DIRECTORATE FOR FOOD, AGRICULTURE AND FISHERIES
ENVIRONMENT DIRECTORATE

OECO WORKSHOP ON THE SUSTAINABLE MANAGEMENT OF WATER IN AGRICULTURE: ISSUES AND POLICIES

THE ATHENS WORKSHOP

CASE STUDIES

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FOREWORD

The Workshop on the Sustainable Management of Water in Agriculture, hosted by the Greek Ministry of Agriculture, was held in Athens on 3-6 November 1997, and included a one-day study visit to areas irrigated by groundwater affected by salt water intrusion. It was opened by the Greek Minister of Agriculture, and brought together around 70 participants from agriculture and environment ministries in 16 OECD Member countries, the Commission of the European Communities (CEC), one Observer country, 5 international organisations (CIHEAM, FAO, UN-DESA, UN/ECE, the World Bank), 3 international non-governmental environmental organisations (BirdLife International, IEEP/CLM, WWF) and one professional farmer organisation (CEA). Their participation was particularly useful in widening the area of discussion.

The Workshop was an integral part of the programme of work on agri-environmental issues in the OECD. Its purpose was to define the key policy issues and the experience and role of different policy measures and market solutions in OECD countries, in the context of the sustainable management of resources and agricultural policy reform, and to suggest areas that might require further work to be undertaken in the OECD. An oral summary of the content and the discussions of the papers, introduced by the rapporteur, led to a broad consensus on the conclusions that emerged from the Workshop.

The Committee for Agriculture and the Environment Policy Committee agreed to recommend the deregistration of the Workshop proceedings, under the responsibility of the Secretary-General of the OECD. The conclusions of the Workshop, the overview paper from the OECD Secretariat, the Summary by the rapporteur, the conceptual papers prepared by consultants, papers by the FAO and the World Bank (invited speakers), official statements, and summaries of the case studies, were published in 1998 as an OECD Proceedings publication entitled: The Sustainable Management of Water in Agriculture: Issues and Policies - The Athens Workshop.

Thirteen OECD Member countries, the CEC, CIHEAM and the UN/ECE, prepared case studies describing specific policies and experiences addressing the issue of sustainable water management in agriculture. This General Distribution document contains the full set of these case studies.

The OECD expresses its appreciation to the Greek authorities for the very active role they played in preparing, arranging and hosting the Seminar, as well as to the eight other financial contributors: Canada, Finland, France, Japan, Spain, Switzerland, the United States, and the Commission of the European Communities.
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AUSTRALIA: A STRATEGIC FRAMEWORK FOR THE REFORM OF AUSTRALIA’S WATER INDUSTRY

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Summary

Of the annual estimated 14.6 km$^3$ of water used in Australia (based on a 1983-84 survey), 70 per cent is used for irrigated agriculture with a production value of about A$ 6 billion (US$4.5 billion). This represents 25 per cent of all of Australia’s agricultural production. It is fundamental to the long-term future of Australia’s irrigated agricultural industry, and the socio-economic regions that it supports, that water resources are managed in an ecologically sustainable manner. This means that water is managed to ensure both adequacy and security of supply as well as water quality sufficient to meet the full range of beneficial uses. A key policy objective of Australia’s governments is thus to bring about a more efficient, equitable and sustainable management of the nation’s water resources.

Australia’s federal system of government poses a number of challenges and opportunities in developing water policies. The six States and two Territories have the prime constitutional responsibility for natural resource management which could lead to fragmented approaches. However, all of the nation’s governments have recognised the need to work together in developing a major national integrated framework for the efficient and sustainable reform of Australia’s water industry.

The Council of Australian Government’s (COAG) Framework for the strategic reform of Australia’s water industry comprises a package of diverse but interrelated measures intended to generate an economically sustainable water industry, with improved outcomes in terms of sustainability of natural resource use, as well as better environmental outcomes. The Framework is designed to ensure that there is a consistency of approaches across the nation. At the same time it allows the flexibility for each jurisdiction to adopt its own approach to implementation, depending on its own institutional and natural characteristics. Because of this flexibility, the COAG Framework (developed to meet the unique requirements of the Australian federal system) could be useful as a generic model for other OECD countries.

The Framework: i) Covers both rural and urban areas and addresses a range of issues including environmental issues, pressures associated with population expansion, and the need to ensure the viability of food production industries. ii) Responds to the need for integrated approaches across a range of issues,

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with a comprehensive package of interrelated measures which together will help ensure that water resources are managed in more efficient and sustainable ways. iii) Recognises the importance of effort at national, provincial and local/catchment levels and the important and unique contribution that each level can make. The reform programme provides an essential strategic national direction, which at the same time takes into account the technical and policy diversity across provincial or State governments. iv) Emphasises the importance of community involvement in working through detailed responses to the COAG reforms, as well as in local “on the ground” activities (e.g. in contributing to integrated catchment management approaches).

The Framework measures interact to address market failures and adjust the institutional framework within which water resources are delivered and used. The aim is to encourage the private individuals who make up the irrigated agriculture industry to use those water resources more sustainably and productively. Through the Framework farmers are offered real benefits in terms of a more secure livelihood, as well as opportunities to exercise much greater control over their own business affairs. This has become a powerful incentive for change at the irrigation district and farm levels.

The challenge is to apply full economic cost recovery principles to water pricing in rural areas by 2001 notwithstanding the difficulties in adopting the economic approach to charging. Approaches to implementation in New South Wales and Queensland provides an indication of the practical considerations of dealing with the policy requirements.

1. Introduction

Water use in Australian agriculture

Apart from Antarctica, Australia is the driest of the continents. Close to three quarters is arid or semi-arid. To provide security of supply for domestic consumption, industry and agricultural production, large investments (approximately US$65 billion in replacement cost terms) have been made in the construction of dams, reservoirs, large tanks and other storages. This has enabled substantial areas to be developed for irrigation. Water management and supply for these areas has historically been characterised by state-owned vertically integrated enterprises.

Almost 75 per cent of all irrigation in Australia occurs within the Murray-Darling Basin (MDB) which covers a surface area of some 1.06 million square kilometres (roughly equivalent to the combined area of France, Germany, Belgium, Switzerland and the Netherlands). The irrigated area in the MDB is 157 000 square kilometres (more than the whole of Greece). The Murray-Darling Basin takes in most of the Australian State of New South Wales, large areas of Victoria and South Australia and a small portion of Queensland.

In Australia as a whole, pasture constitutes 57 per cent of the irrigated area, with crops other than cereals and horticultural crops making up 18 per cent, cereals 15 per cent, grapes and fruit 6 per cent and vegetables about 4 per cent (Figure 1). Of the total area of pasture in Australia, only about 4 per cent is irrigated while 2 per cent of its cereal crop is irrigated. Of the annual estimated 14.6 km$^3$ of water used in 1983-84 (the last major national survey of water use) 70 per cent is used for irrigated agriculture while 21 per cent is used for urban and industrial purposes (Figure 1). Irrigated agricultural production has a value of about A$ 6 billion which represents 25 per cent of all Australia’s agricultural production. Over half of the irrigated area is supplied from State government irrigation schemes. Considerable financial resources are attached to irrigation both in terms of the water harnessing and distribution infrastructure as well as on-farm facilities. Please refer to the Map at the end of this case study.
It is fundamental to the long term future of Australia’s irrigated agricultural industry, and the socio-economic regions that it supports, that water resources are managed in an ecologically sustainable manner. This means that water is managed to ensure both adequacy and security of supply as well as water quality sufficient to meet the full range of beneficial uses.

Against a background of widespread natural resource degradation, including salinisation, waterlogging and algal blooms, which became increasingly evident in the late 1980s and early 1990s, this paper provides a case study of Australia’s experience in developing and implementing a strategic framework for the efficient and sustainable reform of its water industry. Particular reference is made to the rural water industry and irrigated agriculture.

2. Policy issues

Policy issues which needed to be addressed can be broadly categorised in terms of: pricing and asset provision and management; water allocations and trading; institutional arrangements; and water and the wider natural resource base. However, it is accepted that the issues are not mutually exclusive and in many cases, overlap.

Pricing and asset provision and management

One of the main underlying reasons for the problems facing agricultural water users in Australia in the late 1980s, in common with other nations, is that governments have tended to charge less than the full cost of providing water services. As a consequence, funds have generally not been set aside for the refurbishment of irrigation systems which, in some areas, are showing strong signs of deterioration and significant inefficiencies in their function.

In addition past investment in dams and irrigation infrastructure has not necessarily been subject to rigorous economic and environmental appraisal. With the expected growth in demand over the next 25 years additional supplies are likely to be needed. Even with the implementation of an appropriate
demand management strategy, this could require the further investment in major dams and infrastructure. It is important to ensure that new investment is undertaken in the context of optimising current water use and only after a thorough evaluation of the economic viability and environmental sustainability of proposals.

**Water allocations and trading**

Control of water resources in Australia has been vested in the Crown (State governments) and therefore, entitlements to use water have been conferred by the Crown. In some cases these rights to use have been over-allocated. The entitlements to use have generally been conferred as a consequence of ownership of a specific parcel of land. This system resulted in a limited trade of water entitlements across Australia even though the continued use of the water in some areas was neither economically viable or environmentally sustainable. If we are to optimise water use from current developments, it is necessary to ensure that the water is able to move from inefficient, uneconomic and unenvironmentally sustainable uses to higher value, more productive and environmentally beneficial uses. Separation of a water right from land is fundamental to such a system.

**Institutional arrangements**

In some jurisdictions, the roles of resource owner, standard setter and service provider overlapped, leading to potential conflict where a more commercial focus could have led to improved efficiency. The roles and responsibilities of all parties need to be clearly specified.

In rural areas the bulk of the ownership and management of the assets were in the hands of the one government entity from headworks to farm offtake resulting in inefficiencies in delivery of water both to the farm gate and on-farm and a low incentive for change. Responsibility for operational management of irrigation areas thus needs to be devolved to local bodies.

**Water and the wider natural resource base**

As indicated earlier, inappropriate water use has had a major impact on the resource base causing deteriorating water quality in rivers, with increased salinity and frequently occurring algal blooms, and rising water tables under irrigation areas. There is a need to be able to deal with the impact of inappropriate use of water on the wider natural resource base.

Clearly the above policy issues were significant and required co-ordinated action at the highest level of government. A failure to address these issues would have meant that both agricultural water users and the inland waters that they depend upon faced an unsustainable future.

Section 3 of this Case Study discusses the strategy adopted to address these policy issues amid the complexities of a multi-governmental federal system.
3. Policy measures adopted

Policy co-ordination at the national level

Australia’s system of government poses a number of challenges and opportunities in developing water policies. Under Australia’s federal system, the six States and two Territories (regional governments) have the prime constitutional responsibility for the management of their natural resources. Whilst this could lead to fragmented approaches, all of the nation’s governments have recognised the need to work together in developing a major national integrated water reform program for the efficient and sustainable reform of Australia’s water industry.

Co-ordination of policy is achieved at the highest level through the Council of Australian Governments (COAG) which involves the heads of the Federal (Commonwealth of Australia) and State Governments. The linkage between agriculture and natural resource management policy and the need to ensure integration of resource management and use, is covered through the Agriculture and Resource Management Ministerial Council of Australia and New Zealand (ARMCANZ). ARMCANZ is comprised of Commonwealth and State Ministers with responsibilities for agriculture and resource management. New Zealand is represented on the basis of information exchange and co-operation. ARMCANZ is supported by a number of policy co-ordination and specialist committees including the Sustainable Land and Water Resources Management Committee, responsible for the integration of agricultural land and water resources.

Due to its unique position in resource sharing among a number of States, the water and environmental resources of the Murray-Darling Basin (MDB) are co-ordinated by the MDB Ministerial Council and its Commission of government representatives. The MDB co-ordination and integration is achieved through an inter-governmental MDB Agreement, which is backed by legislation in the Commonwealth, New South Wales, Victoria, South Australia and Queensland.

Figure 2 below, indicates the general organisational arrangement for co-ordination of water management policy at a national level in Australia.

The COAG strategic framework for water reform

In response to the policy issues facing water resource management in Australia, COAG agreed in 1994 that States and Territories would implement a national framework for water reform by 2001 (“the COAG Framework”). The Framework covers both the urban and rural sectors of the water industry and has the twin goals of economic efficiency and resource use sustainability.

A further agreement was signed by COAG in February 1995, as part of the national micro-economic reform agenda, to introduce Competition Policy across the government enterprise sector (including electricity, gas, transport and water). This led to implementation of the water reform Framework being a requirement for State and Territory governments to receive payments from the national government to reflect the loss of revenue flowing from introduction of the micro-economic reforms across all sectors. A National Competition Council was established as an advisory body to all governments involved in implementing all reforms, including water.
Although the regional governments were already committed to implementing the reform Framework, the Competition Policy payments have had the unexpected result of providing an additional incentive for implementing the Framework elements in their entirety.

The COAG Framework comprises a package of diverse but interrelated measures intended to generate an economically sustainable water industry, with improved outcomes in terms of sustainability of natural resource use, as well as better environmental outcomes. The Framework is designed to ensure that there is a consistency in approaches, aimed at achieving the goals, across the nation.

Importantly the Framework, at the same time, allows the flexibility for each jurisdiction to adopt its own approaches to implementation depending on its own institutional requirements and natural characteristics. The different approaches being undertaken by the States of Queensland and New South Wales to meet their Framework commitments dealt with in the appendices to this Case Study are good examples of the flexibility that the COAG Framework provides. The Framework, developed to meet the unique requirements of the Australian federal system, could thus be useful as a generic model for other OECD countries.
The COAG Framework measures

As indicated previously the Framework deals with measures for both the urban and rural water industry. For the purposes of this Case Study, only the measures relevant to the rural water industry will be dealt with. For the rural water industry the package of measures, (categorised in terms of the policy issues previously discussed), involves:

Pricing and asset provision and management

− pricing based on the principles of full-cost recovery and transparency;
− future investment in new schemes, or extensions to existing schemes, to be undertaken only after appraisal indicates it is economically viable and ecologically sustainable.

Water allocations and trading

− comprehensive systems of water allocations or entitlements, backed by separation of water property rights from land title and clear specification of entitlements in terms of ownership, volume, reliability, transferability and, if appropriate, quality;
− formal determination of water allocations or entitlements, including allocations for the environment as a legitimate user of water;
− trading, including cross-border sales, of water allocations or entitlements, within the social, physical and ecological constraints of catchments.

Institutional arrangements

− the separation of resource management, standard setting and regulatory roles of government from the roles of providing water services;
− a greater degree of responsibility for local management of water use.

Water and the wider natural resource base

− administration and decision-making to provide for an integrated catchment management approach to water resource management;
− public education about water use and consultation in implementing the water reforms;
− appropriate water related research and use of efficient technologies.

In relation to water quality issues, the implementation of the COAG Framework itself, through improved water use efficiency and specific provision of water for the environment is likely to lead to improved water quality in waterways. However, the COAG Framework also makes specific reference to water quality and in particular, the development of economic instruments for improving water quality, through
requiring governments to support the development and implementation of a National Water Quality Management Strategy (NWQMS).

The objective of the NWQMS is “to achieve the sustainable use of the nation’s water resources by protecting and enhancing their quality while maintaining economic and social benefit.” The NWQMS is based on policies and principles that apply nation-wide and will include guidelines and other documents which focus on a part of the water cycle or a particular activity within the cycle (e.g. rural land uses and water quality). While the various documents agreed by governments, the community and industry under the NWQMS are provided for guidance, implementation of the Strategy is drawn into the environment element of the COAG Framework. Many regional governments now use the NWQMS as a basis for drawing up specific water quality regulations.

One of the guiding principles for the Framework is the adoption of integrated catchment management approaches to water resource management. The support of governments for addressing the institutional requirements for, and where necessary, removing the impediments to the adoption of integrated catchment management approaches is a specific requirement of the COAG Framework. Existing institutional arrangements, which do not recognise integrated catchment management approaches, are often impediments to making better use of stormwater and wastewater.

**Implementing the COAG Framework**

Implementation of the Framework by regional governments, which is now in its third year, is planned over a five to eight year period, with full implementation expected by the end of 2001. The National Competition Council is responsible for monitoring compliance of each jurisdiction with the spirit of intent of implementing the Framework in order to be eligible for competition payments under the National Competition Agreement. A Task Force of officials representing all governments has been established under ARMCANZ to report annually to COAG on implementation in all jurisdictions and to undertake investigations and studies which may assist clarifying issues or ensure (where necessary) consistency of approaches across the variety of jurisdictions.

Key papers which have been prepared in this regard are the National Principles for Allocation of Water for Ecosystems and the National Principles for Water Allocation and Trading.

The Task Force has also developed National Generic Milestones, endorsed by COAG, as a practical aid for implementation of the water industry reform Framework and to provide a check list to ensure that implementation of the reform process is kept on track in the spirit intended.

Progress in implementing the reforms over the past two years has been positive in all regional areas of Australia. Some examples, drawn from the annual report to COAG, include:

**Pricing and asset provision and management**

For urban water services in NSW a two-part tariff system is in place and positive rates of return have also been achieved for these services. For future investment, economic appraisal and ecological viability assessment policies are in place. An interim ruling has been made on bulk rural water prices.

In Victoria, gradual water pricing reform has been achieved over the past 10 years while other States have identified strategies for achieving the COAG targets.
Water allocations and trading

South Australia has introduced a new Water Act which provides for a comprehensive system of transferable water property rights. Other features of the Water Act include: incorporation of the principles of ecologically sustainable development; provision of holistic water resources management within the context of integrated catchment management; provision of water for the environment and provision for devolving greater responsibility for water resources management to local communities through the establishment of catchment management boards.

Other States too, are well down the path towards meeting the COAG requirements within the bounds of their own particular needs. In the State of New South Wales, the government has recently announced a comprehensive Framework of water reforms which is aimed at achieving a better balance in the sharing of water between the environment and water users to ensure long-term sustainability consistent with the COAG requirements. The New South Wales approach is discussed in detail in Annex 1. In Queensland water allocation is being determined through the Water Allocation Management and Planning (WAMP) process. This approach is discussed in more detail in Annex 2.

Institutional arrangements

All States and Territories have taken action to separate management, regulation and service provision. Significant organisational change has occurred in irrigation areas, with some form of privatisation, or corporatisation occurring in most States. The appointment of commercial boards and the devolution of substantial responsibility to customers, has sharpened the commercial focus of the sector and led to improved efficiency performance in many areas. The progressive devolution of pricing and investment decision making is leading to better customer recognition of asset management issues and price/service trade-offs.

Water and the wider natural resource base

A practical example of an integrated approach to resource management is an irrigation area in South Australia — where significant savings have been achieved in water use (including up to half the water used in some cases). These savings followed an initiative to rehabilitate the infrastructure of the region, where a series of open channels was replaced with pipes.

Tasmania has developed Guidelines and a Framework for Catchment Management and has established the Land and Water Management Council to provide broad stakeholder input to natural resource management issues. A state policy for Water Quality Management has also been developed to facilitate the implementation of NWQMS guidelines.

Western Australia has recently announced the Salinity Action Plan, a key strategy for reversing the loss of agricultural land to salinity and protecting and restoring key water resources and high value wetlands. The integration and co-ordination arrangements set out in the Plan is an example of the State’s model for delivery of natural resource management.
**The Murray-Darling Basin “Cap” on water diversions**

Progress on implementing the water reform Framework has gone beyond individual jurisdictions and is occurring at the cross-jurisdictional level. The Murray-Darling Basin Commission (MDBC), which as indicated previously is operated under an Inter-governmental agreement between the governments of the Commonwealth and the states of New South Wales, Victoria, South Australia and Queensland, has made significant progress in the area of institutional change relating to the creation of a “Water Business” to undertake its water operations. The MDBC has also undertaken substantive work in relation to allocations, entitlements and cross-border trading. The “Cap” on diversions, discussed below, highlights the problems being faced in this vital region of Australia and complements the implementation of the reform Framework.

A detailed audit of water use in the MDB, which was carried out in 1995, indicated that diversions (predominantly for agricultural use) have increased by 8 per cent between 1988 and 1994 and that the increase was continuing at a rate of approximately one per cent per annum. The increase was shown to have an adverse impact on the health of the river system. The audit concluded that an appropriate balance needed to be found between water required for consumptive uses and that required to be left in rivers as environmental flows, to ensure that the consumptive uses are sustainable and that the rivers remain in a healthy state.

The existing water allocation system has not been effective for controlling the volume of water diversion, with the main constraint on use being the limitations of infrastructure and channel capacity. A new system of water allocation and a functioning water trading market, as required under the COAG Framework, was clearly needed. What was also required to allow a balance between uses to be achieved was a form of management constraint on future diversions.

In June 1995 after considering the implications of the MDB Water Audit, the Murray-Darling Basin Ministerial Council agreed that a balance needed to be struck between consumptive and instream uses of water in the Basin and agreed to an interim Cap on diversions while the precise details of its implementation were established. An Independent Audit Group (IAG) was established to help interpret differences in approaches taken by the States and to review progress on implementation of an operational Cap to consider ways to resolve inconsistencies and inequities in water use. In November 1996 the IAG reported and made a number of recommendations which have resulted in the agreement by the MDB Ministerial Council on 25 July 1997 to a Cap for the Basin which holds diversions to those which existed in 1993/94.

The result of this historic decision to place a ceiling on further diversions (both rural and urban) will help the objectives of the Framework for a water trading market to reallocate water to be achieved. Although, as discussed in Section 4, much still needs to be done in relation to cost recovery and pricing before such a market can perform in a manner free from the distortion.

4. Economic cost recovery under the COAG framework

**Asset valuation and cost recovery**

The implementation of the Framework has led to a number of challenges, not the least is the challenge to apply full economic cost recovery principles to water pricing. The Framework requires that in rural areas full cost recovery be applied by 2001. An Expert Group, established by COAG, recommended that an
The economic approach to charging is required if resources are to be allocated efficiently and the correct signals are to be given in relation to investment and consumption.

COAG agreed that future charging by jurisdictions should be guided by three basic principles. These are:

1. The full cost of providing water services attributed to specific identifiable beneficiaries or impactors should be recovered by way of charges on them;
2. The costs of public benefits/impact of management which are unable to be attributed and charged to specific beneficiaries/impactors should be treated as community service obligations; and
3. Where costs are subsidised by a jurisdiction or local government authority, any such subsidy or any community service obligation should be made explicit and transparent.

Full economic costs, for the purposes of charging in the Australian water industry are defined as:

1. Operating and maintenance expenses; plus
2. Administrative expenses; plus
3. Externalities — such as for salinity control; plus
4. Depreciation on a replacement cost basis; plus
5. The opportunity cost of capital.

One of the key recommendations from the Expert Group is that, as far as possible, provision should be made in charging arrangements for the loss of service capacity of the asset on the basis of full replacement cost. In other words, if a supply pipe, or a dam needed to be replaced to continue to provide a required service, then the future replacement cost of that asset needs to be reflected in the charges. However, in recognition that it may not be practicable in rural areas to charge on this basis, it was also noted that, as a minimum, provision should be made in charging arrangements for the preservation of the ongoing service delivery capacity of that asset, through a charge based on an infrastructure annuity. This would be subject to beneficiaries of the service provided by the asset being maintained, desiring that the service delivery capacity embodied in the assets should continue.

The effect of this provision is to provide a mechanism for the users of a service (for example shareholders in an irrigation area) to determine the level of service they require and choose to pay for maintaining that level of service.

A current project being undertaken by the Task Force on COAG Water Reform is to further examine this recommendation and provide the water industry with a practical set of guidelines and a financial model for determining the impact on individual entities. This work is currently in draft form and is expected to be completed for endorsement by Ministers in February 1998.

A brief outline of the work being undertaken in New South Wales to set prices for bulk water supplies in rural areas is contained in the boxed case study and highlights the difficulties facing individual jurisdictions as they move to implement the requirements of the COAG Framework.
Cost recovery and water trading

The difficulty in determining full costs is a lesson which could be noted in all countries wishing to improve resource allocation efficiency and to follow the path of full economic cost recovery. When seen in the context of interstate trading of water (another requirement of the Framework) it is not difficult to see why there are impediments to a water trading market between States.

A model on the impact of water trading across the State borders of NSW, Victoria and South Australia, suggests that there will be significant movement of water to NSW from Victoria if there are no restrictions on trade, based on the current pricing regimes existing in those States.

Improved transparency across all jurisdictions will greatly assist in facilitating cross border trade. The Task Force has recognised cost recovery as a major impediment and is undertaking investigative work which is intended to lead to a Framework for consistency of approaches, in particular in bordering States, to full cost recovery.

The New South Wales approach to bulk water pricing

In Australia it is the role of individual jurisdictions to set prices and in doing this they will need to have regard to the COAG Water Reform Framework. Each jurisdiction will have different approaches in meeting the requirements depending on the baseline prior to commencement. For the purpose of this case study the jurisdiction of New South Wales (NSW) is used as an example to highlight some of the difficulties which need to be overcome in setting pricing to achieve full economic cost recovery, however, this should not be taken to infer that the approaches taken by NSW in relation to pricing are in any way better or worse than any other Australian jurisdiction.

In NSW, the responsibility for price setting lies with the Independent Pricing and Regulatory Tribunal (IPART). IPART has been working on the issue of bulk water prices (i.e. the prices which flow through to rural water users) and brought down an interim ruling in June 1996. Its work reflects the difficulty in moving from a regime of the government controlled and operated water service delivery systems to one of full separation including the full cost recovery and economic pricing requirements of the COAG Framework.

In a draft determination on bulk water pricing to apply from 1 July 1997 the IPART noted that significant challenges remained on a number of issues it identified in 1996 before it could give a clear direction on water prices in the medium term. These issues were:

- improving transparency and accountability;
- future capital expenditure requirements;
- the development of a regional focus for charging and service delivery;
- the allocation of costs to user groups;
- the identification of who benefits from particular expenditure; and
the scope for efficiency improvements by the Department of Land and Water Conservation (DLWC) as the NSW agency responsible for water resource management.

In its 1997 draft determination the IPART noted that much work was still required on allocation of costs and identification of benefits. This was due primarily to insufficient documentation on the levels of services arising from costs having been incurred, the complexity of links between river regulation, water use, land use and environmental degradation and an inadequate assessment of the benefits of river regulation for water delivery, flood mitigation, power generation and recreation.

In bringing down its draft determination for 1997, IPART has estimated that its determination for regulated streams in NSW will raise an estimated revenue of A$ 22.1 million, against a DLWC estimate of user share of costs of A$ 47.3 million, suggesting a range over which price increases are still to come, before the Framework requirements are to be implemented. IPART recognises that there is an understatement of revenue which should be recovered from users but is “unable to gauge the degree of understatement until actual expenditures by the DLWC are more accurately accounted for.”

It is interesting to note that the draft determination highlights the difficulties experienced by a pricing regulator set up essentially to set prices for government monopoly services. While there is no difficulty with operational or regulatory costs, the concept of including all economic, including environmental costs, as partly reflected by the DLWC actual expenditures on resource management costs, is far more difficult.

Dealing with resource management costs may prove to be the ultimate challenge.

5. Influence of the framework on agriculture, water and the environment

The dynamics of the Framework as a stimulant to change

The Framework itself acts as a stimulant and facilitator for moving from an unsustainable situation to a sustainable one, in the overall context of enabling individuals to take decisions. A key aspect is the linkages or dynamics between the various reform elements. Developments in one area of the Framework will facilitate or trigger progress on another front. For example, full cost recovery pricing on its own suggests higher per megalitre costs need to be paid. However, in combination with the Framework requirement for more commercial and competitive approaches to water delivery, the institutional arrangements element requirement for separation of responsibilities and devolution of operations as close to the users as possible, price rises are able to be better managed and accepted by growers. Resource use efficiency is thus expected to be achieved across the full water use cycle.

Australia’s agricultural policy is also directed to allow growers to benefit from the reform in water management. Particularly the freeing up of water for a trading market. A combination of higher price through greater cost recovery and the separation of water rights from land has seen a shift of water from low value pasture to higher value horticultural use. Increased opportunities for water trading under the reforms will assist farmers to structure their businesses to increase profitability, or alternatively assist them to leave agriculture if they wish to do so, through income from the sale of their entitlements or property rights to water.
Farmers taking up the opportunities offered by reform

While it is essential that governments implement the full package of measures under the COAG Framework, the introduction of policy settings by governments alone will not achieve fully the goal of efficient, equitable and sustainable management of the nation’s water resources. This will be up to individuals or the community working in partnership with governments.

In Australia, decisions about the use of agricultural resources are made largely by private individuals acting on the basis of information and incentives provided through markets within an established institutional framework. The COAG Water Reform Framework seeks, through its package of measures aimed at addressing market failures and adjusting the institutional framework within which water resources are delivered and used, to encourage the individuals who make up the irrigated agriculture industry to use those resources more sustainably and productively.

Through the Framework farmers are provided with very real benefits in terms of a more secure livelihood, as well as providing opportunities to exercise much greater control over their own business affairs. For example, the pricing reforms, which may lead to increased costs for farmers, are aimed at ensuring that the infrastructure needs of farmers can be met in the future. At the same time the reforms encourage farmers to strive for efficiency and use less water or use it in a more productive manner. This has become a powerful incentive for change at the irrigation district and on farm level and is reflected through the increasing involvement of farmers in restructured water delivery organisations ranging from commercially based co-operatives through to fully privatised irrigation companies.

More efficiency in water use

Australia’s response, in 1996, to the International Commission on Irrigation and Drainage (ICID) WATSAVE survey contains a number of individual success stories relating to increased water use efficiency. They include individual growers experience in the horticultural industry following the introduction of practices such as moisture monitoring technology and irrigation scheduling services. These changes have led to many benefits including increased fruit yields and quality, lower water costs and reduced labour inputs, as well as improved environmental outcomes associated with better matching of farm inputs to crop needs and reduced saline water run-off into river systems.

The adoption of improved water use efficiency practices at an individual level is likely to accelerate as the elements of the reform Framework are implemented. Benefits claimed from the introduction of an Irrigated Crop Management Service (ICMS), run by the Department of Primary Industries, in the State of South Australia, include increases in crop yields of up to 20 per cent, reduction in water use of up to 20 per cent and reduced volumes of water being returned to the river.

While farmers can, as individuals, adopt measures which result in water savings, improved agricultural productivity and environmental benefits, it is important for governments to work together with the community to ensure that the conditions which influence individual decisions are such that collectively they result in benefits to agricultural productivity, water resources and the environment. For example, inefficient, inflexible and run down government owned infrastructure is not conducive to the adoption of improved practices.
**Government working in partnership with growers**

The “Highlands” region in the State of South Australia is a good example of a large irrigation area, about 10 000 ha in size, where there have been significant savings in water use, including up to about half of the water used in some districts. These savings followed the introduction of an initiative to rehabilitate the infrastructure of the region. In implementing this initiative an integrated approach was adopted to address the various issues facing the region, combining rehabilitation activities with measures to improve resource use efficiency, improve environmental outcomes and address adjustment issues.

The success of the initiative resulted from governments (both State and Federal) working in partnership with the community. Through the National Landcare Program, the Commonwealth provided funds for a package of works to replace the deteriorating infrastructure (elementary open channels) with pipes. This support was conditional upon the State government and the growers introducing a range of complementary measures consistent with the COAG Framework, including water allocation and pricing reforms, structural adjustment measures, and implementation of improved land management practices. The infrastructure refurbishment and subsequent structural adjustment of the Highland Irrigation areas, together with legislative change, has led to management control now being vested in the growers through the Management Trusts, in line with institutional requirements of the Framework.

The signs are positive with significant progress being made towards intended outcomes. These include reduced river salinity, reduced groundwater accessions, on farm adjustment leading to more competitive and viable agricultural businesses, and improved water use and allocation arrangements, including the significant water savings mentioned earlier.

6. **Conclusion and future direction**

To summarise, Australia has taken an all encompassing strategic approach to address the many complex policy issues relating to sustainable water resource management. In a nation where the six States and two Territories govern the vast and diverse continent of Australia and where each has constitutional responsibility for management of its own natural resources, the COAG water reform Framework has been developed as a guide for national consistency of direction for action. While providing this guidance and direction, the Framework allows the flexibility for each jurisdiction to adopt its own approaches to implementation depending on its own institutional requirements and natural characteristics.

**Key Framework characteristics**

The Framework:

- covers both rural and urban areas and addresses a range of problems including environmental issues, pressures associated with population expansion, and the need to ensure the viability of our food production industries;

- responds to the need for integrated approaches across a range of issues, with a comprehensive package of interrelated measures which together will help ensure that water resources are managed in a way which is both more efficient and sustainable;

- recognises the importance of effort at a number of levels, namely national, provincial and local/catchment levels and the important and unique contribution that each level can make.
The reform program provides an essential strategic national direction, which at the same
time, takes into account the technical and policy diversity which exists at the provincial or
state government level;

- emphasises the importance of community involvement in working through detailed
  responses to the COAG reforms, as well as in local “on the ground” activities (e.g. in
  contributing to integrated catchment management approaches).

Further research

Much research is currently taking place in Australia to assist in monitoring the impact of current policy
and underpin future policy development. The work of the Land and Water Resources Research and
Development Corporation in relation to irrigation efficiency and monitoring river health is important in
this regard. The Australian Bureau of Agricultural and Resource Economics (ABARE) has also been
developing a modelling system which represents the competing demands for water in the southern
Murray-Darling Basin within Australia and is designed among other things to investigate issues such as
the way in which the water market can facilitate structural adjustment of broadacre farms (a description of
this generic modelling work which may be of interest to other OECD countries is in Annex 3).

Future focus of effort

The focus on future work in the lead up to full implementation of the Framework will be on:

- providing improved clarity on key issues such as full cost recovery in water pricing which
  will lead ultimately to transparency;

- implementing the Cap on diversions in the important production area of the Murray-Darling
  Basin;

- providing the comprehensive system for water allocations to ensure that there is a balance
  between consumptive and in-stream uses including redefining existing allocations where
  necessary;

- ensuring that the market for water transfers functions without impediment or unacceptable
  constraint.

Conclusion

The ongoing implementation of the COAG Framework has already had a substantial impact on the way in
which water is used for agriculture. Not the least of these is the changing attitude among growers as to the
vital role that water plays in their businesses. Far from being a given, included in the purchase of a
property, to be applied at fixed cost regardless of use and potential impact, water is now generally viewed
as a finite business input which needs to be used and applied efficiently for maximum benefit in a way
which ensures that the future resource is sustainably maintained.

The increasing direct involvement of farmers, in areas dealing with the management and operation of the
resource, in place of the government officials is a clear indication that the rules of water arrangements
have changed in Australia. If the policy objective of the COAG Framework is met this will result in the future survival of the water industry in Australia.

As indicated in this Case Study much remains to be carried out in implementing the Framework. This work will be required both at the individual jurisdictional level as it seeks to meet the challenge of its first assessment of progress by the National Competition Council early in 1999 and also by the Inter-governmental Task Force on COAG Water Reform as it seeks to undertake relevant studies to ensure that there is a common understanding to help facilitate implementation progress on some of the key elements in accordance with the milestones.

The COAG Framework for reform of Australia’s water industry, developed to meet the unique requirements of the Australian federal system, could be useful as a generic model for other OECD countries.

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ANNEX 1

1. The water reform process in New South Wales, Australia

Water in NSW

Australia’s population totals 18 million. While compared with many other countries the population is low, however, so too is the water available for use. Australia is in fact the driest populated continent on earth. By world standards Australia receives relatively little rainfall and loses much of this through evaporation. Average rainfall is 420 millimetres, compared with Europe 610 mm and Asia 640 mm. Runoff is also low averaging only 12 per cent of rainfall compared with 40 per cent for Europe.

In addition, Australian rivers experience extreme variations in flows. The Macquarie River in central NSW, for example, has had annual flows ranging from just 2 per cent of the average to 940 per cent. There are not just a wide range in flows between years, but also between months — with distinct variations in seasonal flows.

With low natural rainfall, our agricultural industry depends to a large degree on irrigation. And because of the extreme variations in river flows, large water storages have been constructed on all our major inland river systems to provide more assured water supplies. NSW, for example, has double the amount of water storage for irrigation per square kilometre than the United States. Irrigation accounts for 75 per cent of all water diverted and used in NSW and closer to 95 per cent in the inland regions.

NSW is now at or near the limits of water availability. Most of the inland rivers and some of the coastal rivers are regulated by major dams and control structures. In the inland valleys up to 80 per cent of the natural flows of some rivers are now controlled by major storages and the normal flow at the end of regulated systems has been reduced by between 60 to 80 per cent.

The high degree of regulation and the large water extractions have, while supporting an irrigation industry worth some $2 billion dollars, also come at a cost. The natural flow dynamics of our rivers and groundwater systems have been substantially modified contributing to:

- outbreaks in our river systems of toxic blue-green algae — in 1991 an algal bloom stretched along the Darling River for some 1 000 kilometres;
- dwindling native fish numbers — eleven species of freshwater fish in NSW are now threatened with extinction;
- explosion in the numbers of introduced species such as common carp which have become a pest — in one river a recent fish survey found one carp per square metre of river;
- shrinking wetland areas which are home to many internationally protected water bird species;
- increasing saline inflows into the river systems and in some areas rising groundwater tables which are causing waterlogging and soil salinity and in others rapidly declining groundwater resources.
NSW is not the only State suffering these problems. Australia’s longest river system — the Murray-Darling River — flows through four States, including NSW, and an audit in 1995 of the river system led to an agreement by all the States for an immediate Cap on water diversions. The Cap requires that water diversions be constrained to the level associated with the 1993/94 level of development. Embargoes on new licences now apply across all rivers in the inland and much of the coast as well in NSW.

**Implementing change**

The process of Water Reform which commenced in 1995 encompassed not only the need to provide for the long-term sustainability of our water systems, rivers and groundwater, but extended to a review of water pricing, legislation, catchment management, water delivery services and consultative arrangements with the community. This led to:

- immediate actions to provide for the environmental requirements of the Macquarie Marshes and the Gwydir Wetlands, two major and internationally recognised wetland area;
- establishment of a government working group to develop interim river flow and water quality objectives for each catchment;
- introduction of water management charges for users on unregulated rivers and groundwater systems;
- some additional charges for users on regulated rivers to provide funds for water resource management and infrastructure improvements;
- appointment of an independent tribunal to recommend on water charges;
- setting up of an advisory council to the government with wide community representation to advise on water management.

In August 1997 the NSW Government endorsed further water reforms which consolidated and built on many of the earlier initiatives. The 1997 reforms focus on the following:

*Better balance in the sharing of water between the environment and water users to ensure long-term sustainability*

By 1998/99 environmental flow rules will be in operation on all the major regulated systems. Indicative rules for each valley have already been developed and these will be reviewed by local water management committees over the next year. The committees will also develop water management plans to set the basis for management decisions over the next five years.

While there has been sufficient research on the regulated rivers to develop specific environmental rules (in a number of systems various rules have been tested over the last few years), on the unregulated rivers and most groundwater systems much stricter licensing controls, and monitoring of flows and extractions are needed to provide the necessary background information and support systems to enable specific sharing arrangements to be developed and implemented. Therefore, on these systems, the first step will be to
determine those that are stressed and in need of urgent action or of high conservation value and therefore in need of protection.

Following the classification, as with the regulated systems, local water management committees will be established to develop river flow and groundwater management plans. These will specify the rules and license conditions to provide for the environmental needs and ensure long-term sustainability of these systems. These actions will be backed by licensing reforms to provide improved control over the volumes and timing of water diversions and the introduction of an embargo on new licences on the stressed and high conservation systems (if there is not already one). On the unstressed systems embargoes will be lifted allowing new development up to an established ceiling. Substantial additional resources will be committed for monitoring the quality and quantity of resources and impacts of the rules on the environmental health of the systems. Detailed socio-economic assessments of the impacts on individual farms, rural communities and the State economy are also to be undertaken. The methodology for these assessments is now being developed.

This process is to be further supported through the setting of clearly defined and publicly endorsed river flow and water quality objectives for each catchment. After some 18 months of research an inter-agency working group has now developed interim environmental objectives for each catchment and provided an indicative analysis of the costs of meeting these objectives. Over the next six months there will be a detailed public consultation process on these objectives.

**Creating investment confidence in the water industry**

NSW has recognised the importance of providing a period of resource security to water users to provide stability in the industry and the confidence for future investment. The river management plans will extend for a five year period fixing sharing arrangements for this time. On the regulated rivers, this will be further supported by a guarantee from the Government that the impact of the environmental rules will not exceed 10 per cent of the average long-term water available under the benchmark level of development. [The benchmark is the 1993/94 level of development as required under the Murray-Darling Basin cap.]

An important component of the water reforms will be freeing up of the water transfer market—the buying and selling of water. The rules on the regulated rivers, where water trading has been in operation for over a decade, will be reviewed to remove those that are unnecessarily restrictive. On the unregulated rivers and groundwater systems, water trading will be introduced once the management plans are in place. This will allow water to move to the most productive and highest value uses maximising the returns to rural economies. A computerised trading scheme is also being finalised to provide water users with up to date information on the water that is available for purchase.

Some $33.5 million of State and Commonwealth funding will be provided directly to water users over 5 years to help improve the efficiency with which water is used. This is an area where there is still room for improvement and much of the impacts of the environmental rules could be offset by increased water use efficiencies.

**Reshaping the role of communities and government in water management and water delivery**

The reforms will directly strengthen and increase public participation in water resource management decisions through the water management committees. The committees will be made up of representatives of water users, local government, catchment management committees, aboriginal, industry, environmental
and community interests and government agencies. Membership of the committees will vary to reflect the different make-up of communities in each valley.

A separate water business to take over the delivery of supplies to water users on regulated streams is being established. While it will remain within government, it will be run on commercial lines with specific financial and customer satisfaction targets being set.

The water licensing reforms will also streamline administration and reduce regulatory requirements. Rules will be specified in the management plans and the freeing up of water trading will reduce government’s role in decisions which are essentially about private investment. Through the classification process, resources will be concentrated where they are most needed — on those rivers and groundwater systems which are under stress.

2. Conclusion

The approach to the reforms is a staged one over the next five years. One of the most important aspects of the reform process is that it represents a whole of government approach to water management. All government departments ranging from those involved in environmental protection, fish management, agricultural and regional development and land and water management were involved in the development of the reforms and will be involved in their implementation and the auditing and monitoring of results. In addition the reforms have been supported by the commitment of some $117 million of State and national funds.
1. Water reform in Queensland, Australia — the water allocation and management planning process (WAMP)

To cater for the many competing uses of water the Queensland Government is accelerating the Water Allocation and Management Planning Process. WAMPs are being developed with significant community consultation to apply across a whole river or groundwater basin. WAMP Plans will deliver Queensland’s commitment to the Council of Australian Government’s (COAG) Water Reform Agenda and the Murray-Darling Basin’s Water Audit and Cap on water diversions. They will also fulfil statutory requirements of Queensland’s Environmental Protection Policy for water.

The Water Allocation and Management Planning or WAMP process as it is better known, is a consultative planning process designed to take into account scientific, environmental, social and economic considerations in determining the appropriate balance between water that can be withdrawn for urban, industrial or irrigation purposes and water that should be left to maintain the health of the river or groundwater system. The WAMP process is currently underway in the Fitzroy, Condamine-Balonne, Border Rivers, Logan and Barron River catchments. It is planned to start in the Burnett, Pioneer and Burdekin catchments over the next year. A completed WAMP will also provide the natural resource basis for establishing permanently tradable water property rights which is a policy commitment of this Government. The WAMP process and the establishment of tradable property rights represent a significant change in the way we allocate and manage water.

The eight river basins where WAMPs are currently under development cover 25 per cent of Queensland’s area and include most areas where property rights in water will be most applicable.

The Government’s recently released implementation plan for water infrastructure and development involving a commitment to allocate $1.0 billion over the next 15 years to water infrastructure development including water for agriculture, recognises the importance of the WAMP process. In response to the recommendations of a water infrastructure task force, additional funding will be made available by the Coalition Government to accelerate the development of WAMPs in catchments where development is under consideration as part of the infrastructure and development plan.

The Queensland Government has committed $13 million over 5 years to this initiative. There are currently 30 full time DNR and other contract staff plus 60 other personnel involved to some extent in the WAMP process now underway. Fifteen of the full time staff and consultants are currently working on the Fitzroy WAMP. The viability of new water infrastructure development and the protection of environmental values in the Fitzroy River are directly related to the manner in which various water allocation issues are addressed. These issues will in part be considered through the WAMP process.

Essentially the WAMP process in each area progresses through the following steps:

- The total water resources within a catchment will be defined;
- All existing entitlements within the catchment will be identified;
- environmental flow provisions will be determined;
- additional priority water requirements (for example, town water supplies) will be reserved;
- water resources (if any) for further allocation will be defined;
existing entitlements will be defined under the hydrologic model and, where appropriate, will become tradable within sections of the catchment; and

the rules for further allocation and management of water will be described and documented in a WAMP.

WAMPs will:

- give water users greater confidence in rights;
- establish tradable property rights in water;
- determine environmental flows and improve the health of river systems;
- increase community involvement and understanding of the management of our rivers and groundwater systems.

WAMPs will include:

- allocations for the environment;
- water available for future use and development;
- water to be reserved for future priorities.

The foundation for these planning studies is a basin wide computer based simulation of all the stream flows over the period of available record. These use a daily time interval which is replacing the older monthly time interval models. This means that we will have a computer model which will simulate all the stream flows in a river basin over what is usually an 80 to 100 year period of rainfall and runoff records.

These models can be used to show the impacts of a range of scenarios for addressing the balance between environmental and consumptive water needs.

The best available independent scientific advisers from Queensland and beyond are being used to provide information on the ecological impacts of various flow scenarios. Economic, social and indigenous aspects are also considered. The WAMP process is designed to provide opportunity for community input to address the balance between environmental needs and consumptive needs, based on all the information that has been gathered and modelled.

While it is costly in resources and a time intensive process, the WAMP process will be of benefit to everyone. For existing water users it will better define and secure their entitlements. All groups in the community will know that flows have been specifically set aside to meet the ecological needs of watercourses, wetlands and floodplains. For water needs beyond the limits of what can be allocated, a market in water will allow water entitlements to be purchased from existing entitlement holders.

Under the proposed Natural Resource Management Legislation a completed WAMP will become a statutory plan. However, until the legislation is enacted, WAMPs will be developed as interim policies rather than statutory plans that will be applied in decision-making on licence applications and management of flow events.

The Queensland Government is committed to sustainable development that will allow Queensland to develop its resources while at the same time ensuring that environmental and social values are identified and protected through a transparent planning process that allows for comprehensive community consultation.
ANNEX 3

1. Research into more efficient management of Australia’s water resources

Water resources often have many competing uses, including irrigation, hydroelectric generation, urban supply and environmental and recreational uses. In recognition of the increasing demands for water, Australian governments have introduced a range of water policy reforms which aim to facilitate sustainable use of water resources.

The common property nature of water in rivers and man made delivery systems presents many challenges in resource management, including issues surrounding definition of effective property rights to water and allocation of water for public goods such as in-stream requirements. Further, use of water resources can cause implications for other users, so a broader approach, such as considering these issues by catchment is important.

Pressures are increasing for water policy reforms, and there is a need for tools that are flexible enough to look at a range of policy options. Given that the nature of the economic problem is similar between catchments, there is an advantage in having a generic approach.

To objectively examine the resource use trade-offs inherent in this system requires a modelling approach cast in a system-wide context: integrating hydrological, biophysical and economic relationships. The Australian Bureau of Agricultural and Resource Economics (ABARE) has been developing a modelling system which represents the competing demands for water in the southern Murray-Darling Basin within Australia.

The modelling system was initially developed to consider the corporatisation of the Snowy Mountains Hydro-electric Authority and more specifically the implications to the profitability of the Scheme and irrigation industries downstream if environmental flows were introduced.

The system is an integrated set of hydrological and economic models. The hydrological model contains a detailed representation of the physical flow of water through the system. The model captures both the temporal and spatial variability inherent in river flows in the Basin. It thus enables investigation of the impact of critically low and high flow conditions over an extended time period.

The modelling system includes a replication of the current management of the dams by the irrigation and hydrological authorities. For the irrigation sector, management includes determination of an allocation to water supplies each irrigation season, given the seasonal conditions that prevail.

The economic component of the system is a model of the interaction of farmers and a market for irrigation water. Current ABARE research is focused on developing detailed farm level modules. Representations of major irrigation industries such as broadacre, dairy and perennial horticulture are being developed. To more effectively model the demand for water, these models include the integration of biophysical information such as the relevant agronomic information, rainfall variability and evapotranspiration rates. This allows for the variation in farmers willingness to pay for water, to be shown.

The modelling system is designed to investigate issues such as the way in which the water market can facilitate structural adjustment of broadacre farms. The market provides the opportunity to manage the variability in river flows between years by selling in dry years and increasing production in the
wetter years. The model can also consider the patterns of water trading, and the implications of water trading on the quantity of water available for environmental flows in particular reaches.

Other issues the model could be used to investigate are infrastructure renewal and refurbishment within irrigation districts and the implications of different environmental flow regimes on the profitability and viability of the irrigation industry.

Future developments which are currently being considered include incorporation of cotton industries and expanding the modelling system to other catchments within the Basin.

For more details, please contact Rhonda Treadwell on (61-2) 6272 2043.
GLOSSARY OF TERMS

ABARE
Australian Bureau of Agricultural and Resource Economics

ANZECC
Australia and New Zealand Environment and Conservation Council, comprised of Commonwealth and State/Territory Ministers with responsibilities for the Environment and Conservation

ARMCANZ
Agriculture and Resource Management Council of Australia and New Zealand, comprised of Commonwealth and State/Territory Ministers with responsibilities for Agriculture and Resource Management

COAG
Council of Australian Governments comprised of heads of Federal (Commonwealth of Australia) and State/Territory Governments

Jurisdictions
State and Territory Governments established under the Federation. They are New South Wales, Victoria, Queensland, Western Australia, South Australia, Tasmania, Northern Territory and the Australian Capital Territory.

MDB
Murray-Darling Basin, 1.06 million square kilometres in area covering large areas of the States of New South Wales and Victoria, and a small portion of South Australia and Queensland. (refer Attachment 1)

MDBC
Murray-Darling Basin Commission comprised of an independent President and Commissioners representing resource management and environmental management agencies of the MDB participating governments, Commonwealth, New South Wales, Victoria, South Australia and Queensland.

MDBMC
Murray-Darling Basin Ministerial Council comprised of Ministers holding land, water and environment portfolios from each participating government, Commonwealth, New South Wales, Victoria, South Australia and Queensland.

MDB Water Business
Commercial style entity to handle the River Murray water operations established under the Murray-Darling Basin Ministerial Council (MDBMC).

NWQMS
National Water Quality Management Strategy developed to provide a consistent national approach to water quality management. The 20 documents and guidelines which form the NWQMS are listed in the Bibliography.
Map of Australia showing States, Territories and Murray Darling Basin
AUSTRIA: WATER PROTECTION WITHIN THE AUSTRIAN AGRI-ENVIRONMENTAL PROGRAMME

by Thomas Rech, Ministry of Agriculture and Fisheries, Vienna

Summary

Since the beginning of the 90’s, Austria has taken important steps to reduce water pollution by agriculture, in particular by granting subsidies to farmers. The accession to the EU has intensified this type of approach. The “Environmental Programme for Austria” (ÖPUL) was introduced in 1995 on the basis of EC Regulation 2078/92. About 25 measures are aimed at soil, air and, in particular, water protection, within a programme based on voluntary participation.

A level of participation of 80 per cent was achieved. Some measures encourage farmers to farm according to methods particularly beneficial for the preservation of water quality. The three following criteria must be fulfilled: renouncing to, or reducing the application of fertiliser and plant protection products; complying with a maximum limit for livestock densities; and applying a crop rotation system with greencovering.

The main eligibility criteria for the ÖPUL are a combination of different measures. Only some parts of the programme are relevant to water quality in agriculture. These include: maximum of two livestock units per hectare of productive land; maintaining the share of grassland area; complying with the recommendations of the technical advisory board for land fertility and land protection; maintaining existing elements of the landscape; observance of organic farming methods in accordance with EC Regulation 2092/91 and national regulation concerning livestock keeping on organic farms; ban of application of easily soluble fertilisers; ban of application of synthetic pesticides in accordance with EC Regulation 2092/91; maximum of 75 per cent of cereals and maize; period of 3 months minimum between sowing of green cover and ploughing; planting of cereals, maize, soybean and sugarbeet by way of mulching and underseed in maize; conversion feeding on maize to natural grazing; conversion from maize to grassland.

1. Introduction

Nearly 50 per cent of drinking water demand in Austria is covered by groundwater. This is not a high percentage compared to other countries, but drinking water is mainly taken out of groundwater where the arable land is located. Conventional farming methods possibly endanger the groundwater as it pollutes it with nitrogen, phosphate and plant protection products.
Since the beginning of the 90s, Austria has been trying hard to take measures against this kind of pollution by granting appropriate subsidies. The accession to the EU has intensified these actions. The *Environmental Programme for Austria* (ÖPUL) was introduced in the year 1995 and is based on the Regulation 2078/92. About 25 policies make sure that soil, air and last but not least, water, are protected, corresponding to the possibilities of a programme with voluntary participation.

The amount of the premiums were chosen in a way that losses in yield, which result from respecting the eligibility criterias are not only compensated, but it includes an additional incentive. Consequently, a degree of participation of 80 per cent was able to be achieved. Certain policies consist of particular eligibility criterias which lead the farmers to farming methods which particularly protect water. These criterias are in particular those which determine:

- renouncing or reduction of the application of fertiliser and plant protection products;
- the maintaining of a maximum of livestock densities;
- a certain crop rotation with green-covering.

The following survey describes the *main* policies of the ÖPUL; only relevant parts of the programme are taken into consideration for this article.

2. **Basic subsidy**

*Eligibility criteria:*

- Max. 2.0 LU/ha productive land.
- Maintaining the share of grassland area.
- Complying with the recommendations of the technical advisory board for land fertility and land protection.
- Maintaining existing elements of the landscape.

*Comment:* Most of the farmers take part in this policy. Therefore, an intensification of agriculture — resulting in the accession to the EU was able to be prevented. Particularly the prevention of high livestock densities and maintaining of grassland area are policies with great influence on natural resources.

