1980 from: OCDE, 1994, *Environmental Indicators: OECD Core Set*.

²⁴ Data from 1985 from: OCDE, 1994, *Environmental Indicators: OECD Core Set*.

²⁵ Data for 1990 from: WRI, 1992, *World Resources Report: 1992-1993* for Australia, Belgium, Denmark, Greece, Hungary, Ireland, Korea, Mexico and Poland, and from OCDE, 1994 for all others.

²⁶ Data for 1995 from: WRI, 1996, *World Resources Report: 1996-1997*.

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