3. **Subsidies for farms which use organic farming methods**

*Eligibility criteria:*

Observance of organic farming methods in accordance with Regulation 2092/91 and the national regulation concerning the keeping of livestock on organic farms.
Comment: Organic farming takes particularly into account the intention of the Regulation 2078/92. In 1997, more than 19 000 Austrian holdings are organic farms. This means that approximately one out of ten farms in Austria is organic.

4. Limiting the application of fertiliser and pesticides

Eligibility criteria:

- ban of application of easily soluble fertilisers;
- ban of application of synthetic pesticides;

in accordance with Regulation 2092/91 (organic farming).

Comment: Farmers who apply to these policies are allowed to use only those fertilisers and pesticides which are authorised in organic farming. Therefore this policy is as successful in protecting water as organic farming methods.

5. Stabilisation of crop rotation

Eligibility criteria:

- Max. 75 per cent of cereals and maize.
- From the beginning of the sowing of the green-covering to ploughing, at least 3 months must pass.
- The covering must be planted before 1\textsuperscript{st} November and must not be ploughed up before 1\textsuperscript{st} December.
- Cereals and other with market organisation aids subsidised crops are not to be taken into account as green-covering.

To avoid fallowland without green-covering is the main rule of water protection. Also the prevention of too high shares of cereals and maize is an important policy to avoid water pollution with nitrates. 80 per cent of arable land is concerned by this policy. As a consequence this policy is a further relevant step towards water protection in areas with a high share of arable land.

6. Extensive cereal cropping

Eligibility criteria:

- Subsidies can be obtained for those varieties of wheat, rye, oats and barley.
- Plant protection: no application of plant growth inhibitors or fungicides.
Nitrogen:
- barley max. 50 kg/ha;
- wheat, rye max. 130 kg/ha;
- oats max. 80 kg/ha.
- records concerning the application of fertiliser, plant protection and seeds.

Comment: The use of specific varieties of cereals with a low potential of yield, facilitates the non-use of fungicides and a low degree of fertiliser input. 60 per cent of arable land is concerned by this policy and is therefore cultivated in a rather extensive kind of farming.

7. Protection from erosion on arable land

Eligibility criteria:
- planting of cereals, maize, soybean and sugarbeet by way of mulching and underseed in maize; or
- conversion from maize to fieldforage; or
- conversion from maize to grassland.

Comment: Due to special procedures of sowing or the ban of planting maize, the soil is always covered, and erosion and leaching of nitrogen into the water is avoided.
CANADA: WATER USE AND WATER QUALITY IN AGRICULTURE: CANADA’S NATIONAL POLICIES

by Brad Fairley, Head, Water Quality, Prairie Farm Rehabilitation Administration, Agriculture and Agri-Food Canada, Regina, Saskatchewan

Summary

Since the formulation of Canada’s Federal Water Policy ten years ago, water is becoming an increasingly important environmental issue, particularly as it relates to the agriculture and agri-food sector. The federal and provincial governments implement the policy through a number of short term programmes and, to a lesser extent, permanent programmes, which are intended to improve the sector’s environmental performance and reduce its impact on water resources.

These programmes are primarily based on voluntary approaches relying on information and incentives. In a few cases, they also include a number of economic instruments and more stringent regulations. Together, these initiatives have led to significant improvements in the efficiency of water use and reductions on the impact of agriculture on water.

A number of changes are occurring inside and outside the agriculture sector which will affect the way Canada’s agriculture sector addresses environmental issues in the future. These changes include significant increases in agricultural production and processing; opportunities for Green Marketing; increasing public pressure on the sector to reduce its impact on water resources; and, decreased levels of funding for government programmes.

Given the effectiveness of previous programmes and the agriculture sector’s proactive stance, the Committee in charge of updating the Federal Water Policy has concluded that no major changes to the policy statements related to agriculture are required. It is clear, however, that government and the sector must modify their approach if they are to continue to effectively implement the policy in the future. While voluntarism will continue to play a role, insufficient funding precludes incentive-based programmes. The sector must expand the application of economic-based instruments which can be sustained over the long term without generous government funding. This fact has been recognised and progress is being made on developing some new economic-based instruments.
1. **Introduction**

Canada has an area of just less than 10 M km$^2$. Approximately 7 per cent, 68 M ha of this is agricultural land — crop and pasture (see Map 1). There are 112 000 farms with an average area of 220 hectares. But size varies from an average of 320 ha on the prairies to about 50 ha in the Maritime provinces. Crops range from fruits and vegetables in the more humid coastal and southern portions of the country to grains, oilseeds and pasture in the more arid central prairie regions of the country. Of the cropped acreage, approximately 850 000 ha is irrigated (Statistics Canada, 1997).

![Map 1. The agricultural regions of Canada](image)

The production of livestock represents a significant portion of agricultural activity in Canada. Livestock numbers include 15 million head of cattle with about 80 per cent of those being beef, 11 million hogs and about one million sheep. While traditional livestock dominate, there is a significant move to diversify through the game farming involving species like emu, fallow deer and bison.

Agriculture represents an important part of the Canadian economy. Primary agriculture is worth C$14 billion with processing adding another C$16 billion. Of this C$30 billion, approximately C$17 billion is obtained through exports (Agriculture and Agri-Food Canada, 1997a). While it represents
only 4 per cent of the GDP, agriculture is important because Canada has long viewed itself as a country which helps feed the world.

The federal and provincial governments have a shared role in managing agriculture. While the Federal Department of Agriculture’s interest is primarily related to research, food safety and exports, the Prairie Farm Rehabilitation Administration, a Branch of the federal department, maintains a hands-on approach by working with individual farmers in addressing particular environmental issues. With the federal government transferring ownership of resources to the provinces in the Resource Transfer Act of 1930, the provincial departments of agriculture tend to focus on regulation of the industry as it relates to the management of primary resources such as land and water.

While there appears to be very different roles for the two levels of government, agriculture is very much a shared responsibility, particularly as it relates to environmental issues. Both levels of government see themselves as a partner with the agriculture sector. This partnership approach between both levels of government and the sector in addressing environmental issues is discussed further in Section 3.

2. Policy issues and objectives

In the last decade, water has taken on increasing importance as an environmental issue within Canada. This is demonstrated by a number of policy initiatives which identify water-related issues and articulate strategies to address them.

Canada’s Federal Water Policy (Environment Canada, 1987) is designed to address all issues related to water — everything from water export to drinking water safety. The overall objective of the Policy is to “encourage the use of freshwater in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations.”

The Federal Water Policy is being implemented through five specific strategies: water pricing; science leadership; integrated planning; legislation; and, public awareness. The document provides specific policy statements which are to be used in applying the five strategies. Many of the policy statements are relevant to the relationship between agriculture and water. For example, there is a policy statement related to water use in irrigation which is intended to encourage more efficient use of water by the irrigation sector. Agriculture is addressed indirectly through additional policy statements related to water quality management, groundwater contamination, wetlands preservation, fish habitat management and drought.

This Federal Water Policy has been followed by several more specific policies which focus more directly on water and agriculture. A 1990 Report to the Ministers of Agriculture (Federal-Provincial Agriculture Committee on Environmental Sustainability, 1990) highlighted eight current and emerging issues for the agriculture, including water quantity and water quality, and provided a framework for action.

The National Environment Strategy for Agriculture and Agri-Food (Agriculture and Agri-Food Canada, 1995a) was developed to help the sector address existing and emerging environmental issues. It was endorsed by the Federal and Provincial Ministers of Agriculture in August of 1995 and articulates the following goal with respect to water: “Minimize the negative effects of the agriculture and agri-food sector on water quality and increase water use efficiency.”

Most recently the Federal Department of Agriculture and Agri-Food and several provincial departments have released documents to address environmental issues within their jurisdictions (e.g. Agriculture and
Agri-Food Canada, 1997b). Without exception, these documents highlight water as an area of increasing concern and articulate strategies to deal with different aspects of the issue.

The water use issue is generally related to the amount of water used in irrigation and increasing competition for water. On a national scale, agriculture withdraws a relatively small amount of water when compared with other sectors. In addition, its rate of growth in considerably lower than for other users. However, unlike other sectors, agriculture consumes most of the water it withdraws. This high rate of consumption is becoming an issue in the prairies, particularly as our understanding of instream uses increases. Irrigation water use is also becoming an issue in areas where irrigation relies on groundwater (e.g. Manitoba, Prince Edward Island).

The quality issues revolve around the impacts of agriculture on surface and groundwater. These are primarily related to the impacts of agricultural inputs (e.g. fertilizers, pesticides) and by-products (e.g. manure, irrigation return flows) on water quality. As with water use, the issues related to water quality vary from region to region. For example, a review of existing literature for the prairies shows no clear evidence of widespread contamination of surface or groundwater from agricultural activities (Harker et al., 1997). There are, however, some site-specific problems related to pesticides leaching to groundwater under irrigation and contamination of surface water from feedlot runoff. There are also problems in other regions. For example, aquifers underlying agricultural land in south coastal British Columbia often contain nitrate levels above the guidelines (Reynolds et al., 1995). In Ontario, a survey of 1 300 farm wells in the main agricultural regions of the province found that 36 per cent contained bacteria or nitrate levels exceeding Ontario Drinking Water Quality Objectives (Goss and Fleming, 1993). Similar problems with wells were found in most of the eastern provinces. Monitoring of several rivers located in intensive corn-producing areas of Québec revealed pesticide concentrations that sometimes exceeded objectives (Berryman et Giroux, 1994).

The policies outlined above were implemented through a series of programs aimed at these water quantity and water quality issues. Because of the shared nature of the management of the agriculture sector, the programs have been largely joint federal-provincial initiatives with both levels of government sharing in the funding, administration and delivery of the programs. These programs have included the following: National Soil Conservation Program; the Environmental Sustainability Initiative; and, the Agriculture Component of Canada’s Green Plan. Through each one of these successive programs, water has taken on increasing importance and received an increasing share of the funding of these broad-based programs. Water quality is to be the primary focus of the new National Soil and Water Conservation Program to be launched in early 1998.

These programs have been implemented using a wide range of approaches and instruments. Some of the various policy measures are discussed in Section 3.

3. Policy measures and approaches

There are a couple of major factors that help shape Canada’s approach to environmental issues as they relate to agriculture.

The public believes that agriculture has far less of an impact on the environment than other industries (Advisory Group, 1994). Coupled with the public’s view that agriculture is an important part of the economy and that it represents a lifestyle which merits protection, there has been little public pressure for an aggressive approach to agriculture as it relates to environmental issues.
Because agriculture is a shared jurisdiction, there has been generally a joint federal-provincial approach to environmental issues. In most cases, this means that the federal and provincial governments have pooled financial resources to create large sums of money for fairly generous environmental programs. With government viewing itself as a partner with the sector, it has preferred to rely on incentive-based programs and used regulatory approaches only as a last resort.

These factors have produced an array of policy approaches based largely on voluntary action supported by information, moral suasion and incentives. More aggressive approaches based on economic instruments and regulation are being used in some circumstances but have not received widespread application. Some of the different policy measures and approaches used to deal with water quality and quantity issues are discussed below.

**Water use**

The prairies are the most arid region of the country and account for 75 per cent of all irrigated land in Canada. Thus, the issues associated with water use are most intense in this region of the country.

In keeping the strategy of science leadership, the federal and provincial governments maintain research and demonstration facilities in the three prairie provinces. While quite broad in their focus, these facilities dedicate considerable resources to research and demonstration of equipment and technologies for improving irrigation efficiency. Over the last few years they have helped facilitate the uptake of more efficient approaches to irrigation including: Low Energy Precision Application (LEPA) techniques, scheduling, trickle, and effluent irrigation. It is, however, very difficult to establish the effectiveness of particular initiatives in changing rates of uptake or adoption.

Incentives have also played a role in addressing water use issues. Under the Canada-Saskatchewan Partnership Agreement on Water Based Economic Development, there has been a program in place to encourage the conversion of flood irrigation to more water efficient sprinkler type of irrigation. This agreement has helped accelerate the shift by providing financial incentives. Under the program producers receive funding for up to 35 per cent of the capital cost up to a maximum of C$20,000 per project. To date, the program has led to the conversion of 630 hectares with another 650 hectares planned for this winter. This program has accelerated an existing movement from flood to sprinkler irrigation.

The Government of Alberta established a program in 1980 to subsidize the rehabilitation of the infrastructure supporting the irrigation projects in southern Alberta. As a result, more than 1,000 km of canals were refurbished and, in many cases, lined. While the program has increased efficiency by about 20 per cent (Brown, 1997), it has created some controversy. In many areas, leaking canals had created wetlands that had become valuable wildlife habitat. Immediately after improvements to a particular canal, adjacent wetlands began to disappear. In response to public pressure to protect the wetlands, water is now being diverted from the irrigation canals to help maintain these wetlands.

Changes to the price charged for water have also played a major role in dealing with water use issues. Agriculture and Agri-Food Canada currently operates and maintains six irrigation projects and 22 major storage reservoirs which serve 18,000 hectares of irrigated land in south-western Saskatchewan. In keeping with the policy of making producers pay more of the true cost of water services, significant changes to the water service rates were implemented in the late 1980’s. By the time the new rate structure is fully implemented in the year 2000, the price for water will have increased almost 300 per cent (from C$11.1/ha to C$30.90/ha) with the irrigators paying approximately 60 per cent of the operating and maintenance costs. While the actual amount charged may seem low, it is important to note that irrigators
are only guaranteed 70 per cent of their allocation. It is assumed that the price increase will encourage more efficient water use by the individual irrigators. The rates will be reviewed again in the year 2000.

The price increases in south-western Saskatchewan are reflective of increases for irrigation water throughout western Canada. The Irrigation Districts in southern Alberta have increased prices an average of 50 per cent (from C$17/ha to C$25/ha) over the last 10 years (Alberta Agriculture, Food and Rural Development, 1997). While these prices cover the cost of day-to-day operation and maintenance, the provincial government still subsidizes the cost of major rehabilitation projects (e.g. the refurbishment of canals, drop structures, dams and spillways) based on calculations showing that the taxpayers of the province benefit from the irrigation projects. The provincial government did, however, reduce the amount of money annually available for rehabilitation and reduced the subsidy from 83 per cent to 75 per cent of capital costs (Alberta Agriculture, Food and Rural Development, 1995).

The Federal Water Policy also advocates the use of legislation to address water resource management issues. Although used infrequently, legislation has been used to address water use issues as they relate to agriculture. In response to increasing demand on the water resources of the South Saskatchewan River Basin, a recent drought and the growing concern related to the impact of irrigation withdrawals on instream uses, the Alberta Government placed regulations on water allocations for irrigation in 1991 (Government of Alberta, 1991). The regulations were intended to provide time for the government to examine the situation more closely. Unfortunately, by focusing on the area irrigated the regulations did little to encourage more efficient use. The regulations are up for review in the year 2000 and the Districts are hopeful that any future regulations will encourage more innovative solutions to the problem of limited water resources.

Water quality

Most of the major national environmental programs outlined above also had components aimed at water quality issues. They generally focused on increasing the education and awareness of producers in order to encourage them to voluntarily improve their practices. The programs routinely sponsored demonstrations sites which show how to reduce the impact of agricultural activities and highlight the economic and environmental benefits of improved water quality. For example, there were numerous demonstrations, tours and field days showing producers how to: properly fence waterways and water cattle away from watercourses; reduce the risk of erosion through grassed waterways; and, manage their well to avoid groundwater contamination. Demonstration projects were often followed by incentives to encourage widespread adoption of these practices.

In addition to these more traditional voluntary approaches, there have been some more innovative initiatives where the beneficiaries helped pay the cost of improved environmental performance of the agriculture sector. For example, Edmonton, a city of some 600 000 people located on the North Saskatchewan River, has had ongoing problems with colour, taste and odour in their municipal drinking water during spring runoff. After several years of study, they concluded that most of the problems originated with livestock operations on upstream tributaries. In conjunction with the Alberta Cattle Commission, the City has funded a series of open houses over the last few years to explain the problem to local producers and show them how to reduce the amount of spring runoff flowing directly into the waterways (Gammie, 1995). The program has been very successful. Despite particularly high runoff in the spring of 1997, the City has reduced problems with taste and odour in their drinking water without implementing costly modifications to their treatment system (Reid, 1997).
The Grimshaw Aquifer, which is located in the Peace River area of Alberta, supplies water to a number of communities and rural residents. The aquifer is shallow and unconfined and, thus, at risk of contamination from surface activities, particularly the use of agricultural chemicals in combination with irrigation. To date, the aquifer shows no signs of contamination, but in order to protect their water supply and avoid possible future problems the local residents decided to develop an aquifer management plan. With assistance from the federal and provincial governments, the residents mapped the aquifer, established codes of practice for the overlying agricultural lands and raised the awareness of all residents regarding the vulnerability of their water supply and the need to protect it (Earth Sciences Division, 1997). The development of the Grimshaw Aquifer Management Plan in an excellent example of the type of integrated planning recommended by the Federal Water Policy.

There have been a number of initiatives associated with making producers assume more of the cost associated with pesticide use. The federal government recently consolidated responsibility for the registration of new pesticides within a new agency, the Pest Management Regulatory Agency. This agency now charges industry for the costs of the registration review process — approximately C$18 million per year. With the costs passed on to the producer and ultimately the consumer, it is assumed that this will encourage more appropriate use of pesticides. Industry has also undertaken initiatives to reduce the risk associated with pesticide use by more accurately reflecting the cost of environmental protection in their products. The Crop Protection Institute developed the Container Management Program which includes an aggressive recycling program aimed at ensuring proper handling of used pesticide containers. This program is funded by a charge on each container.

The municipal tax system has long been viewed as a possible tool for encouraging specific behaviour by producers. Several rural municipalities in western Canada have offered rebates for land owners that implement environmental practices on their land. Qualifying farmers receive a declining tax credit over the term of the project. For example, a grassed waterway will earn a credit of 20 per cent the first year, declining to 15 per cent, 10 per cent and finally 5 per cent the fourth year. While most of the rebates are aimed at soil conservation activities, they also provide secondary benefits for water quality and could be designed specifically for water quality objectives. Although most of the municipalities initiated the tax incentive programs with funding assistance from Green Plan, most have continued them after the additional funding ceased and a few have launched the such programs with no outside financial support. The cost to the municipality varies but the Rural Municipality of Huron budgeted C$36 000 for a four-year program with the costs covered through increases in the average tax rate. Between 100 and 200 quarter sections of land may qualify for tax.

Changing approaches

The above examples demonstrate the range of approaches that Canada has used to address environmental, particularly water resource, issues as they relate to the agriculture and agri-food sector. Despite the range of instruments used, Canada has overwhelmingly relied on voluntary programs based on information and incentives to encourage improved environmental performance within the agriculture sector. Approaches based on regulation or economic instruments have been used on a limited basis and have received mixed reviews by both producers and government. It is worth noting that some of the dissatisfaction stems from limited experience and, in some cases, poorly conceived applications. Despite some dissatisfaction with these newer approaches, there are a number of factors which are leading to more widespread application. The forces driving these changes are discussed in Section 6.
4. **Budgetary and economic costs**

Canada has utilized a variety of funding sources to address environmental issues. The vast majority of spending on environmental issues related to agriculture has come through federal-provincial agreements. The two largest programs were the National Soil Conservation Program (NSCP) and the Agriculture Component of Canada’s Green Plan. Including provincial contributions, NSCP provided C$150 million while Green Plan provided C$200 million.

While it is impossible to identify the precise amounts spent on water-related issues under these broad environmental programs, it is clear that the percentage of money devoted to water-related issues has increased. For example, spending on water-related issues increased from 20 per cent of the money available under the National Soil Conservation Program (1989-1993) to about 35 per cent of the money available under the Agriculture Component of Green Plan (1993-1997).

It should be noted that most of these environmental programs require producer participation. That is, the producer must share the cost of a particular project (dollars or in-kind support) to the extent that he/she benefits. It is estimated that the producers would have provided additional resources in the form of cash or in-kind support amounting to an additional 20 per cent of the program value. So the programs have been successful in leveraging some additional resources.

While short-term programs have been the primary way that government has dealt the environmental issues confronting the agriculture and agri-food sector, they have devoted some permanent programming dollars to environmental issues. For example, during the 1990’s the federal and provincial departments of agriculture have spent an additional C$6 million and C$3 million annually on water quality and water quantity issues, respectively (Federal-Provincial Task Team on Sustainable Development, 1996).

5. **Effects of policy measures and approaches**

Producers operate in a changing world: they are constantly bombarded with new information; public perceptions change; and, government programs come and go. Thus, it is extremely difficult to determine the effects of specific policy measures. The effects of the policy measures discussed in the previous sections were outlined in those sections. This section outlines some of the progress being made by Canada’s agriculture and agri-food sectors in the dealing with the water quantity and water quality issues that it confronts.

With the exception of some indicators of related to soil management, quantitative information regarding progress in environmental issues is limited. Changes in farm practices serve as a proxy where environmental monitoring information is limited or incomplete. Some of the farm practices for which data exist are related to water quality.

As follow-up to the Federal Water Policy released in 1987, the government prepared a progress report in 1990 (Interdepartmental Committee on Water, 1990). The report highlights some of the achievements related to the policy statements in the original document. This progress report, along with some other more recent publications, demonstrate some of the progress made on water issues. Some highlights related to agriculture are presented in the following Figures 1, 2 and 3.
Figure 1. Water intake for agriculture in Canada, 1972-1996

![Water intake for agriculture in Canada](image1)

Figure 2. Farm area treated with pesticides in Canada, 1971-1996

![Farm area treated with pesticides in Canada](image2)
There are also some interesting data for some of the provinces (Federal Provincial Task Team on Sustainable Development, 1996):

- In the B.C.’s Fraser Valley the percentage of dairy farms which are able to store in excess of four months of manure production has increased from 43 to 64 per cent.

- Since 1991, there has been a 29 per cent increase in the number of farmers adopting Best Management Practices in British Columbia.

- Alberta has shown a 30 per cent decrease in summerfallow from 1989 to 1995.

- Saskatchewan has put in place programs for recycling used oil and tires.

- In Manitoba, 80 per cent of pesticide containers are now recovered.

- More than 50 per cent of producers in Ontario have prepared farm management plans to improve environmental performance.

- Since 1991, the number of producers in Québec using grassed waterways has increased five fold.
Since 1984, there has been a 126 per cent increase in land area with erosion control practices in New Brunswick.

Prince Edward Island has seen a 200 per cent increase in land area with cover crops.

In Newfoundland, approximately 45 per cent of farms have been mapped to improve soil and water management.

While it is possible to document changes in farm practices, it is very difficult to assess the overall effects on the environment. That is, are the changes in practices being made by producers producing a significant improvement in the water resources? Continued cuts in environmental monitoring programs make this question even more vexing.

It might be tempting to assume that simply counting changes in farming practices may be enough, but it clearly is not. It is important to demonstrate to producers that the changes they are making are producing measurable benefits to society. It is equally important that society know the extent to which agriculture is or is not responsible for environmental degradation and if the sector is improving its environmental performance. Without this information it will become increasingly difficult to recruit the sector to help address the issues. Thus it is vital that Canada completes its work on agri-environmental indicators.

6. Future developments

A number of changes are occurring inside and outside the agriculture and agri-food sector which will have a profound impact on how Canada approaches environmental, including water resources, issues.

Both the federal and provincial governments have set targets for growth within the agriculture and agri-food sector. For example, in 1993 the federal and provincial governments agreed to increase agri-food exports by 50 per cent — from about C$13 billion in 1993 to about C$20 billion in the year 2000 (Goodale, 1994). These country-wide targets have translated into more specific provincial targets. For example, the Province of Manitoba, has targeted a 100 per cent increase in hog production to eight million animals by the year 2000. These targets along with the demise of the Crow benefit, which subsidized the movement of grain to the coast for export, are bound to lead to dramatic increases in production and value-added processing in rural areas. These increases will create new or exacerbate existing environmental issues. For example, there is little doubt that increased production and processing have the potential to create problems with manure management and the effective disposal of processing waste, particularly in areas which lack the necessary infrastructure.

The agriculture sector is undergoing dramatic changes. Depressed land prices in the 1980’s and early 1990’s delayed the natural transfer of land to younger generations. With land prices increasing, this transfer is now taking place very quickly with a corresponding increase in farm size. This consolidation of land in the hands of younger producers will have a number of secondary benefits for the environment. In general, the younger producers are more willing to adopt new strategies and invest in new equipment (Prairie Research Associates, 1990). Many of these investments (e.g. LEPA irrigation techniques, zero-till, off-site watering, manure handling facilities) can significantly reduce the impacts of agriculture on water resources. Thus, the changes in demographics within the agriculture sector are likely to improve its environmental performance and allow voluntary approaches to continue to play a role in the future.

There is a growing worldwide demand for environmentally friendly products, including agricultural products. The agriculture sector sometimes uses Canada’s image as relatively clean and pollution free
place as a way of marketing its goods. There is, however, increasing interest in taking a more systematic approach to environmental marketing. Agriculture and Agri-food Canada (1995b) prepared a report which provided an inter-country comparison of the environmental impact of different production systems as a way of stimulating discussions within the sector regarding opportunities for green marketing. Most recently, a publication by the Saskatchewan Wheat Pool (1997) has stimulated discussions with the agriculture sector regarding the possibility of adopting environmental management systems (e.g. ISO 14000) that may be suitable for certification. Such certification might provide some unique marketing opportunities and, thus, incentive for producers to improve their environmental performance.

Regardless of the actual impact of agriculture on the environment, there is no doubt that the agriculture and agri-food sector will come under increasing pressure to improve its environmental performance. This pressure will come from several sources. An increasingly well informed and concerned public will expect improvements in the quality of its food and the environment from which it comes. There is little doubt that new research studies will provide more information on the precise nature and extent of environmental impacts of agriculture. Last, it is clear that the sector is becoming increasingly aware and concerned about the public’s perception of its impacts on the environment. While they are keen to reduce misunderstandings, it is clear that the sector is intent on improving performance where improvement is warranted. The sector has become much more proactive on environmental issues in the last few years and recognizes that it needs to address both perception issues and real performance issues.

During the last five years federal and provincial governments have been trying to eliminate their deficits and get debt under control. This has led to a steady decline in funding of environmental programs to the point where there is very little support (Figure 4).

**Figure 4. Annual agreement spending 1988/89 to 1997/98**

The federal speech from the throne delivered on 23 September 1997 promised a balanced federal budget no later than fiscal year 1998-99 (Government of Canada, 1997). Similarly, most of the provinces will
have balanced budgets in the same time frame. However, it is unlikely that either level of government will begin new well funded incentive-based environmental programs in the foreseeable future. In response to the throne speech, the Federal Minister of Agriculture stated “there will be no big spending” (Vanclief, 1997). With no new source of funding, it is clear that government agencies and the sector will have to look for new approaches to address environmental issues.

The federal government endorsed program evaluation in the 1980’s and has since required midterm and final evaluations on most short-term programs and periodic reviews (e.g. five year interval for permanent programs). Subsequent evaluations of the environmental programs by Agriculture and Agri-food Canada, have provided some interesting information. While not conclusive, several program evaluations (e.g. Prairie Research Associates, 1992; Advisory Group, 1995) have raised questions regarding the long-term effectiveness of incentive-based programs. There is some evidence that producers abandon the environmental practice as soon as the incentives cease. These questions of effectiveness are encouraging the consideration of different approaches.

Taken together, the changes inside and outside the sector will no doubt lead to new and different approaches. Agriculture and Agri-Food Canada has recognized a need to develop new approaches. The Task Force on Economic Instruments and Disincentives to Sound Environmental Practices (1994) examined the possibility of using cross compliance instruments within agriculture. The task force recommended that the feasibility of using cross compliance as an acceptable mechanism to foster environmental stewardship in agriculture be further explored by all stakeholders. Recently Agriculture and Agri-Food Canada examined alternative policy measures in more detail. It commissioned a study in 1996 which examined the potential application of economic instruments to address environmental problems in Canadian agriculture. While somewhat theoretical, the report concludes that no one instrument is suitable for all situations but that they hold great promise (Weerslink and Livernois, 1996). More recently, Agriculture and Agri-Food Canada has contracted a study to look at specific examples within OECD countries to determine if there are similar opportunities within Canadian programming.

7. Bibliography


FRANCE: PARTNERSHIP BETWEEN THE AGRICULTURAL COMMUNITY AND THE BASIN’S AGENCIES (ADOUR—GARONNE)

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Summary

In the Adour-Garonne Basin, in the south-west of France, agriculture represents a growing share of the region’s general economy. This has affected the quality and the quantity of water in a Basin well provided with water, but where levels are extremely low from the end of spring onwards. Thirty per cent of the Basin area is considered as sensitive with regard to pollution by nitrates and eutrophication of rivers. Similarly, water drawn for irrigation “creates a deficit” of 300 million m$^3$ to the hydrological balance.

Although representatives of the agricultural community have been associated with the work of the Basin’s Agencies since their creation, it is only very recently that they have become aware of the need to be more proactive within these bodies in order to contribute to water conservation and protection.

The master plan for water development and management (SDAGE) recently implemented by the Adour-Garonne Basin Committee prescribes several measures to correct the adverse effects of agricultural practices on water. The SDAGE has paved the way for a framework agreement with farmers. The framework agreement stipulates both taxes and financial aids involved in a contractual partnership for the next 5 years (1997-2001).

The “drawing” tax, applies to all hectares irrigated over and above a threshold of 5 000 m$^3$/year. The rate of the tax remains unchanged for 5 years if the volumes drawn are metered, but rates increase each year if based on an initial flat fee calculated in accordance with a formula provided in the framework agreement. Two rates have been introduced: a basic rate for undergroundwater, hill lakes, and rivers which are not refilled artificially, and a higher rate for artificially refilled water courses. The “pollution” tax will be implemented where livestock farmers do not respect a schedule for the standardisation of waste water.

To supplement farmers’ financial contribution, the Water Agency is contributing FF 235 million (US$40 million) for the 5 years, towards total project costs, estimated at FF 745 million (US$128 million) (excluding the creation of new reserves). The aid programmes are wide-ranging and include: i) the relaunching of the water resources development programme; ii) the increased participation of farmers in collective management of the water resources, together with encouragement to measure the use (meters), save (irrigation in particular), and protect water; iii) the involvement of farmers in the planning and maintenance of river flow; iv) the setting up and monitoring of a programme of pollution reduction based on improved cultivation practices and the control of farm and wine cellar pollution; v) the
implementation of the programme to eliminate mud through agriculture; vi) the recuperation and treatment of toxic agricultural waste; and vii) information programmes.

Through its system of differentiated taxes, the Agency is emphasising the obligation to meter water used for irrigation and the resulting savings in water use. The higher charges for refilled rivers justify the use of public funds to restore water levels adversely affected by farming practices.

Through its expanded aid programme, the Agency is demonstrating its concern for all aspects of farming and thus most of the Basin’s 200 000 farms are involved. The adherence of agricultural representatives to this framework agreement should not hide the reservations and hesitations of certain farmers that the Agency must endeavour to overcome through appropriate communications strategies.

1. Introduction

The Adour-Garonne river basin covers the south-western quarter of France. Two mountain ranges, the Pyrenees and the Massif Central sustain the source of the main rivers. The Garonne, the Dordogne, the Charente and the Adour rivers all flow into the Atlantic Ocean.

It is a first-rate agricultural region, with an Agricultural Area in Use of 5 million hectares, or 45 per cent of the river basin area.

Bordeaux wines, Cognac and livestock, in particular ducks and geese, are some of its best known products; cereal production covers 2 million hectares, with maize cultivation accounting for half this area (40 per cent of French production).

Agricultural activity is playing an increasingly important role in the region’s economy; in 1992, FF 40 billion of its output was exported out of an estimated total of FF 140 billion. The growing share of the agri-food industry in the river basin’s total industrial output, which has risen from 30 to 40 per cent over the past ten years (measured in terms of the amount of environmental pollution generated), also reflects agriculture’s increasing impact on the overall economy of the basin.

Agriculture in its varied forms which shapes the landscapes of south-west France, consequently plays a key role in regional development; this naturally has an impact on water quality and resources in a region that is well endowed with rivers and streams but which, because of its climatic characteristics (an average annual rainfall of 600 to 700 mm), suffers from serious problems of low water by the end of spring.

2. Assessment of the aquatic environment in the river basin

As regards water quality, despite recent progress, large areas are still affected by nitrate pollution and eutrophication in predominantly agricultural regions such as Charente, Adour, the valley of the Garonne or the rivers of Gascogne.

These sensitive areas cover roughly 30 per cent of the overall river basin. However, operations promoting rational use of nitrogen fertilisers (Fertimieux) are currently only being conducted in 10 per cent of these areas (370 000 ha, 9 000 farmers).

Because of the large number of animal farms, with total livestock of 3.2 million cattle, 1.3 million pigs and 26 million fowl, there is also a problem of managing liquid manure (through storage or spreading).
Nevertheless, this livestock only accounts for 10 per cent of the pollution generated by animal farms throughout France. Some 6 000 to 7 000 farms in the river basin are concerned.

As regards water quantity, the very rapidly expanding use of irrigation (which has increased at an annual average rate of more than 5 per cent over the past 10 years) has a serious impact on the naturally severe low water levels (the five-year average low water flow is equal to 15 to 18 per cent of the overall average flow of the main rivers).

To address this situation, the Water Agency proposed a specific programme to create new resources so that rivers with insufficient water would receive at least the amount of water withdrawn for irrigation during the low water period.

Under the Water Resources Development Programme (PDRE) 100 million m$^3$ of additional reserves were already constituted between 1992 and 1996, but another 300 million m$^3$ of reserves would be necessary to achieve a balance between abstractions and natural flows. The Water Agency intends to create these new reserves by building new storage facilities or by signing water withdrawal agreements with owners of existing reserves (for example, with Electricité de France) in order to maintain flows during low water periods; naturally, these investment projects are combined with programmes aimed at saving water in irrigation and ensuring the controlled management of a limited resource.

Today, out of the region’s 200 000 farmers, 35 000 irrigate a total of 600 000 ha. The amount of water withdrawn for irrigation has increased by approximately 10 per cent over the past 6 years and now exceeds 800 million m$^3$. Irrigation accounts for approximately 80 per cent of the water consumed during the summer.

In addition, except for farms belonging to irrigators’ associations, most individual farms do not have metering systems to determine the amount of water used. The agency estimates that some 15 000 meters would have to be installed for economic and rational use of irrigation water to become a reality.

3. Slowly developing partnership

In 1996, an agreement was reached with farmers providing for a complete and coherent programme. This concluded a process of gradually involving farmers in river basin bodies.

Although the farming sector has been represented in the River Basin Committee since it was established in 1970 (moreover, its representatives have regularly served as vice-chairman), in the early years its participation was more symbolic than real.

The first charges for withdrawals of irrigation water could not be introduced until 1978, owing to considerable misgivings and reluctance on the part of some departmental chambers of agriculture.

Some farmers are still opposed to these charges today.

In return for this charge, the Water Agency subsidised approximately 15 per cent of the cost of hill impoundment ponds (ranging from 20 000 to 1 000 000 m$^3$) designed to satisfy the irrigation needs of one or more farms.
This situation, which was marginal but detrimental to farmers’ interests and which seriously hindered complete equity among users, continued until 1996, despite some progress and growing awareness, as reflected by the following:

- the importance of agriculture in concerted water management, which regularly became clear during times of drought;
- the recognised impact of agricultural practices on water quality;
- European directives on agricultural pollution (protection against nitrate pollution, for example);
- and, lastly, the foreseeable challenges for the sustainable development of agriculture, which called for more active and more responsible participation of farmers in river basin bodies.

In 1995, pursuant to the new Water Act of 1992, the River Basin Committee prepared a Water Development and Management Master Plan (SDAGE), which promotes more responsible agriculture within the economy of the river basin.

This Master Plan recommends a number of measures regarding agricultural practices:

- prevention of nitrate pollution of agricultural origin (Measure B17);
- reducing the risks of diffuse pollution through advice to farmers (Measure B18);
- aid to enable farmers to bring livestock buildings into compliance with environmental standards (Measure B19);
- authorisation of new withdrawal equipment only if the biological flow of rivers is respected (Measure C2);
- plans for the management of low water across large hydrographic units (Measure C5);
- development of new resources that are not harmful to the aquatic environment (Measure C6-8);
- development of new metering systems (Measure C24);
- incentives to save irrigation water through technical assistance and financial aid (Measure C26);
- funding by government partners more in line with the priorities of the Master Plan (Measure F13).

The Master Plan was prepared with the approval and assistance of the relevant government departments, and its legitimacy is derived from very broad consultation with all concerned before it was adopted; it has led to an in-depth reassessment of farmers’ involvement in the responsible management of the water resources of the river basin.
In fact, the Master Plan was prepared concurrently with a contractual programme of partnerships with professional agricultural organisations, which meant the River Basin Committee was able to launch both initiatives during the same year.

4. The framework agreement signed with professional agricultural organisations

This agreement lays down concrete provisions based on Master Plan guidelines using specific water agency procedures in the following fields:

- the irrigation charge collected by the Agency, pollution charges for livestock being covered by national legislation;
- the action of the Agency and the aid it can provide to farmers.

Contractualisation of the Agency’s programmes in the agricultural field

This aid is part of the Agency’s VIIth programme, which lays down the procedures applicable to regional and local authorities, manufacturers and farmers for the next five years (1997-2001).

The total amount of the Agency’s aid to farmers is set at FF 235 million for projects evaluated at a total of FF 745 million (improvement and savings of water resources and environment-friendly agricultural practices) [see Annex 1].

Professional agricultural organisations and the Adour-Garonne Water Agency have now combined their efforts to achieve the following goals:

- to reactivate the water resource development programme; voted in 1988, this programme provided for the creation of 600 million m$^3$ of additional water reserves over 10 years. Today, 300 million m$^3$ of reserves must still be constituted;
- to increase farmers’ participation in the collective management of water resources and to encourage them to measure, save and use these resources more effectively (in irrigation, in particular) and to protect them (protection of drinking water supply, for example);
- to involve farmers in the development, maintenance and promotion of the “river environment”;
- to design and monitor a programme for reducing pollution generated by agriculture, based on improved cultivation practices and control of pollution from animal farms and wineries;
- to participate in implementing a programme of sewage sludge disposal by farmers, in the framework of national agreements between the government and professional agricultural organisations;
- to recover and process toxic agricultural waste;
to organise jointly clear and coherent lines of communication with professional agricultural organisations and farmers so that they are better informed and more aware of the operations carried out under this agreement.

Individual agreements, prepared in co-operation with each regional or departmental chamber of agriculture, will lay down the detailed provisions of these partnerships with the Water Agency. Programmes of studies and initiatives will thus be designed and implemented with the aim of protecting the aquatic environment and enhancing water resources while meeting the aspirations of agricultural partners and taking into account the basin’s diversity.

Charges set in consultation with farmers

In the interest of sound management of the natural aquatic environment and of equity among all water users, a charge should be levied on all irrigation based on the volume and cost of the water consumed.

However, three thresholds have been set:
- irrigators who withdraw less than 5 000 m³ per year are not required to pay charges;
- those who withdraw between 5 000 and 10 000 m³ per year will pay a flat-rate charge of FF 256 (value at 1 January 1996);
- beyond 10 000 m³ per year, the charge is calculated based on the volume of water actually withdrawn, which is either metered or assessed at a flat rate. Charge rates remain stable when the volume is actually metered, but increase yearly when the volume is assessed at a flat-rate [see Annex 2];
- a distinction is made between different kinds of abstractions: different rates are charged for water withdrawn from “replenished rivers”, from “non-replenished rivers”, from aquifers and hillside lakes.

The watercourses or portions of watercourses considered to be replenished rivers are listed in the Master Plan and are guaranteed to have available irrigation water for an average of eight out of every ten years.

The list of watercourses or portions of watercourses in this category [Annex 3] and its revisions will be drawn up yearly by the administrative board of the Adour-Garonne Water Agency.

More accurate information on abstractions should make it possible to broaden the base of charges and thus ensure that farmers bear their fair share of financial burden of the river basin within the Agency’s programmes.

5. Conclusion

Having expanded the scope of its aid significantly, the Water Agency now intervenes in all qualitative and quantitative aspects of water management connected with agricultural practices. Concretely, most of the 200 000 farmers in the river basin will be in indirect contact with the Agency through one of its general programmes (such as Fertimieux) or will be directly involved in an investment project with the Agency. Existing agricultural structures will play a decisive role both by promoting programmes and by acting as intermediaries.
The introduction of charges that vary depending on the method of measuring the volume of water withdrawn and on the sensitivity of the environment during the low water period, serves as a mean for the Agency to emphasize the need to meter consumption and the ensuing savings. Similarly, the fact that higher rates are charged for water withdrawn from replenished rivers justifies the use of public funds to maintain low water levels.

The dialogue that ultimately emerged with agricultural leaders reached its logical conclusion in this framework agreement. Nevertheless, opinion polls taken in the river basin show that the aspect of solidarity among all users promoted by water agencies is not fully understood by most farmers, who see only the charges it collects, which they think of “just one more tax”. Consequently, it is important that the Water Agency undertake the necessary communication campaigns to change these opinions and convince farmers that it is in their interest to support this project.

Lastly, it must be stressed that the framework agreement signed in the Adour-Garonne river basin reflects the specific history and characteristics of south-west France. Each river basin’s water agency, guided by its river basin committee, develops its own individual approach to its relations with farmers, even though there are certain common points such as charges or aid. For example, the high range of irrigation charges in the Loire-Brittany region is five times greater than in the Adour-Garonne region.

Such differences, which are the understandable outcome of local management based on equity among all users, do not prevent farmers from participating in water management, but they do mean that there must be a clearly conducted water policy in each river basin. For without farmers’ participation, the sustainable development of agriculture in our regions will be impossible.
ANNEX 1. THE SYSTEM OF AID

The aid granted consists of subsidies or repayable interest-free advances that the Agency can convert from one into the other using a coefficient of equivalence (for example: subsidies are converted into advances using a coefficient of 3.5). All figures given below are maximum rates. After it has reviewed an application, the Agency’s Intervention Board sets the basis for assessing the expenditure in question and the amount and type of aid granted. In some case the amount of aid may be capped.

As a rule, the Agency’s matching subsidies (basic aid + adjustment(s)) are subject to a 50 per cent cap.

TYPES AND AMOUNTS OF AID

Studies and technical assistance

Studies

50% subsidy

(or the rate selected for the specific project)

Agricultural practices and technical assistance

As part of agreements with chambers of agriculture, the Agency promotes the improvement of agricultural practices in order to save water and fight pollution generated by fertiliser application and pest control treatment (the Irrimieux, Fertimieux and Phytomieux advisory programmes).

This aid is of two kinds:

• for the design, implementation, supervision and monitoring of collective programmes.................................................................25% to 50% subsidy
• for individual advisory and technical support services to farmers.........................Subsidy based on scale

Pollution reduction

Agricultural pollution

• Control of animal farm pollution
existing farms .................................................................................................................................................. 34% subsidy

new farms or extensions ................................................................................................................................. 34% advance

**Toxic agricultural waste** (pest control products)

- Collection, packaging and processing in specialised centres *(ceiling price of 15F/kg)* ................. 50% subsidy
- Investment tax credit for transit centres .................................................................................................. 35% subsidy

**Water resource management**

**New water reserves** (capacity of more than 20 000 m³)

**Large P.D.R.E. reserves with a capacity greater than 1 000 000 m³**

- Priority infrastructure operations to reconstitute the DOE (low-water flow objectives) of SDAGE watercourses with insufficient water, including withdrawals from reserves and aqueducts ........................................................................................................................................... 50% subsidy

- Reservoirs with a capacity greater than 1 million m³, which are of lower priority in terms of the SDAGE, including withdrawals from reserves and aqueducts:
  - for the share used to reconstitute DOE .................................................................................. 30% subsidy
  - for the share used to meet water use needs ........................................................................ 15% subsidy

- Equipment for managing the water system (sluice gates) on existing structures ................... 30% subsidy

- Aid for low-water management (AGE) — sharing operating costs incurred by reservoir operators:
  - for water released to improve the low-water flow of a replenished river within the area of influence of the reservoir ................................................................. 5 centimes/m³
  - for water released when abstractions in the area of influence of the reservoir are contractualised, metered and priced ................................................................. 2 centimes/m³

**Hill impoundment lakes with a capacity of 20 000 m³ to 1 000 000 m³**

- Small local supply lakes
  - for the share used to maintain low water levels ........................................................................ 30% subsidy
  - for the share used for irrigation ................................................................................................. 15% subsidy
(A ceiling cost of FF 10/m³ for hill impoundment lakes; the threshold of 20 000 m³ may apply to the accumulated volume of reserves constituted by a single owner within a single drainage basin.)

- Small local supply lakes which replace, between 1 July and 31 October, abstractions from aquifers or watercourses lacking sufficient water listed by the SDAGE................................................................................................................... 30% subsidy

**Well drilling** (aid conditional upon sound aquifer management as defined by the SDAGE)

Eligibility and rates set based on the situation of the well (accompanying groundwater) and measures for protecting water resources and shortages)...........15% or 30% subsidy

**Rehabilitation** of reservoirs and wells to protect an aquifer......................................................30% subsidy

**Quantitative management of water reserves and low water flows**

- Equipment for managing water reserves, operational assessment of irrigation networks and measurement of volumes used.................................................................50% subsidy

- Equipment to control use of irrigation water...........................................................................30% subsidy

**Metering devices**....................................................................................................................70% subsidy

(collective operations have priority)

**Maintenance, management and monitoring of metering equipment**...............................50% subsidy
ANNEX 2. IRRIGATION CHARGES COLLECTED BY THE ADOUR-GARONNE WATER AGENCY

1. Scale of flat-rate charges

The rule is to levy a charge on the volume of water abstracted for irrigation, whether it is metered or assessed at a flat rate. If there is no metering device, flat-rate charges are applied, on the basis of the following water abstraction (see Annex Tables 1 and 2).

Annex Table 1. Volumes to determine flat rate charges

<table>
<thead>
<tr>
<th>Type of Cropping</th>
<th>Sprinkler Irrigation</th>
<th>Spot Irrigation</th>
<th>Other Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed farming (maize, soya, sorghum, peas, field crops)</td>
<td>1 300 m$^3$/ha</td>
<td>1 600 m$^3$/ha</td>
<td></td>
</tr>
<tr>
<td>Aboriculture</td>
<td>2 500 m$^3$/ha</td>
<td>1 750 m$^3$/ha</td>
<td>4 000 m$^3$/ha</td>
</tr>
<tr>
<td>Vegetable cropping and glasshouse cultivation</td>
<td>4 500 m$^3$/ha</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Annex Table 2. Trend of rates in centimes (French Francs) per cubic meter (inflation adjusted)
(Base 1 January 1996)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-replenished watercourse</td>
<td>Metered</td>
<td>2.56</td>
<td>2.56</td>
<td>2.56</td>
<td>2.56</td>
</tr>
<tr>
<td>Groundwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confined groundwater</td>
<td>Flat-rate</td>
<td>2.71</td>
<td>2.76</td>
<td>2.81</td>
<td>2.86</td>
</tr>
<tr>
<td>Replenished watercourse</td>
<td>Metered</td>
<td>2.71</td>
<td>2.76</td>
<td>2.81</td>
<td>2.86</td>
</tr>
<tr>
<td></td>
<td>Flat-rate</td>
<td>2.96</td>
<td>3.16</td>
<td>3.36</td>
<td>3.56</td>
</tr>
<tr>
<td>Hill impoundment lakes</td>
<td>Metered</td>
<td>2.56</td>
<td>2.56</td>
<td>2.56</td>
<td>2.56</td>
</tr>
<tr>
<td></td>
<td>Flat-rate</td>
<td>2.56</td>
<td>2.56</td>
<td>2.56</td>
<td>2.56</td>
</tr>
</tbody>
</table>
### ANNEX 3. REPLENISHED RIVERS

<table>
<thead>
<tr>
<th>NAME OF CATCHMENT BASIN</th>
<th>BOUNDARIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LA CHARENTE</strong></td>
<td>• CHARENTE: from the LAVAUD dam to the confluence with the TOUVRE.</td>
</tr>
</tbody>
</table>
| **LA DORDOGNE**         | • The COLE: from the MIALLET dam to the confluence with the DRONNE.  
                          • The DRONNE: from the confluence of the COLE to the confluence with the L’ISLE.  |
| **LE LOT**              | • The COLAGNE: from the CHARPAL dam to the confluence with the LOT.  
                          • The LOT: from the confluence of the COLAGNE to the confluence with the GARONNE.  |
| **TARN-AVEYRON**        | • The CEROU: from the ST-GEROUD dam to the confluence with the AVEYRON.  
                          • The AVEYRON: from the confluence of the CEROU to the confluence with the TARN.  
                          • The GOUYRE: from the GOUYRE dam to the confluence with the AVEYRON.  
                          • The TORDRE: from the TORDRE dam to the confluence with the TAUGE.  
                          • The TAUGE: from the confluence of the TORDRE to the confluence with the AVEYRON.  
                          • The DADOU: from the RASSISSE dam to the confluence with the AGOUT.  
                          • The LEZERT: from the BANCALIE dam to the confluence with the DADOU.  
                          • The THORE: from the confluence of the ARN to the confluence with the AGOUT (replenished by ST-PEYRES).  
                          • The AGOUT: from the confluence of the THORE to the confluence with the TARN.  
                          • The SOR: from the CAMMAZES dam to the confluence with the AGOUT.  
                          • The TARN: from the confluence of the AGOUT to the confluence with the GARONNE.  |
| **GARONNE-RIVE DROIT**  | • The FILLEIT: from the FILLEIT dam to the confluence with the GABRE.  
                          • The GABRE: from the confluence of the FILLEIT to the confluence with the ARIZE.  
                          • The ARIZE: from the confluence of the GABRE to the confluence with the GARONNE.  
                          • The LEZE: from the MONDELY dam to the confluence with the ARIÈGE.  
                          • The ARIÈGE: from the LABARRE dam to the confluence with the GARONNE.  
                          • The TRIÈRE: from the MENTBEL dam to the confluence with the HERS VIF.  
                          • The HERS VIF: from the confluence of the TRIÈRE to the confluence with the ARIÈGE.  
                          • The VIXIEGE: downstream from the entry of the feeder canal of MONTBEL to the confluence with the HERS VIF.  
                          • The GANGUISE: from the LESTRADE dam to the confluence with the HERS MORT.  
                          • The HERS MORT: from the confluence of the GANGUISE to the confluence with the GARONNE.  
                          • The BALERME: from the BALERME dam to the confluence with the GIROU.  
                          • The LARAGOU: from the LARAGOU dam to the confluence with the GIROU.  |
FRANCE: AN INCENTIVE POLICY FOR SUSTAINABLE MANAGEMENT OF IRRIGATION WATER IN THE LOIRE-BRITTANY BASIN

by François Dubois de la Sablonière, Loire-Brittany Water Agency, Orléans

Summary

Water resources are increasingly threatened, parallel to the development of the economy. The sustainable management of water resources, essential for the maintenance of these activities, requires more discipline in the use of water.

Even in northern Europe where there is an apparent abundance of water, a succession of dry years, coupled with a huge growth in the demand for water, may cause a serious unbalance with shortages and a crisis management.

Economic and statutory tools, some of which are provided for by the latest Water Act of 3 January 1992, have to be put in place to ensure the offer meets the demand with regard to the natural environment, and that water resources are maintained for next generations.

In the Loire-Brittany basin, which covers a third of France’s territory, the development of intensive irrigation constitutes the essential factor of unbalance, particularly for undergroundwaters. The master plan for water development and management of water (SDAGE) of this basin and the Water Agency’s own programme have made the improvement in the management of water resource their main objective.

A strategy in 6 parts has been decided to reach this objective: knowledge of volumes withdrawn; knowledge of available resources; satisfying the needs of aquatic environment (minimal river flow); volumetric management of withdrawals; water saving; and tariff concessions.

The Water Agency, following the user-pays principle, has put in place, an incentive policy (based on payments and taxes) to encourage farmers to carefully manage their irrigation water. In particular, an original pricing policy was set up, based on geo-ecological zones, not strictly based on a linary scale of payment according to volumes withdrawn.

However, these measures will be fully efficient only if, on the other hand, the transfers to farmers under the Common Agricultural Policy take the protection of water resources more into account.
1. Introduction

The six Water Agencies in France are state owned, public agencies under the supervision of the Ministry of the Environment and Land Use Planning which have for their objective to protect water resources in each of their respective hydrographic basins (Figure 1).

Figure 1. Water Agencies
For that, they collect financial charges from water users. These charges are then reallocated by means of financial aid, either for pollution control (quality), or for the improvement of the resources (quantity). It constitutes, therefore, a financially incentive policy. Each agency is autonomous. It’s the application of the polluter-pays and user-pays principles.

It is important to point out that the agencies are neither a contracting authority nor in charge of law enforcement. This system has been functioning for a little more than 25 years.

Included in the Water Act of 3 January 1992, the protection of resources and its implementation in respect to the natural equilibrium are thus the essential justification of the Water Agencies’ intervention programmes which take part in a sustainable development policy.

This following paper concentrates on the action launched by the Loire-Brittany agency for a careful management of water for irrigation.

2. The Loire-Brittany basin

A diversified basin

155 000 km², that is 28 per cent of French national territory. The Loire basin itself: 120 000 km². Approximately 2 000 km of coastline, that is 40 per cent of the shores in the country, of various morphologic types:

- rocky coastlines and open bays;
- closed coastlines with the development of bays with weak currents;
- lagoons and maritime ponds.

Two ancient mountain massifs at both extremities (Massif Armorican and Massif Central) with, in the centre, a vast plain crossed by the Loire river. A hydrographic network of 80 000 km with diversified hydrological features.

Little underground water under the ancient massifs; some important resources but at times too strongly used on the plain.

120 billions of m³/year of rainfall and a yearly flow of 30 billions m³.

\[
\text{Average rainfall: 700 mm/year} \\
\text{Rains filtering through to groundwater on the plains: 150 mm/year}
\]

Many actors involved

10 regions, 31 counties concerned, wholly or partly, more than 7 300 municipalities, 11.5 million inhabitants. A territory with a marked rural character: the average density is 75/km².

The Loire-Brittany basin incorporates two-thirds of French breeding activities (and 50 per cent in the Brittany counties alone), but also almost 50 per cent of cereal productions especially the Centre and Poitou-Charentes regions.
3. Present state

Abstraction

The yearly water abstraction in the Loire-Brittany basin is divided according to 4 large categories of users:

- Local communities (towns, communities, community unions ...) about 1 billion m³ taken yearly, of which 360 million are consumed, that is to say not returning to the natural environment.
- Industry: about 220 million m³ of which only 28 million consumed.
- EDF (Electricity Board): 1.5 billion m³ of which 340 million consumed.
- Agriculture (irrigation): 450 million m³ wholly consumed corresponding to about 320 000 ha (hectares) irrigated (Figure 2).

Irrigation is, therefore, the top water consumer of the Loire-Brittany basin, even if it isn’t the main user. This statement is even truer if we consider the summer period during which irrigation is practised.

Figures 3 and 4 show the shares of different water users according to the quantity taken and consumed, and the type of water resource.
Irrigation by spraying practised in the Loire-Brittany basin is a complementary irrigation allowing to secure yields on soils with low water reserves or to cultivate products that need a great deal of water such as corn.

Figure 5 represents the different types of irrigated crops. Corn, wheat, sugar-beet, proteaginous peas make up the main irrigated crops.
Irrigation structure is presented in Table 1. It mainly concerns individual withdrawals in aquifers, dams and rivers; the collective installations represent only 17 per cent of the irrigated area of the basin.

Table 1. Irrigation structure based on the year 1995

<table>
<thead>
<tr>
<th>Surface irrigated by exploitation</th>
<th>Installation flow at m³/hour</th>
<th>Number of farmers</th>
<th>Surface (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 10 ha</td>
<td>2 to 20</td>
<td>5 617</td>
<td>16 021</td>
</tr>
<tr>
<td>10 to 20 ha</td>
<td>20 to 40</td>
<td>2 497</td>
<td>37 886</td>
</tr>
<tr>
<td>20 to 50 ha</td>
<td>40 to 100</td>
<td>3 675</td>
<td>118 161</td>
</tr>
<tr>
<td>+ than 50 ha</td>
<td>+ 100</td>
<td>1 601</td>
<td>151 650</td>
</tr>
</tbody>
</table>

Installations usually function from April to September (800 to 1 000 hours/year), with a peak in the three summer months (June, July, August) and are capable of filling up a maximum hydric deficit of 100 mm/month.


The rapid evolution of the demand has locally led to some over exploitation of resources with conflicts of use and the drying up of rivers (near to 1 000 km in 1996 in the Poitou-Charentes area ...).

Some administrative measures (water law enforcement) for limiting abstraction are taken each year (limited pumping time, days of prohibition). In some extreme cases, it isn’t allowed anymore to pump water even though irrigation might still be necessary for the plants.
The great geological domains of the Loire-Brittany basin

In the Loire-Brittany basin, we come across 2 great types of geological domains: the base domain and the sedimentary domain.

The base domain of the Massif Armorican and of the Massif Central

This domain is essentially made up of granite rocks, metamorphic rocks (schists, gneiss) and volcanic rocks. Undergroundwater is present there in the deep cracks as well as in the alterations or arenisations of the surface (e.g. granitic arenas).

The cracked or sand-formed zones are generally of limited extensions, which therefore gives a group of discontinued aquifers.

On this substratum, certain basins have been filled at the primary era by some schistose sediments, lime or sandstone (areas of Laval, Châteaudun, Chateau-Gontier, St Etienne). These limestone or sandstone formations contain some aquifers locally interesting.

Also, at the tertiary era, some small basins of very limited extension have been filled by some sediments generally limestone or sandstone. They are commonly called tertiary basins. They contain practically all the aquifers that are exploited for providing drinking water: e.g. aquifer of Campbon or Nort sur Erdre in Loire-Atlantic.

Certain volcanic formations form some reservoirs really interesting and indeed highly renowned, as for example the under basaltic flows of the Chaîne des Puys (Volvic).

The sedimentary domain of the Parisian basin and the Aquitain basin

At the secondary era (about 200-250 million years ago), the sea was present in the Parisian and Aquitain basins. Its gradual retreat towards the Channel on one side and towards the Atlantic on the other has conditioned the organisation of the underground in these basins.

From above, the geological layers are arranged in concentric rings centred on the Ile-de-France for the Parisian basin, and on the Landes for the Aquitaine basin.

Amongst all the geological layers really present, the hydrogeologists globally consider 8 great water levels, each one separated by impermeable or assimilated layers (Table 2).

The aquifers are generally fed by the autumnal and winter rains (October-March) and empty themselves out naturally by some springs or in the water courses of which they insure the flow during the dry period (summer). The relations river-aquifer are therefore important.
Table 2. Water Levels

<table>
<thead>
<tr>
<th>Exploitation level for irrigation</th>
<th>X</th>
<th>XX</th>
<th>XXX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand and sandstone of Trias</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone of the inferior Jurassic period (Lias)</td>
<td>XX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone of the middle Jurassic period (Dogger)</td>
<td>XXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone of the superior Jurassic period (Malm)</td>
<td>XXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand and chalk of the Cenomanian period</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand of Albian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalk of Senonian or Turonian</td>
<td>XX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lacustrian limestone of the tertiary period (limestone of the Beauce, Berry and Touraine)</td>
<td>XXX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

XXX: high
XX: average
X: low

4. The main principles of sustainable management of irrigation water in the Loire-Brittany basin

The strategy for sustainable management of irrigation water in the Loire-Brittany basin relies on 6 main principles:

- knowledge of volumes taken;
- knowledge of available resources;
- satisfying the needs of the natural environment (minimum flow of rivers);
- volumetric management;
- accompanying programs for farmers to a careful management of water;
- incentive pricing.

Knowledge of abstracted volumes

As from April 1991, before the Water Act of 3 January 1992 which made it compulsory, the metering of water for irrigation became a priority for the agency (Figure 6).
If the volumes were metered in the local communities and industries, the biggest part of the volumes taken for irrigation were not metered. Now, water metering is one of the ways of a sound water management. The quantification of water taken is indeed a necessary measure:

- For the farmer himself to manage water better for a plot of land by validating the supposed doses to be carried by his irrigation installation.

- To create water resources management tools.

- For local authorities to manage on a county scale or in the future at river basin level, to plan, share and arbitrate, especially in times of crisis.

- For the Water Agencies to produce more reliable data allowing:
  - a realistic computation of the basis of withdrawal charges;
  - to carry out a better balance-sheet for resources and needs.

A study has been entrusted by the Agency in 1991 to the Society of the Canal de Provence. The objectives were:

- To define the type of equipment adapted to the irrigation network of the Loire-Bretagne basin according to their way of working (water meter, flow meter, electric meter...).
To appreciate the strength, the ease of installation, the ease of use, the reliability and precision of different types of equipment.

To give the precise conditions of installation of the equipment (keeping documents of specification).

To appreciate the investment cost.

To define the type of maintenance needed, its frequency, and to appreciate the corresponding cost and, in particular, according to the size of the equipment stock.

To provide food for thought to the Agency on data retrieval (meter readings...).

As a result of this study, the Agency has built an intervention program of the installation terms for the meters. Thanks to its very high financial assistance (75-80 per cent subsidy), and a network of qualified fitters, the meter stock has rapidly increased: 40 per cent of withdrawal points representing 65 per cent of irrigated surfaces are equipped up to 1 July 1997. In the most intensively exploited groundwater, these rates are respectively 55 per cent and 80 per cent.

The financial investment up to 1 July 1997 is about 100 MF for subsidies rising to 70 MF; the unitary cost of a metering apparatus being approximately FF 15 000. The electronic flow-meters represent more than 50 per cent of the stock; the propelled speedometer as well as the proportional meter or diversion meter share the rest of the stock.

At present, the rate of equipment leaves us to hope for a full completion of the program in 1999.

Knowledge of available resources

If the surface water resources are fairly well known, thanks to the age of the measuring network, the groundwater levels are less known. The generalised measure of hydraulic gradient by piezoelectric networks are recent. The master plan for water development and management (in French SDAGE) has identified some groundwater, classified as being intensively exploited. Considered as such, groundwater units per year reach over an average ratio of 200 m³/ha of the aquifer surface and where conflicts in uses and water courses drying are observed.

The main concerned geological formations are the:

- limestone in the Beauce and senuturonian chalk between the rivers Loire and Loir;
- limestone of the superior Jurassic period, of Dogger and Lias.

In these zones, the Agency encourages, thanks to inciting aids (80 per cent), the study of quantitative data of environment and use.

- Geometry and functioning of groundwater and river hydrosystems.
- Setting up the networks of local complementary measures of management: gauging stations for rivers, piezoelectric meter for groundwater.
– Total knowledge of the uses of water: intake structure, metering the abstracted volumes.
– Modelisation of a system permitting forecast management.
– A minimal flow for biological purposes in river.

Simple (piezoelectric levels, flow of draining rivers) or sophisticated (mathematic models), management tools become a necessity as soon as the intensive exploitation of an aquifer threatens to unbalance its equilibrium.

These tools allow to decide for the best and at the earliest (end of winter to the beginning of spring) the volume of water theoretically exploitable in the year by the whole of the users and at the same time preserving minimum low water acceptable for the springs and the water courses.

This is a fundamental technical aid to establish some rules of equal water sharing between various users and to check their impact.

**Volumetric management**

The final goal for the intensely exploited aquifers is the determination every year of the amount of water that can be exploited in keeping with the patrimonial and environmental value.

The irrigating farmers will be led to manage the water quota which will avoid a management crisis, which is always difficult to put into practice and to be respected. Rotation shift and the practice of irrigation will then be the privileged management tools of limited volume.

Farmers of these zones concerned by these measures are at present considering the water sharing and the allocation of quotas.

**A program for irrigation farmers to promote thrifty management of water**

Thanks to aids rising to 50 per cent of expenses, the Agency provides a substantial assistance to carry actions of irrigation farmers to a thrifty water management.

**Targeted aids**

*on the technical support to irrigation farmers*

– the completion of water schedules;
– following up of the hydratation of the ground (tensiometers, in situ dry oven measures);
– agronomical diagnosis;
– varietal behaviour analysis to water stress;
determination of the real needs of the crops (measurement of real evapo-transpiration of winter wheat);

- dissemination of information.

These actions are valuable. Thus it has been possible to show in certain situations that the excess of water on corn does not increase the yield but could sometimes lead to a decrease.

On the other hand, in the Poitou-Charentes region (county of the Deux-Sèvres), agronomical studies carried out with the help of the Agency have revealed, that in 1996 (dry year), yields reach a maximum for a water dose of about 2 000 m³/ha.

Thanks to the meter and to the acquisition of agronomic data, identical yields on the same types of soil have statistically been established for water volumes almost varying from 1 to 2.

\textit{On water saving}

Since the 1997 irrigation campaign, the Agency has brought help to irrigating farmers drawing water from intensively exploited groundwater and recharged rivers and consuming less water per hectare (Tables 3A. and 3B.). This assistance amounts to a certain percentage of the financial charge and is all the more important since the consumption of water per hectare is weak.

\textit{An incentive pricing policy}

The inclusive fixing rate becomes exceptional and the basis of the financial charge is commensurate to the volume measured by the meter. In order to involve farmers and other users, the basic rate of the charge is raised by 50 per cent in the intensively exploited groundwater sectors and by 80 per cent on recharged rivers.

Thus, by the year 2000, irrigating farmers will pay 5.11 centimes per m³ pumped in intensively exploited groundwater and 6.13 centimes in recharged rivers. In the sectors where the needs and the available resource are balanced, this rate is only 3.4 centimes/m³.

Nevertheless, the amount of the charge is not yet at a sufficient level to set up a limitation factor of quantities of water abstracted.

Indeed, the total cost of irrigation for the farmer is about 1 F/m³, brought on the field.

One can imagine a development of the system towards a differentiated fixing rate with a weak charge up to the value of the water quota, then very dissuasive beyond that value.

It would seem advisable to fix a basic charge at a level which will allow the coverage of the costs related to acquisition of knowledge, the functioning of management tools put in place, as well as operation and maintenance of structures (dams, artificial aquifer recharge, water transfer...) of which the costs of the first installation have been covered by the community.

With this type of fixing rate, water users give themselves the means to keep in good condition the heritage which the community has given them.
### Table 3A. Rate of aid for recharged rivers

<table>
<thead>
<tr>
<th>Section (m³/ha)</th>
<th>Rate of aid for recharged rivers (%)</th>
<th>Aid (centimes/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-900</td>
<td>44</td>
<td>2.60</td>
</tr>
<tr>
<td>900-1000</td>
<td>40</td>
<td>2.45</td>
</tr>
<tr>
<td>1000-1100</td>
<td>36</td>
<td>2.20</td>
</tr>
<tr>
<td>1100-1200</td>
<td>32</td>
<td>1.96</td>
</tr>
<tr>
<td>1200-1300</td>
<td>28</td>
<td>1.71</td>
</tr>
<tr>
<td>1300-1400</td>
<td>24</td>
<td>1.47</td>
</tr>
<tr>
<td>1400-1500</td>
<td>20</td>
<td>1.22</td>
</tr>
<tr>
<td>1500-1600</td>
<td>16</td>
<td>0.98</td>
</tr>
<tr>
<td>1600-1700</td>
<td>12</td>
<td>0.73</td>
</tr>
<tr>
<td>1700-1800</td>
<td>8</td>
<td>0.49</td>
</tr>
<tr>
<td>1800-1900</td>
<td>4</td>
<td>0.24</td>
</tr>
<tr>
<td>&gt; 1900</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 3B. Rate of aid for intensively exploited groundwater

<table>
<thead>
<tr>
<th>Section (m³/ha)</th>
<th>Rate for aid for the intensively exploited groundwater (%)</th>
<th>Aid (centimes/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 900</td>
<td>33</td>
<td>1.687</td>
</tr>
<tr>
<td>900-1000</td>
<td>30</td>
<td>1.534</td>
</tr>
<tr>
<td>1000-1100</td>
<td>27</td>
<td>1.38</td>
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<tr>
<td>1100-1200</td>
<td>24</td>
<td>1.227</td>
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<tr>
<td>1200-1300</td>
<td>21</td>
<td>1.073</td>
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<tr>
<td>1300-1400</td>
<td>18</td>
<td>0.92</td>
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<tr>
<td>1400-1500</td>
<td>15</td>
<td>0.76</td>
</tr>
<tr>
<td>1500-1600</td>
<td>12</td>
<td>0.613</td>
</tr>
<tr>
<td>1600-1700</td>
<td>9</td>
<td>0.46</td>
</tr>
<tr>
<td>1700-1800</td>
<td>6</td>
<td>0.306</td>
</tr>
<tr>
<td>1800-1900</td>
<td>3</td>
<td>0.153</td>
</tr>
<tr>
<td>&gt;1900</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
5. Conclusion

Putting into practice all these measures aims to make different water users of the Loire-Brittany basin aware, so that they adopt a consistent attitude with the needs of sustainable development.

This policy will be led in close consultation within the River Basin Committee, a real Water Parliament, and particularly with representatives of the farmers.
GREECE: SUSTAINABLE MANAGEMENT OF WATER IN AGRICULTURE: ISSUES AND POLICIES

by Panayiotis Selianitis, Directorate of Agricultural Land Reclamation and Agricultural Structures, Ministry of Agriculture, Athens

Foreword

Acknowledgements are due to Mrs. M. Tikof and Mr. D. Moutsatsos, Ministry of Agriculture. The report has benefited from a number of articles, studies, papers, reports relating to specific cases.

Summary

Agriculture in Greece, as is the case in other Mediterranean countries, is still an important sector for food production and employment. An integrated protection plan is necessary to address the sustainable use of water resources used in agriculture taking into account the needs of the environment. Agriculture represents 12 per cent of total G.D.P. and over 20 per cent of the active population is employed in agricultural activities. Agriculture is the largest user of water, in particular for irrigation. The Ministry of Agriculture and the Ministry of Environment, Town Planning and Public Works have the responsibility for planning, financing supervising the implementation of the land reclamation projects for irrigation and drainage.

Agriculture has a need of four-fifths of the country’s water supplies. Surface water accounts for approximately six-sevenths of the total quantity of water, and one-third has its origins outside the country. In coastal areas, due to the over-exploitation of groundwater aquifers, sea water intrusion has appeared.

The geomorphology, the geological structures, the uneven rainfall distribution in space and time, and diminishing precipitation, have all resulted in the scarcity of water resources during the peak period for irrigation. Because of these reasons, there is a need to construct expensive collective and individual irrigation works.

Twenty-eight per cent of total cultivated area is irrigated, of which 40 per cent is irrigated by collective irrigation works and 60 per cent by individual ones. Many of the existing irrigation systems were designed and constructed many years ago and are still using the same technology. They need to be modernised and rehabilitated for minimising waste, reducing drainage requirements and promoting new technologies, such as ferti-irrigation.
The owners of land covered by collective works are members of the 404 Land Improvement Local Boards. These self-administrated organisations charge their members with service fees that cover the administration, maintenance and operation expenses, while the State finances the construction of the collective works. The 10 Land Improvement General Boards are semi-governmental organisations, established by the government for managing general works. Since 1987, the country has been divided into fourteen water districts. Any legal entity or person must obtain a license for the agricultural use of water. This license is given free of charge. Greece loans are provided by the Agricultural Bank to construct individual works for irrigation, livestock, aquaculture and other agricultural purposes.

The main policy issues relative to water quantity and quality are: i) The complexity of the water property rights based on the law, on customary rules and on administrative licenses. ii) Water deficit, especially during the peak period for irrigation in summer, a period similarly crucial for other uses (tourism, public water supply, domestic sector etc.). iii) Structural impediments, including a large number of small, fragmented farms and of non-farmer owners of cultivated land. iv) The ageing of irrigation works that make them expensive to operate and maintain.

The Greek government has taken measures to address the above issues on water resources management in agriculture and to prevent environmental impacts from agricultural activities: i) Implementation of an “improvement plan” under the EC Directives 2328/9 and 950/97 to improve agricultural structures. This “plan” provided terms and conditions for environmental purposes; ii) Environmental Impact Assessment before the construction of infrastructure; iii) Creation of a National Land Registry; iv) Ex-ante studies for rehabilitation and modernisation of the oldest operated collective irrigation works, taking into account users’ skills, maintenance cost, crop pattern, skilled labour, and the possibility for locally provided inputs and services; v) Water resources protection plan provided by an annual decision of the local administrative authorities involving permits and penalties; vi) Quality measurement programme of water used for irrigation; vii) Training and educational programmes for farmers.

The expected outcomes are: reduction of wastes in water; minimising energy use; improved drainage; promotion of irrigation in conjunction with better fertilisation, tillage and pest control; protection of water quantity and quality; flexibility for better irrigation services, increased crop diversification and market-oriented agricultural production; and, environmentally and economically sustainable operation of the irrigation systems.

1. Introduction

Sustainable Agricultural Development is the management and the conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such sustainable development (in agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.

High world food production is due to the successful application of modern agronomic technology, particularly to the introduction and wide adoption of new high-yielding varieties, the increased application of fertilizers to soils with adequate moisture, and to more effective means of pest control. Adequate moisture from rainfall is not always available in the arid and semi-arid areas and must be applied artificially by irrigation. 40 per cent of the world’s food already comes from irrigated land and according to some estimates half or even two-thirds of the potential increment in production will come in the future.
from irrigated land. The 260 million hectares of irrigated land around the world have played a crucial role in enabling the farming community to produce an abundance of food at low and relatively stable prices.

The importance of environmental protection and conservation measures has been increasingly recognised during the past two decades. It is now generally accepted that economic development strategies must be compatible with environmental goals. This requires the incorporation of environmental dimensions into the process of development. The United Nations Conference on Environment and Development (UNCED) in its Agenda 21, Chapter 18: Protection of the Quality and Supply of Freshwater, underscored the importance of environmental protection and conservation of the natural resource base in the context of water resources development for agriculture and rural development.

Soil erosion, desertification, salinization, sea water intrusion at coasts and waterlogging reduce productivity and jeopardise long-term sustainability. Wise management of the environment requires an ability to forecast, monitor, measure and analyse environmental trends and assess the capabilities of land and water at different levels, ranging from a small irrigated plot to a catchment.

Conventionally all types of agricultural practices and land use, including animal feeding operations (feed lots), are treated as non-point sources of pollution. The main characteristics of non-point sources are that they respond to hydrological conditions, are not easily measured or controlled directly (and therefore are difficult to regulate), and focus on land and related management practices. Control of non-point sources, especially in agriculture, has taken place through education, appropriate management practices and modification of land use. Agricultural activity is only one of a variety of causes of non-point sources of pollution. However it is generally regarded as the largest contributor of pollutants of all the categories. Non-point source pollutants, irrespective of source, are transported overland and through the soil by rainwater and melting snow. These pollutants ultimately find their way into groundwater, wetlands, rivers and lakes and, finally, to oceans in the form of sediment and chemical loads carried by rivers. The ecological impact of these pollutants range from simple nuisance substances to severe ecological impacts involving fish, birds and mammals, and on human health.

The agricultural impacts on water quality are diverse from the following activities: Tillage/ploughing, fertilizing, manure spreading, pesticides, feedlots/animal corals, irrigation, clear cutting, silviculture, aquaculture.

The water quantity and quality database that is available is of little value in water used in agriculture and in pollution management at the river basin scale nor is useful for determining the impact of agriculture relative to other types of anthropogenic impacts. Further more the produced data is often quite unreliable. Further, the data are not assessed or evaluated, and are not sufficiently connected to realistic and meaningful program, legal or management objectives. Significant for agricultural programmes is that water quality data are rarely collected by ministries of agriculture. Nevertheless, sustainable agriculture within the framework of comprehensive basin management will require relevant and reliable data upon which to make management decisions. This will necessitate intervention by agriculturists in existing water quantity and quality data programmes if relevant data are to be collected for agricultural management purposes.

The aim of this report is to give a concise picture of the framework for the water supply and management used in Greek agriculture, the lessons from experience and the need of reforming water policies in agriculture. It was impossible to make a complete review of policies measures and practices of the water resources management in Greece, because of the lack both of adequate quantitative data information and the river basin authorities. The main emphasis in this report is given on the issues relating to the water
quantity rather than the water quality because Greek experience has shown that the water quantity is “The Subject”.

The actual structure of the report is as follows:

- First, the background against which agricultural activities are taking place in Greece is presented and a description is given of what seems to be the most important characteristics of Greek agriculture in relation to the environment.

  - In Section 3 the main policy issues are presented, as well as the objectives in relation to water quantity and quality in agriculture.
  - Section 4 presents the main policy measures and approaches to address the above issues.
  - Section 5 contains budgetary and economic costs associated with the implementation of these policy measures and approaches.
  - In Section 6 the effects and approaches on agriculture, water and environment of these policy measures are described.
  - Finally, Section 7, as a conclusion, gives a discussion on the future need for re-orientation of agricultural policies towards less water demanding agricultural produces and a reforming water policy in agriculture.

- Second, a general discussion.

2. The background

The physical environment of the Mediterranean is inherently more vulnerable than that of the more temperate regions of northern Europe. There is a considerable variation in the temperature and precipitation levels from year to year and more importantly a disjunctive between the two. Greece is a typical Mediterranean country in which all types of what we use to call “Mediterranean climate” are present. Furthermore, its great variety of geomorphological structure and geological variation of the region, has created an environment that supports a wide range of vegetation. However this is not matched by an ability to produce yields at the level achieved in northern Europe. In many areas of the country the temperature, ranging in extremes during the year, high precipitation to high relative humidity, result to frost that poses a major threat to crops. Table 1 gives a picture of the geomorphological structure of Greece and Table 2 shows the inclination of land.

<table>
<thead>
<tr>
<th>ALTITUDE (m)</th>
<th>% OF TOTAL AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 600</td>
<td>42.6</td>
</tr>
<tr>
<td>200 &lt;… &lt; 600</td>
<td>27.1</td>
</tr>
<tr>
<td>&lt; 200</td>
<td>30.3</td>
</tr>
</tbody>
</table>

*Source: National Statistical Service of Greece.*
Table 2. Inclination of land

<table>
<thead>
<tr>
<th>SLOPE</th>
<th>% OF TOTAL AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5%</td>
<td>38.5</td>
</tr>
<tr>
<td>5% &lt; ... &lt; 10%</td>
<td>23.2</td>
</tr>
<tr>
<td>&gt; 10%</td>
<td>38.3</td>
</tr>
</tbody>
</table>

Source: National Statistical Service of Greece.

Its insular complex contains as many as 3 000 small islands, of which 217 are inhabited, covering 19 percent of the country’s total land area. With the exception of certain big islands, like Crete, Evia, Rhodes, Lesvos and Corfu, all the others are less than 150 square kilometres.

The total area of the country is 13.2 million hectares, distributed among different uses (Table 3).

Table 3. Land use (percentage)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural land</td>
<td>29.7</td>
</tr>
<tr>
<td>Pastures and meadows</td>
<td>39.5</td>
</tr>
<tr>
<td>Forestry</td>
<td>22.6</td>
</tr>
<tr>
<td>Other uses</td>
<td>8.2</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: National Statistical Service of Greece.

Greece is divided into thirteen regions as provided for by the Presidential Decree 51/1987. Table 4 shows the distribution of the 10.3 million Greek population across regions, counties, municipalities and communities.

Agricultural land is more or less made of sedimentary and volcanic rocks. It has been created by disintegration mainly of calcaereous earth and of conglomeratic psammites. Hence, the appearance of intense soil erosion, at least in some parts of the country. Table 5 indicates the pluriannual average values for sediment loss from 18 relative stations from the Public Electricity Company (D.E.H.), Directorate of Hydro-electric Works’ Development. The values are provisional and they will be revised in the future.
Table 4. Greek population across regions, counties, municipalities and communities
(census of 17 March 1991)

<table>
<thead>
<tr>
<th>REGIONS</th>
<th>COUNTIES</th>
<th>POPULATION</th>
<th>MUNIC.+COMMUN.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. EASTERN MACEDONIA AND THRACE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drama</td>
<td>96 554</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>Evros</td>
<td>143 752</td>
<td>7</td>
<td>80</td>
</tr>
<tr>
<td>Kavala</td>
<td>135 937</td>
<td>7</td>
<td>65</td>
</tr>
<tr>
<td>Xanthi</td>
<td>91 063</td>
<td>2</td>
<td>35</td>
</tr>
<tr>
<td>Rodopi</td>
<td>103 190</td>
<td>2</td>
<td>36</td>
</tr>
<tr>
<td>II. CENTRAL MACEDONIA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imathia</td>
<td>139 934</td>
<td>6</td>
<td>53</td>
</tr>
<tr>
<td>Thessaloniki</td>
<td>946 864</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Kilkis</td>
<td>81 710</td>
<td>4</td>
<td>74</td>
</tr>
<tr>
<td>Pella</td>
<td>138 761</td>
<td>6</td>
<td>77</td>
</tr>
<tr>
<td>Pieria</td>
<td>116 763</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Serres</td>
<td>192 828</td>
<td>7</td>
<td>139</td>
</tr>
<tr>
<td>Chalkidiki</td>
<td>92 117</td>
<td>6</td>
<td>67</td>
</tr>
<tr>
<td>III. WESTERN MACEDONIA</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Grevena</td>
<td>36 797</td>
<td>2</td>
<td>68</td>
</tr>
<tr>
<td>Kastoria</td>
<td>52 685</td>
<td>6</td>
<td>53</td>
</tr>
<tr>
<td>Kozani</td>
<td>150 386</td>
<td>10</td>
<td>127</td>
</tr>
<tr>
<td>Florina</td>
<td>53 147</td>
<td>2</td>
<td>88</td>
</tr>
<tr>
<td>IV. EPIRUS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arta</td>
<td>78 719</td>
<td>3</td>
<td>79</td>
</tr>
<tr>
<td>Thesprotia</td>
<td>44 188</td>
<td>4</td>
<td>97</td>
</tr>
<tr>
<td>Ioannina</td>
<td>158 193</td>
<td>6</td>
<td>299</td>
</tr>
<tr>
<td>Preveza</td>
<td>58 628</td>
<td>6</td>
<td>58</td>
</tr>
<tr>
<td>V. THESSALY</td>
<td></td>
<td></td>
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<tr>
<td>Karditsa</td>
<td>126 854</td>
<td>5</td>
<td>138</td>
</tr>
<tr>
<td>Larissa</td>
<td>270 612</td>
<td>7</td>
<td>153</td>
</tr>
<tr>
<td>Magnissia</td>
<td>198 434</td>
<td>9</td>
<td>70</td>
</tr>
<tr>
<td>Trikala</td>
<td>138 946</td>
<td>6</td>
<td>136</td>
</tr>
<tr>
<td>VI. IONIAN ISLANDS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zante</td>
<td>32 557</td>
<td>1</td>
<td>46</td>
</tr>
<tr>
<td>Corfu</td>
<td>107 592</td>
<td>5</td>
<td>89</td>
</tr>
<tr>
<td>Kefallinia</td>
<td>32 474</td>
<td>4</td>
<td>73</td>
</tr>
<tr>
<td>Lefkada</td>
<td>21 111</td>
<td>3</td>
<td>37</td>
</tr>
<tr>
<td>VII. WESTERN HELLAS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Etoloaokarnania</td>
<td>228 180</td>
<td>17</td>
<td>197</td>
</tr>
<tr>
<td>Achaea</td>
<td>300 078</td>
<td>8</td>
<td>225</td>
</tr>
<tr>
<td>Helis</td>
<td>179 429</td>
<td>10</td>
<td>207</td>
</tr>
<tr>
<td>VIII. STEREA HELLAS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viotia</td>
<td>134 108</td>
<td>13</td>
<td>61</td>
</tr>
<tr>
<td>Evia</td>
<td>208 408</td>
<td>12</td>
<td>153</td>
</tr>
<tr>
<td>Evritania</td>
<td>24 307</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>Fthiotida</td>
<td>171 274</td>
<td>13</td>
<td>168</td>
</tr>
<tr>
<td>Fokida</td>
<td>44 183</td>
<td>5</td>
<td>86</td>
</tr>
<tr>
<td>IX. ATTIKI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attiki</td>
<td>3 523 407</td>
<td>88</td>
<td>62</td>
</tr>
<tr>
<td>Argolida</td>
<td>97 636</td>
<td>8</td>
<td>61</td>
</tr>
<tr>
<td>Arkadia</td>
<td>105 309</td>
<td>10</td>
<td>233</td>
</tr>
<tr>
<td>Korinthia</td>
<td>141 823</td>
<td>8</td>
<td>108</td>
</tr>
<tr>
<td>Lakonia</td>
<td>95 696</td>
<td>11</td>
<td>131</td>
</tr>
<tr>
<td>Messinia</td>
<td>166 964</td>
<td>9</td>
<td>270</td>
</tr>
<tr>
<td>X. PELOPONNESE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesvos</td>
<td>105 082</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>Samos</td>
<td>41 965</td>
<td>5</td>
<td>43</td>
</tr>
<tr>
<td>Chios</td>
<td>52 184</td>
<td>9</td>
<td>32</td>
</tr>
<tr>
<td>XI. NORTHERN AEGEAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dodecanissos</td>
<td>163 476</td>
<td>12</td>
<td>57</td>
</tr>
<tr>
<td>Cyclades</td>
<td>94 005</td>
<td>11</td>
<td>105</td>
</tr>
<tr>
<td>XII. SOUTHERN AEGEAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iraklio</td>
<td>264 906</td>
<td>13</td>
<td>154</td>
</tr>
<tr>
<td>Lassithi</td>
<td>71 279</td>
<td>5</td>
<td>82</td>
</tr>
<tr>
<td>Rethimno</td>
<td>70 095</td>
<td>3</td>
<td>127</td>
</tr>
<tr>
<td>Chania</td>
<td>133 774</td>
<td>8</td>
<td>146</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>10 258 364</strong></td>
<td><strong>457</strong></td>
<td><strong>5 318</strong></td>
</tr>
</tbody>
</table>

*Source: Ministry of Internal Affairs, Public Administration and Decentralization.*
Table 5. Selected values for sediment loss

<table>
<thead>
<tr>
<th>River</th>
<th>Location</th>
<th>Period</th>
<th>Riverbasin km²</th>
<th>Average loss tons/secx10⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nestos</td>
<td>G.Papadon</td>
<td>1965-1983</td>
<td>3.278</td>
<td>10.70</td>
</tr>
<tr>
<td>Kalaritikos</td>
<td>G.Gogou</td>
<td>1966-1976</td>
<td>203</td>
<td>4.71</td>
</tr>
<tr>
<td>Arachthos</td>
<td>G.Tsimovou</td>
<td>1964-1978</td>
<td>640</td>
<td>15.40</td>
</tr>
<tr>
<td>“</td>
<td>G.Artas</td>
<td>1962-1976</td>
<td>1.855</td>
<td>234.10</td>
</tr>
<tr>
<td>“</td>
<td>G.Plakas</td>
<td>1961-1978</td>
<td>970</td>
<td>88.76</td>
</tr>
<tr>
<td>Evinos</td>
<td>PorosRiganiou</td>
<td>1969-1977</td>
<td>860</td>
<td>1.71</td>
</tr>
<tr>
<td>“</td>
<td>G.Bania</td>
<td>1969-1974</td>
<td>906</td>
<td>1.87</td>
</tr>
<tr>
<td>“</td>
<td>Kioteki</td>
<td>1966-1974</td>
<td>1.481</td>
<td>60.15</td>
</tr>
<tr>
<td>Venetikos</td>
<td>G.Grevenon</td>
<td>1962-1982</td>
<td>817.7</td>
<td>1.95</td>
</tr>
<tr>
<td>Aliakmonas</td>
<td>Ilarion</td>
<td>1962-1982</td>
<td>5.005</td>
<td>73.41</td>
</tr>
<tr>
<td>“</td>
<td>Statista</td>
<td>1962-1982</td>
<td>2.724</td>
<td>7.37</td>
</tr>
<tr>
<td>“</td>
<td>Prodromos</td>
<td>1962-1974</td>
<td>6.075</td>
<td>80.82</td>
</tr>
<tr>
<td>“</td>
<td>Velvendos</td>
<td>1962-1971</td>
<td>5.830</td>
<td>83.62</td>
</tr>
<tr>
<td>Acheloos</td>
<td>Messochora</td>
<td>1969-1973</td>
<td>633.5</td>
<td>1.96</td>
</tr>
<tr>
<td>“</td>
<td>Avlaki</td>
<td>1965-1984</td>
<td>1.349</td>
<td>36.94</td>
</tr>
<tr>
<td>Aoos</td>
<td>G.Konitsis</td>
<td>1963-1983</td>
<td>665</td>
<td>22.39</td>
</tr>
</tbody>
</table>

Source: Public Electricity Company.

Table 6 shows that the cultivated land area has remained almost unchanged over time, except for land under tillage, which shows a decrease to the benefit of orchards.

Table 6. Agricultural land use in Greece

<table>
<thead>
<tr>
<th>LAND USE (in %)</th>
<th>1980 Total</th>
<th>of which irrigated</th>
<th>1985 Total</th>
<th>of which irrigated</th>
<th>1991 Total</th>
<th>of which irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable Crops</td>
<td>59.6</td>
<td>26.3</td>
<td>59.3</td>
<td>31.3</td>
<td>58.2</td>
<td>34.0</td>
</tr>
<tr>
<td>Horticultural Crops</td>
<td>3.2</td>
<td>74.1</td>
<td>3.1</td>
<td>86.9</td>
<td>3.0</td>
<td>93.4</td>
</tr>
<tr>
<td>Viniculture</td>
<td>4.6</td>
<td>13.0</td>
<td>4.3</td>
<td>14.9</td>
<td>3.9</td>
<td>19.3</td>
</tr>
<tr>
<td>Orchard Trees</td>
<td>20.3</td>
<td>23.0</td>
<td>21.5</td>
<td>24.4</td>
<td>22.8</td>
<td>28.0</td>
</tr>
<tr>
<td>Olive Groves)</td>
<td>(15.4)</td>
<td>-</td>
<td>(16.3)</td>
<td>-</td>
<td>(16.6)</td>
<td>-</td>
</tr>
<tr>
<td>Fallow land</td>
<td>12.2</td>
<td>-</td>
<td>11.9</td>
<td>-</td>
<td>12.2</td>
<td>-</td>
</tr>
<tr>
<td>T O T A L</td>
<td>100.0</td>
<td>23.4</td>
<td>100.0</td>
<td>27.3</td>
<td>100.0</td>
<td>29.7</td>
</tr>
</tbody>
</table>

Source: National Statistical Service of Greece.
Agriculture is an important economic sector for the country, since it still contributes by as much as 12 per cent to the GDP. Although, official statistics show that it implies over 20 per cent of its active population, one should bear in mind the high level of rural people using agricultural activity as a complementary income source, as well as the fact that the country’s highly productive agricultural land is exceptionally small (50 per cent of the total agricultural land).

- The Law No. 1739/1987 (in its provisions “Water resources management” and others) sets up a technical division of the country into fourteen water districts. Table 7 indicates the distribution of water resources and water use by water district. The appraisal estimates that run off from the land is 64 838 million m$^3$ and the useful volume is 69 000 million m$^3$ (58 700 surface water and 10 300 groundwater).

Table 7. Distribution of water resources and water use by water district

<table>
<thead>
<tr>
<th>District number</th>
<th>District area km$^2$</th>
<th>Precipitation</th>
<th>Runoff '000 m$^3$/yr</th>
<th>Useful volume '000 m$^3$/yr</th>
<th>Water used in 1980 '000 m$^3$/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>Ground-water</td>
</tr>
<tr>
<td>01</td>
<td>7 304</td>
<td>7 450</td>
<td>3 462</td>
<td>3 750</td>
<td>3 050</td>
</tr>
<tr>
<td>02</td>
<td>7 314</td>
<td>7 197</td>
<td>3 400</td>
<td>3 550</td>
<td>2 650</td>
</tr>
<tr>
<td>03</td>
<td>8 464</td>
<td>5 811</td>
<td>1 316</td>
<td>1 950</td>
<td>1 000</td>
</tr>
<tr>
<td>04</td>
<td>10 417</td>
<td>14 300</td>
<td>12 896</td>
<td>10 600</td>
<td>9 750</td>
</tr>
<tr>
<td>05</td>
<td>9 976</td>
<td>15 600</td>
<td>8 895</td>
<td>8 750</td>
<td>8 500</td>
</tr>
<tr>
<td>06</td>
<td>3 201</td>
<td>1 470</td>
<td>219</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>07</td>
<td>12 223</td>
<td>8 837</td>
<td>1 981</td>
<td>2 950</td>
<td>1 900</td>
</tr>
<tr>
<td>08</td>
<td>13 162</td>
<td>9 766</td>
<td>3 356</td>
<td>4 600</td>
<td>3 250</td>
</tr>
<tr>
<td>09</td>
<td>13 696</td>
<td>10 599</td>
<td>4 356</td>
<td>4 950</td>
<td>4 100</td>
</tr>
<tr>
<td>10</td>
<td>10 389</td>
<td>6 596</td>
<td>7 120</td>
<td>7 600</td>
<td>6 900 (1)</td>
</tr>
<tr>
<td>11</td>
<td>7 213</td>
<td>4 422</td>
<td>4 419</td>
<td>4 750</td>
<td>4 200 (2)</td>
</tr>
<tr>
<td>12</td>
<td>11 240</td>
<td>8 780</td>
<td>10 983</td>
<td>11 300</td>
<td>10 900 (3)</td>
</tr>
<tr>
<td>13</td>
<td>8 312</td>
<td>8 074</td>
<td>1 355</td>
<td>2 600</td>
<td>1 300</td>
</tr>
<tr>
<td>14</td>
<td>9 011</td>
<td>4 500</td>
<td>1 080</td>
<td>1 250</td>
<td>1 000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>113 402</strong></td>
<td><strong>64 838</strong></td>
<td><strong>69 000</strong></td>
<td><strong>58 700</strong></td>
<td><strong>10 300</strong></td>
</tr>
</tbody>
</table>

Note: (A) Urban use (B) Agricultural use (C) Industrial use (D) Total. (1) 4 219 from F.Y.R.O.M., (2) 2 300 from Bulgaria, (3) 7 430 from Bul. & Turquie.

Source: Centre of Planing and Economic Research (K.E.P.E.).

The country is divided into four climatic zones of different temperatures and rainfall distribution during the year. a) The lengthy dry season (3-5 months) during the year, with high temperatures often reaching over 40 degree C; b) the stream-like rivers with very low water discharge during the dry season and c) the inadequate and uneven distribution of the average annual precipitation among Eastern Western and Insular
areas of the country, create the need for expensive infrastructural works for the water supply among the
peak period of irrigated crops. Agriculture is the main consumer of water used. In 1993 the estimated
amount of total water use was 8 706.3 million m³ (see Table 8).

Table 8. Water uses (1993)

<table>
<thead>
<tr>
<th>Water use</th>
<th>Volume `000 m³</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>7 600.0</td>
<td>87.3 (1)</td>
</tr>
<tr>
<td>Domestic</td>
<td>964.1</td>
<td>11.1 (2)</td>
</tr>
<tr>
<td>Industry</td>
<td>142.2</td>
<td>1.6 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>8 706.3</td>
<td></td>
</tr>
</tbody>
</table>

Source: (1) Eurostat, (2) Estimated.

A detailed analysis of the above amount shows that 3 100 million m³ that is used by agriculture stems
from groundwater resources. Agriculture uses more than three-quarters (80-85 per cent) of the country’s
water available supplies of all uses. The country is a “water deficient” of average less than 1 000 m³
water supplies per person per year.

Greek government has the responsibility for planning, financing and applying for all land reclamation
projects (flood control, soil conservation, irrigation and drainage, transportation of potable water, etc.).
The main Authorities of governmental plans of land improvement projects are a) the Ministry of
Agriculture and b) the Ministry of Environment, Town Planning and Public Works. Since 1990, the
Ministry of Agriculture has evolved a National Project of infrastructural works, small dams and artificial
reservoirs, constructed in the insular and less favourite areas in the country for both urban and irrigation
purposes.

The use of irrigated water has increased markedly over the last 20 years. Before 1978 there were
853 000 hectares of irrigated land and today the amount is 1 320 000 hectares with a rate increase of
64.7 per cent. These are collective works and the authorities in charge are the Land Improvement Local
Boards (T.O.E.V.) for the local works and the Land Improvement General Boards (G.O.E.V.) for the
general works that affected more than one local work. The irrigated land from the collective irrigation
works is 40 per cent of the total irrigated land in the country. Table 9 indicates the main crops irrigated by
the collective irrigation works.

The T.O.E.V. are self-administrated organisations, established and operating with the principles and the
guidelines of the concepts of the co-operative institutions, for the local irrigation (or drainage) constructed
works. They are administrated by a 5-member or 7-member administrative council elected by the General
Meeting of the Representatives. The Representatives are elected by the Local Meeting of the
Member-owners that benefit from the collective irrigation (or drainage) works. The owner of land
properties that benefit by the works are charged by the Organisations to pay service fees and charges that
cover the administration, maintenance and operation expenses. Today 408 T.O.E.V. have the
responsibility for the budget, the sharing charges and fees amongst the benefited farmers and the
collecting of revenues from self-operated mechanisms or from specific procedures through by
Agricultural Bank of Greece (loans) and decentralised local Public Finance Service (D.O.Y.). The
G.O.E.V. are semi-governmental organisations, established by the government for general (more than one T.O.E.V.) affected works. They are administrated by a 7-member administrative council with five members assigned by government and two members elected by the T.O.E.V.

Table 9. Main crops irrigated by collective irrigation works

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>56,891.2</td>
<td>81,018.2</td>
<td>93,464.6</td>
<td>123,639.7</td>
</tr>
<tr>
<td>Rice</td>
<td>17,008.2</td>
<td>15,525.5</td>
<td>15,037.5</td>
<td>23,677.0</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>41,357.8</td>
<td>34,609.8</td>
<td>38,463.0</td>
<td>46,837.8</td>
</tr>
<tr>
<td>Tobacco</td>
<td>9,896.7</td>
<td>13,710.8</td>
<td>11,904.1</td>
<td>11,922.2</td>
</tr>
<tr>
<td>Maize</td>
<td>77,579.6</td>
<td>107,546.4</td>
<td>105,015.1</td>
<td>93,946.1</td>
</tr>
<tr>
<td>Orchard Trees</td>
<td>48,820.0</td>
<td>51,951.0</td>
<td>68,175.3</td>
<td>71,586.1</td>
</tr>
<tr>
<td>Vines</td>
<td>3,854.4</td>
<td>3,952.3</td>
<td>3,043.2</td>
<td>3,814.5</td>
</tr>
<tr>
<td>Vegetables</td>
<td>22,431.1</td>
<td>27,466.5</td>
<td>17,339.4</td>
<td>20,017.8</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>12,272.9</td>
<td>21,292.7</td>
<td>25,075.0</td>
<td>23,851.8</td>
</tr>
<tr>
<td>Others</td>
<td>11,842.3</td>
<td>14,666.5</td>
<td>30,667.1</td>
<td>22,403.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>301,954.2</td>
<td>371,739.7</td>
<td>408,184.3</td>
<td>441,696.4</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture.

Agriculture in Greece has been determined by the physical and social landscape in which it operates. Traditionally this has involved high levels of direct consumption and diversity in the crops grown. Agricultural holdings are generally small and divided into a great number of parcels with a high percentage of the local work force actively employed in farming, often in a part-time capacity. The multiple job holding, small farms, local markets and diverse low input cropping have supported an adaptive agriculture capable of responding to the uncertainties of the physical and climatic environment.

Agriculture in Greece is constantly under pressure from the other sectors with much higher potential and economic weight and usually end up reducing part of the share of agricultural water use. Highly productive agricultural land is not more than one half of the total agricultural land, mainly concentrated on plain and coastal areas of the country. Two kinds of pressure are exerted on this land: one that leads to changing of its use towards tourist activities, tourist infrastructure, etc. The second relates to degradation due to intensive farming. In the first case, the problem is especially acute on the insular part of the country, where one can find islands that are depopulated during winter, while during summer, they become overcrowded by tourists, mainly using small areas of productive land for summer resorts. It is in those cases that agricultural products, which were previously locally produced, have to be transported from the mainland on highly expensive terms, in order to feed those over-populated areas. In the second case, intensive farming, aiming at getting highest effectiveness, is bound to lead to considerable strain upon natural resources of the area and, hence, to environmental degradation. There is, however, one more aspect, namely the intensive farming on marginal land in areas where most fertile land has been used for other purposes (industrial uses, resort, etc.). In this case, intensive farming, used to substitute fertility,
again exerts considerable strain upon natural resources, while it may not render the aimed level of effectiveness. In countries like Greece, retaining most of highly productive land for agricultural purposes may result in relatively higher environmental benefit than would have been the case if this land was used for other non agricultural purposes, because in these areas there were constructed many infrastructural works (flood control, large irrigation schemes, drainage works, etc.).

The average consumption of fertilizers units per ha in Greece is very low when compared to other European partners; it represents the 87 per cent of the EU average and it is 2 times lower than that of the UK, 3 times lower than that of Germany and 5 times lower than that of the Netherlands. It should be noted that, although the average consumption of Nitrogen fertilizer units per ha was increased during 1980-90 by 26.8 per cent, the annual rate of increase during the second half of the decade was significantly lower (1.1 per cent) than that of the first one. This increased use of fertilizers was mainly due to the subsidisation policy which was implemented until 1992. However, since July 1992, all fertilizer subsidies have been abolished, and this is estimated to have lead to a decrease of per hectare consumption down to the 1980 level.

Total population of Greece is 10.2 million, of which 3.5 million live in the area of the Capital city, Athens. Since 1951, the country has started to lose its agricultural character, although it still remains less urbanised than most of other OECD countries. It is important to note the reversing of the age pyramid, especially in the rural areas, with an average age exceeding 55 years. There are many mountainous and insular parts in the country difficult to approach, which cover over 50 per cent of the total area. There still lives 20 per cent of the total population, in about 10 000 small and medium sized settlements, most of which have been characterised as traditional and perceivable. The great number of rural settlements have proved to be economically non viable and this has lead to gradual depopulation and, eventually, to soil erosion. In fact, more than 60 per cent of the remaining mountainous and insular rural settlements of this type, already inhabited by the 18 per cent of the population, are at the verge of depopulation, land abandonment and, finally, of soil erosion.

A great part of the active working population (20 per cent of the total) involved in farm work of some form, although, many of them have other sources of income. The average age of Greek farmers exceeding 58 years, for reasons mentioned above, and moreover, due to the unwillingness of farmers children to continue farming. The model of economic growth in Greece aims at increasing the average farm size level from 3.5 hectares in 1971 to 4.3 hectares in 1991, although this still represents only the 25 per cent of the EC average one.

Contrarily to most other countries of northern Europe, major environmental degradation is merely due to relative scarcity of water resources, especially in southern and insular part of the country and much less to pollution that is caused from intensive farming practices. As it has already been argued, the average consumption of chemical inputs per ha is relatively low and it is expected to lower even more given the abolition of all fertilizers subsidies. However, this does not mean that there are no areas that intensive use of chemical inputs is taking place. Moreover, it is important to note that one fourth of all surface water has its origin outside the country’s frontiers (Table 7). On the other hand, drought, which is an ordinary natural phenomenon in Greece, may cause scarcity of water resources. In Greece as much as 50 per cent of water resources is lost into the sea, 40 per cent evaporates and only 10 per cent is percolated into the soil. So, an intensive use of this limited amount of groundwater, especially on flat and/or coastal areas, almost certainly leads to a lowering of groundwater level and to saltwater intrusion; this it may cause a gradual degradation of both soil and groundwater resources. According to provisional measurements, saline water covers about 30 000 hectares of agricultural land (2.3 per cent of the total irrigated land).
There is an increasing number of individually supplied water installations, that play a crucial role to irrigated crops during the peak period. Most of these works are financed with loans from the Agricultural Bank of Greece (A.T.E.), which is the main source of interest capital loans to farmers. This supported much of the capital investment of the private sector, and enhanced the expansion of irrigated agriculture. Today, loans are more difficult to obtain by farmers struggling to borrow money for the purchase of agricultural technologies which are becoming more expensive, both in unit cost and in terms of meeting the demands made upon them as degradation becomes more extensive (i.e. the need for deeper drilling). Groundwater plays an important role in water resources availability and represents the 41 per cent of the total water used in agriculture.

3. Main policy issues and objectives

In this section there is a selection of issues relative to water quantity and quality, which have over-arching implications for agriculture in Greece.

Water property rights

The Legislative Decree 608/1948 Administration and Management of Water used in Irrigation stipulates public and private water used in irrigation. Thereafter, the jurisprudence has decided that the water under the surface of the private land property is private water and belongs to the owner of that land. Government is empowered by «eminent domain» privileges to override this private property right. The Law No. 1739/1987 states that «Water is a physical good», for covering social needs, and sets up some principles for the water resources management. The Presidential Decree 256/1987 «Water use license» enumerates the water uses as follows: Agricultural, Urban, Industrial, Environmental, Transportation, etc. The competent Authorities for giving these licenses are the local decentralised services of the following Ministries respectively: Ministry of Agriculture, Ministry of Internal Affairs, Public Administration and Decentralisation, Ministry of Development, Ministry of Environment, Town Planning and Public Works, Ministry of Transportation’s.

Water property rights for quantity and dependable flow of suitable quality, and therefore for protection from pollution, is a basic requirement for agricultural development. In Greece these rights are significant, especially in the rural context for settlement of water conflicts. They are based on the law, on customary rules and on administrative licenses. Water allocation to different users is administrated through water licenses, which allow to prevent or to minimise water conflicts. Since 1987 irrigation water is not a “appurtenant” to the irrigated land and any legal entity or person must obtain a license for agricultural water use. The provisions for the water resources management depend on the Greek, EC and International Laws upon the Water Relation and the Protection of the Environment.

Water deficiency

Taking into account the dry and warm climatic conditions generally prevailing in the country, and especially during the irrigation peak period (15 July-15 August), agriculture has become the major water consumer. As it is the case in most countries of the Mediterranean Basin with similar warm climatic conditions and uneven rainfall over the year, the estimated use of water used in agricultural activities amounts to 80-85 per cent of the county’s total water consumption (Table 7).
Structural weakness

The small farm size is approximately 4.3 hectares. The number of farms is 850-900,000. The average age of Greek farmers is 58 years and there is an unwillingness of farmers’ children to continue farming. Due to the law of inheritance, a great amount of the total agricultural land has belonged to non-agricultural owners, and thus there is no strong connection with the agricultural associations and agricultural production.

Rehabilitation and modernisation of the existing collective irrigation works

The infrastructure works (flood control, surface and deep drainage, irrigation project, etc.) were aiming at modernising the agricultural sector in Greece, protecting the plain from sedimentation and the rural population from malaria and other diseases. A wide range of technical obstacles must be overcome to insure the sustainability of irrigation. These include flooding, waterlogging, salinity, silting of reservoirs and deterioration of infrastructure. They affected the few large areas (plain and coastal ones) of the country, where the land can economically be irrigated by gravity flow. That land is located on the banks of large rivers where the construction of diversion structures were feasible to operate.

The problems are solvable in principle, provided that necessary economic resources are available. The irrigated land that benefits from collective irrigation works, measures 441,696.4 hectares (1995) and the number of administrative units responsible for the operation and maintenance are 408 local (T.O.E.B.) and 10 regional (G.O.E.B.). Many of the existing irrigation systems were designed and constructed 30-40 years ago and are still using the same technology. Rehabilitation and modernisation can minimise waste, reducing drainage requirements and promoting irrigation with essential concurrent operations (e.g. Fertilization, tillage and pest control). In many places, inefficiency is perpetuated by institutional inertia and conservative attitudes are a part of the problem. Some of the new irrigation systems developed in the industrialised countries are indeed too highly mechanised, complex, energy-intensive and large in scale to be directly applied to low-capital, low-technology areas, where farming is often practised on a small scale and the relative costs of labour and capital are very different. Hence ready-made modern technology often fails when introduced arbitrarily into these areas. Modern communication and water control technology support a service-oriented mode of operation as opposed to supply-oriented mode. These technologies respond to T.O.E.V. and G.O.E.V. demand for more flexible irrigation services, enabling crop diversification and market-oriented production. Moreover, modernisation has provided the greatest potential for convenient services, and environmentally and economically sustainable operation to the irrigation systems.

4. Main policy measures and approaches

The Regulations (EEC) No. 797/85 and 2328/91 “on improving the efficiency of agricultural structures”, provided economic measures for the installation of modern irrigation systems (sprinkler or low-pressure sprayers), the construction of boreholes and for farm machinery purchase through a farm’s “Improvement Plan”, as well as for the environmental purposes and rural and agricultural amenities. The Ministry of Agriculture has made a draft proposal for the establishment of a Water Resources Management Organisation.

Due to the water deficiency and the climatological drought, the government is considering the need of constructing expensive infrastructure works for both urban and agricultural purposes in the less favourable areas of the country (flood control, soil conservation, drainage, irrigation, etc.). These works are planned,
financed and applied by competent authorities with terms provided by Environmental Impacts Studies, according to the Laws No. 1650/86 and No. 1739/87 and the ministerial decision No. 69269/5387/25-10-90. Furthermore there is a quality measurement programme in action, of the water resources used for irrigation, according the EC Directives No. 77/795, 81/856 and 86/574.

The National Land Registry has been created quite recently with a specific timetable, and it is being carried out in two distinct stages: Stage A 1994-1999 and Stage B 2000-2009, at an estimated total cost of $ 900 million (250 billion dr) by the Ministry of Environment, Town Planning and Public Works with financial aim from the EC relative programme.

The government is beginning (with respect of the Legislative Decree No. 1277/72, Art.1), to make post-evaluation studies for existing large irrigation schemes, on a one-by-one basis, for planning, financing and applying rehabilitation and modernisation, taking into account the technical and organisational requirements such as:

- **Matching the design to the user’s capacities**
  The choice of the hydraulic restructure to control water needs to take account of users’ capacity, preferences and social coherence. Flexibility of operation is a key criterion because social and economic patterns were changed with time.

- **Designing for maintenance**
  The layout, dimensions and reconstruction of a system determine maintenance as well as operational requirements. The available skills and resources for maintenance need to be considered. Knowing whether maintenance will be done through individual or collective effort and whether maintenance has to be paid in cash or contributed in labour is equally important.

- **Designing for freedom of crop choice**
  They take into account the economic, social and farming conditions, the need for crop choosing and therefore farmers spread their risk and respond to changing variables like the water or commodity prices.

- **Designing for labour capacity**
  The amount and timing of labour demand are important issues. Choice of a plot size significantly affects labour requirements to irrigate with small individual drip systems.

- **Designing to reduce dependence on external inputs and services**
  The choice of infrastructure should be influenced by the local capacity for operation and maintenance. For example, central pumping stations should be replaced by decentralised smaller pumps at different locations that may be easier to maintain. Flexible cropping patterns usually reduce the dependence of a scheme on particular marketing services or on the supply of specific inputs.

- **Designing with consensus**
  The design process should incorporate regular discussions with the water users’ Organisations. A wide range of technical options need to be discussed to ensure that farmers’ priorities are taken into account, including the site, the plot size, method of field irrigation, etc. to avoid costly modifications and that the costs do not exceed those of conventional designs.
The pattern of water use can serve as an indicator of development: as wealth increases, so does the water withdrawal shift from agriculture to industry and the domestic sector. The issue of water scarcity in Greece is very complex due to the climate and physical characteristics of the country. With increasing pressure on limited water resources, competition is certain to increase among neighbouring regions, and among sectors within regions. There is no strong and technically explicit body of law to extend its jurisdiction beyond the simple sharing of annual quantities of river water to more complex questions of sharing during droughts and floods, to pollution problems, and to shared groundwater resources.

The present legislative provisions for water resources management and the protection of the environment, obligate the local administrative authorities of each county to set up an appropriate and effective permit and penalty system for the two above purposes. According to this system, one must obtain a license for groundwater abstraction from aquifers and surface water resources, and for all agricultural purposes and uses (irrigation, livestock, aquaculture and agricultural industry purposes). These licenses are clarified on a case-by-case basis taking into account all of the relevant aspects for protecting aquifers against overpumping and water resources depletion. The license for the water use includes the legal status of the user, the purpose, the amount, the location, the duration and the technical characteristics of the abstraction. The local administrative authorities set up an annual administrative decision with relative measures, penalties and fines for those who construct water supply works without license or violate the licence’s terms. Moreover The Public Electricity Company (D.E.I.) refuses to make the necessary electrical connection for the installation without a valid license provided.

Since 1970 the above-mentioned Company has implemented a programme for farm electrification which provides advice about electrical installations and offers reduced costs for farm machinery and non-dwelling farm buildings.

Training programmes for farmers on water management and use for irrigation as well as for the maintenance of public and private irrigation constructions are provided by qualified professionals. Short-and middle-term programmes are released in the Centres of Vocational Agricultural Education (K.E.G.E.), established throughout the country. The educational and training programmes for the new-aged farmers supported by EU Reg. 2328/91, are released at the Technical and Professional Schools (T.E.S.).

5. **Budgetary and economic costs associated with the implementation of these policy measures and approaches.**

Investments in agriculture have had a remarkable decrease over the last four decades:

- The public investments in agriculture as a part of the total Agricultural investments, had decreased from 52.8 per cent in 1961 to 39.5 per cent in 1991 and thereafter with an average annual decrease of 3.4 per cent in stable prices.

- The above investments as a part of the total public investment in Greece had decreased from 24.1 per cent in 1961 to 7.3 per cent in 1991.

- The total private sector investments in agriculture have decreased from 17.1 per cent in 1961 to 5.1 per cent in 1991.

Investments in water infrastructure works (irrigation systems, drainage, flood protection, waterlogging, roads and electricity) are rather low, and represent only 5 per cent of the total Greek public investment.
programme. Table 10 shows the trend of the public investments (expenses) in agriculture compared with the total infrastructural public investment.

Table 10. Public investment in land reclamation works (’000 million dr)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EXPENSES at current prices</th>
<th>INDEX</th>
<th>EXPENSES at 1982 prices</th>
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<tr>
<td></td>
<td>Total</td>
<td>Agr. Water Infrastructure</td>
<td>Price in 1982</td>
</tr>
<tr>
<td>1975</td>
<td>4.22</td>
<td>1.22</td>
<td>3.20</td>
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<td>1976</td>
<td>4.20</td>
<td>1.57</td>
<td>2.84</td>
</tr>
<tr>
<td>1977</td>
<td>4.55</td>
<td>1.65</td>
<td>2.53</td>
</tr>
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<td>5.04</td>
<td>1.81</td>
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<td>8.44</td>
<td>2.55</td>
<td>1.20</td>
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<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>37.85</strong></td>
<td><strong>-</strong></td>
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<tr>
<td>1982</td>
<td>9.71</td>
<td>3.30</td>
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</tr>
<tr>
<td>1983</td>
<td>8.85</td>
<td>4.63</td>
<td>.834</td>
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<tr>
<td>1984</td>
<td>9.90</td>
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<td>1985</td>
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<td>1987</td>
<td>13.17</td>
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<td>1988</td>
<td>15.30</td>
<td>9.96</td>
<td>.362</td>
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<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>106.63</strong></td>
<td><strong>-</strong></td>
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<tr>
<td>1990</td>
<td>23.80</td>
<td>14.90</td>
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<td>1991</td>
<td>30.20</td>
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<td>1992</td>
<td>59.15</td>
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<td>69.36</td>
<td>48.36</td>
<td>.168</td>
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<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>182.51</strong></td>
<td><strong>-</strong></td>
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<tr>
<td>1994</td>
<td>59.76</td>
<td>38.91</td>
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<td>1995</td>
<td>51.69</td>
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<td>1996</td>
<td>47.71</td>
<td>27.18</td>
<td>.128</td>
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<tr>
<td></td>
<td><strong>SUBTOTAL</strong></td>
<td><strong>159.16</strong></td>
<td><strong>-</strong></td>
</tr>
<tr>
<td>TOTAL</td>
<td>-</td>
<td>-</td>
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</table>

Source: Ministry of Agriculture.
It has been argued that the T.O.E.V. charge their members to pay service fees and charges that cover the administration, maintenance and operation expenses of the local large irrigation (or drainage) collective schemes. In 1994 the total amount of these charges and service fees was 22 billion dr and the average expenses was 50 000 dr per ha (US$ 92 million and US$ 210 per hectare respectively). In the same year, the T.O.E.V. employed 600 permanent employees and 5 000 seasonal working people.

Until 1995, 94 908 individual small irrigation schemes and 17 981 livestock installations and non-dwelling farm buildings were connected with electric power and the total amount of the public investment share was 16.7 billion dr (US$ 68 million).

The Agricultural Bank of Greece (A.T.E.) give short-and long-term loans to the farmers with current interest for their need for the agricultural activities including loans for irrigation.

The educational and training programs for the new-aged farmers and for continued professional education for all agricultural activities were financed by the European Social Fund.

6. Effects on agriculture, water, and the environment of these policy measures and approaches

The pattern of water use can serve as an indicator of development: as wealth increases, so does the water withdrawal shift from agriculture to industry and the domestic sector. With increasing pressure on limited water resources, competition is certain to increase among neighbouring regions, and among sectors within regions. Greek legislation always gives priority to potable water use. There is no strong and technically explicit body of law to extend its jurisdiction beyond the simple sharing of annual quantities of river water to more complex questions of sharing during droughts and floods, to pollution problems, and to shared groundwater resources.

In areas with saltwater intrusion, conjunctive use of surface and groundwater consists of combining the use of both sources of water in order to minimise the undesirable physical, environmental and economic effects, and to optimise the water demand/supply balance. This possibility should be systematically explored when considering a river basin management programme, which should take into account the following major factors for accessing the feasibility of the above conjunctive use: a) the underground storage capacity that should be able to absorb important volumes of flood in a short period of time; b) the production capacity of the aquifers that should be able to return the water stored as significant discharge per unit production well; c) the availability of excess surface water for recharging the aquifers; and d) the economic and environmental benefits derived from this option compared with surface storage alternative. The case of Argolid Valley was discussed.

Rehabilitation and modernisation can minimise waste, reduce drainage requirements and promote the irrigation with essential concurrent operations (e.g. fertilization, tillage and pest control). In many places inefficiency is perpetuated by institutional inertia and conservative attitudes are a part of the problem. Modern communication and water control technology support a service-oriented mode of operation as opposed to supply-oriented mode. These technologies respond to the T.O.E.V. and G.O.E.V. demand for more flexible irrigation services, enabling crop diversification and market-oriented production. Moreover, modernisation has provided irrigation systems with the greatest potential for convenient services and an environmental and economical sustainable operation. It is absolutely necessary to take into account the special requirements mentioned in Section 4.
7. Future developments to address emerging concerns

Policy makers must take into account the following factors in examining ways for a rational management of water resources used in agriculture: the uneven spatial allocation of water resources in Greece (mainly due to morphological and geological land composition, and uneven rainfall distribution); a quarter of the total surface water originating outside the country; long dry seasons during the year; the periodical appearance of drought; and limited highly productive land. This could be achieved by shifting towards crops and cultivation techniques that are less water consuming and by devising an integrated protection scheme addressing water management, soil erosion and water utilisation, and including broader environmental purposes.

The National Land Registry will allow to ensure a rational allocation of land use and a lower pressure in agriculture, in insular, coastal and peri-urban areas of the country. That land inventory should be implemented according to the financial framework of Reg. 2328/91, to maintain active farm population in rural areas with direct relation to sustaining a healthy environment, and may provide the basis for enhancing multifunctionality in rural areas of the country.

8. General discussion

In Greece, the agricultural sector is characterised by constant change, culminated in the developments that followed the accession of the country to the EEC. Most agricultural commodities are used as food. Trends in food consumption per capita are important for the development of the sector. New technologies at farm level have been introduced, implying change in the structure of production and the input mix. An examination of past trends, reveals major changes in food consumption. Such changes, as well as the four-fold increase of expenditure on meat, and to a smaller degree on other food items, except for bread and cereals, show that the increase in income had a significant impact on the allocation of food expenditure to the various food items. The decrease in the budget share of food is a direct consequence of the increase of incomes.

The trade balance has always been in surplus for crop products and in deficit for livestock products. The composition of output has remained unchanged, and the crop output constitutes about two-thirds of total agricultural output. An observation in support of the long-term nature of this characteristic is that fixed capital stock in agriculture has increased substantially in perennial crops (orchards), while animal numbers have remained relative stable or have even declined in certain cases. Changes in input prices may also have a significant impact on output composition and input use. The labour cost constitutes the major cost item on agricultural production and determines the adoption of mechanical technology. Changes in consumption patterns should ultimately be linked to shifts in production patterns. This link has not materialised in Greek agriculture, with adverse consequences on the trade balance of the sector. Although the concentration of exports on crops and the imports on livestock products has characterised Greek agricultural trade patterns since 1960, the trade balance turned negative after the Greek’s accession to the EEC. Agricultural exports are confined to certain crop products, e.g. fruits and vegetables, tobacco, cotton, etc.. Agricultural imports are almost entirely livestock products, mainly meat, milk and cheese. The agricultural exports are concentrated on products with unstable prices and relatively small demand elasticity and the agricultural imports are consisted by products with stable prices and relatively high demand elasticity.

Many billion dr of public and private investment are already in place. Incremental investment in modernisation, completion, and rehabilitation will benefit from these “sunk costs” and yield high rates of return. Technological developments in agronomy, even the pace of their arrival slows down, can improve
the returns to irrigation. Indeed the availability of an assured supply of soil moisture is a precondition for many of the forthcoming agronomic and biotechnology projects. Progress in engineering (such as drilling techniques, use of cheap and light plastic, and advances in the management of construction) should lower capital costs of water.
ITALY: THE CAPITANATA IRRIGATION SCHEME — EXPERIENCES IN WATER SUSTAINABILITY

by Marcello Mastrorilli (Istituto Sperimentale Agronomico — Bari), Pietro Corona (Consiglio Superiore dell’Agricoltura — Roma) and Giovanni De Seneen (Consorzio di Bonifica della Capitanata — Foggia)

Summary

The Capitanata irrigation scheme is located in Apulia, southern Italy, and is characterised by scarce water resources and high water losses by crops. It is run by a Consortium (the Consorzio di Bonifica) that associates almost all farmers over an area of more than 200 000 hectares. The Consortium is in charge of the water resource survey, distributing water to farms and maintaining the conveyance systems.

Since water is scarce with respect to demand by farmers, the Consortium operates into three directions in order to make the use of water sustainable in semi-arid environments:

- **Extension services**: This covers the services provided through VIDEOTEL to farmers for the weekly prediction of water needs by the different crops of the area. It is intended to make VIDEOTEL services available on INTERNET. A number of flow meters at the upstream head of the irrigated fields allows to compare the volume used by farmers with the recommended one.

- **Water pricing**: a special tariff (binomial) is applied to those farmers who exceed the irrigation volumes recommended by the technicians of the Consortium.

- **Survey of alternative sources of water**: the possibility of recycling waste waters from cities for use by agriculture is under study.

1. **Introduction**

A good knowledge of the different water bodies in the area and of their physical origin is important for a sound and correct use of water resources relative to the different water uses and the decision-support to be taken for matching the needs in the different sectors of drinking, agricultural, industrial and municipal sectors (referred to domestic hygiene, artisanship, public and private gardens and so on).

After describing the major Italian hydrographic systems, the present law on defence of waters will be presented, and a special case study will be examined: the Capitanata irrigation scheme.
Capitanata is located in southern Italy (province of Foggia) and presents problems related to the sound use and management of water resources. In this area, water resources are scarce with respect to the demand by farmers. Farmers have proved to have a great entrepreneurial capacity in converting their farms from extensive to intensive agriculture, through the introduction of irrigation. The challenge now is: will the farmers be able to use water in a sustainable way?

2. The Italian hydrographic situation

Orography is the main cause of the big differences in hydrographic and hydrologic situations between the north and the centre-south of Italy. It influences the spatial and time changes of weather perturbations.

In fact, the Alpine mountain chain in the north acts as a barrier to rain and snow formation and helps the formation of precipitation in that area and in the Po valley and Veneto plains, also during the hot season. Therefore, the high altitudes favour the formation of glaciers and masses of perennial snow which are the cause of the continuity of summer water flux in the hydrographic system of northern regions.

Moreover, in the north there are important geological formations that help maintain water, and different calcareous massifs which increase in the Alps, the accumulation effect already guaranteed by glaciers.

In the plains of those fertile areas, water richness has increased, thanks to the nature of alluvial soils, which are permeable and suitable for the formation of huge aquifers. The regulation of large Alpine lakes strongly increases the availability of water in the northern regions.

The central, and even more so, the southern environments are different. The latter are characterised by the presence of the Apennine watershed, including its continuation in northern Sicily.

By analogy with the setting, we can compare the Sardinian-Corsican massif to the Apennine orography.

Of course, we are interested in the central-eastern Sardinian segment. These mountain chains, due to their height, cannot produce the same rainfall as those in the north. Glaciers are formed, but there are only short-lived snow accumulations.

As a consequence, there is nearly total meteorological aridity from April through to September, which is not counterbalanced by water flows in the hydrographic network, except for some areas in the Centre, with the rivers Tiber and Arno; and in the South with the river Sele and others few cases, unfortunately very unusual, where the source supply occurs and this is caused by propitious geological formations with an accumulation capacity.

In fact, the covering of impermeable schists of most of the Apennine basins and the impermeability of many plains crossed by the rivers, produce the surface losses of autumn and winter rainfall, which is not as intense as in the Po valley and subject to recurrent, plurannual droughts.

A special aspect is the smallness of the flow of the few aquifers of these regions, often threatened by the salinity of sea water, as in the case of Apulian coast lines. Therefore, much attention is required during withdrawal of water in order to preserve and ensure the sustainable use of these aquifers.

For this purpose, the former Cassa per il Mezzogiorno (The Southern Italy Development Fund) has carried out the only possible type of action; which is, the regulation of water flows through reservoirs for
different uses. In fact, it is necessary to provide water for drinking purposes and for a well-balanced development of the whole southern economy, which is impossible without adequate quantities of water.

As far as irrigation is concerned, it is to be pointed out that in 1950 only 50,000 hectares were irrigated thanks to the Cassa per il Mezzogiorno. Nowadays, there is a surface area of 900,000 hectares, with dams and water systems which have to meet the water needs, but also ensure the transfer of water to face the needs in the inexorably dry years.

3. Irrigation and legislation

Legislation to regulate the use of water resources has been professionally set up. This legislation has taken into account the evolving situation that has given priority to the problems of pollution, water bodies safeguard, priorities in use and water saving.

However, legislation on water has always aimed at gradually exceeding the private criteria and those of individual property and discretionary use of this irreproducible good. From an historical point of view, there has been an evolution, increasingly oriented to meeting the general needs for public interest and giving priority to the various uses of special social and economic importance. The issuance of the C.A. No. 1775/33 on water and hydroelectric plants confirmed the principle that water, for uses of general interest, is public.

Over the last 40 years Italy has progressively managed to be part of the seven more developed countries. However, the improved standard of living has resulted in increased urbanisation and huge and unexpected increases in water consumption, with great pollution of watercourses and aquifers. This situation led to the issuance of the Merli Law or Law No. 319/76, aimed at controlling, in an organic way, the problem of municipal and industrial release of pollutants in water bodies. This measure has turned out to be little efficient also because of its inadequate application.

The same problems emerged at the international level which led to changes in domestic and community policies on water resources. As a result, in our country there has been the issuance of the Law No. 183 of 18 May 1989 on soil conservation. Although the contents of this milestone of our legislation are well known by other countries, it is important to remember that Law No. 183/89 confirms a key principle: the guiding concept according to which water use and its protection must both be considered within the hydrographic basins which they refer to.

In fact, water use and protection are two different aspects of the sole indissoluble problem of water resources management. Through basin projects (all related to topics towards a sounder use of surface and underground water), resource management involves efficient hydraulic, irrigation and aqueduct systems, assuring the multiple water uses and the safeguard and improvement of water bodies.

At last, the control of water use has been integrated with the issue of the Law of 5 January 1994, No. 36 on water resources. This Law, known as the Galli Law in its Article 1 makes increasingly binding the principle of advertising authorised users of water, principle which was included in the previous C.A. No. 1775/33, fixing the public character of all kinds of water, that is without taking into account if water can or cannot be of public use.

Moreover, Law No. 36/94 considers, in a uniform way, the problem of water resources management, taking into account the phases of withdrawal, use and release, with greater attention being paid to the quality aspects and, of course, to the different public interests. The concept of integrated water service,
which encompasses all services of water withdrawal, conveyance and distribution, is based on a single-handed water management, without neglecting the phases of negotiation with all concerned public bodies.

Moreover, the law on soil protection confers to the Authority of the hydrographic basin, the task being to fix and update periodically the water balance, with the aim towards assuring an equilibrium between the different needs and the availability of resources which can be found in the same basin.

It is also recommended not only to avoid jeopardising agricultural needs, but on the contrary, to take into account the irrigation-agriculture ecosystem. The law states in its Article 2, sub-section 1, that: “… in drought periods and, however, in the cases of water shortages, during which the diversions in progress are regulated, the agricultural use must be assured just after use for human needs consumption”.

Therefore, due attention has been given to the necessity of assuring crops the quantity of water required at the different growth stages of the growing cycle. This is particularly important in the South were the physical, pedological and climatic conditions make water the limiting factor for agricultural production. The study proposed in this report has been chosen to show one of the most dramatic hydrological situations of the South in Italy.

4. Irrigation water in the Capitanata irrigation scheme

As in most of southern Italy, the Capitanata scheme (about 450 thousand hectares) does not have the huge available reserves constituted by the snow on the mountains, nor sources that could supply perennial water courses of importance. Its main water source (except for some zones having underground water) is the rainfall whose amount and distribution over time (concentrated mainly in the autumn-winter period) affect the cropping patterns and limit them to dry crops (cereals, leguminous and autumn-winter forage crops). Water resources are distributed through collective irrigation systems that cover, in Capitanata, an area of 200 thousand hectares. The whole scheme includes two main irrigation subschemes: the Fortore and sinistra Ofanto. They receive water, respectively from the Fortore dam and the Ofanto river.

What is the extent of the present irrigated agriculture in the agricultural economy of the territory? The analysis of data referring to 1993 results in the situation reported in Table 1. The first data that emerge from the reading of the table is the incidence of the value of the agricultural production obtained through irrigation as compared with the total. Briefly, over one-quarter of the cultivated surface, more than 72 per cent of the gross marketable output, is produced (minus animal farming products — about 170 billion liras). It is evident that the irrigation over about 108 thousand hectares certainly represents the driving factor of agriculture.

It is right to observe here the amount of irrigated areas, not only to stress the importance of irrigation in terms of labour, but also for a more effective interpretation of all the problems related to the use of water.
Table 1. Irrigated crops in the province of Foggia in 1993

<table>
<thead>
<tr>
<th>Irrigated crops</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vineyard</td>
<td>25.5</td>
</tr>
<tr>
<td>Olive trees</td>
<td>7.4</td>
</tr>
<tr>
<td>Orchards</td>
<td>3.3</td>
</tr>
<tr>
<td>Vegetables</td>
<td>22</td>
</tr>
<tr>
<td>Fodder crops</td>
<td>0.9</td>
</tr>
<tr>
<td>Row crops</td>
<td>17.5</td>
</tr>
<tr>
<td>Tomato</td>
<td>20.3</td>
</tr>
<tr>
<td>Wheat</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Total (ha)</strong></td>
<td><strong>108.304</strong></td>
</tr>
</tbody>
</table>

5. Crops grown

By comparing the irrigated surfaces in 1975 with those irrigated in 1993, the evolution of irrigated agriculture in the province is evident. In a twenty year period, the irrigated surface area has increased by 60,000 hectares, i.e. by 123 per cent. It is certain that the collective irrigation systems of the Consortium have contributed to this evolution.

The analysis of trends in grown crops gives evidence, however, of a lack of willingness for innovation. In fact, the crops grown remain basically the same, although there is a regular trend, with the tree crops on the increase to the detriment of the fodder and row crops.

Cropping patterns are especially determined by the structure of the farm and their size in particular.

The Capitanata scheme (with the plain area in particular), is equally affected, as is generally the case in Italy, by the problem of the reduction in the agriculture area.

However, the reduction in the number of farms has not entailed an increase in the average size of farms. The average value is of about 8 hectares but the farms that tend to consolidate and play a decisive role in the productive economy are those between 10 and 50 hectares.

The number of farms smaller than 5 hectares is however high. They indicate the presence of a type of agriculture that is not marginal but that is integrated in a production system where part-time (agricultural or extra-agricultural) labour is a supporting element.

Indeed, this is the type of farming typical of the area around cities and villages. Moving far away from the villages, agriculture becomes more efficient, more modern and mechanised and better integrated in the market: well defined fields, modern mechanisation and cultivation techniques, efficient production structures in terms of farm surfaces and farm equipment.

Both in the Fortore scheme and in the sinistra Ofanto scheme, the driving element for change is the expectation of producing an income; therefore:
— in small farms, tree and shrub crops play a major role since they allow to stabilize income in the long term and a better distribution of family labour;

— in larger farms, herbaceous crops do prevail: industrial row crops and vegetables. Among the latter, yearly fluctuations are observed depending on the prices, on the market demand and also, simply, because of a tendency to imitate others.

Land tenure in the two irrigation schemes is profoundly different; in sinistra Ofanto, the small and medium farms are quite widespread, so much so that the average farm size is of 1.73 hectares, whereas in Fortore, tree crops prevail and the average farm size exceeds 10 hectares.

This land tenure system obviously has some repercussions on the cropping patterns: in sinistra Ofanto, tree crops prevail (vineyards, olive trees and orchards cover more than 70 per cent of the irrigated surface), in the Fortore scheme, more mechanised herbaceous crops better adapted to larger farms prevail; among the latter, tomato and sugarbeet play a major role. A lesser surface is grown with vineyard and olive trees.

A further element of this scenario is the leopard-spot diffusion of irrigation from well waters. However, the characteristic of the hydrogeological system of Tavoliere (Apulian plain) that doesn’t allow the short term recharge of groundwater and the excessive withdrawal from groundwater (due to the great number of unauthorized wells), has almost irreversibly impoverished the groundwater resources.

The above preliminary considerations being presented, a prediction is made of the possible evolutionary scenario of the Capitanata scheme in the medium-long term.

A key question concerns the capacity of the groundwater to sustain the present withdrawal, considering a daily consumption per irrigated hectare of 2 500 m$^3$, should be equal to 150 millions cubic meters per year. The growth rate of storage reservoirs and wells is such that in a few decades irrigation with well waters will be concentrated only at sites particularly favoured by the recharge of groundwater (karst areas at the foot of the Gargano mountains), supposing that there is no further deterioration of the water for irrigation (increased salinity).

The consequence will be the transfer of irrigated herbaceous crops towards the area served by the collective irrigation system, resulting in a massive increase of demand of the already scarce availability of water.

In the last twenty years, rather than an innovation of the product, there has been an innovation of production processes and consequently the more or less considerable increase in specific cropping.

It is very difficult to try and predict the situation in the future. There are too many factors that can interfere and modify any hypothesis related to the development or planning strategy. Among these, it is worth mentioning the availability of water, the community agricultural policy, the market and the capacity to compete, qualitatively and quantitatively, with the European and the Mediterranean partners.

There is no doubt, however, that Mediterranean crops will be given priority in the choice of species to be included in the cropping patterns to be adopted.

Knowing that a further expansion of tree crops is unlikely, due to an excess of the product compared with demand, our opinion is that if we could organise a modern marketing system, there would be very interesting opportunities for the horticultural sector both for industrial processing and for fresh markets.
This is to be correlated both to the strategic position of this region with respect to the major domestic and European markets, and to the mild climate that makes it possible to produce throughout any period of the year, and especially to the organisation and the size of farms. The only obstacle is again, a modern and efficient organisation of the market.

For more than ten years, a large part of the area equipped with irrigation has been oriented to the cultivation of industrial crops: sugarbeet and tomato compete with each other.

6. Action 1: Management of collective irrigation systems and extension service

Since the availability of water is scarce with respect to the demand by farmers, the Consorzio operates in three directions in order to make the use of water sustainable in semi-arid environments.

As previously mentioned, the amount of water allowed has been standardized in all the schemes to 2 050 m$^3$/hectare on the served area. Such a volume has to be used in the course of the irrigation season that generally goes from 1 March to 30 November.

Since irrigation water is delivered on demand, through a pressurised pipe network; it was assumed that no more than 50 per cent of the total volume can be guaranteed in the peak period from 15 June to 15 August.

It has to be observed that in the areas where various crops are grown, in the last two years, the on demand delivery schedule has fully responded to the design functions; in the Fortore scheme, and especially where sown crops prevail, single cropping of sugarbeet or tomato has caused some problems in water supply. This led to the introduction of a rotational delivery schedule which is, indeed, very difficult to perform.

The experience acquired in the course of irrigation management has contributed to transform the approach of the extension service. The need was felt to perform an activity more specifically oriented to irrigation.

In conformity to the Law 54/1981, that appointed the Consorzio di Bonifica as the agencies in charge of extension services in irrigation, technicians have started enriching their competencies in the field of irrigation, with deeper insight in crop water requirements. The first results materialised by the preparation of irrigation technical sheets for main crops grown. These sheets were illustrated during meetings organised at the municipality level, with the trade unions and the offices of the Extension Service of the Consortium.

Later on, the same service worked in activities aimed at a better use of the water resource, through the simple and systematic dissemination of the results found in the literature about irrigation, with special reference to a more accurate estimate of crop water requirements through the collection of the agrometeorological data of the stations spread on the land.

The agrometeorological data, collected in a data bank, are processed at the central office of the Irrigation agency with the help of a special computer software.

The final output materialises into the preparation of weekly bulletins adequately disseminated to farmers with the participation of the associations, co-operatives, entrepreneurs and various offices.
A considerable step foreword in the dissemination of information on irrigation occurred with Telecom, through the National Project Agrivideotel.

Since 1990, the Consortium has acquired huge experience in this sector and has produced, in 1991, according to the provisions of the EEC Regulation 2052/88 co-financed by the Ministry of Foreign Affairs and the Regional administration, a programme for the diffusion of this tool within farms. The information supplied at present is oriented to be a decision-support for the entrepreneur referring to the water volumes and the rotations, so much so that the entrepreneur is capable of interacting with the system by customising the information supplied and adapting it to the cropping needs of his farm.

The major objective is to optimise the use of water by improving the application, the farm and the scheme efficiency. The result must have positive effects on management, since the activity carried out allows to match the needs of farmers with the quality of the service offered by the Consortium, thus harmonising water demand and supply.

The Consortium has to face numerous management problems in the course of irrigation; one of the major ones is certainly the choice of the decision criteria to be adopted when the resource is insufficient to meet the demand. Such insufficiency can be due to:

- the scarcity of stored resources;
- the enlargement of irrigation schemes.

Thanks to its capillary presence on the land, the Consortium can properly assess the gap between water demand and supply and it often denounces the precarious situation that requires increasingly frequent emergency actions.

Another aspect, worthy of consideration, is the problem posed by crop specialisation in some areas. Large areas cultivated with a single crop does not fit in with the management principle of the collective irrigation systems, in that it concentrates the demand of water in space and time. With such a concentration, the conveyance pipes designed to convey the water required to irrigate a scheme with variable cropping patterns, cannot meet the demand; therefore, in order to minimise the risks and damages, a rotational delivery is imposed. Farmers, however, are too used to an on demand delivery to be willing to accept the rotational system.

In future, the Consortium will make huge efforts to intensify field activities in the search of new water supplies, without neglecting the possibility of using unconventional waters and conveying water from other regions. The farmers are asked to make a sounder and more efficient use of water for a better saving and greater benefit to the crops.

In order to control the consumption of water by farmers, the determination of crop water use to be introduced in the water balance, has been done, so far, using the Class “A” pans located in climatically homogeneous areas. At present, 11 agrometeorological stations are in operation and they are equipped with evaporation pans.

By comparing the actual consumptive use of the main agricultural crops with the effective supply (rainfall and irrigation), at the end of the irrigation season, a quite heterogeneous deficit condition is evident: for tomato crop, the cumulated deficit is of low significance percentage wise, whereas for other crops, like olive trees, the deficit is significantly evident. For some autumn-winter crops (for instance autumn
sugarbeet) that benefit from winter rainfall, a positive value was observed and in some cases it is rather high.

Finally, when comparing the water volumes recommended with those actually supplied, the gap is evident, especially for crops irrigated by sprinkling. This can be mostly attributed to organisational problems and to the type of irrigation system used.

7. **Action 2: Water tariffing and irrigation**

In order to discourage the improper use of irrigation water supplied by the Consortium (usually excess volumes are supplied to the crops), a special pricing technique has been conceived: the binomial tariff.

The farmer receiving water, pays a fee for maintenance plus a fee for management. In the first fee he pays a fixed sum depending on the size of the land served by the Consortium. In the second fee, he pays a minimum sum and a share proportional to consumption. The more he exceeds the amount of water assigned to the farms, the more expensive is the water. If farmers, for a given period of time, continue to use amounts of water higher than those assigned to them, the Consortium will be obliged to cut the supply of water.

The amounts of water assigned to each farm are estimated on the basis of a schedule that takes into account the farm surface, the crop grown, the growth stage and the meteorological conditions.

8. **Action 3: Waste water recovery**

The programme for recovering and re-using unconventional waters, foresees actions at three sites: S.Severo, Lucera and Foggia.

*S.Severo:* the available discharge is of about 0.2 m$^3$ sec$^{-1}$ of water, over 24 hours. Such a discharge can be exploited for a period of 9 months and then it would be allowed to recover 4.5 million cubic meters per year. Such a huge amount could be used partly to supply the sectors of districts 11 of the *Fortore scheme* still incomplete, and partly to integrate the requirements of the district from the beginning of the irrigation season in spring to the closure of the system in winter.

*Lucera:* there is the possibility to recover about 0.1 m$^3$ sec$^{-1}$ to integrate the flow to district 5A of the *Fortore* for about 2 million cubic meters per year.

*Foggia:* it represents the most important source of unconventional water recovery in the province. The discharge amounts to about 1 500 l sec$^{-1}$. The volume that can be recovered is of about 40 million cubic meters per year. In this context, there is the possibility to use the Contessa channel (in Manfredonia area) for storage, with a capacity of about 9 million cubic meters.

9. **Conclusions**

The three actions described so far will be much more effective if followed by a stronger and more consolidated professional and cultural maturity in the use of irrigation water. Farmers are mostly concerned, but also public authorities and society are directly involved in the problem of sustainable water use.
Summary

The Japanese agricultural irrigation system has the following characteristics:

- It depends mainly on water diverted from river flows: 90 per cent of irrigated land depends upon river water.
- It has a long history: most existing irrigation facilities were originally developed some hundred years ago.
- Rice cultivation is the major user of the irrigation facilities, since rice requires a larger amount of water than other crops.
- There are a great many users of irrigation water, reflecting the history of small-scale farming.

These characteristics have led to the establishment of local bodies known as land improvement districts (LIDs or water users’ associations). These associations, endorsed by the Land Improvement Act, are voluntarily organised by the farmers themselves, to share the responsibility for water distribution. They are prevalent in regions throughout Japan where rice paddy field agriculture is predominant.

The irrigation sector policy comprises both long-term and short-term perspectives. Regarding long-term policy, major issues for ensuring the sustainability of rice cultivation are:

- securing a set amount of irrigation water; and
- ensuring a constant supply of this volume of water.

Various legal, institutional, and financial measures were established after World War II to address these issues. They include preservation of policy consistency with flood protection, clear definition of water rights, promotion of multi-purpose projects, respect for farmers’ initiatives and involvement in planning and implementing projects, defining the roles of Government, local governments, and farmers, and encouraging intersectional transfer of water from agriculture to other uses.
Regarding short-term policy, major issues are:

- ensuring equitable distribution of water in times of drought; and

- minimising government intervention and maintaining financial discipline so that efficiency in distributing water can be achieved and sustained. Several policy measures to address these issues include: ensuring the sustainability and transparency of LID operations through legal and institutional instruments; ensuring 100 per cent recovery of O&M costs from farmers; and encouraging temporary water transfer from agriculture to other uses.

Regarding environmental impact, irrigation for paddy-field rice cultivation has never caused salinity or waterlogging within two thousand years. Moreover, agricultural water channels, with their abundant water flow, have formed part of the traditional Japanese rural landscape that has gradually built up around paddy fields over many hundreds of years.

Future strategies are likely to be:

- to preserve the consistency of policies with agricultural structural reforms;

- to promote water transfer from agriculture to other sectors (or within the agricultural sector when desirable); and

- to pay due attention to the preservation of the environment.

1. Introduction

_Brief historical background behind the development of Japanese irrigation systems_

Paddy Rice Cultivation: Rice cultivation has been the major agricultural activity in Japan, by which the large population has been supported due to this crop’s productivity and sustainability despite Japan’s poor agricultural production resources, especially land resources (see Figure 1). After struggling with this lack of resources for over one thousand years, rice cultivation was found to be the obvious solution: rice can be continuously cropped in the same area, and gives a higher yield per area than other cereals. During the 17th century in particular, as well as afterwards, farmers increased their efforts at expanding rice production, primarily encouraged by severe rice-based taxation under the feudal system and supported by the continuous development of irrigation technology.

Irrigation Systems for Rice Cultivation: Rice requires more water for cultivation than any other crop. The availability of irrigation water is, therefore, essential for the sustainability of rice production in Japan. Reflecting this, 80 per cent of irrigated land, which accounts for 55 per cent of agricultural land, is used for rice cropping. Irrigation systems have been gradually developed over the last several hundred years, in which most of them replaced even older ones. Consequently, there are few instances in modern Japan where a completely new rice irrigation system has been developed. Almost all construction currently being carried out may be considered as either rehabilitation of, or an extension of, already-existing systems.
Figure 1. Population and agricultural production

Structure of the paper

The second section reviews some of the basic conditions under which the present irrigation system was developed including surrounding natural conditions such as climatic and geographic features. This section is also supplemented by an Annex, which gives more detailed background information.

The third and fourth sections analyse irrigation policies from the viewpoint of both long- and short-term perspectives. The long-term policy described in Section 3 mainly relates to decisions for investment in the construction of physical irrigation facilities while the short-term policy in Section 4 refers to those related to operation and maintenance of the irrigation systems. It is necessary to clearly distinguish between long- and short-term policies to gain a full understanding of the impact of each type of policy on the efficiency of the overall system. It should also be understood that both long-term and short-term policies must be designed so as to harmonise with each other, taking into account the interdependence of each policy. Both policies feature legal, institutional, and financial policy measures, which are discussed in detail in each section. Intersectoral allocation of water in both the long- as well as the short-term is also detailed in these sections.

The final section discusses the possible future strategies.
2. Characteristics of irrigation systems in Japan

Some basic characteristics

The first characteristic of the Japanese irrigation system is its great dependence upon water diverted from river flows. Although in the past, irrigation ponds were traditionally used in some areas, today, under the present system, nearly 90 per cent of irrigated land depends upon river water. (See Table 1.) Since river watershed amounts are uncertain anywhere in Japan, it is extremely difficult to stabilise the availability of water. Virtually no groundwater is used as irrigation water, whereas municipal and industrial water partially depend on groundwater.

<table>
<thead>
<tr>
<th>Year</th>
<th>River</th>
<th>Pond</th>
<th>Groundwater</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1907</td>
<td>70.5</td>
<td>22.4</td>
<td>7.2</td>
<td>100.0</td>
</tr>
<tr>
<td>1987</td>
<td>87.2</td>
<td>11.4</td>
<td>1.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: MAFF.

The second characteristic is its long history. Existing irrigation facilities have been repeatedly renewed and rehabilitated. Resources previously invested in the facilities have all reached (or even surpassed) their service life but the irrigation systems based on them nevertheless still continue to function. Our ancestors’ strenuous efforts have been built upon by present-day users, permitting long-extant water distribution rules to remain in place even today as water rights.

The third characteristic is that rice cultivation is the major user of the irrigation facilities. This monoculture-like state leads to the concentrated utilisation of water during specific periods, during which an extremely large volume of water is required. In recent years, greenhouse horticulture, some of which requires irrigation, has gradually increased in popularity. However, in existing irrigation areas, water utilisation for purposes other than rice cultivation are not commonplace.

The fourth characteristic is that there are a great many users of irrigation water, and decision-making on a variety of matters concerning its distribution are determined by groups organised by the users themselves. In Japan, the number of farm households is exceedingly large, and all farming tends to be carried out on a small scale. Moreover, since their management is centred around rice cultivation, and farm size varies only little, this renders the structure of these user groups homogeneous.

Institutions

Most irrigation systems are managed by local bodies known as land improvement districts (LIDs or water users’ associations); these are voluntarily organised by the farmers themselves to share the responsibility

for water distribution. These organisations are prevalent in regions throughout Japan where rice paddy field agriculture is predominant; the policy principles behind Japanese water distribution can be seen in the operations of these organisations. The structure of a typical LID is shown in Figure 2.

Figure 2. Hierarchical structure of water management

Irrigation water distribution is fundamentally based on the principle of equality. The greatest area of concern among farmers is how water should be distributed during periods of drought. The entire (limited) volume of water is equally allocated within the organisation using the rules for a rotation block system known as “bansui” in times of drought. The principle of equality has, so far, proven the only solution that helps all parties concerned to reach consensus under unusual conditions.

3. Water distribution, not planting, is rotated. Turn-out sluice gates are opened or shut to equalise the time during which water is directed into each channel so that the same volume of water will reach each paddy field. The duration of water flow is strictly determined by calculating the volume of water available.
The second principle underlying water distribution is marked by high degree of risk-aversion in securing a supply of irrigation water. The dependence upon irrigation from rivers means that water utilisation efficiency is significantly affected by the amounts of precipitation in each year. Availability of irrigation water is a crucial determinant of the performance of rice cultivation. Therefore, it is necessary to secure water rights that allow rice production to be continued even in time of drought. Even in cases where the amount of irrigation water supplied is temporarily limited, planting is rarely restricted. This is because water savings may be enhanced through the strict enforcement of irrigation water recycling within the area and more stringent water control at each stage of management. The implementation of these temporary measures does not imply that water utilisation in normal circumstances is somehow wasteful, or that further water can be saved.

3. Long-term policy

Major policy issues

The long-term major policy issues for ensuring the sustainability of rice cultivation are: (1) to secure a set amount of irrigation water; and (2) to ensure a constant supply of such a volume of water. These two issues are related to two other policy goals, which are: (1) to stabilise rice yield; and (2) to achieve equal distribution of water, both of which are essential for realising a reliable food supply policy and the social welfare of the local community.

Various water resource development projects have been carried out to stabilise the irrigation system, during which three points had to be considered: adjustments in concert with flood control projects had to be done without fail; adjustments between irrigation and non-agricultural water uses had to be made; and implementation arrangements for irrigation investment had to be clearly defined. Various legal, institutional, and financial measures were established after World War II to cope with all these problems.

Policy measures to address key issues

Legal measures

River Law: The River Law has influenced the way how Japanese irrigation systems have developed, since they are very much dependent on river flows. This law, originally enacted in 1896, and substantially revised in 1964, consists of two parts: flood control and water utilisation.

Consistency with flood protection: Water utilisation facilities in rivers cannot be constructed unless they are fully consistent with flood control policy in countries like Japan that are frequently beset by disasters as a result of heavy rainfall. Obviously, they need to meet appropriate design criteria governing river structures for flood resistance; in addition, they often have flood prevention functions themselves. Accordingly, it is desirable to optimise both their design and use, striking the best available balance between the benefits obtained from flood control and those from water utilisation.

4. The new River Law, to come into force in December 1997, also mandates the dual purposes of improving and preserving the river environments.

The River Law provides the basis for harmonising water utilisation objectives with flood control policy. The Law requires that the government play a central role as the river manager in regulating these water utilisation facilities due to the public interest aspect of flood control, although the actual operation of these facilities rests with their users.

Water Rights: Another legal aspect of the water utilisation system is the setting out of water rights, by which sufficient incentives for proper investment in developing water resources have been ensured. Water rights, although given formal legal status under the River Law, had already long existed as established custom or tradition. Since the 19th century, most of the natural river flow has been consumed by the agricultural sector. The exploitation of water resources was already under way in parallel with the development of agriculture. After the Meiji Restoration (1868), however, the water needs of the hydraulic power generation sector began to compete with those of the agricultural sector. Water demand from the non-agricultural sectors also drastically expanded as a result of industrial development as well as growth in urban activity. To meet the increased demand, new investments had to be made to augment the water supply. New water use entitlements became necessary so as to secure investments in water resource development. Water rights also minimise conflicts between the rights of users.

There are two aspects to the allocation of water rights. First, water rights are set out with reference to a drought year. In other words, parties with water rights are ensured a supply of irrigation water even in years of scarce rainfall, which are likely to occur once every 10 years on average. Water rights are not granted to new users who cannot meet this criterion; therefore, those wishing to use more water must develop new water resources such as the construction of a reservoir dam. Secondly, the volume of water available for agriculture is further specified in detail for each month. With some slight allowances, monthly permissions for water use are designed to protect other users, e.g. industrial and hydropower generation (see Figure 3).

**Figure 3. Seasonal assignment of permits for agricultural water use**

![Seasonal assignment of permits for agricultural water use](image)
Institutional measures

The first important institutional measure established in the post-war water utilisation system is the rules clearly set out for co-operation by multiple sectors in water resources development. Multi-sectoral development allows for economies of scale. For the implementation of specific projects, the Power Resources Development Law, the Specific Multi Purpose Dam Law, and the Water Resources Development Public Corporation Law were all enacted. Unified rules for the allocation of construction costs among the various sectors have come to be required in light of the joint construction of multi-purpose dams, including uses such as agriculture, flood control, power generation, and urban consumption. Thus, the principle was established that each sector should share the cost in accordance with the benefit that it receives, or alternatively, with the costs of alternate projects has come to be applied.

The second institutional measure established is the setting-out of fundamental policy towards basin-wide water resources development, and providing opportunities to co-ordinate investment projects. The Water Resources Development Law was enacted and placed into force as a long-term water resources plan. The Water Resources Development Public Corporation was organised as an institution specialising in multi-sector joint water resources development beginning with the agricultural, industrial, domestic, flood control, and power generation sectors as the major consumers of water. The opportunity for discussion of water course changes was also provided and government involvement eventually enabled nitre-regional reallocation of water resources to be promoted in many regions.

The third institutional measure is to define a clear process under which irrigation projects are to be carried out. More importantly, the Land Improvement Law enacted in 1949 stipulates that all land improvement projects, including water projects, are permissible only if applied for by the beneficiaries. The application is usually filed by an LID, but this organisational foundation sometimes lacks the administrative ability to actually carry out large scale projects. If the investment becomes large in scale, a variety of wider-area co-ordination activities are also required. The central, prefectural, and municipal governments, therefore, jointly provide various supports for project implementation. LIDs also organise prefectural-level federations as well as a national organisation in an effort to provide administrative and technical services.

The last institutional measure taken is that the government itself have established a hierarchical administrative structure for constructing facilities to supply water from reservoirs to agricultural fields, taking into account the relative positions of all parties concerned from the technical and institutional points of view. Additional water reaches end-users through different stages of irrigation facilities such as reservoirs, diversion dams and main canals constructed by the central government, and secondly, through canals constructed by prefectural governments, and finally through farm canals constructed by LIDs. Without the overall successful implementation of these projects, nothing would take place as expected. The function of co-ordinating planned projects, from those in the Central Government to those in the LIDs, is essentially undertaken by the prefectural and central governments.

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6. However, since projects smaller than regional-scale cannot be effectively implemented, no personal applications were allowed.
Financial measures

The government also renders sizeable financial assistance with the construction of water facilities ranging from around 60 per cent for the central government-operated projects to 50 per cent for the prefectural government-operated projects\(^7\).

There are several arguments that can be used to support subsidies for irrigation projects. First, subsidies can be justified by the fact that irrigation facilities have a public interest component; e.g. dams can serve as flood protection facilities; canals can receive drainage from urban areas surrounding agricultural fields and also provide open spaces along them. Without subsidies, the provision of these facilities would be at a level less than is socially desirable, or they might not exist at all.

Figure 4. Typical pattern of land use — unconsolidated paddy field

Secondly, subsidies can help these projects achieve an economically optimal size by encouraging all farmers in the project areas to participate. Since the existing small-scale (and scattered locations) of the individual fields makes for land use by farmers who are quite closely associated with each other (see Figure 4), it is therefore desirable to have all farmers join in the project. Otherwise, the new facilities become both extremely inefficient, and relatively costly. The nature of the economies of scale and the

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\(^7\) In the cases where the central government directly implements a project, basic facilities of 3 000 hectares or more in beneficiary area are constructed. The prefectural government undertakes the construction of a trunk-line channel balancing tributary-level facilities of 200 hectares or more in beneficiary area. The construction of lateral water facilities of 20 hectares or more in beneficiary area is undertaken by a LID as its project.
indivisibility inherent to the irrigation projects requires collective operation in consideration of local land and river conditions. The larger the project district, the larger the number of farmers involved and, therefore, the more likely is it that people will all have different ideas. To persuade all of the farmers to participate, huge transaction costs are required, possibly endangering project execution. Any reduction in the burden of project costs through the use of subsidies will enhance farmers’ incentive to participate in the project.

All projects are legally required to undergo prior appraisal, taking into account consistency with the overall agricultural policy. An analytical cost/benefit analysis determines whether any project can be put into effect. Project evaluation is made on an overall basis for all the projects involved, namely, every dam construction, trunk-line channel, and terminal farm improvement project. The benefits resulting from projects considered are mainly attributable to the labour cost savings in rice production, since almost any increases in paddy area have not been permitted since 1969 when overproduction of rice took place. This helps in preserving consistency with the agricultural structures improvement policy.

**Intersectoral water transfers**

Water rights have, so far, been allocated to the agricultural and non-agricultural sectors using increments in supply from the development of new water resources. This incremental approach makes sense only when new water users’ willingness to pay exceeds the cost of development of any new water resources. This is, however, becoming less effective as development costs continue to rise. If this trend remains unchanged, late-coming water consumers may become unable to obtain water rights, which is the main driving force behind the pressure to reallocate water from agriculture to the other sectors.

If some paddy fields are converted to other land uses, which require less water, or if they are abandoned, a water surplus is generated in the agricultural sector. It is not actually easy to reallocate irrigation water to the urban sector unless the abandonment of land is spatially collective. In 1972, the Ministry of Agriculture established an agricultural water rationalisation project that positively attempted to divert water to non-agricultural sectors, by improving existing irrigation systems so as to reduce water intake. Under this project, water reallocation has so far been implemented at 10 locations, mainly in large urban areas. To compensate for such water reallocation, the cities concerned are to pay part of the project expenses required for this rationalisation. This may be considered as a quasi-market trade of water rights although water trading is strictly prohibited under the River Law; this transfer is the only reallocation of water with indirect payment that is legally permitted.

The reallocation of water from agricultural to municipal use has given birth to a large, socially positive effect — that of eliminating additional dam construction. In connection with dam construction, there is concern over any resettlement of residents from the expected reservoir areas, or the loss of many precious wildlife species and archaeological heritage. Also, in Japan, since land suitable for dam construction is already scarce for geographical reasons, it is expected that any future dam construction will require huge development costs. Water reallocation should, therefore, be promoted under rationalisation projects if the cost required for agricultural water rationalisation is less than the total of new dam construction costs as well as any negative effects due to dam construction. It is remarkable that rationalisation projects also

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8. Moreover, in the case of rehabilitation projects (accounting for more than 80 per cent of the irrigation projects in Japan), no water investment can be executed without agreement of farmers who actually use the facility. Therefore, full participation is significantly important for implementing projects.
require the same negotiation process with agricultural users as the construction of a new irrigation facility, due to the unique feature of collective water use by local farming operations.

Table 2. Water rationalisation project

<table>
<thead>
<tr>
<th>Location</th>
<th>Area (ha)</th>
<th>Water Use (m³/s)</th>
<th>Transfer (m³/s)</th>
<th>Project Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Satteryo &amp; Gongendo</td>
<td>n.a.</td>
<td>n.a.</td>
<td>2.7</td>
<td>1968-73</td>
</tr>
<tr>
<td>2. Shogawa</td>
<td>12 710</td>
<td>60.1</td>
<td>0.5</td>
<td>1975-99</td>
</tr>
<tr>
<td>3. Gongendo</td>
<td>1 217</td>
<td>5.5</td>
<td>1.5</td>
<td>1973-86</td>
</tr>
<tr>
<td>4. Satteryo</td>
<td>1 343</td>
<td>5.9</td>
<td>1.4</td>
<td>1974-87</td>
</tr>
<tr>
<td>5. Shibahara-yosui</td>
<td>1 681</td>
<td>12.3</td>
<td>0.8</td>
<td>1976-91</td>
</tr>
<tr>
<td>6. Izumisano</td>
<td>453</td>
<td>1.2</td>
<td>0.1</td>
<td>1974-80</td>
</tr>
<tr>
<td>7. Tsuyama-tobu</td>
<td>551</td>
<td>2.3</td>
<td>0.3</td>
<td>1973-88</td>
</tr>
<tr>
<td>8. Shitoki</td>
<td>229</td>
<td>0.9</td>
<td>0.1</td>
<td>1980-87</td>
</tr>
<tr>
<td>9. Saitama-goguchi-niki</td>
<td>15 380</td>
<td>44.6</td>
<td>4.3</td>
<td>1978-94</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>47 794</td>
<td>182.2</td>
<td>15.5</td>
<td></td>
</tr>
</tbody>
</table>

Source: MAFF Bureau of Structure Improvement.

Environmental problems

Generally, in agricultural areas where environmental problems occur, a conservation-oriented water utilisation method should be needed. A typical environmental problem associated with irrigation is salinization. In Japanese paddy-field rice cultivation, however, no salinity is ever experienced. Paddy field rice cropping may, in this sense at least, be deemed as a sustainable farming.

Agricultural water channels, with their abundant water flow, have formed part of the traditional Japanese rural landscape that has gradually built up around paddy fields over several hundred years. In Japan, any increase in the amount of water shed into agricultural channels is considered as favourable to the environment as it leads to the preservation of both landscape and wildlife as well as aiding in groundwater conservation. It should also be noted that most of the irrigation projects in Japan relate to the rehabilitation of existing facilities, which appears to be neutral with respect to maintaining environmental conditions.

4. Short-term policy

Major policy issues

Short-term policy refers to the variety of measures necessary for the implementation of actual water distribution. It involves concrete rules for water distribution and as well as measures required to routinely maintain and operate facilities. The main policy issues over the short-term are: (1) to ensure equal
distribution of water in case of drought and (2) to minimise government intervention and maintain financial standards so that efficiency in distributing water can be achieved and sustained.

**Policy measures to address key issues**

**Legal measures**

Agricultural water rights: Well-defined water rights are also contributing to our successful achievement of the equal and efficient distribution of water. In Japan, water rights are generally entitled to groups of farmers (e.g. LIDs), not to individual farmers as stated below. For instance, especially in a severe drought year, the volume of water that could be taken from a river would be much smaller the volume defined in a water right. Each farmer has to jointly use limited water according to both predetermined priority and the equality principle laid out by the water associations.

Although water rights have been established as property rights, and strictly followed, very little water transfer, either permanent or temporary, takes place within the agricultural sector. The fact that water trading is prohibited by the River Law as mentioned earlier is the primary reason; however, a more fundamental reason for the non-appearance of water markets within the agricultural sector is attributed to the actual agricultural structure in the rice sector. Adjacent farm fields are rarely owned by the same farmer, and it would appear desirable for farmers to draw independent channels into each individual field of their respective farms. However, since each farm plot is very small in terms of area (some measuring 500m$^2$ at most), independent channels would have constituted an extremely inefficient system. This is the reason why adjacent farm fields jointly use one intake from a lateral canal. Under these conditions, it is difficult, on a practical level, to trade water, which would require the approval of all farmers sharing the same intake.

Accordingly, water rights had to be locally designated. Although a specific water right is not always linked to a specific piece of land, water rights are substantially inseparable from land ownership.

Land improvement district (LID): The second legal measure is the designation — by law — of land improvement districts as organisations which control water distribution. The Land Improvement Law, enacted in 1949, stipulates a comprehensive system for land improvement projects. The Law provides the LID with two distinct roles: the first being the carrying out of investment projects, while the second consists of facility management, including daily water control. The LID, located as it is between the river manager and the farmers, functions as an intermediary organisation that is virtually engaged in the substantial control of water facilities.

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9. The law stipulates the grant to each water facility. Paddy fields entitled to water rights are more expensive to purchase or rent than upland fields within the same region.

10. In the historical background of the LIDs, there was a public water utilisation organisation called the Water Users” Association which was originally founded to take water from rivers or irrigation ponds. This organisation, in early 1900s, was reorganised into 3 legal bodies called the Ordinary Water Users” Association, the Association of Farmland Consolidation, and the Earthwork Association, under three different sets of laws. Each organisation differed in its intrinsic purpose but each came to fulfil the function of irrigation water control. After the end of World War II, these three bodies were merged in LIDs following the enactment of the Land Improvement Law.
Institutional measures

As stated previously, LIDs are the primary institutions for managing irrigation water in a regionally collective manner. Table 3 shows the present number of LIDs according to scale. The areas covered by most LIDs are smaller than the paddy fields of normal US and Australian paddy farms. Each has 100 or more individual farmers within its organisation.

Table 3. Land improvement district

<table>
<thead>
<tr>
<th>Area Size</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100ha</td>
<td>3 689</td>
</tr>
<tr>
<td>100-500ha</td>
<td>2 757</td>
</tr>
<tr>
<td>500-1 000ha</td>
<td>677</td>
</tr>
<tr>
<td>1 000-2 000ha</td>
<td>356</td>
</tr>
<tr>
<td>2 000-5 000ha</td>
<td>244</td>
</tr>
<tr>
<td>5 000-10 000ha</td>
<td>56</td>
</tr>
<tr>
<td>&gt; 10 000ha</td>
<td>17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7 796</strong></td>
</tr>
</tbody>
</table>

Source: A Survey on Land Improvement Districts.

Also, one of organisational features of the LID system is its hierarchical structure in operation and management. When an LID is established, pre-existing traditional irrigation control bodies are usually converted into a legal LID; these traditional bodies in general have hierarchical structures, in which there are a large number of small groups of farmers distributing water from an intake at a lateral canal, which in turn is operated by a federation of those small groups. This leads to the situation in which LIDs can avoid entering very detailed arrangements regarding the distribution of water within villages, although LIDs take strong initiatives in resolving conflicts among individual farmers within LIDs.

The other feature to be noted here regarding the sustainability of the LID system is its democratic and transparent operation, which may be observed in the following two respects: first, a representative system is employed for decision making. Representatives elected by the members of the LID are the supreme decision-making body. Although the board of directors frequently lends strong direction, organisational governance is intended to rest with association members through meetings of elected representatives. The other aspect of the democratic system is equality. Each member of the association has one equal voting right, regardless of the size of the land area managed by each member.

LID management is, however, normally carried out with the complementary support of administrative agencies. As pointed out earlier, LIDs are subject to a 3-level hierarchical integration — into a regional federation (at the prefectural level), and the central federation (at the national level). Each level corresponds to the government’s respective hierarchical organisation. These federations not only supply guidance and training in facility improvements, repair, control, and other techniques but also assist each land improvement district by establishing a land relocation centre to effectively fulfil the land registration task as one of their key operational responsibilities.
Each LID is managed in such a manner so as to take local characteristics into account. This is because unique local factors, due to availability, or conventional utilisation, of water resources are too significant to neglect. The importance of agricultural water rights is reflected in the system’s design.

Financial measures

An LID controls water distribution, and collects fees from farmers. The organisation is, in principle, managed on a self-sustaining basis and funded by the fees collected from association members. The operation and maintenance fees for rice irrigation systems collected by LIDs from farmers are on the order of 3 254 yen per 0.1 ha per year on average, which is equivalent to 2.5 per cent of the production cost of a paddy farm. This agricultural water fee is a flat rate corresponding to area, regardless of the amount of water actually used. Table 4 shows the financial state of a typical land improvement district.

One of the reasons why the government entrusts water facility control to LIDs is that LIDs are in the best position to monitor and appreciate the demands of their many small-scale users. It is impossible for government to co-ordinate requirements adequately for all users. The LID has been established as an intermediate body voluntarily organised by farmers, thereby resulting in cost savings for system management.

Table 4. Financial accounts of a land improvement district

<table>
<thead>
<tr>
<th>Item</th>
<th>Amounts (Thousand Yen)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fees</td>
<td>19 703</td>
<td>24.7</td>
</tr>
<tr>
<td>Grants</td>
<td>21 812</td>
<td>27.3</td>
</tr>
<tr>
<td>Loans</td>
<td>17 877</td>
<td>22.4</td>
</tr>
<tr>
<td>Others</td>
<td>9 912</td>
<td>12.4</td>
</tr>
<tr>
<td>Brought forward</td>
<td>10 453</td>
<td>13.1</td>
</tr>
<tr>
<td><strong>Receipt Total</strong></td>
<td><strong>79 757</strong></td>
<td><strong>100.0</strong></td>
</tr>
<tr>
<td>Operation</td>
<td>5 777</td>
<td>7.2</td>
</tr>
<tr>
<td>Maintenance</td>
<td>2 484</td>
<td>3.1</td>
</tr>
<tr>
<td>Repair</td>
<td>13 108</td>
<td>16.4</td>
</tr>
<tr>
<td>Balance Carried Forward</td>
<td>10 306</td>
<td>12.9</td>
</tr>
<tr>
<td>Payment on Loans</td>
<td>31 499</td>
<td>39.5</td>
</tr>
<tr>
<td>Others</td>
<td>5 793</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>Expense Total</strong></td>
<td><strong>68 967</strong></td>
<td><strong>86.5</strong></td>
</tr>
<tr>
<td>Surplus</td>
<td>10 790</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Note: on the LIDs that do not currently deal with any investment project. This covers totally 360 LIDs.

Source: MAFF, 1996 Survey on Operation of Land Improvement District.
Theoretically, judging from the principle of equality and the present fee collection system employed, this organisation does not possess a system capable of achieving allocative efficiency of water distribution: i.e. those farmers having a higher degree of willingness to pay are not always granted preferential water distribution, nor does it contain economic mechanism to equate marginal productivity of irrigation water and/or marginal cost for irrigation water supply among users.

It should be noted, however, that the prevailing fee system does not result in serious inefficiency in distributing water for paddy fields for the following reasons. First, almost all the users of agricultural water are rice producers, and there is no significant difference in farm size\textsuperscript{11}. It is therefore, quite unlikely that there would be an extremely large difference in their willingness to pay (marginal productivity of irrigation water), which is one of the reasons for their adhering to a flat rate system.

Second, water rights can serve as instrument to deter inefficient use of water. Whereas a flat rate fee structure may allow all farmers to equally use water until the marginal productivity of their irrigation water becomes zero, when normal rainfall is expected, farmers are actually restricted by water rights to take water only to a certain extent barring any regional disputes or environmental problems with the rivers.

Third, there is the other cost of using water in addition to irrigation fees charged by the LIDs, which provides opportunities for farmers to equalise their marginal value of water with their marginal water supply costs. As long as farmers themselves draw water into each of their fields, they have to bear the implicit costs of self-employment to maintain and operate terminal water facilities. Accordingly, their marginal cost is not always zero. This marginal cost grows significantly in times of drought when a limited amount of water must be used as ingeniously and effectively as possible\textsuperscript{12}.

\textit{Intersectoral water transfers}

A special arrangement is generally in place to realise temporary water transfers among sectors, which departs from the basic principle of distribution of water based on water rights. In cases where an extraordinarily severe drought takes place, additional water redistribution becomes necessary. Droughts usually occur in July-August but cannot be forecast until they actually take place, preventing the prior preparation of adequate measures in response. Moreover, if one or two typhoons hit, the water supply and demand situation sometimes changes completely. It is, therefore, extremely difficult to operate dam reservoirs at the beginning of cropping season so that they can be well prepared for a coming drought (As is clear from Figure 5, the frequency of drought occurrence fluctuates considerably from year to year).

If a drought occurs, while first establishing order based on local and conventional priorities, water is distributed in accordance with the in-house principle of equality. Even if a drought below the minimum reference of water shortage level takes place, the principle of equality is pursued within the agricultural sector, only raising the problem of required adjustments with the non-agricultural sectors. In the non-agricultural sectors, with some groups that have more recently become users, there are no fixed rules for responding to unexpected droughts. Moreover, partly due to the use of municipal water permitted

\textsuperscript{11} Even if a paddy field owned by a farmer is large in total area, the cultivation of scattered fractional plots of farmland does not make the economies of scale of rice cropping management fully realised.

\textsuperscript{12} The equal distribution in times of drought imposes additional costs on farmers, as reported from certain survey results that found costs to be three times as large in a severe drought year as compared to a normal year.
under conditional water rights, water rights are sometimes refused in times of drought\textsuperscript{13}. Because excessive reductions in the supply of city water cause a much graver social impact than agricultural water, it is virtually impossible to halt city water distribution. This is a situation in which the regular rules of water distribution based on water rights do not apply at times of drought, and accordingly, requires intersectoral negotiations without reference to water rights. In 1994 when a drought affected economic activities in various parts of Japan, with water intake restrictions issued at 41 dam reservoirs, and with users responding by restricting their use of water, the rate of saving of the agricultural sector was higher than that of the urban sector in three-fourths of the affected regions.

Figure 5. Occurrence of drought problem

\begin{figure}
\centering
\includegraphics[width=\textwidth]{drought-graph.png}
\caption{Occurrence of drought problem}
\end{figure}

\textit{Source: National Land Agency.}

For the purpose of conducting such negotiations, an organisation known as the Water Utilisation Adjustment Council has been established based on the River Law. In Japan, there are 186 organisations (according to 1991 survey results), 115 of which now function as drought arbitrators. The council is established, at times of drought, under the administrative guidance of the river manager, and is composed of the LID, river administrative agencies, and other water users (See Table 5). One council is set up for each river water system. Through discussions at this drought council, irrigation water is temporarily transferred from the agricultural to the urban sector but this is a provisional and stop-gap measure, and as such is rarely subject to pecuniary compensation.

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|c|}
\hline
Year & 1965 & 1975 & 1985 & 1995 \\
\hline
Water Saving & 10 & 20 & 30 & 40 \\
\hline
\end{tabular}
\caption{Water Saving Comparison}
\end{table}

\textsuperscript{13} Conditional water rights refer to those rights that are contingently and tentatively set, as in the case where, despite demands e.g. for waterworks that have already been put in place, dam development is delayed and behind schedule that prevents normal water rights from being set. Conditional water rights are permitted during a limited period and on condition that water can be taken only when the reference water shortage level is exceeded. Renewal provisions for normal water rights are not applied to this type of water right, which is, therefore, permitted only if a future supply of water is secured.
Table 5. Members of the Drought Council

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Participation Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of Councils</td>
<td>183</td>
<td>100</td>
</tr>
<tr>
<td>Land Improvement District</td>
<td>157</td>
<td>86</td>
</tr>
<tr>
<td>Municipal Water Supply</td>
<td>64</td>
<td>63</td>
</tr>
<tr>
<td>Manufacturing Water Supply</td>
<td>31</td>
<td>17</td>
</tr>
<tr>
<td>Electric Power Generator</td>
<td>51</td>
<td>28</td>
</tr>
<tr>
<td>Administrator</td>
<td>155</td>
<td>85</td>
</tr>
</tbody>
</table>

Source: MAFF Bureau of Structure Improvement.

The particular rules for water transfer at times of drought have not always been determined in advance. The administrative agencies participate in these negotiations as users. Institutionally, the river manager is vested with the ultimate authority for arbitration and mediation but, in every region, some point of compromise has so far been made through voluntary discussion without actual involvement of the river manager in the process of negotiations. This is typically construed as nothing more than a response to a particular contingency and does not usually result in the permanent reallocation of water rights.

5. Future strategies

Future strategies needed in the irrigation sector are: (1) to preserve the consistency of policies with agricultural structural reforms; (2) to promote water transfer from agriculture to the other sectors (or within the agricultural sector when desirable) with full consideration to the marginal value of water for each sector; and (3) to pay due attention to the preservation of the environment.

Regarding policy consistency with agricultural structural reforms, irrigation systems need to be flexible enough to respond to changes in water use patterns by farmers that are associated with these structural reforms. For instance, increasing farm sizes tend to concentrate water use within a certain period, which may require substantial changes in the physical layouts of the systems.

In addition, the financial incentives for small farmers joining rehabilitation projects are becoming smaller. This complicates the problem as to precisely who should pay how much of the rehabilitation costs. As stated above, all farmers need to join in the project for ensuring optimally large size of project even in the case of rehabilitation. Therefore, insufficient incentives of participation for small farmers could fail to make the efficient field base as infrastructure and raise the economic cost of farmers intending to increase the size of their farms.

Regarding the promotion of water transfers, future supply and demand conditions should be examined. First, future demand for water in non-agricultural sectors is uncertain. Demand for water in the industrial sector will not grow at the rate so far observed, while the demand for urban household-use water may continue to grow in future, depending also on the extent to which demand management policy works effectively. Secondly, there is increasing social and economic resistance to dam construction, which is
likely to make it increasingly difficult to develop new large-scale water resources. In particular, there are increasing environmental concerns associated with dam construction.

A market transfer mechanism could obviously be an efficient tool for reallocating water from a theoretical point of view. However, in the case of water reallocation within the agricultural sector, as is apparent from the above discussions, a market mechanism is not applicable due to the institutional system as well as the structure of agriculture itself. To ascertain the feasibility of using a market mechanism, it is first necessary to compare efficiency improvements following the introduction of market mechanisms with the costs for their introduction. The present physical state of Japanese farmland significantly raises the enforcement costs of water transfer. Unless the control and monitoring of actual water use can be realised at each plot of farmland, water transfers may fall short of completion. Scattered land ownership among many small-scale farmers requires a considerable amount of money for the introduction of workable facilities for control and monitoring. The progress of agricultural structural reforms may make the cost of monitoring the flow into each plot less expensive, which may eventually result in the increased feasibility of market-oriented water reallocation.

With respect to water transfers from agriculture to other sectors, the right of quasi-market trading of water under agricultural water rationalisation projects is one possible approach available at the present time. Transaction costs associated with establishing institutional arrangements between the irrigation sector and other sectors should be minimised to promote these transfers.

With respect to the preservation of the environment, the basic nature of the rice irrigation system in Japan (i.e., dependent as it is on river flows in humid areas) helps us to avoid any environmental problems which usually stem from irrigation dependent on groundwater in arid or semi-arid areas (e.g. salinity, etc.). Moreover, the Japanese irrigation system has proven itself sustainable over its several hundred year history, and does not have any environmental problems. The main focus in the future should therefore be on the preservation of the positive environmental impacts including the preservation of landscapes when irrigation systems are to be rehabilitated.

6. Bibliography

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ANNEX

What defines the Japanese water utilisation system?

1. Natural conditions

Climatic conditions, to start with, are the chief natural conditions for defining the technical and institutional framework of water utilisation. Japan has substantial rainfall, amounting to an annual average precipitation of approximately 1 700 mm. However, the period of rainfall is limited to the rainy season in June and the typhoon season in September, during which precipitation is concentrated. Some districts have considerable snowfall, part of which melts in spring, adding to the water available. Annex Figure 1 shows the rainfall pattern in Saga City in the southern part of Japan for the past 30 years. Both seasonal and year-to-year fluctuations are violent. This abundance of rain and the natural pattern of rainfall in the production areas form the basis of Japanese rice farming.\(^{14}\)

Annex Figure 1. Monthly rainfall for thirty years, 1967-1996

Source: Meteorological Agency.

In some mountainous areas, subsoil water including spring water enabled rice cultivation. Historically, paddy field development in such regions preceded others. It was, however, unstable and restrictive production. No large-scale development of paddy fields could be implemented until irrigation water from rivers was available. However, water resources development was not always easy. The abundant but seasonally concentrated precipitation allowed rain water to immediately and collectively flow into rivers. Furthermore, the distance from the catchment area to the plain is short and rivers are steep so that rainfall in mountainous areas loses no time in reaching downstream. For this reason, water intake at the upper reaches of rivers, even in the plains areas, was difficult and rivers were also frequently flooded. The performance of water utilisation could not be improved without first successfully controlling floods, but monarchies were extremely energetic in constructing flood control projects from the medieval to the modern eras, finally enabling constant paddy field development. In the meantime, the occurrence of floods frequently resulted in damage to water facilities and increased their maintenance and control costs.

In areas without any large-scale rivers, irrigation ponds were frequently built to secure water resources. However, irrigation ponds were not suitable for wide-area irrigation. Successful flood control and progressive large-scale irrigation utilisation projects made agricultural water utilisation dependent upon irrigation from rivers. At present, river irrigation accounts for nearly 90 per cent of rice farming.

It is no exaggeration to say that Japanese irrigation water has been used only for paddy-field cultivation. Fully 95 per cent of Japan’s annual 58.9 billion-ton agricultural water usage (1994 estimates) is used as paddy-field irrigation water. Because of abundant rainfall upland crop cultivation does not require irrigation so that existing agricultural water rights were mostly granted to paddy fields. In the pre-war period, however, some upland crop and facility horticulture partly began the intensive use of irrigation water.

2. Historical background of agricultural structure

The long history of the water utilisation systems reflects an agricultural transition. Resource concentration, rice cropping, small family farm management, scattered farm plots, and land owner-operation are the characteristics of current Japanese agriculture. Rice farming does not suffer from continuous cropping damage and affords annual planting on the same farmland. Since rice yields more than other crops, farmers gradually converted agricultural land into paddy fields where water could be made available. An extremely labour-intensive production technique was adopted in the early stages of economic development. A high land productivity could be realised with careful practice. The size of peasant management established both during and after the early modern era remained on a subsistence level and land holdings were also small.

During and after the Meiji era (1868-1911), with the exceptions (at best) of the use of horses and cattle, the entire production system depended upon human muscle power and, therefore, the optimum scale of a plot of paddy-field farmland was extremely small. Small farm plots owned by one farmer were not collected in one place but often arranged so as to be inserted between other plots. One of the reasons was that, if the farm plots were scattered, the risk of disease and insect damage could be avoided. Also, with scattered plots, collective work would also be facilitated. Japanese agriculture during that period of economic development was under a condition of surplus labour but, due to seasonal peak-times of agricultural work, farmers within a community always co-operated with each other for rice planting and

harvesting. This made the mixed presence of farm plots more desirable for collective work on all farm plots by all people.

These scattered farmland plots and small-scale management characteristics greatly influenced subsequent land market formation. On such a foundation, it is difficult to promote smooth trade because the transaction costs are too high. After World War II, further mechanisation led to the adoption of labour-saving technologies. The optimum plot scale apparently expanded both from a technological as well as an economic point of view, but it was not easy to institute desirable large-scale management, due to scattered small-scale farm plots and an underdeveloped land market. (See Annex Table 1)

These land use conditions also gradually formed the foundation for a co-operative approach to water utilisation. In all areas of Japan, it was a general practice for farmers to establish an irrigation control association to control water use. Water has always been treated as if it were collective property. Farmers were always strongly interested in fairness of water distribution, because water availability is one of the critical factors in management performance. While working together, however, management results were still attributable to individual responsibility. Rainfall amounts expected in normal years caused no problem with water distribution. The most important area of discussion revolved around how water should be distributed when a drought takes place. Ultimately, people agreed to a principle of perfect equality within the irrigation control body and to appropriation rights among such bodies.

Since water rights were solely limited to landowners, only landowners could become members of irrigation control bodies. In the pre-World War II period, large landlords contributed to the management of these organisations. In addition, the construction of water facilities was also funded in large part by the landlord. Nevertheless, tenants eventually bore the cost through increased rents as a result of increases in water supply. The farmland reforms at the end of World War II, however, dismantled the landlord/tenant farmer system. The government, as a result, was committed, both directly and indirectly to the construction of water facilities and the management of irrigation control bodies.

### Annex Table 1

Japanese farm households (main islands)

<table>
<thead>
<tr>
<th>Management size</th>
<th>Number of Farms</th>
<th>Cultivated Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(number)</td>
<td>(thousand ha)</td>
</tr>
<tr>
<td>&lt; 0.5 ha</td>
<td>1 418</td>
<td>384</td>
</tr>
<tr>
<td>0.5-1.0 ha</td>
<td>925</td>
<td>650</td>
</tr>
<tr>
<td>1.0-2.0 ha</td>
<td>682</td>
<td>936</td>
</tr>
<tr>
<td>2.0-3.0 ha</td>
<td>201</td>
<td>479</td>
</tr>
<tr>
<td>3.0-5.0 ha</td>
<td>101</td>
<td>373</td>
</tr>
<tr>
<td>&gt; 5.0 ha</td>
<td>36</td>
<td>274</td>
</tr>
<tr>
<td>Total</td>
<td>3 363</td>
<td>3 097</td>
</tr>
</tbody>
</table>

Source: MAFF, 1995 Farm Census.
Summary

The “Baakse Beek” is a watershed (the water system-unit) located in the eastern part of the Netherlands. It covers about 34,000 hectares, mainly grasslands for dairy production.

Sustainable water management for this watershed can be achieved through redesigning the surface water system, establishing a “water co-operation” with farmers, agreements with the drinking-water production company.

Certain restrictions on agricultural use (e.g., use of nutrients) could be (financially) be compensated by the drinking water production company, for which the availability of groundwater would increase and the costs of purifying groundwater decrease.

1. Introduction

The “Baakse Beek” is an agricultural area in the eastern part of the Netherlands where a concept of integrated use for agricultural, natural and drinking water purposes is being developed.

The Dutch authorities are convinced that this idea can be realised and, to a certain extent this is confirmed by research results. Nevertheless it is not yet implemented and existing data are only estimations. Due to social, societal and historical circumstances, emphasis must be made on the existing resistance from farmers and the fact that much persuasion still has to be made. This task may or may not be the responsibility of the State Government.

This case study is structured along the following lines:

First of all, the water situation in the Netherlands is described in general terms, including the main water problems. It may seem strange for a country such as the Netherlands — meaning the low countries — but drying out problems exist as well as excess water problems — from rivers and sea — and pollution problems of surface water and groundwater.

Then information is provided on the institutional aspects of water-management in the Netherlands, and the positioning of non-governmental organisations. The administrative structure is logical, but complex. It
includes various governmental layers, the position of water boards, and drinking water production companies, and involves co-operation with non-governmental organisations of farmers and naturalists.

The “Baakse Beek” case concerns a trial to find sustainable methods for water management. It gives future perspective to agricultural activity — in this case dairy — and to drinking water production, being also beneficial for nature conservation and nature improvement. Although technically a rather simple concept, the “Baakse Beek” project is complex in its administrative elaboration. The report gives special attention to some considerations related to the process of implementation.

2. The water situation in the Netherlands

The Netherlands is a very flat country at the conveyance of three main rivers, the Rhine, the Maas and the Schelde. Therefore the Netherlands is a delta region, bordering the North Sea.

As known world-wide, the country has a very high population density and an important part of the Netherlands is situated below sea level. In these parts of the Netherlands it is necessary to pump constantly for satisfactory living and industrial conditions and agricultural produce. Ten thousands of acres of our richest farmland are situated in reclaimed polders, some meters below sea level.

In general terms there is excess water coming in from Eastern and Southern countries by the rivers and from rain. Nevertheless there are serious drying out problems, partly caused by the artificially built water management system and partly caused by ground lowering (subsidence) as a result of pumping in peat areas below sea level. Water problems concern surface water as well as groundwater and the problems are quantitative as well as qualitative.

Being a delta region, a lot of attention has to be given to surface water problems. Beside the raising of sea level, solutions have to be found for extremely high river levels. In 1993 and 1995 the situation was dangerous due to very heavy water flow in rivers, mainly the Rhine and the Maas. In 1995 250 000 people and all livestock were evacuated from the Rhine and Maas areas due to the risk of the dikes breaking. The quality of the surface water in agriculture is poor, containing high concentrations of phosphate and nitrate.

Drinking water is produced from surface water, as well as from groundwater. In the western part of the Netherlands drinking water is predominantly produced from surface water — and from groundwater in the eastern part of the country.

Producing drinking water from groundwater is a very safe process, due to ground filtration, the raw material for producing drinking water is free from bacteria and viruses.

The groundwater is becoming increasingly polluted by nitrates, pesticides and phosphates, with a corresponding increase in the cost of purification. Agriculture in the Netherlands is intensive with relatively very high production per square metre. This has been achieved due to the development of technology and the use of fertilisers and pesticides. This intensive agriculture also caused a relatively high pollution rate.

Apart from the pollution of groundwater, there is also a new problem of groundwater shortage. Besides the drinking water production companies, industry and agriculture use a lot of groundwater. The necessary drainage of agricultural land has led farmers who suffer droughts in very dry seasons, to invest in irrigation systems which are fed by groundwater. This has resulted in nature areas suffering from
drying out because of the lower surface water levels, due to lower groundwater level. In the whole of the Netherlands there are more than 600 000 hectares nature area which suffer from drying out. This is one of the reasons why in State legislation the expansion of groundwater extraction is prohibited. Drinking water production companies have to find alternative ways to find their raw material.

The eastern and southern parts of the country are well above sea level. Here mainly sandy grounds occur. Also in those high sandy grounds agriculture has intensified over the last half century due to relatively cheap inorganic fertilisers and to the agricultural structure of the rural area.

In particular, the water management system has been structured so that a surplus of water can be drained very quickly to rivers, lakes and the sea, whereas a shortage of water can be replenished from rivers and lakes just as quickly. As a result the general surface water level is lowered, so the fields are accessible earlier in spring, resulting in a longer production season, and therefore a higher production.

The quick replenishing in case of dry circumstances almost always means that trophic surface water is brought to less trophic areas, with direct consequences to natural habitats. The lowering of the bottom water results in less seepage water, where seepage water is of vital importance for many of the country’s most valuable and endangered vegetation.

In the eastern part of the Netherlands there are also large groundwater quantities underneath the high sand grounds, which are used as raw material for drinking water production.

Ironically, the problems of drying out and high levels of surface waters are both due to the structure of rural areas that permit quick drainage. The practice of storing surface water has been abandoned. These problems have to be faced on a watershed-basis. In the Netherlands it is called “the water system thinking”.

3. Institutional aspects in water management

In the Netherlands there are three levels of general government: the State Government; the Provincial Government (the counties) (12); and the Municipalities (over 450). The general concept is that State government makes the strategic policies, Provincial government the tactical policies and the Municipalities the operational policies.

Beyond that, we have some 60 water-boards, which must be seen as “functional” governmental bodies, with an operational task on the surface water system.

Within the State Government, at least three ministries are involved in water management.

- The Ministry of Transport, Public Works and Water Management, as the name already indicates, is the first ministry responsible for general water policy, legislation concerning water, and safety from high water (river-dikes and coasts).

- The Ministry of Physical Planning and Environment is responsible for water quality standards and the State legislation on drinking water and industrial water use.
The Ministry of Agriculture Nature Management and Fisheries is, in general terms, the State
government body in water affairs of the rural area. Because of the importance of water for
agriculture, nature, fisheries and recreation.

The legislation made by State government and parliament in the Netherlands can be characterised as
framework legislation. Certain objectives are laid down in the legislation, the regulations have to be filled
in later. This may be done by Ministries, but can also be done by provincial government, water boards or
municipalities.

There are 12 Provinces in the Netherlands. The “Baakse beek” is situated in the Province of Gelderland.
The provinces play an important role in the co-ordination of sectoral policies, as it is on the provincial
level that many sectoral plans are made, which have to take account of the policies in other sectors.

The provinces have legislative responsibilities in water policy and environmental policy. They also
supervise the spatial planning which is a legislative responsibility of the municipalities. Nowadays there
is a development in provincial integration on environmental, water and spatial planning policies, which
leads to one integrated planfigures for each provincial territory.

In water issues, the provinces are responsible — within the State governmental framework — for
construction and control of provincial waterworks and they have statutory powers regarding water boards
to supervise their activities.

Provinces are also responsible for groundwater management, qualitatively as well as quantitatively. For
instance, drinking water production companies get their licenses to extract groundwater as raw material
for drinking water production, from the provincial government.

The majority of tasks concerning qualitative and quantitative aspects of surface water is delegated by the
provinces to the water boards. The tasks concerning groundwater are taken care of by the Provinces
themselves.

So, extensive co-ordination between the managers of groundwater (implementation at provincial level)
and surface water (implementation on a water board level) is needed, as both water types have strong
influences on each other’s quality and quantity aspects.

A difference used to exist between water boards with only quantitative tasks on the surface water system,
and water boards with only qualitative tasks and the same surface water system and on sewerage in the
same area.

Recently the State government passed legislation that all water boards will have to be “integrated water
boards”. This means that through reorganisation, the water boards in the Netherlands will have
quantitative and qualitative responsibilities on the management of the surface water. State government
made the legislation and Provincial government is responsible for the implementation, by way of
provincial regulations. It must be said that a number of already existing “integrated water boards” tried
very hard to incorporate the responsibility for groundwater in the new legislation as well, without success.

With the new legislation in preparation, the operational groundwater management responsibility is thought
to be incorporated by the water boards. This seems logical, since surface water and groundwater are so
coherent. Meanwhile, intensive co-ordination between water boards and provincial government remains
necessary.
4. The “baakse beek” concept

The project “Baakse Beek” is named after a brook system the “baakse beek” in the eastern part of the Netherlands, in the province of Gelderland.

This tiny river drains some 34 000 hectares, which equals roughly 100 000 acres. It builds a “watershed” (a water system unit).

The system of surface water originates in the eastern part of the area which lies some 18 meters higher than the western part of the area, almost 34 kilometres further. Eight meters of the altitude difference exist in the first 3 kilometres, 10 meters in the next 30 kilometres. The whole area has surplus rainwater of approximately 3 000 cubic meters per hectare/per year, meaning a surplus of more than 100 million cubic meters of water every year. 

Geologically, the area consists of a former riverbed of the Rhine which has been filled with sandy river deposits. Later, wind-driven sand deposits occurred. In the bottom there is only one water-transporting layer, which makes the area vulnerable to pollution.

Hydrologically the study area was entirely isolated; water only could get out of this area by evaporation or by a small overflow. From World War II onwards, the draining system has been structured so that agricultural production could be optimised, so that surplus of water could be drained quickly. A water transportation system towards this watershed was never established in this area, which is somewhat unusual.

This “Baakse Beek” area consist almost entirely (85 per cent) of grassland. The predominant agricultural use is dairy (800) and pig farms (900). Some 15 per cent is in use as arable land. The dairy is, as we call it, “bound to land”, the pig farms are quite independent of land, although by manure-rights the binding to land exists to some extent. Some 600 diaries contain 85 per cent of the cows in the area. The mean diary holds 50 cows and milks some 400 000 kg. of milk a year.

Some 51 000 people live within the area; 30 000 in 3 large villages and well over 20 000 in another 14 villages and rural areas. Therefore the “Baakse Beek” area is sparsely populated and is still quite primary — apart from the changes in the drainage system, no major changes in the morphological situation have appeared.

Presently, the drainage system and the extraction of groundwater for drinking water production and for agricultural purposes, cause a lowering of the bottom water. Because of that, some nature areas, depending on seepage water are deteriorating.

The idea of the “Baakse Beek” concept is (in quintessence), the rebuilding of the drainage system and the re-establishing of agricultural use so that water surplus (100 million cubic meters/year!) is held in the study area for as long and as much as possible, in circumstances where water quality is not negatively influenced by agricultural use, so that preceding the drainage system, it is appropriate for drinking water production.

It is thought, that rebuilding the drainage system will need twice as many ditches which are half as deep as those existing nowadays. As a result, the level of the surface water will be some 40 centimetres higher, storing some 50 to 60 million cubic meters of water more than that of today in the ground! This would also mean in the Spring, farmers can start work in their fields some three weeks later than at present and in
an average wet year it will add only one week to the working season period. That means that the production season is shortened and the total production is lowered, estimated at minus 20 per cent.

Re-establishing agricultural use is thought in terms of diminishing the use of inorganic fertilisers, so that the surplus of nitrate is reduced to 150 kg/ha/yr and of phosphate to 20 kg/ha/yr. These figures are far lower than the average surpluses nowadays, which are about 400 and 75-80 kg/ha/yr. Also the use of pesticides is abounded completely. This means that quality standards known from drinking water extraction areas (close around the pumping spots), are implemented in the whole area of the “Baakse Beek”. This means that the type of agricultural activity in the whole area must be fixed. This is one of the difficulties to overcome.

A sort of consolidated dairy, using high productive cattle at low densities would be the best agricultural use. Other types of agricultural use, with higher fertiliser surplus or with the use of pesticides cannot be allowed in such a system. (The pig farms could be maintained, if they are closed systems, with no loss of manure in the area.).

The lowering of production by 20 per cent in the dairy, can be met by payments of the drinking water production company, since the costs of purification and the investments in water infrastructure are very much less than in the actual foreseen situation.

The drinking water production company in this region, recently published its long-term future plan. Procedures in groundwater extraction, as well as finding suitable places (obtaining permits), are very long (some 10 years) and since State Government legislation prohibits an increase in the amounts of groundwater used for drinking water production, the companies have to foresee long-term strategies. A reliable and therefore acceptable alternative to groundwater use, is the use of water from riversystems. The water is pumped up in the vicinity of the river, so actually the groundwater is constantly replenished from the river.

Therefore the drinking water company here chooses to extract its raw material from three river systems, which urges it to make large investments in transporting pipes and purification installations. It can be expected that the price of drinking water will rise, within 10 years, to some 3.50 guilders a cubic meter. We calculated that in the “Baakse Beek” concept, the costs of a cubic meter could be about 2 guilders, some 40 per cent cheaper.

Apart from the price of drinking water, the amount of water available for drinking water production is important. The long-term future plan of the production company calculates a need of 48 million cubic meters in 2015. In case of faster growth of the demand of drinking water, new investments will be necessary. The “Baakse Beek” concept can achieve at least 50 million cubic meters of raw material for drinking water production and probably more.

The idea is that farmers should establish co-operation with the drinking water production company to find a beneficial solution for both parties, to establish sustainable positive effects on agriculture, drinking water production and nature.

The benefits of the concept of the “Baakse Beek” are:

- A structural solution to drying out problems and a restoration of seepage water influence in vulnerable nature areas.

- A new source of income for farmers and a sustainable agricultural use.
A sustainable drinking water production against lower costs.

If this concept could be put into practice, it would create strong links between the main stakeholders, which can be seen as a condition towards sustainable development of rural areas.

5. Problems in implementation

Until now, the relationship of the non-governmental farmer organisations with drinking water production companies, has often resulted in disagreement, since farmers had to prove that groundwater extraction had a negative effect on their production. Also, as a result of huge drainage projects all over the country in previous decades (for agricultural interests), a lot of biodiversity has deteriorated. Over the last decade, projects to raise surface water levels have been mainly directed at the improvement of nature, which has made farmers suspicious. Furthermore, the agricultural sector in Europe, and especially the highly intensive agricultural sector of the Netherlands, faces a complete reorientation, resulting in a “wait and see” attitude from farmers.

The water production companies mainly have governors from provincial and municipality boards who want to develop long-term strategies, which consist of solid and reliable solutions. The “Baakse Beek” concept means an unprecedented and definite, alternative solution for which the climate does not yet exist.

The water boards are not responsible for the groundwater, and have predominantly farmers as board-members. Furthermore, the costs of the water boards are largely paid by farmers, which rose significantly during the last few years, leading to some hesitation for new ideas on the issue of water with farmers as well as with water boards.

Nowadays, the limitations in agricultural water use is hardly present in agricultural policies in the Netherlands. If the concept of the “Baakse Beek” is implemented, it would probably be necessary to establish provisions at the provincial level, an idea which makes farmers nervous and makes provincial authorities cautious about their ability to propose new solutions, fitting within the strategic concepts of the State government.

A solid scientific concept on the sustainable management of a very small quantity of our Planet’s water, beneficial for agriculture, nature and drinking water production, situated in a highly developed country such as the Netherlands, is a much harder task to implement than might be expected, although this must be applicable world-wide.
NEW ZEALAND: THE IMPACT OF POLICY REFORMS ON WATER QUANTITY AND QUALITY ISSUES

by MAF Policy, Ministry of Agriculture and Forestry, Wellington

Summary

New Zealand agricultural use of water is estimated to total around 350 million cubic metres for livestock farming, and more than one billion cubic metres for irrigation of pasture, agricultural and horticultural crops.

New Zealand has implemented wide ranging economic reforms over the past decade. Markets now play the prime role in the allocation of economic resources, thus ensuring that adjustment occurs on a gradual and continuing basis. Since 1984, government assistance to agriculture has been virtually eliminated.

Although, water used in agriculture is only a small part of the 300 billion cubic metres of water available annually, the combined agricultural, urban and industrial use can place pressure on particular groundwater aquifers and surface water resources during summer low flows and/or drought periods. Pastoral agriculture is the main source of pressure on water quality.

In the mid-1980s, the Government reformed its environmental legislation, which culminated in the launching of the Resource Management Act in 1991, under which local authorities have primary responsibility for most environmental issues. Instruments used by these authorities include: regulation and polluter pays principle; user-charges for services such as pest and flood control; and research and development for problems such as erosion and nonpoint source water pollution.

While in the past, Governments had pursued an active policy of promoting and subsidising the development of community irrigation and rural water supply schemes, in 1988, the Government announced its intention to sell its capital share in community irrigation schemes. Ten years later, the asset sales programme is now completed. Very few schemes realised a significant sale price. Efficiency gains are anticipated in the medium to longer term because irrigator ownership will provide greater incentives for efficient operation and maintenance of the schemes.

To mitigate the impact of climate risks and to enhance land productivity, Governments had encouraged use of water resources by providing subsidies for irrigation schemes, and for rural community water supply schemes. Prior to the removal of subsidies in 1988, there were high rates of assistance for irrigation. Now irrigation development must be privately financed, and to proceed requires approval of environmental permits.
User-pays and polluter-pays principles are well established in New Zealand. Farmers are required, for example, to install effluent disposal systems at their own cost and face the prospect of fines if not complying with regional government regulations. Furthermore, for a range of activities, farmers must obtain environmental permits and pay the administrative and on-going monitoring costs associated with permits. To address nonpoint source pollution problems, local authorities are encouraging landowners to take collective responsibility for devising solutions to meet community expectations. To ensure that their production systems are sustainable, the farming sector has taken several initiatives to address environmental issues, including codes of practice, formation of landcare groups and development of on-farm indicators.

Under the Resource Management Act 1991, the resource consent process provides Regional Councils the powers to control water abstraction and diversion, and discharges to water, for stated periods.

More intensive farming systems are placing pressures on available water quantities and water quality. After a decade of fundamental economic, institutional and legislative rethinking and reforms, future changes to policies affecting water use and water quality in New Zealand will largely focus on correcting omissions and anomalies that inevitably emerge from a period of such rapid and wide ranging adjustments.

1. Introduction

New Zealand occupies approximately 27 million hectares of predominantly hilly and mountainous terrain. Of this, around 13.6 million hectares is used in pastoral and horticultural farming systems. A further 1.6 million hectares is planted in forests of exotic species for timber production [StatsNZ, 1997]. Over 18.5 million hectares has slopes of greater than 12 degrees, of which around 13.5 million (50 per cent) hectares have slopes of greater than 28 degrees [StatsNZ 1995].

Maritime climatic influences lead to a relatively even annual distribution of rainfall in New Zealand which coupled with the topography, favours the predominant pastoral farming systems of land use. However there is some variation in local climate conditions, ranging from the subtropical conditions of north Auckland, to cold subalpine tussock grasslands in the central north Island and southern Alps. Orographic effects on the moisture laden prevailing westerly winds as they encounter the southern Alps mountain range, lead to heavy precipitation on the western side of the South Island and a resultant rain shadow climatic effect on the eastern coast, where extensive plains subject to extended periods of summer soil moisture deficits, have been the principal sites of irrigation development.

NZ water resources

New Zealand has an estimated total annual precipitation of some 300 000 to 600 000 million cubic metres per year, however, its geographical and intertemporal distribution is variable. Surface water (rivers and lakes), provides about 60 per cent of the water consumed\(^\text{16}\), with the remaining 40 per cent being drawn from underground aquifer water resources. The ambient groundwater resource is thus of major significance in particular regions.

\(^{16}\) Uses, excluding hydro-electricity generation.
Use of the water resource

Hydro-electricity generation makes by far the greatest demand on New Zealand water resources, using in excess of 100 000 million cubic metres of water per year (Table 1). The New Zealand human population of 3.6 million generates an annual use by households and industry estimated to total 210 and 260 million cubic metres, respectively. Around 87 per cent of the population is supplied by public water supply systems, with the rest depending on independent domestic supplies (collected rainwater, aquifer bores, or supplies from streams). Industry obtains about 30 per cent of its requirements from public supply systems and 70 per cent from its own resources.

Table 1. Estimated annual use of water in New Zealand

<table>
<thead>
<tr>
<th>Water Use</th>
<th>Quantity million cubic metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Generation</td>
<td>100 000</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1 100</td>
</tr>
<tr>
<td>Livestock</td>
<td>350</td>
</tr>
<tr>
<td>Industry</td>
<td>260</td>
</tr>
<tr>
<td>Household</td>
<td>210</td>
</tr>
<tr>
<td><strong>Total Annual Use</strong></td>
<td><strong>101 290</strong></td>
</tr>
<tr>
<td><strong>Annual Precipitation</strong></td>
<td><strong>300 000-600 000</strong></td>
</tr>
</tbody>
</table>


Agricultural use

Agriculture use is estimated to total around 350 million cubic metres for livestock farming and 1 100 million cubic metres for irrigation of pasture, agricultural and horticultural crops (see Table 1).

Economic reforms

In the past decade New Zealand has implemented wide ranging economic reforms. The reform programme was an urgent task, made necessary by the slow economic growth and high level of external debt of the New Zealand economy. Government intervention in all aspects of the economy had led to severe resource misallocation and high levels of assistance that could no longer be maintained. The reform programme aimed to achieve sustainable economic development. Government intervention in all areas of the economy was drastically reduced, and markets rather than government fiat, now play the prime role in the allocation of economic resources, thus ensuring that adjustment occurs on a gradual and continuing basis. In 1984 and succeeding years, government assistance to agriculture was virtually eliminated.
2. Main policy issues

Water quantity

Apart from hydro-electricity generation, and reflecting the relatively small population in New Zealand, agriculture emerges as the main pressure on water stocks and flows, in particular because of the irrigation use of water in agriculture and horticulture production systems. Although, water used in agriculture is only a small part of the total available water resource, the combined agricultural and urban and industrial use can place pressure on particular groundwater aquifers and surface water resources during summer low flows and/or drought periods.

Water quality

Because of the relatively small population in New Zealand, and extensive use of land in pastoral agricultural production systems, pastoral agriculture also emerges as the main source of pressure on water quality. Agriculture contributes to increased sedimentation, nutrient enrichment and faecal contamination of surface waters through run-off from farm land, and through point source pollution in the lower reaches of some streams and rivers. There is also nitrate contamination of groundwater resources in some catchments. Processing of agricultural products is a further significant source of pressure on water quality in some areas. However there has been a reduction in number of processing sites and application of improved pollution management procedures by remaining processing units, which has resulted in some abatement of this source of pressure on water quality during the last decade.

Reform of water policies

In the mid-1980s, New Zealand eliminated a range of subsidies that were distorting resource use in agriculture. As a result, government policy was no longer actively promoting unsustainable production practices. At the same time, the government embarked on a broad reform of environmental law. This culminated in the Resource Management Act 1991, with its stated purpose of promoting sustainable management.

Under the Resource Management Act, local authorities have primary responsibility for most environmental issues. These authorities use a variety of instruments:

- **Regulation and polluter pays** for activities commonly identified as “pollution”, and to protect waterways and small areas of valuable habitat.

- **User-charges** for services such as pest and flood control.

- **Research and facilitation** for problems such as erosion and non-point source water pollution where lack of information is a major part of the problem.

- **Selective purchase** of, or permanent easement over, large or ecologically very significant areas (usually by central rather than local government), thus ensuring their permanent protection.
• **A combination of regulation and selective land purchase** to protect valued landscapes (this is needed only in very specific local areas).

In addition, both central and local government are encouraging **voluntary, co-operative approaches** by the private sector. Agricultural organisations have taken several initiatives to address environmental issues, including codes of practice, formation of landcare groups and development of on-farm indicators by farmers themselves. Farming leaders sense that consumers in New Zealand and overseas are increasingly interested in how a product is produced, in addition to traditional quality concerns. Farming groups are therefore supporting efforts to ensure that their production systems are sustainable and that this can be demonstrated to consumers.

**Institutional reforms and sale of irrigation schemes**

In December 1987, Government announced a decision to disband the Ministry of Works and Development [MWD], a department of state, which had amongst a wide range of other roles, both policy and delivery functions in relation to water resource management through its operation of the National Water and Soil Conservation Organisation. Until this decision, the Government, through the MWD, had under the Public Works Act 1981, and its antecedent amendments, pursued an active policy of promoting and subsidising the development of community irrigation and rural water supply schemes. Such schemes, because they benefited from substantial public subsidies, were subject to cost benefit analysis appraisals, as a component of the final Government decision making process. The MWD was responsible for the operation and ownership of community irrigation schemes while Local Authorities or groups of affected farmers generally had title to, and were responsible for the operation of rural water supply schemes. By March 1988, the MWD had been disbanded, with policy functions and former staff being shifted to a range of other departments of state.

In February 1988, the Government announced its intention to sell its interest in community irrigation schemes; a marked departure from its previous involvement in both the funding and management of such schemes on behalf of agricultural users. The Treasury negotiated the sales, and the Ministry of Agriculture and Fisheries became responsible for managing the schemes until sold, the transfer of the assets, resolution of issues and removal of all statutory rights and Crown interests in land. Principal objectives were:

• to place all community irrigation schemes on a fully commercial basis including full operating cost recovery;

• to remove Government from ownership and management of community irrigation schemes and to eliminate all Government funding from existing schemes and any future irrigation developments.

The asset sales programme is complete. Very few schemes realised a significant sale price, and for some schemes there was a net payment to irrigators. Issues of equity and irrigators’ ability to pay overrode any immediate economic efficiency gains. Efficiency gains are anticipated in the medium to longer term because irrigator ownership will provide greater incentives for efficient operation and maintenance of the schemes.
Principles of water pricing and allocation among users

Irrigation is a major consumptive use of water in New Zealand, comprising around 57 per cent of all withdrawals, compared to withdrawals for livestock of around 18 per cent. The South Island has the largest area irrigated, while the North Island has the largest area of irrigated horticultural crops (see Table 2). The locations of community irrigation schemes are set out in Maps 1 and 2 containing maps of the North and South Islands. As a part of a long standing policy to mitigate the impact of climate risks on livestock and crop farming and to enhance land productivity, successive Governments had actively encouraged this use of water resources by providing subsidies for irrigation schemes, and for rural (livestock and farm household) community water supply schemes. The assistance rates for irrigation, removed in 1988, were higher than that provided for most other types of agricultural development.

Table 2. Irrigation in New Zealand

<table>
<thead>
<tr>
<th>Land Use</th>
<th>North Island</th>
<th>South Island</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>ha</td>
<td>ha</td>
<td>%</td>
</tr>
<tr>
<td>Pasture</td>
<td>10 098</td>
<td>154 625</td>
<td>164 723</td>
<td>64.2</td>
</tr>
<tr>
<td>Arable</td>
<td>1 760</td>
<td>63 479</td>
<td>65 239</td>
<td>10.4</td>
</tr>
<tr>
<td>Horticulture</td>
<td>17 504</td>
<td>9 121</td>
<td>26 625</td>
<td>25.4</td>
</tr>
<tr>
<td><strong>Total Annual Area</strong></td>
<td><strong>29 362</strong></td>
<td><strong>227 225</strong></td>
<td><strong>256 587</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Irrigation method</th>
<th>North Island</th>
<th>South Island</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray</td>
<td>17 626</td>
<td>123 542</td>
<td>141 168</td>
<td>55.0</td>
</tr>
<tr>
<td>Flood</td>
<td>1 757</td>
<td>100 918</td>
<td>102 675</td>
<td>40.0</td>
</tr>
<tr>
<td>Trickle</td>
<td>9 979</td>
<td>2 765</td>
<td>12 744</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Total Annual Area</strong></td>
<td><strong>29 362</strong></td>
<td><strong>227 225</strong></td>
<td><strong>256 587</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Source: NZ Department of Statistics (1987), relating to 1985 agriculture census data.
Map 1. North Island irrigation schemes
Under the policies applying immediately prior to the removal of subsidies, the government funded 70 per cent of the off farm costs to develop community irrigation projects, including costs of investigation, head works, distribution and half of the costs of on-farm delivery systems as well. Additionally, the on-farm costs were eligible for concessional development loans, with deferred capital and interest terms available during the early 1980s, further increasing the concessional element for that period. Government also effectively subsidised delivery costs and water charges to irrigators, as most irrigation schemes operated at a loss. Authorising legislation provided for 30 per cent of the off farm capital costs to be repaid over 40 years. However, high interest rates in the 1970s resulted in debts that could not be recovered. The inability to recover capital and operating deficits were some of the factors leading to the privatisation of the schemes in the late 1980s and early 1990s.
Although time series data are not available, water abstractions for agriculture are expected to have stabilised, compared to the period 1978-1985, when the highest levels of subsidies were available for irrigation development. More recently, demand for irrigation water has been building, and various schemes are under investigation. However, in contrast to earlier policies, none of these projects are receiving government assistance, with the exception of one scheme that had been at an early stage of development at the time when government policies were revoked. This community scheme received a single grant of NZ$1 million because of benefits enhancing the environment (low flows). All of the current proposed projects will need to be privately financed, and apply for and obtain the necessary environmental permits, if they are to proceed.

**How are water quantity and quality issues addressed in agriculture and environment policies?**

User-pays and polluter-pays principles are well established in New Zealand. Farmers are required, for example, to install effluent disposal systems at their own cost and face the prospect of fines if not complying with regional government regulations.

Furthermore, for a range of activities, farmers must obtain environmental permits and, in an increasing number of circumstances, must pay the administrative costs and on-going monitoring costs associated with the permit. To address non-point source pollution problems, local authorities are encouraging landowners to take collective responsibility for devising solutions to meet community expectations. The farming sector has taken several initiatives to address environmental issues, including codes of practice, formation of landcare groups and development of on-farm indicators by farmers themselves. These initiatives should help them to respond positively to consumers as they become more interested in production processes. Although there is still some way to go, New Zealand is moving towards internalisation of environmental costs in order to encourage the efficient and sustainable use of natural resources.

3. **Main policy measures**

There are a number of pieces of New Zealand legislation which have a bearing on water use and water quality. The administration of water (and soil) resources is achieved through the Resource Management Act 1991, administered by the Ministry for the Environment. The Ministry for the Environment also has oversight of the Soil Conservation and Rivers Control Act of 1941, which is administered at a local level by the 9 Regional Councils to provide protection against flooding (and erosion). The operation of communal water supply systems are subject to the approval of the local Medical Officer of Health, who draws on the specifications of the guidelines in the *Drinking Water Standards for New Zealand*, [Ministry of Health, 1995].

**The Resource Management Act 1991**

The Resource Management Act 1991, is an overarching piece of legislation providing an environmental planning framework that has devolved much of the responsibility for environmental management, including planning, policy-making and implementation, to regional and local authorities. Regional Councils have powers to control water abstraction and diversion, and discharges to water, while District Councils influence water quality through their land use planning functions. Discharge consents and water permits, amongst other things, are thus determined at a local level.
The purpose of the Act is to promote the sustainable management of natural and physical resources. The Act provides a means for planning how the people of New Zealand can use, distribute, or preserve natural and physical resources, including rivers, lakes, groundwater, coastal and geothermal areas; soils, forests, farmlands, the air and the constructed environment of buildings, bridges and other structures. The Act places emphasis on the effect a proposed activity may have on the environment, and provides for the community to become involved in making decisions about resource management.

In the Act Sustainable management means managing the use, development, and protection of natural and physical resources in a way or at a rate which enables people or communities to provide for their social, economic and cultural well-being and for their health and safety while:

- Sustaining the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations.
- Safeguarding the life-supporting capacity of air, water, soil and ecosystems.
- Avoiding, remedying or mitigating any adverse effects of activities on the environment.

**Resource consents**

A resource consent gives a person or organisation the permission to develop a natural or physical resource, and/or carry out an activity that affects the environment in some way for a stated period. Resource consents replace the many different permissions granted under the previous law. Regional Councils are responsible, *inter alia* for issuing Water Permits and Discharge Permits. Any taking of, damming of, or discharge to water requires a resource consent, unless the operative Regional Plan specifically states that a consent is not needed. Individual household, livestock and firefighting uses of water are exempted by the RMA from requiring a resource consent.

The Ministry for the Environment has overall responsibility for environmental policy advice to Government. Government adopted in 1995 an Environment Strategy, which takes a longer term view of New Zealand’s environmental priorities [MfE 1995]. In establishing their regional and district plans Regional and District Councils are to take into consideration national environmental policies and matters of national importance.

4. **Future developments**

There are both water quality and quantity considerations that are of concern to policy makers.

**Emerging concerns**

While non-point source pollution from agriculture has been a concern, there have been increasing efforts and employment of new technologies to address this impact of pastoral agriculture on water quality, including riparian and wetland retirement and careful fertiliser and effluent management.

The growth in dairy farming, coupled with a move away from discharge of effluent to water, a policy of most Regional Councils, is causing increased application of organic wastes (mainly dairy shed effluent) to land. There is also increasing treatment of municipal sewage in this way. Development of new
technologies, such as constricted wetlands, are all factors that have the potential to cause increased groundwater contamination and/or runoff to surface water, unless managed carefully.

Management of underground water to protect it from pollution, and in some coastal areas, from salt water intrusion, is an increasing concern of some Regional Councils.

In addition to quality impacts, land use changes may have impacts on water quantity. Land use change from relatively extensive sheep and cattle farming systems to dairy farming is likely to lead to substantially increased use of water on such properties. Also, some local authorities are giving consideration, for example, to the depletion effects, that planting of exotic production forests may have on water availability within a catchment.

The intensification of farming (including dairy farming and horticulture) is leading to increased demand for irrigation use of water, for example, in the Northland region, which raises a conflict in use of water between use for farm production purposes and maintenance of in stream flows and related environmental values of habitat, fisheries and other aspects of biodiversity.

New Zealand has experienced a decade of fundamental economic, institutional and legislative rethinking and reforms, which have had dramatic impacts on resource management and resource managers. Future policies will largely focus on correcting omissions and anomalies that inevitably emerge from a period of such rapid and wide ranging adjustments.

5. Bibliography


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6. **Legislation — Acts and Regulations**

The Resource Management Act 1991  
Ministry for the Environment

The Soil Conservation and Rivers Control Act 1941  
Ministry for the Environment

The Health Act 1956  
Ministry of Health

The Water Supply Protection Regulations 1961  
Ministry of Health

Irrigation Schemes Act 1990  
Ministry of Agriculture

Public Works Act 1981  
Ministry for the Environment
SPAIN: THE INSTITUTIONAL MANAGEMENT OF IRRIGATION WATER IN SPAIN

by José A. Ortiz Fernández-Urrutia, Ministry of Agriculture, Fisheries and Food, Madrid

Summary

As a Mediterranean country whose main climatic features are medium to high temperatures, irregular, uncertain and in general, low precipitation — Spain has, throughout time, frequently experienced severe water shortages during the crop seasons. This situation compelled its first inhabitants to look for solutions to assure crop yields, finding soon that the only way to cope with this unfair condition was to artificially apply water to the crops, i.e. to resort to irrigation. Thus they developed and improved for centuries an advanced system, not only of irrigation networks and application methods and practices, but also of institutions for water management aimed to achieve a sound and equitable share of the always scarce and uncertain water resources.

The result of this experience is the present institutional set-up of irrigation water management, regulated by the Water Act of 1985 (WA/85), now subject to a process of revision in relation to the latest social and technical conditions prevailing in Spain as well as to be in conformity with other international regulations and directives. According to the WA/85 the global water management in Spain is based on two basic principles. First, all waters, either surface or underground, together with the space they affect (known as “water public domain”), are a public good and therefore shall be controlled and administered by the Central Government (the intra-communities basins) or its equivalent in the Autonomous Regions (the inter-communities basins), according to the Nation’s or Region’s general interests. The Ministry of the Environment and the Regional Governments are the only ones entitled to grant concessions for water use and for specific purposes. Second, the global water administration is based on the principle of river watershed hydraulic unity.

The administration and management of water resources within each river basin, as well as the entitlement to grant concessions to use water in the water public domain, is entrusted to the River Basin Authorities. These Agencies are mixed institutions governed by Boards composed of officials belonging to the Central Administration and water rights users, in proportion to the (economic) interests concerned. For instance, the average composition of the Governing Boards of all the Spanish River Basin Authorities is roughly 51 per cent administration officials, 35 per cent users other than irrigators (urban supplies, industries, power plants, etc.) and 14 per cent irrigators.

In turn, according to the WA/85, all farmers or users, withdrawing water from a single source or benefiting of a single concession must form a Users Association (UA) or an Irrigators Community (IC). These are independent institutions that, although attached to the Basin Authorities, are regulated by their
own Ordinances and governed by different and specific bodies. Their members are democratically elected among the users, and are responsible for the legislative, executive and judicial functions, respectively performed by the General Assembly, the Governing Board and the Irrigation Jury or Water Court. The latter is aimed to achieve: the best use and most equitable share of water available to avoid water wasting or misuse and so reducing environmental hazards; to maintain infrastructures in good state of use and improve the irrigation system and application methods in order to raise efficiencies; and to settle disputes between users or users and Community’s personnel, etc.

Several small ICs within irrigated areas may group together in a Central Board or a General Community to improve performance, strengthen their position for the defence of their common interests, and benefit from the assistance of technical services that could otherwise be unaffordable. This is the case of the General Community of Urgel Canals Irrigators (GCUCI), which groups 21 Ordinary Communities or Collectivities, subdivided into 125 districts or irrigation sectors, which permits personal attention given to individual farmers and assures the best and quickest solution to their problems through the governing bodies, either of the Collectivity or of the General Community.

The governing bodies of the GCUCI, and particularly the Governing Board are assisted by technical, administrative and water distribution services that support the Board in all management decisions such as the filling and discharge regimes of the Oliana reservoir and the volumes diverted through the main Urgel Canals, etc. The organisational set-up of this General Community has proved to be highly effective not only from a human point of view but also as the best tool to achieve important economies of irrigation water and a more protective behaviour to the environment. This experience deserves consideration as it could be applied in other countries.

PART ONE: THE INSTITUTIONAL MANAGEMENT OF IRRIGATION WATER IN SPAIN

1. Introduction

Spain (the mainland and the islands) has a total surface area of 50.8 million hectares (Mha), with a Total Arable Land of 27.1 Mha (53.3 per cent). The mainland, which has a surface area of 49.25 Mha (84.3 per cent of the Iberian peninsula), is located in the south-west corner of Europe, lying between positive-latitude parallels 36° and 43°, and it brings the Mediterranean basin to a close on the western side.

On account of its geographical location, there is a strip of land running from East to West, almost through the middle of the country that marks the front for the northward advance of the desert, dividing continental Spain, from a climatic standpoint, into two distinct halves: one to the north that is relatively wet, with an average annual rainfall of some 707 mm, and another to the south, patently dry, with a rainfall amounting to less than 450 mm a year, and even dropping to less than 7 mm in the months of July and August (see Table 1). The rainfall is unevenly distributed and not well suited for agriculture, not only in spatial terms but also in time throughout the year, with cold and wet periods in autumn and winter, and dry hot periods in summer — the peak months of crops water requirements; as a result, even though Spain as a whole has sufficient average rainfall, its exploitation solely by natural means — i.e. without water regulation of any kind — cannot meet the plants requirements at times of maximum evapotranspiration.

As a result of these conditions of semi-aridity and uncertain rainfall, the earliest inhabitants of the Iberian peninsula, back in pre-historic times and particularly those settled along the Mediterranean coast, had to
resort to arranging man-made supplies of water for their crops as the only way to succeed in getting harvests and to ensure food production.

Table 1. Average rainfall by catchment basins
(figures in mm, period covered 1930-96)

<table>
<thead>
<tr>
<th>Hydrographic watersheds</th>
<th>Autumn-Winter</th>
<th>Summer</th>
<th>Annual Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>“WET SPAIN” (Northern watersheds)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North of Spain, Duero, Ebro, Catalonia and Tajo</td>
<td>73.1</td>
<td>30.8</td>
<td>706.9</td>
</tr>
<tr>
<td>“DRY SPAIN” (Southern catchment basins)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guadiana, Guadalquivir, South of Spain, Segura and Júcar</td>
<td>55.1</td>
<td>6.7</td>
<td>442.3</td>
</tr>
<tr>
<td>WEIGHTED MEAN FOR THE MAINLAND</td>
<td>68.4</td>
<td>22.2</td>
<td>624.3</td>
</tr>
</tbody>
</table>

A native irrigation system can be traced back to the first millennium B.C. in the Mediterranean region; such practice being boosted and developed successively by Phoenician, Greek and Carthaginian influences, was further consolidated by the presence of the Romans and Visigoths, taking us well into modern times, culminating under the Arabs who, influenced by the experience of the Syrians, Lebanese and Egyptians that, arriving from also arid and short of water regions, brought in highly improved techniques in terms both of practical applications and of association-based frameworks for the equitable allocation of that resource. In these systems, that are still used in many cases today, can be perceived the germ of our current institutional system.

It is fitting here to make special mention of the Water Court of the Plain of Valencia (Tribunal de las Aguas de la Vega de Valencia): according to some researchers it was created around 960 A.D., under full Arab domination and, after the conquest of the city of Valencia in 1239, the King Jaime I gave his authorisation for this Court to continue to be used as it was and so, it has subsisted until now, almost unchanged, both as a model institution that has served for others that were to be created all over the world, and as a bench mark for the legislators of the Water Laws of 1866 and 1879, who saw in that Court a good example, worthy to be followed in establishing the present system of Irrigators Communities in Spain.

The economic importance of irrigation for Spain in the past, that can be deduced from the foregoing, remains important today and so will be in the future. Indeed, it suffices to note that nearly 60 per cent of Spain’s total agrarian commodities comes from the 3.4 Mha of irrigated land (13 per cent of the Total Arable Land), with estimated yields per hectare 5 times higher than the rainfed equivalent.

2. Historical background

It is to be taken for granted that the first ethnic groups settling near rivers and other sources of water must have quarrelled for the control of that resource on account of its scarcity in the summer months and its
uncertain supply, in rivers lacking of any kind of regulation at that time. This quarrelling must, no doubt, have prompted the appearance of some primitive forms of association among those early irrigating farmers and water users, and these associations, governed at first by basic principles of social living and then by others with a firmer legal base, as was the case with the Romans and Moors, gave rise during the Middle Ages to ever more perfect organisations, such as guilds, syndicates, boards etc., that were set up in connection with diversion structures on watercourses with the aim of an equitable administration and allocation of the diverted water for irrigating crops, maintaining the system in good operational state, and settling any conflicts that might arise among the farmers over the rights to utilise the irrigation facilities and the resource.

During the Middle Ages, these irrigators associations took on their present assembly-based form, with the Assembly emerging as the highest authority, charged with adopting resolutions for general application. By then these irrigators associations were already ruled by their own Regulations, which set down provisions for the maintenance and use of their irrigation facilities, even though the municipalities, with greater legislative power, could and did take action on their decisions.

With the aim of bringing order to the workings of all these organisations, each one with its own specific and varying rules and practices, a start was made in the 13th century on producing highly detailed legislation on the possession and use of water (in Aragon, under James I and in Castile, under Alfonso X the Wise with his law compilation in “Las Siete Partidas”), out of which was later to emerge the outlines of the present form of the Irrigators Communities.

It was indeed during this final stage of the Middle Ages when the notion of water being a public good took root, with rights being granted by the royal authority, representing what was later to become the State and the Government, for the use of water (irrigation, supplies, mills, etc.) by private individuals. This notion has undergone development over the centuries down to our own day.

3. Water authorities in Spain

When the Bourbons came to the throne in Spain, progress was made in all sectors of economic activity, irrigated agriculture among them, with a boost in irrigation works. At the same time, the role of the State as “administrator”, granting water rights so that it could be properly used by private users, became ever more sharply defined. Following a number of legislative acts dealing with irrigation and water, the legislative process culminated in the late nineteenth century with the Water Law of 1879; this Law sets out an administrative structure for water, organised as it is now, in graded levels, running from the top level formed by the State, as the administrator for the proper use of the resource and as the body entitled to grant rights, down to the lowest level comprising the users, and going through intermediate levels with organisations that brought those benefiting from the water together, grouped in terms of their social or economic purpose and their location in the territory.

It was initially at this intermediate level that the Irrigators Communities (Comunidades de regantes) appeared to fulfil very specific tasks that would later be commented, such as gathering farmers benefiting from the same outlet or irrigation system, which on its turn is associated with the concession allowing to use the water.

That was the institutional framework in place at the start of the 20th century, with just over a million hectares under irrigation, plus an ambitious plan for expansion, since it was thought that the economic development of the country depended on irrigated agriculture. The Law of 7 July 1905 on assisting small irrigation systems, and particularly that of 7 July 1911, consolidated the encouragement...
given from the State to this activity by setting up a system for financing irrigation works, still enduring today, which was the real force behind its implementation.

This growing involvement of the State, added to its former supervising or controlling role, led to an increased complexity and further subdivision of the second-highest organisational level, giving rise to a new body for co-ordinating the interests of water users or beneficiaries with those of the other citizens which, through the State’s Administration could take charge not only of the water control but also of the execution of the necessary works.

Thus there arose the concept of a mixed body formed as an association to bring together both the general interests of the State and those of the users, and this idea, along with the concepts of formal independence from the State’s basic administrative system so as of grouping according to natural territories sharing a common hydrography, was the starting point for the creation of the Hydrographic Confederations or Drainage Basin Authorities or simply Basin Authorities.

The Hydrographic Syndicate Confederations were created by Royal Decree of 5 March 1926, which cleared up the field of how the country’s water resources were to be managed. It turned the catchment basins (of the main rivers) into units for study and action, and gave those Confederations the task of drawing up plans for using the water, co-ordinating the various interests at work in each basin, among which irrigation is found to be the largest consumer, using about 70-80 per cent of that resource. With this aim, the first Confederation to be created was that of river Ebro basin, followed subsequently by all the others.

The old Water Act of 1879 has underpinned water development in Spain for over one hundred years. However, the evolution of society, new forms and requirements in water use, the need to preserve this resource in terms of quality and quantity, the effects of water use on the environment etc., and changes arising in the Government itself, all made it necessary to subject that Water Law to thorough review, being therefore replaced by the Law enacted in 1985, the text of which is currently under new revision for the purpose of making partial improvements. These improvements, though not changing its general thrust in any substantial way (it having been essentially maintained anyway from the 1879 Law), will enable the experience acquired over the twelve years elapsing since it was enacted to be turned to good account — experience that includes events as significant as the great drought of 1992-1996.

One of the most important changes in this 1985 Law as compared with its 1879 counterpart was to bring both surface and underground water together as public water, both types being placed under State control to make better use for a sustainable exploitation. Moreover, in that Law, the Hydrographic Confederations were ratified as Drainage Basin Authorities, those being instated as single, indivisible bodies in their respective hydrographic areas: the drainage basin.

In this context, two facts are worthy to note: (1) that the Spanish model of Hydrographic Confederations, dating from 1926, has subsequently been adopted in various places around the world, notable examples being the Tennessee Valley Authority (USA), created in 1933, the “Agences du Bassin” (France), in 1964, and the Water Authorities (UK), in 1973, among many other less prominent examples, and (2) that section 11 of the European Chart of Water (1968), coming 42 years after the creation of the Spanish Confederations, recommends that water administration be dealt with by catchment basins, regardless of political borders or administrative boundaries. These two facts show that Spain may justly be regarded as the world pioneer both in the concept that drainage basins shall be handled as indivisible units for managing water resources and in the creation of the Hydrographic Confederations or Drainage Basin Authorities for administering those resources.
The water and the concessions of use

Before going into our analysis of the bodies directly involved in managing irrigation water, we must devote some attention to the central subject-matter of this paper — water — and how the right to benefit from it is gained.

Water, whether flowing on surface (rivers etc.) or stored underground (aquifers), is regarded by the Water Law 29/1985 (W.L.) as a public good, and as such it is under the sole control of the State, the State being entitled to grant concessions on the basis that “The concessions shall be granted taking into account the joint rational exploitation of surface and underground resources. The grant of a concession does not guarantee the availability of the volumes of water granted.” (W.L. Art. 57-2).

The State, through delegation onto the Ministry of the Environment and from there down to the Basin Authorities, grants water rights as requested by the various users, among whom are the irrigators who, either as private individuals or as farmers associated in Communities, are the largest users, accounting for 70-80 per cent of the water resources available.

The procedure for obtaining a water right is set down in Article 104 et seq. of the Royal Decree for Hydrological Planning (RDPH): some requirements must be met and several reports submitted; the details of these are not relevant here, and so we will try to describe the process in a simple, easy-to-understand manner.

The applications for water concessions for irrigation must be made either by individuals or by Irrigators Communities to the Basin Authority through its Water Commissariat which, after the obliged announcement for public enquiry, along with the reports on the application compatibility or incompatibility with the Basin’s Hydrological Plan and those of the Autonomous Regions concerned, of the Ministry of Agriculture, Fisheries and Food and of the surveys carried out on-site, comes to a final assessment to the Authority advising on the granting or not of the concession.

The water concessions are granted for specific purposes, acting upon well-defined projects, and can be withdrawn if the characteristics of the work or the intended use made of the concession are changed. Before entering the grant in the Water Register of the Basin Authority, these must check the details of the grants entered in their provisional registers. The granting of a right may be reconsidered when there is a change in the factors that led it being granted, or when the applicant asks for it to be reviewed, or when there are reasons of force majeure, or when it must be reviewed to bring it into line with the basin’s Hydrology Plan.

In all cases, “Concessions are to be regarded as made without prejudice to third parties” and, moreover, “The water under concession shall be used as provided in the concessional grant and may not be applied to any other use nor may it be used on different land if granted for irrigation purposes”.

Drainage Basin Authorities or Hydrographic Confederations

The first Hydrographic Syndicate Confederations were originally conceived as self-governed bodies, according to the current Water Law of 1985: “The Drainage Basin Authorities (or Agencies), also known as Hydrographic Confederations, are public-law entities with their own legal form that is distinct from that of the State, subject for administrative purposes to the Ministry of Public Works and Zoning (today Ministry of the Environment), and enjoy full functional independence in accordance with the provisions of this Act”, and “They are governed by the legislation applicable to Autonomous State Agencies for all
matters not envisaged in this Law or in the Regulations issued enlarging upon or implementing it” (Art. 20) — which does not mean that they are truly Self-governed agencies, but rather that they are subject to the legislation provided for such entities.

Their territorial bounds are to comprise one or more indivisible catchment basins, the only limitation being international boundaries.

**Functions of the Basin Authorities**

Their functions, as set down in the Water Law (Art. 21), shall be:

- To prepare the Basin Hydrological Plan as well as to follow up and revise said plan.
- To administer and control the use of the water.
- To administer and control those uses which are of public interest or which affect more than one Autonomous Region.
- To design, build and exploit works carried out by means of the Authority’s own resources, as well as works entrusted to it by the Government.
- Those functions arising out of agreements entered by the Authority and Regional Governments, Municipalities or other public or private agencies, corporations, entities or individuals.

**Government and administration bodies**

“The management bodies of the Basin Authorities are the Government Board and the President.” (W.L. Article 24).

Their organisational structure is made up of a President, who has substantial duties and is appointed by the Council of Ministers at the recommendation of the Ministry of the Environment, a Water Commissioner, a Technical Director and a General Secretary, appointed by the Ministry of the Environment at the recommendation of the Director General of Hydraulic Works and Water Quality. Also present at this “top level” is the Head of the Water Planning Office, who is responsible for drawing up the Water Plan for the basin concerned. These provisions for selecting the governing bodies, at least as far as the President and what we have called the “top level” are concerned, give the Basin Authorities a clear political connotation, which determines their policy for action.

Their governing bodies, in a framework of participation for the pursuit of the functions specifically attributed to them by the Law, are:

- **The Government Board**: This Board is chaired by the President of the Confederation, aided by those holding the top-level posts mentioned above, and it is the supreme authority of the Basin Agency, in which all the users and their interests are represented. The Central Government shall be represented by at least three members: one from the Ministry of Public Works and Zoning (today Ministry of the Environment), one from the Ministry of Agriculture, Fisheries and Food, and one from the Ministry of Industry and Energy; any
An Autonomous Region which would have elected to become part of a Basin Authority shall be represented by at least one member. The Government Board puts forward the Basin Authority’s Action Plan, approves the accounts and draws up the yearly budgets, does the preparatory work on matters to be put to the basin Water Council, passes resolutions on irrigation rules in time of drought, officially declares over-exploitation of aquifers, and takes decisions relating to the assets of the Basin Authority. At national level, the representation of the irrigators in the Government Boards, although they consume over 70 per cent of the resource and bear over 50 per cent of the expenses of the Confederations, accounts only for the 15 per cent (q.v. RB-2 Field G).

- **Basin Water Council**: This is the Water Planning body for the basin, made up of representatives from the various sectors of users. It is responsible to report on and express conformity with the Basin Hydrological Plan and then to submit it for approval to the Central Government, through the Ministry of the Environment, this approval being made by a Royal Decree on recommendation of the Ministry of the Environment. The Water Council is composed of representatives of all Government Departments related with the use of water resources, of representatives of the various sectors of users’ interests, of technical services of the Basin Authority, and of the representation of the Autonomous Regions (W.L. Article 34).

On the basis of all the Basin Hydrological Plans, the Ministry of the Environment and all the Departments connected with the use of water jointly draw up a National Water Plan, which must by law be submitted for enquiry to the National Water Council before enactment by Parliament.

- **Exploitation Committee**: these are managing bodies, usually restricted to an area that can be irrigated or to a set of interrelated rivers, and their mission is to co-ordinate the running of the water works and water resources of that specific area. Their membership, among which users are represented in accordance with their interests and the service they provide for the Community, is set down in the regulations.

- **Reservoir Discharge Committee**: The task of this Committee is to prepare and draw up proposals for the President of the Basin Authority regarding the programme for filling and emptying the basin reservoirs and aquifers, taking into account the rights of the different users. Its composition and functions thereof is set down in the regulations, in accordance with and in proportion to the interests concerned.

- **Users’ Committee**: This is “... made up of all users that form part of the Exploitation Committee, with the aim of co-ordinating the exploitation of the hydraulic works and water resources in the whole basin, without detriment to the system of concessions and the rights of the users” (W.L. Art. 32).

- **Works Committee**: In order that future users connected with a works project that has been approved may be directly informed of its implementation and of any incidents affecting it, the Government Board is entitled, at the request of such users, to set up a Works Board as envisaged in the regulations (W.L. Art. 32).

- The **Planning Office** is charged with and responsible for drawing up the Basin Water Plans, which are used for producing the National Water Plan.

The Water Act establishes (Article 38) that planning is to be arranged through the Basin Water Plans and the National Water Plan, these being public documents that are binding within the territory marked out,
and their “general objective is to achieve the highest degree of satisfaction in meeting requests for water, and to balance and harmonise regional and sectorial development, increasing the quantity of the resource available, protecting its quality, saving on its use and rationalising its uses in harmony with the environment and other natural resources”.

**Irrigators Communities**

*Legal basis and nature*

Bodies with similar functions to those known today as Irrigators Communities have existed from time immemorial under a wide range of names (syndicates, boards, guilds, etc.), and are indeed referred to in the text by Antonio Rodríguez de Cepeda used by the drafting Commission in submitting its Draft Provisions to the Ministry of Development, that draft being the starting point for the Water Act of 1866 (3 August), and the text stating: “The community of interests arising from the collective use of public water demands joint administration. This task has been entrusted since the far-distant past to Boards elected by those persons concerned, which under names such as Syndicates or other equivalent, have looked after the administration of common funds and the right distribution of water in accordance with special Ordinances” (q.v. Martín-Retortillo (RB-6). As can be seen, the need for legislation that would harmonise these “Syndicates” had been felt ever more pressingly by jurists dealing with water-related themes since the start of the last century.

Despite these precedents, however, it was the Water Act of 1879 the first Spanish legal body that specifically dealt with the organisation of the Irrigators Communities (ICs) and set their operational structure and objectives, devoting 25 of its 258 articles to those associations.

So, the ICs are typically Spanish institutions which, over the course of many centuries and in their different associative forms, have held the mission of ensuring that water is properly distributed, settling conflicts among irrigators, maintaining the irrigation infrastructures in good condition, and organising irrigation within their territory, they having been used as a model for legislation in many countries abroad.

Pérez, Toledo and Arrieta define them as “Public-Law Corporations with a legal mandate to share out and administer water concessions as self-governed bodies, in accordance with regulations drawn up by the users themselves and approved by the Administration”.

The most recent and for the moment latest Water Law (29/1985, of 2 August 1985) devotes 11 out of its 113 articles to the ICs, among them being Article 74.1 which reads: “Users Communities are Public-Law Corporations in nature, subject to the Basin Authority, which shall look after the observance of the Bylaws or Ordinances and the proper and orderly use of water”. Their public nature is required by their purpose of achieving the best administration and management of public water, sharing out streams, settling disputes between irrigators and acting as a policing force (RB.3, Valero de Palma).

Thus, the ICs are indispensable agents for the sound management of public water. Consequently, the legislation establishes firstly, as a legal necessity, that the users of water and other purposes of the water public domain enjoying a single water source or right must constitute a Community of Irrigators (or of Users when the water is not to be used solely for irrigation), upon which it then confers the status of Public-Law Corporations, giving them public powers, in such a way that the COIs are thereafter bound to exercise, without the option of waiver, the powers assigned to them for carrying out their mandate for providing proper management of the nation’s water resources, in line with the rights they hold.
Another legal provision with which the ICs must abide is the Regulations on the Water Public Domain (approved by Royal Decree 849/1986 of 11 April), which enlarges upon the aforementioned Law 29/1985, and sets out the legal principles, rights and duties for the users.

The Royal Ordinance of 25 June 1884 approved the “Official Model for Irrigators Communities” and established the official model for Community Bylaws and Regulations; this model, drawing its inspiration from the bylaws existing in the most prominent and long-standing Communities, preserves and respects the application of time-honoured rules. These provisions, which were amended by the Order of 13 February 1968, are an essential set of regulations, since they stipulate the nature of rights with respect to both the Community and the users, and they served as a model in drawing up the Regulations of the current Water Law.

Respect for time-honoured rights and for local customary traditions as regards water management is a constant force behind Spanish legislation, so much so that the 1879 Act recognised the value of “historical law” and even bound the Irrigation Syndicates to respect such acquired rights and local habits.

It is worth noting that even though the ICs, as Public-Law Corporations (Water Act, Art. 74.1), are attached to the Basin Authorities, they are given internal autonomy for management purposes within the limits of the Law through their own Bylaws and Regulations; the latter, in line with a very general official model, must be set down as regards the details by the irrigators themselves and then submitted to the Basin Agency to which they belong for approval.

As regards the legal entity of the ICs, it can be pointed out that the entity is independent of its members, and that the ICs are entitled — though only through their governing bodies and not directly by the irrigators individually — to buy, sell, make contracts, bring legal actions before the courts and undertake any kind of legal action.

Furthermore, the fact that the ICs are not self-governed bodies of the State Administration means that State has no power to assign their assets to any other end or to seize them, to make appointments to management posts, to review their accounts, or to take action in any activity that is specific and exclusive of the Communities.

**Mission of the Irrigators Communities**

Even though we have already touched upon this matter, it must be made clear that the ICs are the bodies charged with organising collective use of the public surface water and groundwater assigned to them so that it may be properly shared out and administered, in compliance with the provisions of their Bylaws.

Thus the ICs’ functions include drawing up an appropriate irrigation rotation for sharing the available water among the irrigators in a fair manner, arranging a bailiff roster for turning the outlets on and off in accordance with the irrigation rotation, dealing with the upkeep of the distribution network, preventing fraud and malpractice in sharing out the water, reporting transgressors, and informing the Irrigation Jury of any disputes arising among the users. The ICs are also charged with keeping the censuses of irrigators up to date so that charges for irrigation are made equitably among users.

Obliging users by law to organise themselves into ICs is justified by the existence of goods and means that are common to the entire area that can be irrigated, such as:

- The water, the reason for the government granting systems.
The water transportation and distribution network.

The service areas of completed hydraulic works.

The organisation of the Irrigators Communities

Article 76 of the Water Law established that “every users association shall have a General Meeting (or Assembly), a Governing Board and one or several Juries. The resolutions of the General Assembly and of the Governing Board, within the scope of their powers, shall be executed in the manner and in accordance with the requirements set down in the Administrative Procedures Law, without detriment to the right to appeal to the Basin Authority”.

Apart from this, under the provisions of the Water Public Domain Regulations (WPDR), legal representation of the Community is held by its President, or by the Vice-President in the absence of the former, they being electing by vote by the General Meeting for the period of office stipulated in the Bylaws. Administrative functions fall to a Secretary, holding the powers and duties set down in the Bylaws or Regulations, or agreed by the General Assembly.

Irrespective of any specific features each Community of Irrigators may have, all such Communities exercise legislative, executive and judicial functions in pursuing their management work.

The General Meeting (or Assembly)

This is the sovereign body of the Community. Article 216 of the WPDR establishes that “The General Meeting, shall consist of all the users in the Community, shall be the sovereign body thereof, and shall be vested with all the powers not specifically granted to any other body”. Consequently, it has legislative functions, such as electing the President, Vice-President and Secretary for the Community, electing the members and deputy members of the Government Board and of Irrigation Jury, electing the representatives for the Basin Authority, examining the Board Report and approving its accounts and budgets, drawing up drafts for Community Bylaws and the Rules for the Board of Directors and the Irrigation Jury, setting fees to be paid by the irrigators, applying for further water rights, acquiring and transferring ownership of goods, etc.

The Governing Board

Article 219 of the WPDR states that “The Governing Board shall be elected by the General Meeting and shall be responsible for the fulfilment of the By-laws, and the implementation of its own resolutions and those adopted by the General Meeting” (W.L. Art. 76.3).

Accordingly, the Governing Board, made up of members elected by vote by the General Meeting, has the duty of exercising executive powers, such as ensuring that By-laws are complied with, appointing and removing employees, drawing up budgets, organising and sharing out the irritation water, attending to the upkeep of the works, etc., in accordance in all cases with its own Rules and By-laws, and subject to the mandates of the General Meeting. The President of the Board is to be appointed in accordance with the provisions of the Ordinances or By-laws or, if there are none, by the members of the Board through majority voting. The same procedure is used for appointing the Vice-President. The Governing Board
also has the task of appointing a Treasurer and a Secretary from among its members, unless they are not already serving at the Community.

To summarise Art. 220 of the WPDR, the following powers are held by the Government Board:

- To watch over the interests of the Community, to foster its development and defend its interest.
- To appoint and remove Community employees in accordance with law.
- To draw up the Board report and the budgets, to propose fees for collection and to prepare accounts for the General Assembly.
- To take decisions for achieving better water distribution, respecting acquired rights and local customs.
- To submit amendments to the By-laws or any other relevant proposal to the General Meeting for approval.
- To arrange for the upkeep of the water modulation and allocation systems, etc.

The Irrigation Jury

The Water Courts, which are probably as ancient as the joint use of water systems itself and which were the forerunners of the present-day Irrigation Juries, gradually acquired prestige and authority over the centuries until finally, in 1848, their jurisdiction was explicitly recognised (q.v. Al-Mudayna, RB-1).

As was the case with the Water Courts, the object of the Irrigation Juries (WPDR articles 224 and 225) is to exercise judicial or arbitration-related functions in disputes involving Community members or disputes between the bailiffs and the Community members, settling without fuss or delay, and at no cost to anyone, any disputes arising in connection with the sharing out and use of the water, and so not having to turn to the general courts of Spain. Article 125 of the Spanish Constitution gives constitutional recognition to these Irrigation Juries when referring to “time-honoured Tribunals” as forms of administering justice (q.v. RB-2 and RB-3):

“Citizens may bring community prosecutions and participate in the Administration of Justice through the institution of the Jury, in the manner and in the criminal-law cases stipulated in legislation, and in time-honoured and traditional Courts.”

On the subject of the Irrigation Jury, Article 76.6 of the Water Law says: “It is the task of the Jury to hear the facts of cases arising among the users in the Community within the scope of the Bylaws, to impose on transgressors the penalties indicated in the regulations, to set the amount to be paid in compensation to the injured parties and any duties to be performed stemming from the transgression. Hearings shall be public and verbal following custom and the Regulations. Verdicts of the Jury shall be enforceable.”

And at this point we must cite once more, as the point of reference par excellence, the Water Court of the Plain of Valencia, which has been working in exactly this way for over a thousand years. “The Jury shall be made up of a President, who shall be one member of the Government Board of the Community, and appointed by that Board, and by a variable number of members and deputies decided by the General
Assembly in accordance with the Bylaws. The Secretary shall be the Secretary of the Government Board or the person designated for this role in the Bylaws” (HPDR, Article 224).

The Irrigation Juries operate as de facto courts. Actions can be brought by the Board members themselves, by the Community bailiffs, or by any irrigator, and the actions are submitted to the Board’s President who, if the action is in order, will instruct the Secretary to issue the summonses to attend the hearing.

The verdicts of the Jury are carried by absolute majority. In the event of a split vote, the President has the casting vote. The Jury’s verdicts are enforceable, and can only be overturned by appeal to the same Jury after the issue of a report by the Board of Directors. After the appeal for reversal is completed, an appeal for judicial review can be filed before the general Courts of Justice of Spain.

Irrigators/Users Communities and types of association

Aside from the legal obligation (W.L. Article 73) for users of water from a single outlet or right to constitute a Users or Irrigators Community, that same Article offers another option in cases in which the main use is irrigation: “Communities of users of surface or underground water, when the use of which affects their common interests, may constitute a General Community for the defence of their rights and for the preservation and furtherment of those interests”.

With this same aim of protecting their interests against third parties, and for achieving better ordering and use of their own irrigation, the Law makes a provision by which “individual users and communities of users may form a Central Board of Users by agreement”, and it goes so far as to establish that “The Basin Authority may, when the general interest so advises, make it compulsory to form the various types of Communities and Central Boards of Users”.

As is the case with ordinary Communities, “The General Communities and the Central Boards of Users shall be composed of representatives of the users concerned. Their Bylaws and Regulations must be approved by the Basin Authority” (W.L. Article 74.3).

The General Communities are composed of a President — generally the President of the Community using the most water — and as many other representatives of the Communities so grouped together as they may decide among themselves, their number being in proportion in all cases with the amount of water used by each. However, the General Community cannot become involved in any matter that is the sole concern of each of the member Communities.

In addition to the above-mentioned associations of Communities, others can be formed for specific purposes, such as the Communities for underground water, bringing together aquifer users, the Communities for the joint use of surface and underground water, which are self-explanatory, the Communities for waste waters, for the building, running and improvement of header lines, sewage plants etc. (W.L. Article 82), the Drainage Communities, for draining waterlogged land, and Communities for the defence of water and flood abatements (RB-3, Valero de Palma).

Apart from these Communities, and in view of the need to set up and maintain consistent criteria among all the various Spanish bodies whose chief common purpose is using water for irrigation, an association called the National Federation of Irrigators Communities of Spain (FNCRE) was formed in 1955 with the
aim of bringing together all the non-profit corporations devoted to administering water for agricultural uses.

The chief aim of this organisation is to facilitate the exchange of ideas, projects, proposals and projects concerned with improving irrigation throughout Spain. Other functions covered by it include making sure that expertise can be exchanged as regards the legal, administrative and practical aspects of sharing out water for irrigation; embracing the aspirations of its member Communities as regards improving their irrigation systems; providing guidance on the setting up of new irrigation groups and on the running of existing ones; guiding, and representing if necessary, its associates and their interests and collective rights with respect to State Bodies; and acting as an arbitrator for settling differences arising between any two or more Communities in the Federation when requested to do so by those Communities.

The Government has acknowledged the worth of this Federation for consultations on many occasions, prominent among them being the drafting of the Water Laws and their associated Regulations and the National Water Plan.

Moreover, the FNCRE is a member of the Standing Commission of the National Congresses of Irrigators Communities (Ministerial Order of the Ministry of Public Works, 12/10/72); a Consultative Body for the Ministry of Public Works (Ministerial Order of the Ministry of Public Works, 12/01/78); a standing member of the National Water Board (Royal Decree 827/1988 of 29 July, Article 16.1-d); a member of the Advisory Committee on the Environment (Royal Decree 224/1994); a member of the Commission for the National Electricity System and other Working Groups of the Central and Autonomous-Communities governments; a constant contributor to the work of the Ministry of Agriculture, Fisheries and Food; and finally the sole representative of the irrigation sector on the national level (q.v. FNCRE, RB-8).

Although joining the FNCRE is voluntary, it currently takes in the vast majority of the Communities of Irrigators in Spain, through their General Communities in many cases, and represents the interests of nearly 2 million hectares of irrigated land.

In addition to the advantages gained through Communities of Irrigators coming together in General Communities (protecting their interests with respect to third parties, improving the use of common facilities etc.), there is another very important advantage: having access to competent legal services, help with accounts, agricultural consultants etc. at a cost that together they can easily afford though singly they could not.

**Community members: Rights and duties**

Being an Irrigators Community member or a “comunero”, is linked to being an owner, whether of land in the area that is irrigated by water under the right run by the Community, or of mills and other facilities having the right to use that water.

A fundamental right of the Community members is the use of water, in accordance with the fair and orderly sharing out arranged by the Community, the water being shared out in proportion to the area of land owned and registered in the Land Register, or in accordance with the irrigation rotation system organised.

The Water Public Domain Regulations establish that the owners of property registered with the irrigation system — and only them or their legal representatives — have the right to hold posts in the Community. They also stipulate that all owners shall have speaking and voting rights in the Assembly, the number of
votes of each owner-irrigator being allocated in proportion to the area of their lands, though no one owner-irrigator is entitled to have votes amounting to 50 per cent of the total.

The Community members also have the right to be informed of all matters dealt with at the General Meetings, attending them and reviewing their resolutions. They may also be represented by somebody else before the Community, though nobody else may substitute for them in the exercise of posts in Community bodies.

The duties of the Community members can be summarised under two headings:

- **Compliance with the rules**, entailing compliance with the Bylaws and with validly adopted resolutions issued by the governing bodies of the Community, the members being liable to penalties if they transgress those provisions.

- **Paying the fees and apportionment** set, even if water is not used. To leave the Community, the irrigator must pay up all the debts pending with the Community, plus the proportional sum due from him for amortisation of works already made. In this respect, Art. 75.4 of the Water Law and Art. 212 of the Water Public Domain Regulations establish that: “The claims of the users associations for preservation, cleaning or improvement expenses as well as any other debt arising out of the administration and distribution of water, shall be charged to the property or industry which receive said services, and the users association shall be able to request payment by means of summary executory proceedings for the collection of settled sums owed to the Government (“via de apremio”) and to prohibit the use of the water until the debts have been satisfied, even in the event the land or industry would have been transferred to a new owner. The above will also apply to fines or compensations imposed by the Irrigation Tribunals or Juries.”

**The future role of Irrigators Communities**

The conditions imposed on Spanish agriculture by the European Community’s Common Agricultural Policy (CAP) and the GATT agreements (at present, and future WTO agreements) on the expected world-wide liberalisation of agricultural markets and the attendant reduction in export subsidies for agricultural produce put our irrigation-based farms up against an inexorable situation: They must either improve and attain competitive levels in terms of prices or quality, or suffer decline and abandonment.

Furthermore, any irrigation-based farm will be subject in the future to ever increasing restrictions as regards water resources, compliance with environmental preservation and safeguarding regulations, and strict compliance with the legislation enacted at State and Regional levels in that regard.

Consequently, irrigated farms of the future (both those now existing and all potential ones) will have to gear themselves to increasing their productivity and achieving more rational and economical water use. To this aims either the Central and the Autonomous Regional Governments shall support the necessary actions according to their budgetary possibilities through appropriate forms of financing or granting aids for the **improvement and modernisation of the facilities of traditional irrigation schemes**.

The first objective in improving and modernising irrigation systems is **water saving**, since it is held that this way of increasing the water resources available for other uses is much cheaper than carrying out new harnessing or storage works. Water savings can be achieved by increasing efficiency (by reducing leakage in transport and distribution systems, or by improving the networks or their management as, for
instance, building storage basins, etc.), or by improving the techniques and systems used in applying the water, or by modifying cultivation practices, selecting less water demanding varieties, etc.

A second objective in improving irrigation systems is increasing their competitiveness as compared with other markets, which must be achieved through reducing operating costs by consolidating holdings, cutting the cost of tasks such as operating gates or cleaning out channels, introducing irrigation systems that can be automated (sprinkler, localised, etc.), and perhaps changing crops, in accordance with market demand, etc.

The Irrigators Communities must play a fundamental role in all this, since they are responsible for maintaining the distribution network and the fair sharing out of the water, and they must also be responsible for improving and unifying irrigation conditions throughout the area for irrigation, encouraging the implementation of distribution-on-demand systems, improving the state of the channels and the service roads, and even maintaining and rehabilitating hydraulic works of historical and cultural interest.

Another important issue regarding the ICs’ future role is the need for the water authorities to arrange for the management of irrigation facilities to be transferred to them; in this way, as has happened in other countries (Mexico sets an example of this), the farmers would become more aware of their responsibilities as managers of the system, saving on irrigation water and reducing operating costs to levels that are well below what can be achieved when management is overseen by the State.

For all these reasons, in connection with improving and modernising irrigation systems in terms of the two objectives mentioned above, we take the view that the role of the Irrigators Communities must be strengthened within the decision-making bodies of the Basin Agencies and by increasing their autonomy and the financial resources needed to accomplish this task.

PART TWO: CASE STUDY-THE GENERAL COMMUNITY OF URGEL CANALS IRRIGATORS

1. Introduction

The region known as “The Urgel Plain” comprises part of the Western Depression of Catalonia, which was originally occupied by a gulf lying between the Pyrenees and the Catalan-Balearic Massif and linked to the Mediterranean Sea of our own times. During the Cenozoic Era, this gulf was cut off from the sea and formed a large lake that eventually dried up through evaporation. Its level was raised by filling with alluvial material, as is typical of foothills, from the Pyrenees and Catalan mountain ranges, and these materials gave rise to the present-day soil, relatively young, deep and highly suitable for agriculture.

However, the climate of this region has from time immemorial restricted the pursuit of agriculture based solely on natural conditions, despite the good soil conditions and its high productive potential: scarce and uncertain rainfall and high temperatures and potential ETs during the peak months of plants’ water requirements (Table 2), this situation being also aggravated by periods of practically total drought.
Table 2. Mean monthly rainfall, temperatures and potential evapotranspiration in the plains of the Urgel region (historical mean values)

<table>
<thead>
<tr>
<th>MONTH</th>
<th>RAINFALL mm/month</th>
<th>TEMPERATURE °C</th>
<th>POTENTIAL ET mm/month</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>25.98</td>
<td>4.75</td>
<td>18.72</td>
</tr>
<tr>
<td>February</td>
<td>17.54</td>
<td>7.12</td>
<td>36.29</td>
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<tr>
<td>March</td>
<td>29.37</td>
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<td>June</td>
<td>40.08</td>
<td>21.14</td>
<td>154.03</td>
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<tr>
<td>July</td>
<td>14.11</td>
<td>24.61</td>
<td>178.93</td>
</tr>
<tr>
<td>August</td>
<td>25.12</td>
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<tr>
<td>September</td>
<td>47.44</td>
<td>20.36</td>
<td>96.85</td>
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<tr>
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<td>52.80</td>
</tr>
<tr>
<td>November</td>
<td>31.43</td>
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<td>December</td>
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<td>5.73</td>
<td>12.94</td>
</tr>
</tbody>
</table>

ANNUAL TOTAL 392.11 1029.60

2. Historical background

For the reasons outlined above — good soils but scarce rainfall on critical periods for crops — the idea of applying water for irrigating this region goes back to time immemorial. The first settlers, who date from the Hallstatt period, or from the pre-Iberian and Roman groups, left remains of their settlements, but not of any irrigation works, though it is very likely that they undertook such works; the first signs of irrigation works go back to the time of Arab domination, when local networks of irrigation channels were built in some places in this region, taking water from the Corb and Cervera rivers, which are tributaries of the river Segre.

Moving on to more recent times, the first written reference on record is a request made in 1345 by Infante James, Count of Urgel, for the “water draughtsman” (i.e. engineer) Guillem Cata, who was directing the works for the Manresa canal at the time, to undertake a study for routing a canal for irrigating the Urgel Plain. For unknown reasons, that initiative was frozen for a century and a half, until 1506, when Charles I, in view of the economic and social benefits that would accrue from transforming that region, ordered plans to be drawn up for the formal building of a canal, or “Royal Channel”, diverting water from the river Segre. This project was once more held up, and Philip II tried in vain to relaunch the canal project (even resorting to the influence of the monks in the Poblet monastery), which was to be paid for by the beneficiaries through special taxes. During the reign of Philip III, there were the beneficiaries themselves who insisted on its implementation, their efforts being unsuccessful despite their offer to pay for the works through contributing three-tenths of the harvests reaped from their irrigated lands (q.v. R-1).

During the course of the following reigns, and despite the interest of each successive monarch, all endeavours continued to be to no avail, probably on account of pressures stemming from the local interests of powerful livestock-farming groups; however, in the end, social pressures deriving from the poverty and hunger then besetting the region’s farmers finally succeeded in overcoming those interests: the Royal Decree of 3 November 1852, in the reign of Elisabeth II, declared of public interest.
the construction of a canal taking water from the river Segre, in the municipality of Ponts, for the irrigation of 90,000 hectares in The Plain of Urgel, and authorised the company Girona Hermanos, Clavé y Compañía to build that canal, granting it the right to running a flow of 33 m³/s for a period of 99 years; very soon afterwards the right was transferred to the company Sociedad Anónima Canal de Urgel, and this company, though experiencing major technical and financial difficulties, managed to complete the project between 02/09/1853 and 8/11/1861, the first irrigation occurring on 3 March, 1862.

Between 1863 and 1870, only 7 m³/s were in operation. However, the ever-growing area of irrigated land along with the intensification of agriculture and other uses which needed to be dealt with — chiefly urban and industrial water supplies — soon exceeded the capacity of the original provision of the Main Canal’s 33 m³/s, and so the Urgel Canal company applied for, and in 1919 obtained, a further concession (which was transferred to the Sindicato de Riegos del Canal de Urgel in 1926) to build a second Auxiliary Canal, also diverted from the river Segre, in order to cover the requirements that could not be met by the Main Canal, the work being approved through the Royal Decree of 25/09/1928. This Auxiliary Canal, with a capacity of 16 m³/s, was to draw its water from the San Lorenzo reservoir, also on the river Segre, downstream from the influx of river Noguera Pallaresa in order to take advantage of its waters, which were already regulated by the Camarasa reservoir among others.

When the 99-year period of the concession granted under the Royal Decree of 03/11/1852 was over, the Ministry of Public Works resolved, through the Ministerial Order of 10/08/1964, that the Urgel irrigators ought to set up a General Community, which would hold in perpetuity the right to using waters and all the works needed for irrigation. To that aim, this General Community was formally constituted on 24/12/1964, and its President was granted the Main Canal of Urgel by the Minister of Public Works on 17/11/1965, and the Auxiliary Canal by the Director of the Hydrographic Confederation of the Ebro one year later, on 19/10/1966.

The water concession was regulated through the above-mentioned Royal Decrees of 03/11/1852 and 29/09/1928, which authorise maximum flow rates of 33 m³/s and 8 m³/s to be respectively diverted to the two canals, for the purposes of irrigation, water supplies and industrial uses, under certain conditions, the main ones being:

- The maximum volume of water to be used for irrigation shall never exceed 9,000 m³ per hectare per year.
- The General Community is entitled to use the drained water, the water flowing in the rivers and drains crossing the irrigated area, and the underground water within its boundaries.
- The rights granted under this concession shall be maintained until 1 January 2061, in accordance with the provisions of the Water Act of 02/08/1985.

3. The hydrological and distribution systems of Urgel canals

The whole present irrigation system of Urgel Plain is based on regulating the river Segre system, whose mean annual flow at Ponts is 1,000 hm³, in such a way that maximum benefit may be derived from all the water carried by the river and its tributaries throughout the year. At present, the waters of the Segre are partly regulated by the Oliana reservoir, built in 1958 with a capacity of 101 hm³, of which only 75 hm³ are utilizable, for the purposes of irrigation, urban water supplies, livestock and industrial supplies, and the production of electricity. Its capacity is low, and only assures the regulation of some 300 hm³ a year, as against the 500 hm³ needed, and so it cannot fully cover the requirements of irrigation and water
supplies, particularly in dry mountain years. Acceptable regulation will only be achieved through the building of the Rialb reservoir, also on the river Segre: this reservoir, situated at elevation 430 and due for completion in 1999, will have a capacity of 400 hm³, and thanks to it a regulation provision of 800 hm³ will be reached from the Oliana-Rialb system, with a 93 per cent guarantee.

The basic network for water transportation and distribution includes the Main Canal, which draws its water from the Tossal diversion dam in the municipality of Ponts, with an intake capacity of 41 m³/s. The Main Canal runs bordering the north, east and south sides of the irrigated zone, following approximately the contour line of 300 meters over sea level, over a length of 144.2 km, and finally discharging into the same river Segre in the municipality of Montoliu de Lleida. It has 192 outlets or openings (locally known as “orificios” or holes), and four Main Ditches run out from it in an east-west direction, with a capacity of 4 m³/s each and a total length of 101 km and a further 140 outlets (“orificios”).

The Auxiliary Canal starts out from the San Lorenzo de Montgay dam in the municipality of Camarasa, downstream from the confluence of the Noguera Pallaresa with the Segre. It runs roughly southwards at or near elevation 225 m o.s.l., and comes to an end at the km 133 point on the Main Canal in the municipality of Artesa de Lleida. The Auxiliary Canal crosses the second, third and fourth Main Ditches, and refills them at the crossing points, enabling them to provide suitable supplies to the last downstream Communities. The water supply for the Auxiliary Canal is guaranteed by the aforementioned regulation provisions on the river Noguera Pallaresa.

Thus the Main Canal has the assignment of irrigating the upper area of the plain (some 49 000 hectares), and the Auxiliary Canal the lower part (some 21 700 hectares), which gives an average total of actually irrigated surface of some 70 700 hectares. To this surface must be added, for the purposes of arranging water provisions and setting charge rates, 4 500 hectares as the equivalent for urban, livestock and industrial supplies, and a further 700 equivalent hectares for sewage. Hence the total average annual figure, for supply purposes, amounts to some 75 900 hectares.

In fact the volumes diverted each year for irrigation and other uses to both the Main and Auxiliary Canals are usually below the flow rates granted, owing to the aforementioned insufficient regulation of the Segre’s hydrographic system. Therefore users in the area have to adjust their yearly water consumption to keep in line with the water available each year, which is always less than the volume of the concession. The completion of the Rialb reservoir as mentioned above is thus an urgent matter for this area, since it will cover supplies to meet the real requirements of the area all year round. After covering those water reserves, there are future plans for the Main Canal to be enlarged from its initial design flow of 41 m³/s to 56 m³/s, so that it can channel up to 48 m³/s, in a first phase, and for the Auxiliary Canal to be enlarged up to the 16 m³/s of its total capacity. It is thus envisaged that water supplies available, currently ranging between 0.45 and 0.55 l/s.ha, can be increased to 0.8 l/s.ha when all these regulation works are completed.

The main irrigation network is supplemented by a secondary distribution network, with some 3 000 km of conductions, mostly piped running at low pressure, and a drain network with approximately 800 km of drains, of which some 300 km are open-channels and the remainder underground drains.

There are nearly 500 outlets in all along the main network, all of which are fitted with Parshall flumes for measuring the water diverted to the ditches and pipes of the secondary network.
4. Agriculture and livestock farming

The current crop distribution is approximately as follows:

- Alfalfa 28.2%
- Fruit trees (apple, pear and peach trees) 24.4%
- Maize 20.2%
- Winter cereals 16.3%
- Vegetables, sundry crops and fallow 10.9%

This distribution is determined by the availability of water, by soil types, by the climate in general, and by livestock uses (alfalfa, maize etc.). The shortage of water makes it necessary to devote a part of the land to winter cereals in order to reserve greater volumes of water for the more profitable spring-summer crops, which are also the ones with the highest water needs.

At present, leaving aside crops that are the object of compensatory payments under the EU’s Common Agricultural Policy, the most profitable crops in this area would seem to be the fruit trees and some horticultural products, particularly onions grown in the open air, though increasingly the best returns are achieved by the best-run farms.

As for mixed agricultural and livestock farms concern, there are some 4 000 of them, prevailing those to pig fattening, with nearly 1.5 million heads and some 45 000 sows, and to laying stock (155 000 hens) and chickens (2.3 million broilers). To these must be added some 75 000 dairy cows, 35 000 beef cattle and 25 000 sheep.

5. Institutional organisation and irrigation management

The General Community of Urgel Canals Irrigators

The General Community of Urgel Canals Irrigators (GCI) is the central institution for the entire management of the water diverted to the Main and Auxiliary canals for irrigating the area and other uses, and according to its Bylaws (Article 1), it is composed of:

1. “all owners authorised to irrigate their fields with water diverted from the river Segre to the Main or the Auxiliary Urgel Canal, grouped together in” ... the 21 Ordinary Communities or Collectivities of the region;

2. Members of the GCI are also:
   a) Representatives of the 68 Town Councils authorised to use water to their respective urban-supplies;
   b) 89 owners (according to the list in the Bylaws) of industrial concerns, for which a specific register is kept.

3. Also “integrated in the GCI are all those authorised to use the underground or drainage water, either directly or through the digging of wells, galleries or feeders, within the irrigation zone.” (Article 1.4).
Before the GCI was constituted, the Urgel Canals users (irrigators and others) were represented by the General Syndicate of Irrigators and by the Central Board of Irrigators, regulated by the Provisional Regulations of 24/08/1863, which were later replaced by the final version of 17/12/1934, enacted by the Order of 23/01/1936.

The present GCI is a Public-Law entity attached to the Ebro Basin Authority or Hydrographic Confederation. It was formally constituted by the Ministerial Order of 24/12/1964 and is governed by Ordinances and By-laws drawn up by the participants themselves and approved by the Ministerial Order of 14/03/1966. Both Regulations were later partially modified by the Ebro Authority in order to adapted them to the provisions of the Water Act 29/1985 and to the Hydraulic Public Domain Regulations (Royal Decree 849/1986), being finally approved through two resolutions of that Basin Authority issued on 11/03/1986 and 26/02/1992.

The chief activity of the GCI is the management of irrigation in an area of some 71 000 ha, in addition to dealing with urban water supplies for some 70 municipalities with over 120 000 inhabitants, and to supplying water for a large number of industries, either through special ditches for their private use or via municipal water mains.

The number of irrigating owners runs to around 20 000, though the number of entrepreneurs with agriculture as their main activity falls short of 1 000, with farming units of between 10 and 1 500 ha.

Ordinary communities or collectivities

All the owners authorised to irrigate their land with water drawn from the river Segre via the Main and Auxiliary Canals are grouped into 21 Groups of Communities, and these collectively make up the General Community. Their places of work, the areas of land under irrigation, the figures calculated in terms of equivalent hectares for other uses needing to be covered, and the limits for each, are specified in the Bylaws, Table 3 offering a synopsis of this.

To achieve better distribution and use of the water, the irrigation zone is divided into three sub-zones: the High zone (H) taking in Groups numbers 1 to 4, plus 20 and 21, the Mid zone (M) covering numbers 5 to 12, and the Low zone (L) for all the others.

The Ordinary Communities or Collectivities are governed by their own By-laws, which are similar to those of the GCI, although at a lower level. The highest governing body of the Groups is their General Assembly, formed by all the irrigators and by representatives of the other non-irrigation users.

The General Assembly holds two ordinary meetings a year, in which the President of the Community and the members of its Irrigation Jury are elected, the budgets are approved, and decisions falling within their scope are taken on matters of general interest — e.g. concerning better distribution for the water coming out of the main network’s outlets, drawing up strict irrigation shifts on the basis of land areas and crop and soil types; cleaning and upkeep work on the channels; carrying out lining and consolidation work on the beds etc.; and any other tasks allocated to it by the General Community of Irrigators.

The 21 Ordinary Communities are further sub-divided into districts (from 3 to 10 per Community, depending on its size). The irrigators in each district elect a representative or “Trustee” (“Síndico”), who then form the Members of the Governing Board which is known, in this case, as the “Ruling Board” of the Collectivity and meets from time to time in pursuit of its functions.
**Table 3.** Head offices, irrigated areas and equivalent hectares for other uses of the collectivities comprised in the General Community of Urgel canals irrigators 
(according to its by-laws)

<table>
<thead>
<tr>
<th>COMMUNITY</th>
<th>IRRIGATED LAND</th>
<th>OTHER LAND</th>
<th>COMMUNITY</th>
<th>IRRIGATED LAND</th>
<th>OTHER LAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Head office</td>
<td>Hectares</td>
<td>Equiv. ha</td>
<td>No.</td>
<td>Head office</td>
</tr>
<tr>
<td>1-H</td>
<td>Montgal</td>
<td>5 151.75</td>
<td>357.01</td>
<td>12-M</td>
<td>Bellvis</td>
</tr>
<tr>
<td>2-H</td>
<td>La Fuliola</td>
<td>7 157.82</td>
<td>344.48</td>
<td>13-L</td>
<td>Miralcamp</td>
</tr>
<tr>
<td>3-HA</td>
<td>Bellcaire</td>
<td>6 517.08</td>
<td>309.75</td>
<td>14-L</td>
<td>Torregrossa</td>
</tr>
<tr>
<td>4-H</td>
<td>Ivars d’Urgell</td>
<td>4 298.37</td>
<td>108.07</td>
<td>15-L</td>
<td>Els Alamús</td>
</tr>
<tr>
<td>5-M</td>
<td>Linyola</td>
<td>3 776.10</td>
<td>51.8</td>
<td>16-L</td>
<td>Bell-lloc d’U.</td>
</tr>
<tr>
<td>6-M</td>
<td>Tèrmens</td>
<td>3 113.62</td>
<td>47.98</td>
<td>17-L</td>
<td>Juneda</td>
</tr>
<tr>
<td>7-M</td>
<td>Castellnou S.</td>
<td>783.41</td>
<td>33.58</td>
<td>18-L</td>
<td>Artesa Lleida</td>
</tr>
<tr>
<td>8-M</td>
<td>Bellpuig</td>
<td>2 422.78</td>
<td>239.69</td>
<td>19-L</td>
<td>Borjas Blancas</td>
</tr>
<tr>
<td>9-M</td>
<td>Golmés</td>
<td>2 551.17</td>
<td>152.36</td>
<td>20-H</td>
<td>Linyola</td>
</tr>
<tr>
<td>10-M</td>
<td>Miralcamp</td>
<td>3 249.38</td>
<td>45.88</td>
<td>21-H</td>
<td>Artesa Segre</td>
</tr>
<tr>
<td>11-M</td>
<td>Mollerusa</td>
<td>2 400.28</td>
<td>96.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Governing bodies of the General Community of Irrigators*

According to its By-laws (Article 13), “the Community shall have a General Meeting or Assembly, a Governing Board and an Irrigation Jury”.

“The Community shall have a President, a Vice-President and a Secretary directly elected by the General Meeting” (Article 14) which, for periods of 4 years, can be chosen from any of the participants unless there are grounds for incompatibility.

The President is the legal representative of the GCI; he/she must chair the meetings of the General Assembly, notify the Governing Board of its resolutions, and summon the Mayors and industrial users to elect their representatives at the Assembly.

*The General Meeting*

The Assembly, or General Meeting of Users, is the sovereign body of the GCIs; it holds ordinary meetings, twice a year (in February and October), and extraordinary meetings whenever so requires the importance of the items to be dealt.

The General Meeting shall be formed by: (a) the 125 district “trustees” (síndicos) making up the 21 Collectivities mentioned above; (b) a representative from each of the municipalities supplied by the Urgel Canals; and (c) a representative of the industrial users. Each one of them are voting members, the value of each member vote being proportional to the number of hectares that he represents. Furthermore, the Assembly is attended by the Chairmen of the 21 Ordinary Communities and the members of the GCIs’ Irrigation Jury, who have voice but no vote.
The Assembly of the General Community has powers: to elect its President, Vice-President, Secretary and Irrigation Jury’s members and deputies; to revise and approve the annual budgets submitted to it by the Governing Board so as the Activities Report; to make charges; to amend the By-laws; to settle disputes arising between its Groups; to authorise new use applications or works to be carried out on the canal network; to make changes to the assets of the CGIs, etc. These resolutions are adopted by absolute majority of the hectares represented.

**The Governing Board**

This is the body charged with ensuring that the By-laws of the CGI are respected, and that its own resolutions and those adopted by the General Meeting are fulfilled. It is formed by: (a) the Presidents of the 21 Collectivities into which the irrigated area is divided; (b) a Mayor, representing the towns being supplied with water from the Canals; and (c) a representative of the industrial users, all of whom are appointed for periods of six years. The Governing Board itself appoints a President, a Vice-President and a Treasurer-Clerk from among its members, as well as the President of the GCIs’ Irrigation Jury.

Apart from ensuring compliance with the By-laws and with the resolutions of its meetings and those of the General Meeting, the Governing Board has the duty of reporting on the member renewals and its bi-annual composition to the Basin Authority, as well as carrying out any orders received by the General Community from the Ministry of the Environment, the Basin Authority, or the Autonomous Government of Catalonia in matters of their competence.

It must also watch over the interests of the GCI; reconcile the interests of the Ordinary Communities; set down rules for the proper governance of the GCI in all matters beyond the competence of the Ordinary Communities; monitor Oliana discharges so that the resources are in line with the irrigation-season needs; and deal with the policing of the main watercourses, so as with their cleaning, upkeep and consolidation.

Among others, the Governing Board has also the task to calculate the hectare-equivalent figure for water uses other than irrigation, seeking the greatest fairness in sharing out Community charges. It can also order, at the users’ expense, the installation of flow meters to avoid abuses or misuse of the water volumes allocated and, in times of scarcity, proclaim extraordinary measures for water saving or preferential water use in terms of crop and water-use priorities.

The Governing Board has a Permanent Commission to ensure smoother running, and several specialised consultative thematic Committees which advise the Board and the Permanent Commission on measures to be adopted in matters of their competence.

**The Irrigation Jury**

The purpose of this body, established by the GCI By-laws in compliance with Art. 76 of the Water Act 29/1985, is to hear and resolve in hearings concerning cases faults or offences committed by the users against the Bylaws or the resolutions and provisions of the General Meeting or the Governing Board, in matters not delegated upon the Ordinary Communities.

After examining the reports submitted concerning such faults or offences, and arranging the relevant hearings with the participation of all parties involved, along with the Technical and Legal Services of the GCI, the Jury applies the statutory penalties or sets the compensation payments stemming from the
transgression, provided that the transgression concerned does not fall rather to the Irrigation Juries of the Ordinary Communities.

Employees of the Governing Board and of the Collectivities are obliged to report immediately any misdemeanour coming to their attention. Failing to respect this obligation is regarded as a very serious misdeed.

The Jury is made up of a President, appointed by the Governing Board from among its Members, four Official Members and four Deputy Members, selected by the Board from those who are not Members of the Board, and holding office for periods of four years. Half the posts are renewed every two years.

**Support services for the General Community**

**Technical services**

They are entrusted with the maintenance, improvement and modernisation of the facilities in operation, and the control, circulation and on-time and equitable water distribution. These Services and their field teams have technical staff and foremen who are competent to carry out their work, which they do in accordance with tried and tested working methods of proven effectiveness, though using modern technologies such as computers for drawing up water-distribution schemes, radio-telephones, motorised movements, suitable machinery for carrying out their tasks, and Parshall flumes at each of the 500 outlets or “holes” of the main network for controlling and monitoring the volumes granted to each secondary ditch (or pipe).

**Administrative services**

In view of the great administrative complexity of the General Community, these services are of vital importance for it to work properly.

They comprise the Secretariat and the Services for Legal, Fiscal, Labour, Accountancy and Revenue affairs, as well as service departments for dealing with routine and Irrigation-Jury cases.

The increasing computerisation of these tasks enhances their efficiency and reliability, though this does not detract from the human contact and personal attention that many of the issues arising in the delicate relations with irrigators require.

**Water distribution**

Among the aforesaid specialised thematic Committees, the most important is, undoubtedly, the water Distribution and Circulation Committee. It is composed by most of the Members of the Governing Board and by the Heads of the Technical Service and of the Distribution and Circulation Office; it meets once a week during the irrigation season to study the Oliana reservoir inflows, discharges and useable reserves and the forecast demand in the zone. On this basis it proposes a weekly schedule to the Governing Board for the reservoir discharge, stating the water flow to be diverted, hour by hour, through the various channels of the main network, so as the compensations for the most needy Collectivities or districts in order to maintain a joint and equitable distribution throughout the area during the course of the following week.
Once the discharge regime has been decided, the Distribution and Circulation Office arranges the proportional sharing out, for which purpose it uses: (a) maps of the entire area and of the surface covered by each of the 500 outlets along the main channels; (b) irrigation schemes or tables, drawn up with the help of computers, copies of which are given to the foremen and ditchriders working in the field and to the Collectivity concerned; (c) the measuring sections and the reference Parshall flumes at the head and all along each canal or ditch, to know the flows circulating through each stretch; (d) equivalence tables between contiguous flow measuring sections, to adjust the volumes discharged by the outlets to the fixed amounts set for each reference flume; (e) Parshall flumes at each outlet of the main network, i.e. at the head of each secondary ditch, to adjust the manual sluices at the discharge point in accordance with the tables; and (f) the reports which are to be filled in every day by the bailiffs-intendants for checking compliance with the irrigation scheme.

In this we can see a very important point: that the entire water-management process, from determining the amount of water that can be drawn off from the Oliana reservoir down to the allocation of the water to the fields, is under the sole control of the irrigators and the users themselves, the state not playing any direct part in it.

The most widespread irrigation technique used throughout the area is the gravity (traditional) irrigation method, the water being directly delivered from the main canals to the secondary distribution network through outlets fitted with Parshall flumes, on a strict basis of turns. However, with a view to saving water and improving irrigation management and convenience for the irrigators, the modern methods of localised and sprinkling irrigation are increasingly popular, and already account for 12 per cent of the irrigated area.

With this structure, the overall efficiency of the transportation and distribution canals and ditches, in which some stretches still consist of unlined earth channels, is over 0.90 at present, which show how low the losses are in this network.

Given that there is usually a shortage of water for irrigation, distribution is arranged keeping the flow rates from the outlets at values lying between 0.40 and 0.55 l/s.ha, with 10 to 12 days intervals between consecutive applications.

This water shortage makes it necessary to plan out supplies so as maximise on-farm irrigation efficiencies, To this purpose attempts are made to limit application time to no more than 2 or 3 hours/ha, making sure that the instantaneous flow rates at the head to the field are not less than 70-80 l/s; moreover the soil types are borne in mind in all cases, in order to establish variable modules for each type, with the more permeable soils being cultivated in shorter fields (basins, furrows) and with slopes of 0.3 — 0.4 per cent, and the more impervious ones in longer fields with slopes in the order of 0.1 per cent.

Also with economy in mind, and with the aim of making use even of the run-offs from the area as well, 40 wells have been dug in areas where the greatest phreatic accumulation from such run-offs occurs, in order to reuse for irrigation the percolated water; 400 storage reservoirs have also been built to store night flows and to allow irrigation to be arranged in the daytime for reasons of convenience; and all this falls within the competence of the Collectivities.

**Water cost: Tariffs**

Article 10 of the Ordinances sets down in detail the criteria for sharing out the costs between the various users of the water. The expenses of the General Community and of the Collectivities it comprises are met
by rates which must be paid (By-laws, Art. 11) without exception by all users, irrigators, industrials and municipalities.

The irrigation charges are applied in terms of the area irrigated, the rate being 3 000 pesetas per “obrada” of land (1 hectare = 2.29 obradas), i.e. 8 810 pesetas per hectare, for investment expenses in the improvement and rehabilitation of general use hydraulic structures, for maintenance expenses and for Community management expenses. Furthermore, the Ordinary Communities have their own budgets, which have widely varying impact on each area unit, depending mainly on their own projects for improving the secondary distribution network (wells digging, building of storage reservoirs and other improvement works), with the charges ranging from 8 000 to 10 000 pesetas per hectare, or even more in some cases. Taking the two rates together (General Community and Collectivity), an annual average tariff can be estimated at some 21 000 pta/ha for a reference consumption level of 6 000 m³/ha per year.

Municipal supplies are computed at a rate of 300 l/inhab.day, on the basis of updated population censuses, making each 6 000 m³ with consumption rights equivalent to one hectare, and applying a price that is five times higher than the irrigation price.

For waterfalls used for generating mechanical or electric power, each horsepower of its power rating is taken to be equivalent to one hectare.

For farms, swimming pools, industries and other uses, each 1 200 or 3 000 m³ of water (depending on whether or not it is consumed) that they are entitled to use is seen as equivalent to one hectare. In the case of farms, the consumption is calculated per head of livestock, in accordance with unit values given for each species of stock in the National Water Plan.

Sewage from livestock farming have been abolished; for sewage coming from other sources, each 3 000 m³ are made equivalent to one hectare of land.

Other functions that fulfil the General Community of Irrigators

As regards urban supplies, as frequently mentioned above, the General Community of Irrigators has been given the task of supplying nearly 70 municipalities in the area. Although this commitment does not include sanitary control of the water to be supplied, the GCI, entirely at its own cost and without passing that cost on to the benefited municipalities, has set up a network for taking samples of the water and analysing its quality throughout the length of the 320 km of main canals and ditches, in order to guard against polluted or unwholesome water getting into the municipal supply network.

Environmental protection is another dominant concern of those in charge of the GCI, and it has prompted various courses of action, the cost of which is also covered by the irrigators of the Urgel Plain, such as banks reafforestation in unlined stretches of the main canals and reafforestation of other areas, chiefly with native species (pines, oaks, holm oaks, etc.), there now being over 20 000 trees forming forests and groves that are open to the public, adding considerable charm and beauty to the landscape and much appreciated by local people as places for rest and recreation.

The proliferation of farms for livestock breeding in the region, as also mentioned above, particularly pigs, poultry and cattle, is resulting in the production of some 800 000 m³ of solid and liquid manure each year; this is then distributed in an uncontrolled manner as organic fertiliser for crops, which is causing storage problems and problems of pollution in runoff water and in the wells. To alleviate these problems, the Department of the Environment of the Autonomous Government of Catalonia, at the request
of and in conjunction with the GCI, has launched a number of initiatives, such as: (a) setting up liquid-manure storage reservoirs in which that manure is kept all year round and used in a rational way, at the most convenient application time for the plants; b) several treatment plants, similar to those used for urban sewage, with final treatment using chemical products to precipitate out the nitrates and phosphates. At one of these plants, a pilot program is being carried out by the University of Barcelona in which a patented process of purification by means of controlled bacterial treatment is being developed.

The future of irrigation in Urgel

The growing commercial pressure from national and international markets, brought about by the agreements of the World Trade Organisation and by the Common Agricultural Policy of the European Union, is forcing Spanish agriculture to raise its competitiveness at a very fast pace. For that reason, the methods of management and operation of the Urgel Canals are being adapted, as fast as budgetary possibilities does allow to new techniques in enterprise organisation aspects, mechanised installations for facilities construction, irrigation operation, etc.; consequently, rehabilitation of the existing structures and their modernisation are now objectives of the GCI, with the additional purpose of saving water to improve the exploitation of the scanty resources available.

This approach by the GCI, aimed to increasingly appreciate the value of water as a resource, entails assessing the various stages in the water-application process. The irrigation efficiency at field level shows a wide variation, depending on the irrigation method used, the plot size and slope, the soil texture, the application depth, the duration of the irrigation, etc. In the case of the Urgel Zone, the field efficiency ranges from 0.50 to 0.75; and since sprinkler and micro irrigation methods reach application efficiencies of 0.90, these methods are expanding significantly in this area. Furthermore, considering the whole irrigated area, the global efficiencies range between 0.50 in some stretches of still unlined ditches to 0.94 in the main canals.

In any event, the structural and managerial improvements will on the one hand reduce the costs of the Community, and thus the irrigation charges and the farming costs, and on the other free up large volumes of water, which could then be used either to raise the amount supplied to the current users or to extend the area under irrigation. However, such improvement works are very costly, and cannot usually be afforded by the farmers themselves. In this sense it is important to note that although some of the benefit of the works and measures adopted to improve the irrigation schemes efficiency goes to the farmers themselves in the first place, in the form of labour-saving, automation, increased output etc., another major part of the benefit goes to society, and so it would seem fair for the costs to be borne equitably by all sectors benefiting, and not just by the irrigators.

Rehabilitation

The measures envisaged for rehabilitating the irrigation system include: lining the still unlined canals sections; completing the low-pressure piping of the distribution network; replacing the old regulation equipment (sluice gates, weirs and diversion structures), which need excessive surveillance and labour, by constant-level gates, duckbeak weirs, mask modules etc.; computer-programmed gates opening and closing in the canals and fitting electronic devices for the remote control of gates; building intermediate storage reservoirs to avoid night irrigation; and computerising all the entries, records and administrative operations of the Community, which will entail savings in management that will be passed down to reduce irrigation charges.
Modernisation or remodelling

Modernising the irrigation system means applying the newest techniques to the oldest structures, or else remodelling them using the most advanced irrigation and/or management criteria. The main aims of this modernisation and remodelling works are to save water and to reduce the network operational costs, both of which are of vital importance in the irrigation schemes of the Urgel Plain on account of the scarcity of the resource and the cost of labour in that area.

In the area of this study modernisation and/or remodelling works are needed on: (a) the main canals network; (b) the secondary distribution network; and (c) the activities related with irrigation management.

As regards the main canals or transportation network, the new canals must be concrete-lined throughout, and laid out on simpler and better routes, with tunnels, siphons and aqueducts wherever they are needed.

Furthermore, they must be designed to allow continuous water flow regulation that matches the water supply to the demand at all times in order to avoid excess water being lost to the drains. For this, interactive regulation systems need to be used bringing substantial water savings while keeping the traditional mode of operation of the distribution network.

It will also be necessary to bear in mind the ever more widespread trend towards adopting pressurised irrigation systems, and so to foresee the works and installations they require to mitigate demand peaks, building intermediate regulation reservoirs and so on, or any other kind of work to prevent water surpluses being drained away.

As regards the distribution network, it can be said that its needs are virtually a scaled-down version of the needs of the main network: renewing sections of piping that have deteriorated through use, causing water losses through seepage; providing piping for the rest of the network; planning distribution systems that can cope with pressurised irrigation; automating the opening and closing of gates at the outlets of the main network, etc.

Most of the irrigation management tasks can be streamlined and modernised perfectly well by using present computer and electronic systems. The drawbacks of regulation relying solely on mechanical operation of gates on the basis of downstream demands can be overcome by using regulation systems that work by levels associated with demands coming likewise from downstream via a teletransmission line with sensors all along the channel; the line sends the signals picked up by the sensors to a reception centre, where the demand patterns received from the network as a whole are analysed and then produced the relevant orders that are transmitted to each individual gate.

When network programming is arranged a few hours or days in advance, these tasks are performed on the basis of the current demands and the volumes of water stored in each section of the canal. Using this data, forecasts for future demands are made as a function of data on climate, crop patterns, labour required and available, etc., taken from previous periods of similar features.

It can be understood that through today’s high technological performance in electronic and computerised devices, the regulation of transport and distribution networks can reach an automation level as much sophisticated as desired, the only limitation being the cost, which will in the end be the determining factor to apply the most appropriate level for each case.
6. Summary and conclusions

The current Spanish Water Act (29/1985) provides that all water, whether surface or underground, is a public good, and that it is to be administered by the State through the Ministry of Public Works (now of the Environment). From a hydrographic point of view, for managerial reasons, the territory is divided into River Basins, patterned in accordance with the main rivers and taking in indivisible geographic regions. Administering and organising water resources within each River Basin is the task of a River Basin Authority or Hydrographic Confederation which, by government delegation, is entrusted with the granting of water concessions to applicants who can prove proper use of the water granted to them. The Basin Authorities are public agencies of a mixed State-User nature, governed by Boards made up of representatives from all sectors concerned.

The Users Communities (or Irrigators Communities if irrigation is the main activity) is the next administrative level down, and brings all the users together. These Communities are fully autonomous, since their governing bodies are made up solely of the irrigators-users themselves, but each one is attached to its own Basin Authority and the Communities are bound by their own By-laws and Ordinances. They are usually the holders of water concessions, and have the mission of looking after the proper use of the resource granted to them, maintaining the irrigation facilities in good condition, paying irrigation fees and rates, and settling disputes between irrigators, or between irrigators and the Community itself, through Irrigation Juries whose members are appointed from among the irrigators themselves.

In the case of the General Community of Urgel Canals Irrigators, as fully described above in this paper, we take the view that it should serve as a model in terms of organisation and good water management for other institutions with the same concerns all over the world.

The present administrative structure for water in Spain stems from and embodies experience in management stretching back centuries; it is wholly democratic, just and fair, and is noteworthy:

- for its simplicity: there is the State, which is the sole administrator of the water as a public good; the Basin Authorities, which are governed jointly by the Government and the users, and have powers bestowed on them by the State for granting water concessions and ensuring proper use and conservation of the water; and the Irrigators Communities (or Users), which hold the concessions for using the water and are governed exclusively by the users, in pursuit of the missions described above; and

- for its concern at all levels for saving and conserving water resources, preserving the quality of the water and maintaining aquatic ecosystems and the water-related environment.

7. Acknowledgements

I would like to express my gratitude to Antonio José Alcaraz Calvo and Ricardo Segura Grañño, both at the Directorate General for Hydraulic Works and Water Quality of the Ministry of the Environment, to José María Martín Mendiluce, the Chairman of the Spanish Committee on Irrigation and Drainage, to Andrés del Campo García, the President of the National Federation of Communities of Irrigators of Spain, and to Xavier Coll Gilabert and Salvador Arqué, who are respectively President of the Governing Board and Head of Technical Services of the General Community of Urgel Canals Irrigators, for their contributions and suggestions and revision of this paper, improving it through making their vast experience and knowledge in this field available.
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Summary

The key issue associated with water quality in Switzerland is the nitrogen content of groundwater. The maximum tolerated level of 40 mg NO$_3$-l is exceeded in some agricultural areas. Around 75 per cent of nitrate leaching into groundwater originates from soils used for agricultural purposes. For running water and groundwater the set target is 25 mg/l NO$_3$-N for nitrate and 0.0001 mg/l of active ingredient for pesticides.

It is expected that, by year 2002, on the basis of current trends and measures that can be implemented by then, the pollution of air and water bodies by agriculture can be reduced from 96 000 to 74 000 tonnes N per year nation-wide, representing a cut of around 23 per cent compared to 1994. These predictions are based on the Water Protection Act, the Ordinance on Pollutants of the Environmental Protection Act and the agricultural policy reform process.

The water protection act obliges livestock holders to be equipped with farm manure storage facilities with a capacity of at least 3 months. It lays down a maximum stocking rate of 3 Livestock Units-Manure (or 315 kg total N and 45 kg P) per hectare of agricultural area for each individual farm in the valley areas. The Cantons may be compelled to set lower values in certain cases, depending on the site concerned.

The ordinance on pollutants stipulates, *inter alia*, that waste product and mineral fertilisers may be used only in cases where the farm’s own manure supply is insufficient or ill-adapted to the nutrient requirements of the plants.

The agricultural policy reform process allows ecological services to be compensated by means of direct payments. This is implemented through three main ecological programmes: Integrated Production (IP), Organic Farming (Org.) and Ecological Compensation. Only those farms that are able, *inter alia*, to demonstrate a levelled out nutrient balance are entitled to participate in the IP and Org. programmes. By 1996, 60 per cent of Switzerland’s agricultural area was already farmed according to integrated production methods and 5 per cent of the area met the requirements of organic farming.

According to model calculations, the greatest impact on the nitrogen balance is expected to result from the agricultural policy reform process. This process will allow a 23 per cent reduction of the N-loss potential in the years to come and will also produce considerable changes in the agricultural structure. Depending on the period considered, it will lead to savings in the national economy of between 340 and 680 million
Swiss Francs (between 235 and 469 million US dollars). The additional federal budgetary expenditure on direct payments would amount to SF 700 million (US$483 million) between 1995 and 2002, with a simultaneous reduction for the burden on consumers of SF 1 400 million (US$996 million). Annual value added for the agricultural sector should decrease by SF 200 million (US$138 million) a year over this period. The legal bases for the second step of the agricultural policy reform process are currently being discussed at Parliament level and are expected to take effect at the beginning of 1999 at the earliest.

1. Present situation

The level of precipitation in Switzerland is generally so high that, with the exception of very limited areas and special crops, irrigation is not necessary and there is generally enough drinking water available. Approximately 80 per cent of drinking water comes from groundwater and spring water sources, the rest being supplied by lakes (FOEFL, 1993b).

Water quality and agriculture

Around 75 per cent of nitrate leaching into groundwater originates from soils used for agriculture. Groundwater that is influenced little by anthropogenic factors (e.g. in the Alps) has nitrogen contents of 0 to 5 mg NO$_3$ /l, while average values for the groundwater of the gravel beds of the central region range between 20 and 35 mg NO$_3$ /l. In crop growing areas in particular, the maximum tolerated level for Switzerland of 40 mg NO$_3$ /l is exceeded in some cases. Available data obtained from the examination of groundwater and spring water catchments show that nitrogen contents are on the upward trend. Unfortunately, no representative statistics with corresponding time series data are available at present. Nitrogen and phosphorous are also lost into surface water. Braun et al. (1991) reached the conclusion that, of the nitrogen input into the waters of Switzerland’s Rhine catchment area downstream of the lakes in 1986, around 41 per cent originated from agricultural sources and around 45 per cent from municipal sewage plants.

In the case of phosphorous, around a sixth was of agricultural origin (surface runoff and erosion); the phosphorous concentration has lessened in the meantime (Jakob et al., 1994), due partly to the development of sewage treatment plants (phosphate precipitation) and partly to the coming into force of the 1986 ban on phosphate in washing powders.

According to investigations by Kozel (1992), in nearly 50 per cent of the samples taken, the contamination of groundwater with pesticides reached atrazine levels in excess of the maximum tolerated level for Switzerland of 0.1 ppb. Other active substances were found in isolated cases only. However, these findings are not representative of groundwater and spring water pollution in Switzerland as investigations focus mainly on those areas where there is a suspicion of higher-than-average values. Atrazine pollution is thought to be connected primarily with its extensive use over many years as a herbicide on railway grounds and in the cultivation of maize. Later on, the quantities used per unit of area were greatly reduced and atrazine has not been used on railway tracks since 1993. According to local investigations, groundwater contents are on the downward trend (FOA, 1994). Finally, as for phosphorous and ammonium, heavy metals are retained in the soil to a relatively large extent and are thus little subject to leaching. They present no immediate danger for groundwater, but can also seep into surface water by means of surface runoff and erosion.
The importance of nitrogen and phosphorous for the environment

Nitrogen plays a crucial role in environmental processes (FOEFL, 1996). It is found in many different forms and is a vital nutrient as well as a pollutant. Human activities have greatly increased the fluxes and concentrations of the various nitrogen compounds and altered the nitrogen balance:

- Nitrogen oxides are produced in combustion processes and conveyed into the air. Motorised traffic, heating and incineration plants as well as industrial and commercial production methods all play a role in this. These oxides are conveyed from the air (in some cases in altered forms) to vegetation, soils and bodies of water.

- Agriculture is a source of emissions into the air and bodies of water: ammonia from the use of farm manure in livestock farming and nitrous oxide are conveyed into the air. Nitrate is leached into groundwater from crop and vegetable growing in particular. Moreover, various nitrogen compounds are subject to surface runoff into streams, rivers and lakes.

- Ammonium, nitrates and nitrites are washed into surface water with treated and untreated waste water.

Nitrogen emissions lead to increased water and air pollution, thus causing problems for man, animals, plants and ecosystems, which differ from region to region.

Phosphorous naturally restricts the growth of algae and aquatic plants in relatively unpolluted stagnant waters. Phosphorous inputs caused by surface runoff and soil erosion from agricultural areas cause a sharp increase in the formation of algae and, via the decomposition of dead and sedimented biomass, lead to oxygen deficiency in deepwater, which can even result in the complete atrophy of this sphere of life.

Nitrogen emissions in Switzerland

Table 1 shows Switzerland’s nitrogen balance for 1994. It should be taken into account that the quantitative analysis method does not allow any conclusions to be drawn concerning the potential harmfulness of nitrogen compounds. NO\textsubscript{x} emissions originate mainly from traffic, ammonia emissions from livestock production, N\textsubscript{2}O emissions from plant production, nitrogen in surface water from sewage plants and nitrate in groundwater from crop and vegetable growing. Agriculture is the main source of ammonia, nitrous oxide and nitrate emissions.
<table>
<thead>
<tr>
<th></th>
<th>Total into the air</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NO₂</strong></td>
<td>43</td>
</tr>
<tr>
<td><strong>NH₃</strong></td>
<td>55</td>
</tr>
<tr>
<td><strong>N₂O</strong></td>
<td>11</td>
</tr>
<tr>
<td><strong>N into surface water</strong></td>
<td>46</td>
</tr>
<tr>
<td><strong>NO₃ into groundwater</strong></td>
<td>46</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>201</td>
</tr>
<tr>
<td>Compared to 1990²</td>
<td>250</td>
</tr>
</tbody>
</table>

**Table 1. Nitrogen emissions for Switzerland in 1994 (in 1000 t N/a)**

- From traffic, households, industry, commercial activities into the air
- From agriculture into the air
- “Natural” sources

1) Or natural nitrogen input increased by anthropogenic activities (rough estimates).


**Aims of the Swiss agri-environmental policy**

*Ecological aims of the Agricultural Policy Reform*

Environmental protection is set out in the Federal Council’s communication (1996) regarding the Agricultural Policy Reform in the following concrete terms:

- Arable land, pasture and forest or groundwater reserves should be used in such a way that their long-term regenerative powers are preserved.

- Pollution from degradable waste and emissions may not exceed the absorption power of the ecosystems.

- Biodiversity is to be maintained.

- Non-renewable resources, such as fossil energy sources, may not be exhausted.

**Aims of the Water Protection Act**

Article 27 of the Water Protection Act defines the following strategic objective: “Soils are to be managed in accordance with the latest technological developments in such a way as to avoid repercussions for bodies of water, particularly from surface runoff and the leaching of fertilizers and pesticides”.

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The following operational objectives are of particular importance for agriculture:

- The target requirements for substances affecting the water quality of running water and groundwater. The target is 25 mg/l NO$_3$-N for nitrate and 0.0001 mg/l per substance for pesticides.
- A levelled out fertilizer balance.
- Sufficient farm manure storage facilities with a capacity of at least 3 months.
- Soil nutrients, the nutrient requirements of the plants, the habitat and the weather conditions are all to be taken into account in the use of fertilizers.
- Ensuring that a minimum level of water remains when water is taken from bodies of water.

**Nitrogen balance targets**

The “Nitrogen Balance Switzerland” project team (FOEFL, 1996) drew up purely ecological objectives for Switzerland (i.e. without taking account of feasibility) for the individual nitrogen compounds that are of consequence for the environment (Table 2).

Table 2. Anthropogenic emissions of various nitrogen compounds: Actual status, expected reduction by 2002, ecological targets and goal shortfalls

<table>
<thead>
<tr>
<th>In 1000 t N/a</th>
<th>Status 1994</th>
<th>2002 with measures</th>
<th>Ecological target</th>
<th>Goal shortfalls compared to 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen oxides into the air</td>
<td>43</td>
<td>33</td>
<td>11 - 16</td>
<td>17 - 22</td>
</tr>
<tr>
<td>Ammonia into the air</td>
<td>55</td>
<td>48</td>
<td>25 - 30</td>
<td>18 - 23</td>
</tr>
<tr>
<td>Nitrous oxide into the air</td>
<td>10</td>
<td>9</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Nitrate in groundwater</td>
<td>34</td>
<td>21</td>
<td>15 - 20</td>
<td>1 - 6</td>
</tr>
<tr>
<td>N input into the CH Rhine catchment area downstream of the lakes</td>
<td>46</td>
<td>41</td>
<td>25 - 35</td>
<td>6 - 16</td>
</tr>
</tbody>
</table>

1) To be established in the framework of an overall strategy for reducing all greenhouse gases.
2) Including indirect input via groundwater.

*Source:* FOEFL, 1996.

The following considerations were of particular importance in their deliberations:

- Nitrogen oxides NO$_X$: Nitrogen oxides are a significant precursor to ozone formation. In Switzerland the latter is confined to nitrogen oxides. In order to meet the guidelines of the Ordinance on the Conservation of Clean Air (Luftreinhalteverordnung), nitrogen oxide emissions would have to be reduced by 75 per cent compared to 1985.

- Ammonia NH$_3$: A maximum input of 10 kg total N per hectare per year in sensitive ecosystems can be taken as an ecologically sustainable deposition target. The target for NO$_X$ and the import/export balances for NO$_X$ and ammonia were also to be taken into account.
− Nitrate in groundwater: In the medium term the nitrate concentrations in the groundwater concerned are to be reduced to below the present Swiss guideline in force of 25 mg/litre. A significant reduction of the nitrate concentration is only possible by lower inputs; the sluggishness of the groundwater system means that the resulting effect is seen only in the long term.

− Nitrogen in surface water: As a result of evidence of over-fertilisation which emerged in the 1980s, the countries bordering on the North Sea issued a declaration of intent as early as 1987, with the aim of reducing phosphorous and nitrogen inputs by 50 per cent. The reduction thus achieved bears some relation to this objective, which still has a purely political basis.

On the basis of available scientific data (Braun et al., 1994; Häfliger et al., 1995), the project team proposed reduction measures which also take account of economic considerations. Agricultural measures are thus associated with lower costs for the national economy than measures relating to combustion and water treatment. The project team expects that, by the year 2002, on the basis of current trends and the measures that can be implemented by that time, the pollution of the air and bodies of water by environmentally relevant nitrogen compounds of agricultural origin can be reduced by 22 000 tonnes N to 74 000 tonnes N per year for the whole of Switzerland, representing a cut of 23 per cent compared to 1994.

2. Measures designed to improve water quality

Measures already implemented

Water Protection Act

The Federal act of 24 January 1991 on the protection of bodies of water obliges all those concerned to take every appropriate action to avoid harmful effects for water bodies. The act further sets out in more concrete terms the actions that are to be taken in livestock farms to avoid endangering bodies of water with farm manure and how to manage soils so that these bodies are not harmed by surface runoff and leaching. The act, which took effect on 1 November 1992 and whose transitional period expired on 31 October 1997, lays down a maximum stocking rate of 3 Livestock Units-Manure (LUM) or 315 kg total N and 45 kg P per hectare of agricultural area for each individual farm in the valley areas and obliges the cantons to set lower values for certain sites (according to soil stress limits, altitude and topographical conditions, for example).

Environmental Protection Act/Ordinance on pollutants

Appendix 4.5 of the Ordinance on environmentally harmful substances of 9 June 1986 relating to the Environmental Protection Act (Ordinance on Pollutants) governs the distribution of fertilizers and soil improvers. Fertilizers and similar products may be dispensed only on the condition that, when professionally used, they can harm neither the environment nor man indirectly via the environment and that set requirements, including ones relating to quality (pollutant level) and to instructions for use are met. Sewage sludge and compost may be used only if proof of need is supplied and only in limited quantities. Farmers with access to farm manure may use waste product and mineral fertilizers only if their own supply of farm manure is insufficient or ill-adapted to the nutrient requirements of their plants. Nitrogenous fertilizers may be used only during the growing season, and liquid fertilizers only when the
soil is capable of soaking up and absorbing them. The use of fertilizers is banned in marshland and wetlands, officially protected groundwater catchment areas and in and around hedgerows and boscage, as well as in a 3 m wide strip along surface water.

**Agricultural Policy Reform: first stage ending 1995**

The introduction of direct payments in 1993 was the first step in the Agricultural Policy Reform. It allowed income policy to be separated from price policy (Art. 31a LwG) and the farmers to be compensated for ecological achievements (Art. 31b LwG). These new direct payment tools enable the Confederation to meet the obligations imposed on it by the WTO Agreement via price reductions and the modification of border protection measures.

On the basis of the Ecological Contribution Ordinance (Art. 31a LwG), payments have been made since 1993 to farmers participating in the following programmes:

- **Integrated Production (IP)**
  Requirements: Equalised nutrient balance (N and P), use of pesticides only when necessary, doing without certain treatments, minimal mulching, maximum stocking (LUM) rate (dependent on production area), etc.

- **Organic Farming (Org.)**
  Requirements: As for IP, plus ban on the use of chemical/synthetic pesticides, readily soluble mineral fertilizers and chemical/synthetic nitrogen fertilizers, as well as restrictions on bought-in foodstuffs.

- **Ecological Compensation**
  Extensively used meadows and arable land, fruit trees, etc.

In addition, special programmes encourage animal-friendly livestock husbandry.

**Measures under examination**

Model calculations were made for the agricultural sector in the framework of work carried out by two project teams. The “Nitrogen Balance Switzerland” project team (FOEFL, 1996) was given the task of elaborating a strategy for the gradual management of environmental problems arising from the emission of harmful nitrogen compounds. The team examined the impact of the measures set out below. The task of the “Ammonia Emissions Switzerland” project team (Stadelmann et al., 1996) was to elaborate a catalogue of measures for reducing agricultural ammonia emissions and to assess their farm economic impact. The results of their investigations are not presented in this report as ammonia has no direct influence on water quality.

**Agricultural Policy Reform: second stage from 1995 onwards**

The aim of the second stage of the Agricultural Policy Reform (Agricultural Policy 2002) is to improve the competitiveness and market conformity of agricultural production in Switzerland by liberalising market regulations and improving production bases. It is also designed to further liberalise prices and margins, contribute towards reducing production costs, encourage efficient structures and gear agriculture as a
whole towards sustainable production. Simultaneously, the special ecology subsidy (meeting of an ecological performance target via general direct payments according to Art. 31 a LwG) is to be continued.

The Agricultural Policy Reform has repercussions at the level of prices, production methods and specific measures. It is also intended that market forces should come more to the fore in the agricultural system. This has implications for the Swiss nitrogen and phosphorous balance, as well as for the use of pesticides and thus — it is expected — for improving the quality of drinking water and surface water.

**Reduction of the livestock population**

The cantons are obliged to reduce the number of Livestock Units-Manure (LUM) permitted per hectare, as far as the site conditions (soil stress limits, altitude and topographical conditions) so require. In 1995 the Cantonal agricultural directors decided on a uniform site-related restriction of LUM according to problem areas for the whole of Switzerland. The values suggested for 1 November 1997 onwards range between 1.4 LUM (147 kg N, 21 kg P) in mountain area 4 and 3 LUM (315 kg N, 45 kg P) in the valley area. In terms of the 1993 livestock census, which revealed 1.4 million LUM for the whole of Switzerland, action is therefore required in 9 600 affected farms.

**Incentive taxes on nitrogen fertilizers**

Incentive taxes on fertilizers are a means of accelerating improvements in efficiency and reducing the buying-in of fertilizers. Incentive taxes increase factor prices in a well-targeted manner and have the same influence on the product/factor price ratio as falling product prices. Incentive taxes increase the nitrogen fertilizer production factor, thus creating an incentive for the more efficient use of farm manure. The result is a better organisation of crop rotation in terms of efficient nitrogen use, increased cultivation of nitrogen-fixing crops and lower risk premiums for the use of fertilizers. In addition, these effects reduce the use of mineral nitrogen. Ecological compensation areas thus become more attractive. The resulting loss of income for the sector is less significant if there is full reimbursement than if the same effect had to be achieved via product price increases. If time limits are applied, incentive taxes allow environmental agricultural policy targets to be reached more quickly. However, they cannot solve regional nitrate and ammonia problems. To do so, far-reaching measures are needed at the level of agricultural structure and cropping systems. Incentive taxes are being considered for the eventuality that the ecological targets (see Section 1, Aims of the Swiss Agri-Environmental Policy) of the Agricultural Policy Reform and the Water Protection Act fail to be met.

**Higher percentage of organic farming**

Organic farming, in which a relatively small amount of externally produced nitrogen is used, produces significantly less surplus nitrogen than the other farming systems. From the point of view of nitrogen problems, it is therefore an efficient basis for a solution. The higher factor input generates additional production costs, which are not completely offset by the market. Should the organic sector expand, the difference in prices that can be achieved on the markets compared to the products of integrated or conventional farming can be expected to decline (loss of market niche). Although a complete conversion to organic farming would further reduce nitrogen surpluses of agricultural origin, it would not eliminate them to the extent needed (farm manure management).
3. Implications of the measures examined

The environmental, agricultural and financial implications of the measures proposed by the Nitrogen Balance Switzerland project team described in section 2, Measures under examination, are set out below, based on the results of model calculations.

**Implications for the environment**

In order to calculate the impact of the Agricultural Policy Reform, it was necessary to make assumptions regarding future trends in basic economic, technical and agri-political conditions. The difference between the 1994 farm situation and that of 2002 can be explained by a partial overlapping of the following four effects:

- **Price effect:** The difference in producers’ prices compared to the EU is only half as great in 2002 as in 1994.

- **Effect of the percentage of the different farming systems:** For 1994 the basis used is 28 per cent IP and 2 per cent organic farming. For 2002 the assumptions are 96 per cent IP and 4 per cent organic farming (Variant: 73 per cent and 27 per cent).

- **Area effect:** The pressure for intensification is weakened by developments in the structure of farms.

- **Productivity effect:** Advances in productivity reduce the surface required for a given national production volume. On the other hand, they are conducive to intensification.

The implementation of the Agricultural Policy Reform (“Agricultural Policy 2002”) can be expected to reduce the nitrogen loss potential by 28 000 tonnes N per year compared to 1994, if 96 per cent of Swiss farms participate in IP and 4 per cent in organic farming programme respectively, and by 32 000 tonnes N per year in the case of 73 per cent IP and 27 per cent Org. A condition, however, is that the supposed efficiency increase potential (reduction of the currently witnessed exceeding of the fertilizer norms by 60 per cent) is exhausted. Table 3 provides information concerning the effect of the various measures on the nitrogen emissions from Swiss agriculture.

The effect of further measures in addition to those constituting the “Agricultural Policy 2002” package was examined. The systematic implementation of the Water Protection Act (WPA) leads to a reduction of the N loss potential of 3 000 tonnes N per year if the LUM limits are achieved by a redistribution of the existing livestock population and of 10 000 tonnes N per year if there is an effective reduction of the animal population. For the purposes of Table 3, an effective reduction of around half the surplus was assumed, resulting in a reduction of approx. 3 000 tonnes N per year.

The effect of an incentive tax on nitrogen fertilizers was investigated by Lehmann et al. (1995) according to the basic 1994 conditions, i.e. without taking account of the Agricultural Policy Reform package. An incentive tax of 50 per cent of the trade price of nitrogen (approx. 1.60 CHF per kg N) would lead to a reduction of the nitrogen loss potential of around 7 000 tonnes N per year. If this measure is implemented in addition to the Agricultural Policy Reform package, its effect is reduced accordingly. The main consequence expected is its contribution to a levelled out nitrogen balance at the national level: the
incentive tax would accelerate and reinforce the increase in efficiency encouraged by the Agricultural Policy Reform.

### Table 3. Effect of Agricultural Policy Reform on nitrogen emissions from Swiss agriculture (1 000 t N/year)

<table>
<thead>
<tr>
<th></th>
<th>Total N loss potential</th>
<th>of which N₂O-evaporation</th>
<th>of which NH₃-evaporation</th>
<th>of which NO₃-leaching¹</th>
<th>of which not environmentally relevant (N₂)</th>
<th>Sum of environmentally relevant nitrogen input²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status 1994</strong></td>
<td>123</td>
<td>8</td>
<td>51</td>
<td>37</td>
<td>27</td>
<td>96</td>
</tr>
<tr>
<td><strong>Agricultural Policy Reform (AP 2002)</strong></td>
<td>28</td>
<td>1</td>
<td>7</td>
<td>14</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Reduction compared to actual status</td>
<td>23 %</td>
<td>13 %</td>
<td>14 %</td>
<td>38 %</td>
<td>26 %</td>
<td>23 %</td>
</tr>
<tr>
<td><strong>Status 2002</strong></td>
<td>95</td>
<td>7</td>
<td>44</td>
<td>23</td>
<td>20</td>
<td>74</td>
</tr>
<tr>
<td><strong>Further measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase of Org. to 27 %</td>
<td>4</td>
<td>0.3</td>
<td>1.9</td>
<td>1</td>
<td>0.8</td>
<td>3</td>
</tr>
<tr>
<td>Reduction LUM / WPA⁴</td>
<td>3</td>
<td>0.2</td>
<td>1.4</td>
<td>0.7</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>Incentive tax⁵</td>
<td>7</td>
<td>0.5</td>
<td>3.2</td>
<td>1.7</td>
<td>1.5</td>
<td>5</td>
</tr>
</tbody>
</table>

1) Assumption: 8 per cent in surface water, rest in groundwater.
2) Total emissions of ammonium, nitrous oxide and nitrate in air and bodies of water.
3) Assumption: Proportional distribution of loss potential for the individual forms of N corresponding to Agricultural Policy Reform.
4) The effect of the Livestock Unit-Manure (LUM) reduction is only additional to the Agricultural Policy Reform if the whole Swiss LUM population is reduced.
5) The effect of incentive taxes is not additional to the Agricultural Policy Reform.


Analysis of Table 3 shows that about half the reduction of agricultural N loss potential into the environment, achieved by the package of measures constituting the Agricultural Policy Reform, is caused by NO₃-leaching.

The nitrogen input from agriculture may be reduced by about 40 per cent. The emissions of N₂O and NH₃ both fall by approx. 10 to 15 per cent. These are estimates of the loss potentials of the various forms of nitrogen with consequences for the environment. The figures are therefore to be interpreted with a certain amount of caution.

### Implications for agriculture

The investigations by Häfliger *et al.* (1995) show that, as well as contributing to the increase of the overall efficiency of nitrogen, the package of measures constituting the Agricultural Policy Reform also induces significant changes in the agricultural structure:

- 13 per cent drop in labour requirements (approx. 11 000 full-time workers);
— 20 per cent to 25 per cent fall in capital investment;
— reduction of arable land and roughage acreage of around 80 000 and 40 000 hectares;
— increase in the area of ecological compensation to 120 000 hectares;
— fall in pork production of around 15 000 tonnes.

Financial implications

Costs for the national economy

Table 4 shows that the Agricultural Policy Reform package represents the most favourable of the measures examined from the point of view of the national economy. The savings in costs for the national economy generated by this measure amount to a total of between 340 and 680 million SF per year. This advantage for the national economy comes primarily from the release of investment capital and resulting savings in the import of approved inputs. The significant difference between short-term and medium-term cost effectiveness is explained by the fact that not all the capital concerned is movable in the short term, some of it being invested in non-transferable movable assets or real estate.

### Table 4. Comparison of the cost effectiveness of individual measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Effect total in t N/a</th>
<th>Costs for the national economy (minus sign = profit) in SF/t N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Policy Reform (AP 2002)</td>
<td>27 000 - 28 000</td>
<td>- 12 500 - 24 500</td>
</tr>
<tr>
<td>Agricultural Policy Reform with IP and 27% Org.</td>
<td>31 000 - 32 000</td>
<td>- 11 000 - 22 500</td>
</tr>
<tr>
<td>Incentive tax on N (50%)</td>
<td>7 000</td>
<td>- 1 600</td>
</tr>
<tr>
<td>Implementation of Water Protection Act with decrease of surplus livestock &amp; relocation of surplus livestock</td>
<td>7 100 - 10 300, 3 200(^i)</td>
<td>+ 16 000 + 6 000(^i)</td>
</tr>
</tbody>
</table>

1) It can be seen that, with a reduction of LUM, cost efficiency is in the upper range of the N loss potential reduction given that surpluses are hardly conducive to the efficient use of nitrogen.
2) Assumption: Nitrogen is used efficiently because of the more even distribution over the whole territory.

Source: FOEFL, 1996, adapted.

Incentive taxes reduce the time it takes to achieve a lower N loss potential for the sector and are advantageous to the national economy in that they generate savings in mineral fertilizer imports.

The systematic implementation of the Water Protection Act could generate costs for the national economy if demand were such as to require additional meat imports. At present, however, a steady change in the population’s eating habits is emerging. In the event of a continued drop in meat consumption, accompanied by much more liberal market regulations, it should be possible to reduce the livestock
population in the medium term without additional costs for the national economy. A decisive factor is the speed with which the reduction can be achieved in the problem areas. In the medium term, surplus livestock could be relocated to areas with lower LUM figures at no additional cost to the national economy, which would contribute to a more efficient use of nitrogen from farm manure.

Impact for rural income, consumer spending and national financing

A halving of the difference in prices compared to EU levels as part of the Agricultural Policy Reform lies behind the lower final production figures for agriculture in 2002 [Table 5, a)]. As far as the goal to stabilise income in the farms is concerned, part of the direct payment requirements for that purpose can be covered by savings in price and sales support [Table 5, d)]. The remaining part would have to be covered by additional national financing [Table 5, e)]. The reduction in consumer spending [Table 5, f)] is evaluated by subtracting the additional national expenditure from the sum of the savings in expenditure on foodstuffs (lower producer prices) and savings in agricultural costs [effects of structural change, Table 5, b)].

National expenditure on direct payments and investment aid amounted to 1 930 million SF in 1995. By the year 2002 this will rise by 1 230 to 3 160 million SF per year (see Table 5). In the same period, an increase in annual national expenditure of around 700 million SF can be expected, accompanied by a reduction for consumers of 1 400 million SF.

The annual income for the sector (interest on invested personal capital and payment for work done) should fall by 200 million SF in this period.

Table 5. Changes in agricultural sector income and national expenditure brought about by the Agricultural Policy Reform

<table>
<thead>
<tr>
<th>In million SF per year</th>
<th>Total change in the period 1995 to 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Final agricultural production (falls in profits including reduction of national expenditure on sales and price support measures)</td>
<td>- 1 930</td>
</tr>
<tr>
<td>b) Agricultural costs (preferential treatment, own work and personal capital = reduction in costs for the national economy)</td>
<td>- 700</td>
</tr>
<tr>
<td>c) Direct payments and investment aid (additional requirement)</td>
<td>+ 1 230</td>
</tr>
<tr>
<td>d) National expenditure on price and sales support (saving)</td>
<td>- 530</td>
</tr>
<tr>
<td>e) National expenditure on direct payments, price and sales protection (c+d)</td>
<td>+ 700</td>
</tr>
<tr>
<td>f) Reduction for consumers (raw materials, a-d)</td>
<td>- 1 400</td>
</tr>
</tbody>
</table>


The reduction of the livestock population brought about by the implementation of the Water Protection Act entails a loss of income (wages and salaries) at the sectorial level of approx. 90 million SF. The extent of this loss is explained by the fact that most of the farms concerned are located in areas where there are no alternative sources of income. If surplus LUM are not reduced but relocated to areas with lower livestock densities, there is no resulting loss of income for the sector, although there are corresponding gains and losses for the individual farms. No impact on national financing is to be
expected as long as the losses are not compensated. Consumer spending should not be affected to a significant extent.

Incentive taxes have virtually no influence on consumer prices. The implications for national financing depend on how the incentive taxes are recuperated and who bears the associated administrative costs. The administrative costs for an incentive tax on fertilizers are estimated at approx. 0.5 million SF. In the case of 100 per cent recuperation, the loss of income for the sector is low. If the money goes to the Federal treasury, a 50 per cent rate of tax on the present end-user prices would mean a loss of around 110 million SF for sectorial and business income. The greater the reduction in the consumption of mineral fertilizers, the lower this amount.

4. Implementation of measures

Implementation status

In 1996 the Federal Council published its communication on the Second Stage of the Agricultural Policy Reform (Federal Council, 1996). The package is currently being prepared by the relevant parliamentary commissions and will be discussed by Parliament in the winter of 1997/1998. Subject to an all-encompassing referendum, this new legal basis for agriculture will enter force at the beginning of 1999 at the earliest.

The transitional period for the Water Protection Act expired at the end of October 1997. The point at which the act takes full effect will depend primarily on its implementation by the cantons responsible.

The introduction of an incentive tax on nitrogen fertilizers will be up for discussion in the year 2000 at the earliest, and only if the interim assessment in 1999 shows that agriculture cannot meet the environmental targets set for it by 2002.

The introduction of measures for reducing ammonia emissions is scheduled for 2002 at the earliest in the framework of the gradual implementation of the strategy for reducing input into the nitrogen cycle. A catalogue of concrete measures (Menzi et al., 1997) was elaborated and the costs resulting from the measures at farm level (Zimmermann et al., 1997) were determined.

First effects

The following developments are indicators of the first effects of the measures introduced:

- Nutrient balances of the farms included in the ecological pilot farm network.
- The quantities of active substances used in agriculture originating from pesticides.
- Participation in the national ecological programmes.

In the framework of the ecological pilot farm network the requirements for environmentally sustainable agriculture were tested, from 1991 to 1996, in around 150 farms spread throughout Switzerland. Figure 1 shows the effect on the development of the phosphorous balance by way of example. Here it can be seen that the 58 valley farms and the 18 mountain farms reduced their phosphorous surpluses from 19 to -8 kg
P$_2$O$_5$ and from 16 to -4 kg P$_2$O$_5$ per hectare, respectively, between 1991 and 1996. This improvement was achieved by means of a sharp reduction in the use of mineral fertilizers.

**Figure 1. Phosphorous: Supply and demand of Integrated Production (IP) farms in 1991, 1993 to 1996**

![Diagram showing phosphorous supply and demand]


The market statistics for pesticides (Table 6) clearly demonstrate that the amount of active substances used in the treatment of plants since the beginning of the 1990s is on the downward trend. According to FOA (1997a), the ecological programmes, the well-targeted use of pesticides and technical biological advances (e.g. reductions in quantities of sulphonil ureas), among other things, have all contributed to this result.

This is a positive development; however, it is necessary to examine whether the quantities of pesticides used can be meaningfully evaluated for their potential risk to the environment. It is particularly noticeable that turnover has decreased to a lesser extent than the quantities used.

Table 7 provides information concerning the development of participation in the ecological programmes since their introduction in 1993. Of the 64 855 farms receiving supplementary direct payments in 1996 under Art. 31a of the Law on Agriculture (LwG), around 54 per cent were managed on an integrated basis and 5 per cent organically, corresponding to about 65 per cent of the agricultural area in total.
Table 6. Market statistics relating to pesticides in Switzerland
((active substances in tonnes)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Insecticides/acaricides</td>
<td>316</td>
<td>238</td>
<td>246</td>
<td>186</td>
<td>209</td>
</tr>
<tr>
<td>Herbicides</td>
<td>785</td>
<td>676</td>
<td>668</td>
<td>657</td>
<td>625</td>
</tr>
<tr>
<td>Fungicides, bactericides, seed treatments</td>
<td>951</td>
<td>982</td>
<td>973</td>
<td>949</td>
<td>891</td>
</tr>
<tr>
<td>Growth regulators</td>
<td>67</td>
<td>39</td>
<td>33</td>
<td>34</td>
<td>22</td>
</tr>
<tr>
<td>Rodenticides</td>
<td>11</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Total</td>
<td>2 120</td>
<td>1 935</td>
<td>1 921</td>
<td>1 827</td>
<td>1 748</td>
</tr>
<tr>
<td>%</td>
<td>100</td>
<td>91</td>
<td>90</td>
<td>86</td>
<td>82</td>
</tr>
<tr>
<td>Turnover in million SF</td>
<td>135</td>
<td>131</td>
<td>134</td>
<td>131</td>
<td>128</td>
</tr>
</tbody>
</table>


Table 7. Participation in the national ecological programmes

<table>
<thead>
<tr>
<th>Programme</th>
<th>Area (ha)</th>
<th>In % of farms receiving direct payments under Art. 31a LwG 1996</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1993</td>
<td>1996</td>
</tr>
<tr>
<td>Ecological compensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extensively used meadows, hedgerows and boscage as well as litter areas</td>
<td>19 319</td>
<td>31 421</td>
</tr>
<tr>
<td>Floral fallow</td>
<td>0</td>
<td>154</td>
</tr>
<tr>
<td>Extensively used meadows on uncultivated arable land</td>
<td>1 103</td>
<td>4 805</td>
</tr>
<tr>
<td>Non-intensively used meadows</td>
<td>31 039</td>
<td>38 485</td>
</tr>
<tr>
<td>Standard fruit trees (stem &gt;1.5 meter) (trees)</td>
<td>1 903 574</td>
<td>2 397 858</td>
</tr>
<tr>
<td>Farming systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated production</td>
<td>179 152</td>
<td>646 282</td>
</tr>
<tr>
<td>Organic farming</td>
<td>18 908</td>
<td>53 982</td>
</tr>
</tbody>
</table>

Source: FOA, 1997b.

5. Conclusions

The crucial problem for Swiss agriculture as far as water quality is concerned is the growing trend in the nitrogen content of drinking water in crop growing areas. Nitrogen and phosphorous inputs in surface water also have a certain ecological significance. In addition, herbicides have been found in groundwater, but a thorough assessment of the situation is not possible at the present stage.
The set legislative targets for reducing agricultural pollution of the environment are summarised in Section 1, *Aims of the Swiss Agri-Environmental Policy*. The target for nitrate in running water and groundwater is 25 mg/l NO$_3$-N and for pesticides 0.0001 mg/l per substance. The lack of understanding among the general public for publicly funded agriculture causing environmental problems also constitutes a need for action.

The Agricultural Policy Reform and the provisions of the Water Protection Act take this requirement into account. This means that only those farms participating in the IP and Org. ecological programmes — which, among other things, requires a levelled out nutrient balance — are able to benefit from the direct payments designed for that purpose. Furthermore, future entitlement to supplementary direct payments under Art. 31a of the Law on Agriculture (LwG) will be restricted to those farms that are able to supply proof of ecological results, i.e. at least meet the requirements of integrated production. The results of various investigations give reason to believe that environmental pollution can be reduced significantly in this way. The impact of the measures introduced is being monitored by means of an evaluation programme.

Problems relating to water quality primarily affect Switzerland itself, with the exception of nitrogen and phosphorous inputs into the Rhine and related exports. Environmental problems of agricultural origin, however, must be tackled on a global scale, which implies, among other things:

- Co-ordination of measures at the international level, particularly for reducing emissions of N-compounds that are transported over long distances through the atmosphere and for avoiding distortions resulting from competition between countries with different environmental restrictions.

- Elaboration of international guidelines concerning the ecological classification of products for customers’ benefit. Aside from the production aspect, ecological evaluation also has to take account of processing and transport considerations.

- Making society aware of the problems so that they can influence agricultural production methods and the extent of international trade by means of their consumer patterns and eating habits.

6. Bibliography


FOEFL (1993b), Situation der Trinkwasserversorgung. Schriftenreihe Umwelt Nr. 212, 128 S. Herausgegeben vom Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Bern.


LIST OF ABBREVIATIONS

Art.  Article of a piece of legislation
AP 2002 Agricultural Policy Reform: Second stage
CHF  Swiss francs
FAT  Swiss Federal Research Station for Agricultural Economics and Engineering, CH-8356 Tänikon
FOA  Federal Office for Agriculture, CH-3003 Bern
FOEFL  Federal Office of Environment, Forests and Landscape, CH-3003 Bern
ha  hectare
IP  Integrated Production (Ecological programme according to Art. 31 b LwG)
kg  kilogram
l  litre
LwG  Law on Agriculture
LUM  Livestock Unit-Manure according to Water Protection Act
(1 LUM → 105 kg N, 15 kg P)
mg  milligram
M  million
N  Nitrogen, total nitrogen
N₂  Atmospheric nitrogen
NH₃  Ammonia
N₂O  Nitrous oxide (laughing gas)
NO₃  Nitrate
NOₓ  Nitrogen oxides
Org.  Organic farming (Ecological programme according to Art. 31 b LwG)
P  Phosphorous
P₂O₅  Phosphate
ppb  parts per billion
t  tons
WPA  Water Protection Act
WTO  World Trade Organisation
TURKEY: MANAGEMENT OF WATER RESOURCES FOR AGRICULTURE

by Aşıkın Sürmelý, Ministry of Agriculture, Ankara

Summary

Turkey has a land area of 78 million hectares, of which 28 million hectares are cultivated. Annual rainfall averages 500 cubic kilometres. Fresh water available for consumption is estimated at 110 cubic kilometres, excluding outflows reserved for neighbouring countries and water used to prevent saltwater intrusion, to preserve aquatic life, and to dilute pollutants. Precipitation varies annually and regionally within a range of 250 to 3 000 millimetres, which in the drier areas of the country, means that there is a demand for irrigation water in order to produce agricultural commodities. Two-thirds of the 34 cubic kilometres of water consumed annually in Turkey is used for agriculture.

The Government has invested heavily in irrigation infrastructure since the 1950s. Over the last decade, public investment in irrigation has averaged over US$ 500 million annually, converting an additional 80 to 100 thousand hectares of land to irrigation each year. Out of the 8.5 million hectares where there is a potential for irrigation, 4.5 million hectares are currently covered by irrigation schemes. Schemes developed by farmers themselves account for approximately 1 million hectares, while those built by public agencies account for the remaining 3.5 million hectares.

Two General Directorates are responsible for developing irrigation in Turkey: the State Hydraulic Works (DSI), which is a General Directorate under the Ministry of Energy and Natural Resources; and the General Directorate of Rural Services (GDRS), which reports to the Prime Ministry. Large-scale surface-fed irrigation systems are developed by DSI and small-scale systems by GDRS. Groundwater-fed irrigation schemes are developed by both agencies (wells by DSI and distribution systems by GDRS).

Groundwater systems are operated and maintained by irrigation co-operatives. Until recently, all large-scale schemes, and most small-scale schemes which have been developed by DSI were managed by DSI. In 1993, a programme was created to transfer responsibility for the operation and maintenance of these irrigation schemes to water user organisations. Until now, more than 1.1 million hectares have been transferred to user organisations. This change has increased collection rates of irrigation charges, increased the area actually irrigated, improved allocation of water among users, and, most importantly, increased efficiency of agricultural water use.


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1. **Turkey’s unique situation**

Turkey occupies a unique geographical and cultural position situated at the crossroads between Europe and Asia. It is bounded by the Black Sea in the north, the Mediterranean Sea in the south and the Aegean Sea in the west. It is the only peninsula that extends from east to west. Its status as a secular and modernising Republic with an almost entirely Muslim population, and its historical, cultural and linguistic link with the people of central Asia gives it a special geopolitical significance.

2. **The land**

Turkey’s total land area is 76.9 million hectares. The total arable area is 28 million hectares. This total includes approximately 35 per cent of Turkey. This represents an increase of some 250 per cent in the total cultivable area since the founding of the Turkish Republic in 1923. It has now reached its maximum participle limit. Turkey has extensive resources of land and water, and a great diversity of agroecological conditions. Its topography is extremely varied. Numerous mountain ranges run parallel to the northern and southern coasts that surround the central undulating Anatolian Plain which rises upwards from 500 meters in the west to over 2 000 meters in the east. Soils also vary considerably; on gentle slopes soil is deep, moderately fertile and slightly alkaline, and on steeper slopes, it is usually shallow, rocky and infertile. About 80 per cent of soil in Turkey suffers from moderate to severe sheet and gully erosion, and most rivers carry heavy loads of sediment.

3. **Water resources**

Turkey has a total land area of 779 452 km$^2$, of which 765 152 km$^2$ is land and the remaining 14 300 km$^2$ is surface water. Rainfall accounts for an average of 501 billion m$^3$ of water annually. It is estimated that 274 billion m$^3$ of this, returns to the atmosphere through evaporation and transpiration from soil and water surfaces and plants; 41 billion m$^3$ feeds underground reservoirs through leakage and deep percolation; and 186 billion m$^3$ runs off into seas or lakes. Around 6.9 billion m$^3$ of water is added to the country’s water potential through rivers of neighbouring countries.

Thus the renewable fresh (surface) water potential of Turkey is about 234 billion m$^3$ depending on climatic fluctuations. The total safe yield of groundwater resources is estimated at 12 billion m$^3$. Finally, it is estimated that the total (technically and economically) usable surface and groundwater potential of Turkey is 110 billion m$^3$ with 95 billion m$^3$ of this coming from internal rivers; 3 billion m$^3$ of this coming from external rivers, and 12 billion m$^3$ from groundwater resources. The estimated annual water requirements for Turkey is 50 600 billion m$^3$ in 1995 and 58 100 billion m$^3$ in 2000.

The countries great geographical and climatic variety means that its water supplies are often not to be found in the right place and at the right time, to meet demand. The average annual precipitation is 643 mm, but this figure conceals wide variations, for example 250 mm annual rainfall in central parts compared to as high as 3 000 mm in the eastern Black Sea regions. Arid and semi-arid continental climates prevail in central and eastern Anatolia.

4. **Management of water in Turkey**

Mainly there are two ministries involved in the implementation of major irrigation projects (Table 1). The first is the Ministry of Energy and Natural Resources, in particular the DSI (State Hydraulic Works),
whose responsibilities include the design, construction, maintenance and operation of basic infrastructure of major irrigation projects. It was established in 1954 and is responsible for flood control, swamp reclamation, hydropower development, and water supply to cities with a population over 100,000. In recent years, it has been responsible for extending irrigation to an average of nearly 50,000 hectares per year. The second is the Prime Ministry in particular the General Director of Rural Services (GDRS) whose responsibilities include the construction of on-farm works in the irrigation projects constructed by DSI.

<table>
<thead>
<tr>
<th>Table 1. Institutional framework of irrigation water resource management in Turkey</th>
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<tbody>
<tr>
<td><strong>PRIME MINISTRY</strong></td>
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<tr>
<td><strong>STATE PLANNING ORGANISATION</strong></td>
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<td><strong>MINISTRY of ENERGY and NATURAL RESOURCES</strong></td>
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<td><strong>MINISTRY of AGRICULTURE and RURAL AFFAIRS</strong></td>
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<td><strong>GENERAL DIRECTORES of RURAL SERVICES (GDRS)</strong></td>
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<tr>
<td><strong>STATE HYDRAULIC WORKS (DSI)</strong></td>
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<td><strong>GENERAL DIRECTORES of RURAL SERVICES (GDRS)</strong></td>
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<td><strong>Law no: 6200</strong></td>
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<td><strong>Law no: 7478</strong></td>
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<td><strong>7557</strong></td>
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<td><strong>7478</strong></td>
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<tr>
<td><strong>Inland Water Resources Development</strong></td>
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<td><strong>Education of farmers</strong></td>
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<td><strong>Village Roads</strong></td>
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<td><strong>Erosion</strong></td>
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<td><strong>Irrigation</strong></td>
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</table>

GDRS, the successor to the Soil and Water General Directorate (TOPRAKSU), is responsible for small-scale irrigation projects, soil conservation and land consolidation projects and research on soil-water-plant relationships, as well as, settlement and resettlement activities. It is responsible for extending irrigation to nearly 40,000 hectares per year.

By the end of 1995, almost 3 million hectares of land have opened up to irrigation as a result of the efforts of the public sector, with a further 1 million hectares irrigated as a result of private initiative, giving an estimated total of 4,500,000 hectares. Of this total, about 95 per cent is irrigated by surface methods (furrow, basin, border, flooding). The remaining 5 per cent is watered mostly by hand-moved sprinklers and some micro irrigation, mainly in the Aegean and Mediterranean Regions.

On-farm development projects are effective tools for improving efficiency and are cheap to manage; but the rate of success is hampered by the need for a better synchronisation between different implementing agencies and a greater involvement of farmers.
In Turkey, there are about 8 500 000 hectares of land economically suitable for irrigation. Half of this area has already been equipped with irrigation infrastructure. The rapid expansion of irrigated land helps to create rural employment and to alleviate migration from rural to urban areas.

The average yield of irrigated land is 7.6 times that of dry farming land, and the average value-added per irrigated hectare is 2.6 times that of a rainfed hectare.
UNITED STATES: U.S. WATER MANAGEMENT FOR AGRICULTURE — A CASE STUDY OF THE AMERICAN WEST

by The U.S. Department of Agriculture (USDA), Washington

Summary

The availability of water has been central to both the U.S. agricultural economy and to economic development in the western States. For many years, production agriculture benefited from Federally subsidised water and western economic expansion thrived on the construction of reservoirs, aqueducts, and distribution systems to meet increasing water needs. Today, a new economic and political environment calls for non-structural water development through co-operative management, conservation, voluntary water marketing, and increased attention to environmental protection. However, the policies that guide water development and management are changing slowly to accommodate this new environment. The public sector in water management is changing, and institutional and policy reforms are taking place, that promote economic efficiency and meet multiple and competing needs.

1. Water use in U.S. agriculture

Water use

Irrigated agriculture is the dominant use of freshwater in the United States. National irrigated cropland area has expanded by a third since 1969, while field water application rates have declined about one fourth, leaving total irrigation water applied about the same in 1995 as in 1969. The U.S., as a whole has adequate water supplies but an abundance of water in the aggregate belies increasingly limited supplies in many areas. In the arid West, for example, consumptive use exceeds half of the renewable water supplies under normal precipitation conditions. In drought years, water use often exceeds renewable flow. While droughts exacerbate supply scarcity, water needs continue to expand in the aggregate and to shift among uses. Urban growth greatly expanded municipal water demands in arid areas of the southwest and far west though urban uses still consume only a small amount of water relative to agricultural uses. At the same time, demand for water flows for recreation, endangered species protection, riparian habitat, and other environmental purposes has tightened competition for available water supplies in all but the wettest years.

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Irrigated cropland in an important part of U.S. agricultural sector, contributing about 40 per cent of the total value of crops on just 15 percent of total cropland harvested. In 1992, 279,000 farms irrigated 49.4 million acres of crop and pasture land. Irrigated acreage dominated the production of several major crops, including rice with 100 per cent irrigated, orchards (66 per cent), Irish potatoes (71 per cent), and vegetables (65 per cent). Irrigated acreage are substantial for several major field crops, including corn for grain with 9.6 million acres, all hay (8.6 million), wheat (94.1 million), and cotton (3.7 million) (USDA, 1994).

Freshwater withdrawals — a measure of the quantity of water diverted from surface and groundwater sources — totalled 380 million acre-feet (maf) in 1990. Major withdrawal categories include irrigation (9153 maf), thermoelectric (146 maf), public and rural domestic supplies (52 maf), and other industries (28 maf) (Solley, Pierce and Perlman).

Most irrigation water withdrawals occur in the arid western States where irrigated production is concentrated. Combined irrigation withdrawals in the four largest withdrawal States (California, Idaho, Colorado, and Montana) exceeded 75 maf, or nearly half of total U.S. irrigation withdrawals in 1990. The top 20 irrigation States accounted for 97 per cent of U.S. freshwater irrigation withdrawals. Most States rely on a combination of surface and groundwater supplies for irrigation purposes.

Surface water accounted for 63 per cent of total irrigation withdrawals in 1990, with groundwater supply the remaining 37 per cent. Approximately 32 per cent of surface-water deliveries — or 20 per cent of total irrigation withdrawals — was provided by the U.S. Department of Interior, Bureau of Reclamation (BOR).

Groundwater is the primary water source for irrigation in about half of the top 20 irrigation States. Groundwater is pumped from wells drilled into groundwater-bearing strata. Groundwater overdrafting has been reported in many areas in the Great Plains, Southwest, Pacific Northwest, Mississippi Delta, and Southeast. Overdrafting occurs when withdrawals for irrigation and other uses exceed natural rates of aquifer recharge, which results in lowered water levels and reduced total water reserve. Major impacts are increased in pumping costs and long run adjustments in aquifer composition that can lead to land subsidence, saltwater intrusion along coastal areas and loss of aquifer capacity.

While national area of irrigated farmland is near peak levels, varying regional trends reflect differences in water resource conditions. Western irrigation reached its peak with the agricultural export boom of the 1970’s. The Southwest — the first region to fully utilise available water resources — became the first region to begin abandoning irrigated acreage in the face of growing demand for urban and environmental uses. In contrast, farmers in the Northern Plains and eastern regions continue to expand irrigation capacity.

Changes in irrigated acreage are partially attributable to regional weather patterns. The major western drought of the late 1980s affected surface-water supplies across the region. In several south-western States, the drought, combined with competing urban and environmental demands reduced irrigated areas by a million acres between 1989 and 1993. About half this area subsequently returned to irrigation. In the east, unusually wet seasons reduced irrigated acres. In addition to regional shifts in acreage, there has been a shift in the crop mix on irrigated cropland. Sorghum area irrigated has declined significantly due

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19 Surface water availability was below normal over much of the west in 1990. In a normal or above-normal water supply year, the share of water supplied from surface sources is likely to increase.
to improved dryland cultivars, limited water in primary growing areas, and lower returns relative to other irrigated crops.

2. Managing water in the western United States

Federal and State roles in water management

In the United States, the Federal government, state governments, and special water districts share the responsibility for allocating water among competing uses and delivering water to the final consumer. Under the U.S. system of Federalism, States were given the principal authority of water allocation within their own borders. The Federal government, however, retains certain “reserved” rights for water associated with land reserved for Federal purposes, including Indian reservations, national parks and national forests. The Federal government has also served a role in regulating water use on interstate streams and in regulating water quality through the States. Within states, special water districts, as well as public utilities, are often the main providers of water directly to the final consumer. The policies of these latter institutions, which are under the control of the state governments that empower them, are influential in how water resources are managed.

Water resources in the western U.S. are generally managed under the “appropriative doctrine.” The specific features of this doctrine have evolved differently from one western state to another, but in general water rights granted by States are specified in terms of the amount of water diverted from the stream, rather than the amount of water consumed. These rights allow individuals to divert water any distance from a stream for state defined “beneficial uses.” Appropriative water rights (or some portion of the right) is subject to forfeiture through non-use. Appropriate rights also establish a priority system on each stream: each water right has a priority dating from the original diversion date. During periods of reduced flow on the river, appropriators with more recent priority dates (junior appropriations) have their withdrawals curtailed in order to guarantee the right of appropriators with earlier priority dates (“senior” appropriators). While this doctrine served early settlers well, it is currently undergoing some evolution to accommodate changing needs and values.20

One area in which some changes have occurred is the extent to which a water right can be sold or transferred to other uses. In most cases, an appropriative water right can be sold or transferred if there is no harm to other water rights holders. Consequently, a transfer request requires that the state determine the amount of consumptive use and the amount of water returning to the stream or groundwater source that may become the basis of the water rights of another water user. This determination can be complex. However, once several water transfers have been processed in a given geographic location, state authorities build up a knowledge of the basic coefficients of consumptive water use for different crops and for return flows, allowing them to process subsequent transfer requests more expeditiously. Some States have been criticised for making this transfer process more cumbersome than it needs to be in order to adequately protect the rights of other appropriators. The result is that many potential water transfers that would be beneficial to all the parties involved simply do not take place because of the high transaction costs.

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20 In contrast to the appropriative doctrine of the west, water rights in the eastern, southern, and Midwestern parts of the country are generally granted in terms of riparian rights — belonging to the landowners along a water course. These rights are not subject to forfeiture through non-use, but neither can they be severed from the land for diversion to another parcel of land.
Another difficulty is that, in many States, water salvaged through conservation efforts cannot be sold to another water user (or transferred to additional lands owned by the original appropriator). Rather, any salvaged water reverts to the stream and enhances the security of the water right of the junior appropriators. In other words, any reduction in water use stemming from conservation can become evidence that the original diversion was not being fully placed to beneficial use. Investment in conservation measures can lead therefore to a forfeiture of some portion of one’s water right. Such a provision is widely recognised as providing a negative economic incentive for conservation. However, several States (including California) now recognise conservation as a beneficial use of water and allow conserved water to remain the property of the conserving entity.

An important role in the western States has also been played by the federal government — largely through the construction of large water storage and distribution facilities. The primary federal agency involved in such construction is the federal Bureau of Reclamation (BOR). Since about 1950 about 20 per cent of all irrigated acreage in the seventeen western States where the BOR operates has received at least supplemental supplies from federal facilities. The Bureau’s influence in water supply may be understated by this percentage, however, because it controls large surface water delivery facilities in many western States.

In addition to the direct role of the Department of Interior in allocating water supplies, there are several major federal programmes that affect water management. For example, Federal commodity programme provisions alter incentives for agricultural production and irrigation water use. Although commodity programmes have recently undergone historic change (see below for a discussion of commodity programme reform), for many years commodity prices were supported through a complex system of guaranteed farm loans and acreage restrictions, and farm income was supported through direct payments to producers. Price and income supports affect land use, crop choice, and production returns, all of which influence water use decision (Aillery, 1995).

The growth in western agricultural water demand has been attributed, at least in part, to favourable incentives provided by Federal commodity programmes (Lee and Lacewell, 1990; Just et al., 1991). For example, high income and price supports — combined with production–indexed payment provisions prior to 1985 — increased irrigated crop returns relative to dryland production. Irrigated acreage expanded as farmers converted dryland acreage and developed new cropland: higher returns favoured substitution of water for land, where fixed water supplies (due to legal entitlement or pump capacity limits) could be applied over fewer acres (Aillery, 1995).

At the same time, the effect of commodity supports on water use was partly offset by mitigating factors related to the commodity programmes. Set-asides reduced acreage that might be irrigated, potentially lowering the demand for water. Programme participation also reduced production risk associated with revenue variability potentially lessening the need for irrigation as a risk-minimising strategy (Aillery, 1995).

Water use incentives under Federal commodity programme may have conflicted with Federal and State conservation objectives for water-scarce areas. Policy reforms under the 1985 and 1990 farm legislation sought greater consistency across commodity and resources policy goals by reducing support levels for programme production and decoupling programme benefits from input-allocation decision (Aillery, 1995).

Other, more direct, USDA irrigation-related activities were primarily for technical assistance and through various loan programmes. For example, the Agricultural Conservation Program, the Colorado River Basin Salinity Control Program, and the Great Plains Conservation Program provided some cost-sharing
for selected conservation and water quality improvements. Such improvements were initially limited to land levelling and similar land preparation activities but were later expanded to include water quality improvements and conservation practices. Water supply and equipment expenses must be borne by irrigator (Pavelis, 1985).

The Endangered Species Act has played an increasingly significant role in western water resource issues. In a number of basins where endangered fish species are present, courts have ordered the federal resource management agencies (The National Marine Fisheries Service and the Fish and Wildlife Service), requiring changes in management practices to provide greater instream flows during periods critical to fishery needs and to acquire (by lease, purchase, or other arrangement) sufficient water to ensure that fishery needs are met over the longer term. A particularly important location where management changes have occurred to improve the habitat for endangered anadromous fish is in the river systems found in the central valley of California. Legislation enacted in 1992 set aside 800,000 acre-feet from the water supplied by the federal central valley project to meet fishery and other environmental needs. This water was essentially reallocated from existing agricultural and municipal and industrial water users (CBO, 1997).

Irrigation and the environment

The principal environmental issues relevant to irrigation are those concerned with the protection and management of water supplies and water quality (NRC, 1996). Water management reforms are typically aimed at reallocating water based on meet urban, agricultural, and recreation needs and managing water to mitigate negative environmental effects. While irrigation is the most significant use of water, accounting for over 95 per cent of freshwater withdrawals consumed in several Western States and roughly 80 per cent nation-wide, expanding water demands for municipal, industrial recreational and environmental purposes increasingly compete for available water supplies.

The construction of dams and diversion for surface supplies reduces instream flows, altering the natural hydrograph and affecting water temperature and flow regimes, trapping sediments, and changing water quality. In addition to obstructing the passage of migratory fish, these changes degrade spawning and rearing habitat in the stream and riparian areas. The draining and fill in of wetlands for irrigation have significant impacts on waterfowl and other aquatic species that used these habitat for nesting and breeding and also increase the potential for sedimentation and water pollution (NRC, 1996).

Irrigated agriculture affects water quality in several ways including higher chemical-use rates associated with irrigated crop production, increased field salinity and erosion from applied water, accelerated pollutant transport with drainage flows, degradation due to increased deep percolation to saline formations, and greater instream pollution concentration due to reduced flows. Surface return flows and drainage from irrigation are a leading sources of water pollution in rivers, lakes, streams and estuaries nation-wide. According to recent estimates, irrigated cropland in the West accounts for 89 per cent of quality-impaired river mileage and irrigated agriculture accounts for more that 40 per cent of the pollution in lakes with impaired water quality (EPA, 1992) (see NRC, 1996, page 73).

3. Reforming U.S. water management

Many interrelated forces are driving water management reforms in the western States. These forces include: reductions in State and Federal budgets; increasing urban demand for water; increasing demand to meet environmental needs; the decline role of agriculture in some areas; the increasing role and power
of the States in making water use decisions; lack of good dam sites; and changes in public management approaches that emphasise local, decentralised decision making. Types of reform can be broken into four broad classes: reform of organisational mission; policy and institutional reforms; devolution (transferring management from the Federal government to the States), and privatisation.

Reforming organisational mission

Recognising the many criticisms associated with Federally financed water projects, such as inefficient water use and environmental damages, the BOR’s mission has evolved from one based on Federally supported construction of irrigation projects to one based on resource management (BOR, 1987 from NRC, 111). With few, if any, large-scale construction projects remaining in its programme, BOR has increasingly shifted its activities toward maintaining existing facilities and improving its management of water resources. Similarly, the U.S. Department of Agriculture identified improvements in water management as one of the primary agricultural policy objectives for the 1990s (USDA, 1994).

Policy and institutional reform

Recent institutional and policy reforms tend to stress economic incentives as opposed to command and control or regulatory approaches. Economic incentives include voluntary water transfers, creating water markets that reflect the full cost of water storage, diversion and delivery, and subsidising conservation practices. It is well known that Federally supplied water in the west is sold far below the cost of providing it and the disparity between the relatively high prices paid by urban entities and the low prices paid by agricultural users suggests that opportunities exist to use markets and other economic incentives to allow more efficient allocation of water. Other institutional reforms include acquiring water for environmental purposes, and title transfers. However, even when markets are used to provide incentives to allocate, transfer, and conserve water, governments retain an important role in defining and enforcing property rights, making allowance for third party effects, and providing for the public goods associated with instream flows, and regulating the prices of monopolist suppliers.

Water pricing

Prices paid for irrigation water supplies are of considerable policy interest due to their importance as a cost to irrigated agriculture and their impact on regional water use. Increasingly, water pricing is viewed as a mechanism to improve the economic efficiency of water use. Irrigation water prices are typically not set in a market, since market development is not widespread. Water prices are most frequently administratively set and as a result, water expenses are typically based on the access and delivery costs of supplying water and generally do not convey signals about water relative scarcity.

Water resource managers could attempt to administratively set prices in such a manner that the prices move closely to reflect real resource costs. However, this approach would face substantial information and implementation difficulties. The localised nature of hydrologic systems and the externalities associated with water use and reuse would require precise adjustments in water prices — spatially and temporally — requiring high programme costs.

To the extent that water resource managers wish to create stronger incentives to conserve water, establishing a slightly higher price may not dramatically change its use in the current institutional environment. To promote large changes in input use would require very large adjustment in price, all but
prohibited by distributional concerns. In addition, due to the nature of ownership of the water rights, price increase may not result in additional water left instream or available for other uses.

The price irrigators pay for water is usually associated with the expense of developing and providing the resource, including access, storage, conveyance, and in some cases, field distribution — and may not reflect the full social costs of its use. Irrigation water costs vary widely, reflecting different combination of water sources, suppliers, and distribution systems.

Producers respond to changes in water costs and limited water supplies by reducing water use, shifting to alternative crops or varieties of the same crop that use less water, or adopting more efficient irrigation technologies. In some cases, producers may convert from irrigated to dryland farming or retire land from production. Many irrigators have responded to water scarcity and changes in prices through the use of improved irrigation technologies — often in combination with other water-conserving strategies — and irrigators will likely look to technology as one of several means of conserving water in the future.

The choice of irrigation technology is highly site-specific, reflecting locational, technical and market factors. Field characteristics — such as field size and shape, field gradient, and soil type — are perhaps the most important physical considerations in selecting an irrigation system. Other important factors include technology cost (useful life, financing options); water supply characteristics (cost, quality, reliability, flow rate); crop characteristics (spacing, height); climate (precipitation, temperature, wind velocity); market factors (crop prices, energy cost, labour supply); producer characteristics (farming traditions, management expertise, risk aversion, tenant/owner status, commitment to farming); and regulatory provisions (groundwater pumping restrictions, drainage discharge limits, water transfer provisions). In many cases, current technology choice is limited by fixed investments in existing systems at the site. Recent surveys report that 38 per cent of farms made systems improvement from 1990-1994, while no improvements were reported on 56 per cent of farms. Those farms reporting improvements tended to be larger, accounting for 58 per cent of the irrigated acres.

Voluntary transfers

Voluntary transfers of water from agricultural uses to municipal and industrial uses, have been increasingly recognised as a valuable tool and low-cost alternative to structural water development. Facilitating the ability of water right holders to engage in voluntary transfer activities may be more acceptable to BOR contractors, easier to implement, and will result in the same outcome as increasing water prices to more accurately reflect the opportunity cost of water. Voluntary transfers would also necessitate considerably less government intervention in terms of administratively determining prices and lend a degree of flexibility that may not be available through pricing policies. Efficiency would be promoted if any water delivered under contract from BOR projects could be sold to other water users, be they existing project contractors, BOR contractors on other projects, on other projects within the same river system, or non-BOR contractors. Such voluntary water transfers can be short-term leases, long-term sales, or participation in water banking arrangements. Water transfers are adapted to meet local conditions and needs and not all water transfers are straightforward sales of annual water entitlement. The ability to transfer water rights between users and between uses allows water to be put to more productive employment, permitting a more efficient allocation that relies on private incentives. Examples of long-term voluntary water transfers include the following:

- A well established market for water operates in the Northern Colorado Water Conservancy District in the Fort Collins, Colorado, area. The district receives much of its water supplies
from the Bureau constructed Colorado-Big Thompson project. Rights to water supplied by this project are freely traded within the project area.

- A dramatic example of a recent water transfer is the agreement reached between the Imperial Irrigation District and the Metropolitan Water District of Southern California. Imperial receives over 3 million acre-feet annually of Colorado River water. In the fall of 1988, Metropolitan and Imperial reached an agreement under which Metropolitan will pay Imperial to fund conservation measures within the irrigation district in exchange for the conserved water. Under the arrangement negotiated by these entities, MWD will pay over US$100 million for conservation measures and expects to receive about 100 000 acre-feet of water annually.

- The Metropolitan Water District and the Arvin-Edison Water Storage District are also in the process of negotiating an agreement that would provide MWD 14 000 acre-feet of water annually for 25 years in exchange for financing the construction of new water spreading grounds/ponds, extraction wells, a pumping plant and a pipeline to the California Aqueduct. The total cost of these facilities is estimated at US$22.5 million. (BOR, 12 March 1997. Draft Environmental Assessment for Proposal to Transfer CVPIA Water from Arvin-Edison Water Storage District to Metropolitan Water District of Southern California).

- In November, 1988 the El Paso County Water Improvement District No. 1 entered into an agreement to respond to the increasing amount of land being subdivided both inside and outside the city limits of El Paso. For this purpose a new authority was created, with the power to sell water outside the El Paso city limits, as well as to El Paso. This water transfer agreement was signed by the irrigation districts, the newly created authority, the city of El Paso, and the BOR.

Short-term transfers are somewhat more common at least partially because the transactions costs associated with such arrangements are relatively lower than those that would be associated with a long-term permanent transfer. These arrangements usually allow for users to transfer water supplies for a limited period — usually a year — and often occur through an institution such as a water bank. Water banks are generally operated by a government entity and serve as intermediaries between buyers and sellers. Water users with excess water may deposit some or all of it in the bank for rental by others. The bank often sets the price, timing, eligibility of water rights, and eligibility of recipients (MacDonnell et al., 1994). Banks facilitate trading by standardising the transfer process and compliance with regulatory hurdles. Water banks have been used extensively to ameliorate the effects of drought. Examples include:

- Annual water rentals using the system of BOR reservoirs on the Upper Snake River in Idaho reach back to the 1930s. The arrangements are recognised in BOR contracts with water users.

- The State of California established successful water banks in 1991, 1992, and 1994. In 1991 the bank acquired about 800 000 acre-feet and ultimately about 390 000 acre-feet was delivered to 12 purchasers. About 159 000 acre-feet were sold through the Bank in 1992. No Bank operated during 1993. In 1994, the Bank acquired 222 000 acre-feet from sellers in the delta and north of the delta at a price of US$50 per acre-foot. Purchasers were all located south of the delta. After deducting water needed to satisfy bay/delta water quality standards, 173 500 acre-feet was sold to entities south of the delta for US$67.50 per acre-foot delivered to either the state’s delta diversion facilities or the BOR pumping plant at Tracy. Wheeling
charges were on the order of US$30 per acre-foot. As in previous water banks, Central Valley Project (CVP) contractors south of the delta purchased significant quantities of water. However, the 1994 bank differed from previous years in that no fallowing contracts were allowed and all water acquired by the bank was the result of groundwater exchanges.

- Short-term transfer have also occurred in California outside of the state organised water banks. According to a study by Gray, over 3 million acre-feet of water moved between CVP contractors by means of transfers during the 1981-1988 period (Gray et al., 1991). However, most historic transfers of water among CVP contractors were short-term, lasting no more than one year, with almost all of the water moving from one irrigation use to another.

- The Central Valley Project Improvement Act (CVPIA) liberalised the CVP water transfer rules. While no long-term transfers have yet occurred under the authority of this act, numerous short term transfers — many of which otherwise might not have taken place — have occurred. Many of the transfers have been between different lands owned by the same landowner but located in different districts.

Acquiring water for environmental purposes

The procurement of water for environmental purposes is becoming increasingly common. In some regions of the west, such acquisitions also represent a significant share of the local water market. In some locations, private not for profit organisations have also been active in acquiring water for environmental purposes. Some examples of water transfer include:

- **Upper Snake River Basin.** Total water storage in the upper Snake River basin is about 8.6 million acre-feet, of which 8.1 million acre-feet is stored in facilities operated by the BOR. BOR is now required to provide 427,000 acre-feet of water each year to assist in meeting the instream flow needs of anadromous salmon. One of the steps the BOR has taken to assist in meeting these requirements is to initiate a programme to acquire storage entitlement and natural flow rights.

- **Yakima Basin.** One of the primary purposes of the Yakima River Basin Water Enhancement Project is to “protect, mitigate and enhance fish and wildlife through improved water management; improved instream flows; improved water quality; protection, creation and enhancement of wetlands...” and to “encourage voluntary transactions among public and private entities which result in the implementation of water conservation measures, practices and facilities.”

- **Central Valley Project (CVP).** The Fish and Wildlife Service (FWS) and Bureau of Reclamation have been actively acquiring water for environmental purposes since the passage of the Central Valley Project Improvement Act (CVPIA) in 1992. BOR has

21 An excellent example of a private not for profit acquiring water for environmental purposes is the Oregon Water Trust (OTW). In 1996 this organisation completed 25 acquisitions for instream flow purposes in Oregon. Twenty-four of the transactions were annual leases with prices ranging from about US$10 per acre-foot to about US$500 per acre-foot (Oregon Water Trust, 1996). One transaction was a permanent acquisition of 70 acre-feet for a price of US$127 per acre-foot.
acquired significant amounts of water on a short term basis to assist the out-migration of
fall-run chinook salmon down the Merced, Stanislaus, and San Joaquin rivers.

- **Truckee-Carson.** Under the Truckee-Carson-Pyramid Lake Water Rights Settlement Act
  of 1990 Congress directed the Secretary of the Interior to acquire by purchase or other
  means, enough water to sustain 25,000 acres of primary wetland habitat in the Stillwater
  National Wildlife Refuge, Stillwater Wildlife Management Area, Carson Lake and Fallon
  Paiute-Shoshone Reservation wetlands, all within Churchill County, Nevada. In order to
  meet the objective, the FWS has determined that an annual average of 125,000 acre-feet of
  water will be needed. Of this total, FWS expects to purchase up to 75,000 acre-feet, with the
  balance provided from irrigation project drainwater, reservoir spills, and other sources (U.S.
  DOI, 1996).

  The water purchased to date by the Federal and state programmes comes from privately-
  owned agricultural water rights within the Carson District of the Newlands Irrigation Project
  (adjacent to the primary wetland areas). Results of these two water-rights acquisition
  programmes, FWS estimates that irrigated agriculture within the project will be reduced by
  35 per cent over the next twenty years. In both Federal and state acquisition programmes,
  the transfer of water from the existing place of use to the wetlands is subject to state water
  laws and the Federal Operating Criteria and Procedures developed for the Newlands
  Irrigation Project (U.S. DOI, 1996).

**Agricultural policy reforms**

Improvements in water management can also be the result of reforms in agricultural conservation policies. The recent Federal Agriculture Improvement and Reform Act (FAIRA) of 1996 significantly changes U.S. agricultural policy. The new legislation removes the link between income support payments and farm prices by providing for seven annual but declining “production flexibility contract payments” whereby farmers may receive government payments largely independent of farm prices. To receive payments and loans on programme commodities, producers enter in a production flexibility contract which requires them to comply with existing conservation plans for the farm, wetland provision, and planting flexibility provisions, as well as keep the land in agricultural uses (Agricultural Outlook, 1996).

In addition to reforming commodity policy FAIRA introduced new conservation programmes. The Environmental Conservation Acreage Reserve Program was continued to serve as an umbrella to enable USDA to operate conservation programmes in a consistent manner. The Conservation Reserve program was renewed and a new programme, the Environmental Quality Incentives Program (EQIP), was authorised. EQIP provides technical and financial assistance to farmers and ranchers for improved irrigation management well as improvements in cropping and grazing systems, wildlife habitat, sediment control, and manure, pest and nutrient management. EQIP replaces most previous USDA programmes providing financial assistance for irrigation water management, including Agricultural Conservation Program, the Water Quality Incentives Program, the Colorado River Basin Salinity Control Program and the Great Plains Conservation Program. Under EQIP, cost-share and incentive payments are available for a range of eligible structural and management practices. Payments are based on a competitive application process, subject to payment limitations by individual and practice.
**Devolution**

There is a continued emphasis in the U.S. in directly involving multiple stakeholders in water use decisions. The model of a centralised Federal government controlling decision making has been evolving (over two decades) into a more decentralised model that moves decision making down to the level of those most affected by changes in policies or programmes. While national environmental laws and national leadership are still important, States are increasingly more involved in implementing programmes and policies that promote conservation and protect the environment. Some State efforts are independent of the Federal government, but other State-led actions are the direct result of Federal policy designed to include non-Federal partners. For example, the 1986 Water Resources Development Act represented a major departure from previous water resources legislation by requiring equal financial contributions by non-Federal sponsors for civil works projects, cost-shared planning, and an increased non-Federal share cost share for project construction (Rogers, 1993). States themselves have argued that water management should be the primary responsibility of the States and interstate agencies (Rogers, 1993).

Major joint State/Federal efforts are now underway in California, Oregon, Washington, and Idaho to restore the salmon and steelhead fishery in the Pacific Northwest. The fishery has been decimated by a combination for human activities, including farming and ranching, and natural events such as drought. With cost-share assistance from several State and Federal agencies, ranchers have installed sediment-retention structures, improving stream quality and salmon habitat. Other joint programmes emphasise job training to ease the transition of displaced fishermen. Locally led conservation is the hallmark of the approach used by USDA’s Natural Resource Conservation Service to achieve conservation goals. Locally led conservation “brings people together to assess their home place, to set goals, and to identify programmes and other resources that can be used to create a home place they want” (USDA, NRCS 1997).

**Privatisation**

Another alternative reform that would potentially increase the efficiency of use of water resources on BOR projects would be to remove them from Federal control by selling them to private parties or to other non-Federal entities. This proposal is not inconsistent with the existing BOR policy of transferring the responsibility for of projects once projects are complete. However, transferring responsibility for operation and maintenance is not the same as transferring title to actual facilities.

Existing law holds that the title to BOR facilities remains with the U.S. even after water users complete their capital repayment obligations, thus most transfers will require new legislation. However, if non-Federal entities perceive that ownership would provide them with a greater degree of operational flexibility they may be interested in obtaining title to project facilities. Proposals to transfer ownership have arisen in the past (Wahl and Simon, 1988). For example, in 1992 the state of California proposed to take control of the Federally constructed Central Valley Project. A number of meetings were held between state and Federal officials. One of the main issues surrounding the transfer were the present and future financial obligations associated with the project and the extent to which these responsibilities would be Federal or state responsibilities.

The most likely potential purchasers would be the water districts that currently receive project water. However, if the group of purchasers was not limited to the current recipients of project water, competitive bidding could lead to greater sale revenues to the U.S.
In 1995 the BOR undertook an initiative to transfer title to certain of its facilities to non-Federal entities. The criteria that must be met before any project is transferred include:

1. The Federal treasury and the taxpayer’s financial interest must be protected;
2. Compliance with all applicable state and Federal laws;
3. Interstate compacts and agreements must be protected;
4. the Secretary of the Interior’s Native American Trust responsibilities must be met;
5. treaty obligations and international agreements must be fulfilled; and
6. the public aspects of the project must be protected.

Several projects have been transferred to non-Federal entities since the Reclamation’s policy was established (U.S. BOR, 1995).

4. Conclusions

Federal water development of the west has resulted in administrative allocation of water from individual projects to various end-uses, such as irrigation, municipal and industrial use, and hydropower production. Federal development supplemented the efforts of non-Federal entities including individuals, irrigation districts, public utilities and state departments of water resources. These institutional arrangements served the purpose of developing the western U.S., but increasingly have been seen to not be responsive to current concerns about environmental quality, economic efficiency, and distributional issues.

More recently, there has been a clear change in the prevailing view about how best to allocate water. This has included a shift from relying on centralised Federal planning and administrative allocation to greater reliance on market or market-like mechanisms to facilitate economic efficiency gains associated with reallocating water from existing projects to alternative uses. This change is evidenced through the evolution of some state water codes to facilitate transfers, increasing numbers of voluntary transactions, and by the willingness of Federal water managers to facilitate voluntary transfers of Federally supplied water and to purchase water for environmental uses.

However, this process of evolution is not complete. For example, major transfers of water from agricultural to municipal and industrial uses have yet to occur in the Federally constructed Central Valley Project in California even though legislation authorising such transfers was enacted in 1992. In virtually all situations water is still allocated and priced administratively. This shows little sign of changing in the short run.

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COMMISSION OF THE EUROPEAN COMMUNITIES: THE EUROPEAN COMMISSION
PROPOSAL FOR AN EU-WATER FRAMEWORK DIRECTIVE

by The European Commission, DGXI (Environment), Brussels, Belgium

Summary

A proposal for a Water Framework Directive was put forward by the European Commission in February 1997 and is currently being considered by the European Council and the European Parliament. The proposal aims at providing a context in which existing Community requirements on water pollution and water quantity can be integrated with each other and with local policy objectives in an overall water management system. Existing legislation tackles isolated problems: a global quality goal is needed to which all these measures contribute, and against which their effectiveness can be judged.

European Union Member States are required to identify river basins, the geographic unit on which to manage their waters, because by managing the river system as a whole actions can be taken at the most appropriate point in the system. EU Member States must designate authorities responsible for implementing all the requirements of the Directive. The objective of good ecological status must be achieved for all waters by 2010. Derogation from this objective is allowed only in few cases, under certain circumstances. EU Member States must design a programme of measures for each River Basin to achieve this objective.


The Directive sets out a combined approach, which consists of controlling emissions to water through Best Available Techniques (BAT) as a first step, followed by any additional measures needed to achieve the quality objective. For large installations BAT controls are provided by Directive 96/61 on Integrated Pollution Prevention and Control. For small installations such controls are not in place. Therefore the Commission proposed a revision of the Water Framework Directive to integrate the required controls. The revision comprises: selection of priority substances for Community action on the basis of risk; uniform BAT based production and process controls (emission limit values or their equivalent) set at European level; complementary measures on products. The revision was adopted by the European Commission on 26 November 1997.

The need to conserve adequate supplies of a resource for which demand is continuously increasing is also one of the driving forces behind what is one of the proposed Framework Directive most important
innovations — the introduction of “full cost recovery” pricing. By 2010 Member States will be required to ensure that the price charged to households, farmers and industry for water services — such as the abstraction and distribution of fresh water and the collection and treatment of waste water — reflects the true costs. The full cost will also have to include (on the basis of a Commission proposal that will come later) the costs of water use in terms of the damage to the environment it can cause and the depletion of water resources for future generations.

The proposal further requires that cross-subsidisation between the household, industrial and agricultural sectors does not take place. Governments would, however, be able to make an exception to ensure that households are charged at affordable prices for a basic level of water use. But for agriculture in many countries it would mean a considerable change.

1. Existing Community water legislation

Introduction

A wide range of legislation relevant to water was introduced at Community level over the period 1975 to 1996, in response to perceived needs and priorities. Some of this legislation was based on the principle of setting limit values for pollution, controlled at source, while other legislation focused more on the requirement to achieve specific environmental quality standards. It is on the legal basis of Article 130S of the Treaty that the second “name” of water legislation has been adopted like the Nitrates and Urban Waste Water Directives of 1991. In addition, Article 130R §2 of the Treaty provides that the environmental requirements shall be integrated in the definition and the implementation of the other policies of the Community, like the CAP for instance. A brief account of each main piece of this legislation follows, with longer descriptions of those Directives which are to continue to play an independent role once the new Water Framework Proposal comes into effect (see Section 2).

Surface Water for Drinking Water Extraction Directive, 1975

The Directive concerning the quality required of surface water intended for the abstraction of drinking water in the Member States was introduced in 1975 (75/440/EEC). It is designed to protect public health and to protect water against pollution and further deterioration. It applies to rivers, lakes, and storage basins used by the Member States as points of abstraction. Minimum quality requirements of water are fixed in the Directive with a set of guiding or imperative parameters. Among these, nitrates and pesticides have mandatory values which must be respected. If not, the abstraction of water for human consumption is forbidden unless the Member States can treat it correctly (according to Directive 80/778/EEC on drinking water) and provide the Commission with a management plan of the area in order to remedy the problem at source. The limit value of 50 mg/l for nitrates finds it origin in this Directive. Member States also have the obligation to draw up a systematic plan of action for the continuing improvement of surface water. There are two related Directives on measurement methods, sampling frequencies, and exchanges of information on fresh water quality.
The Bathing Water Directive (76/160/EEC)

It aims to protect the environment and human health. It covers more than 18 000 bathing areas throughout the European Union. It requires fortnightly sampling throughout the bathing season and an annual report from Member States. A revision is currently under negotiation in the Council and Parliament. It aims to update the parameters in the 1976 Directive to take account of scientific and technical progress, and to simplify the existing Directive. So far, negotiations have suggested amendments such as tightening the standard for faecal streptococci.

Directive on Discharges of Dangerous Substances to Water (76/464/EEC)

Adopted in 1976, this is a “Framework” Directive which provides for the elimination or reduction of the pollution of inland, coastal and territorial waters by particularly dangerous substances by means of separate “daughter Directives” setting emission limit values for particular substances.

The Member States must take steps to eliminate pollution by substances on List I in the Annex to the Directive, and to reduce pollution by substances on List II in the Annex. List I contains substances selected on the basis of their toxicity, persistence and bioaccumulation, e.g. organohalogen, organophosphorus and organotin compounds; carcinogenic substances; mercury and cadmium compounds; persistent mineral oils and hydrocarbons; and persistent synthetic substances. List II contains substances which have a deleterious effect on the aquatic environment, which can be confined to a given area and whose effects depends on the characteristics and location of the water into which they are discharged. It includes 20 groups of metallic compounds biocides and their derivatives not appearing on List I; toxic or persistent organic compounds of silicon; and substances which have a deleterious effect on the taste or smell of marine products for human consumption.

The Member States must establish a system of prior authorisation for the discharge of List I substances to inland surface waters, territorial waters, internal coastal waters and groundwater, and where necessary into sewers. The authorisation must contain emission limit values restricting the maximum concentration and quantity of the substances allowed to be discharged.

For List II substances, the Member States must establish pollution reduction programmes with deadlines for implementation, and including prior authorisation and compliance with emission standards for all discharges.

Seven “daughter Directives” have been adopted which establish emission limit values and water quality objectives for List I substances, mercury, cadmium, hexachlorcyclohexane and various organohalogenic substances, eighteen substances altogether.


Directive 78/659/EEC on fish water quality seeks to protect those fresh water bodies identified by Member States as fish waters. For those it sets water quality standards for salmonid waters and cyprinid waters. Where the water quality in such designated waters is not in compliance with the standards,

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22. OJ No L 031 05.02.76, p.1.
23. OJ No L 129 18.05.76, p.23.
programmes to reduce pollution have to be set up. Requirements on sampling and monitoring are laid down.

Directive 79/923/EEC on shellfish water quality seeks to protect those coastal and brackish water bodies identified by Member States as shellfish waters. For those it sets water quality standards. Where the water quality in such designated waters is not in compliance with the standards; programmes to reduce pollution have to be set up. Requirements on sampling and monitoring are laid down.

**Groundwater Directive (80/68/EEC)**

This Directive on the protection of groundwater pollution caused by certain dangerous substances seeks to control the direct and indirect discharge of certain substances into the groundwater. This is to be achieved primarily by an authorisation system for discharges as well as disposal or tipping. For certain substances and groups of substances any discharge to groundwater is prohibited (“List I substances”), whilst others (“List II substances”) must be subject to an elaborate authorisation procedure. Member States are to monitor compliance with the authorisation and the effects of discharges.

**Drinking Water Directive (80/778/EEC)**

This Directive relating to the quality of water for human consumption is designed to safeguard human health by establishing strict standards for the quality of drinking water. Member States have to monitor drinking water quality and take the necessary steps to ensure compliance with the mandatory standards. In its annexes, the Directive provides the parameters and parametric values, patterns and frequencies of analyses, and reference methods of analysis.

A revision of the Directive proposed by the Commission is presently being negotiated in Council and the European Parliament. The objective of the revision is to bring legislation up to the state of science and experience, to review the parametric values and to improve the management structure under the Directive.

The 1980 Directive sets limit values for 66 substances (including pesticides and nitrate) which may not be exceeded in water used for drinking. An update of this Directive is currently under negotiation in the Council and Parliament. This reduces the number of substances covered (from 66 to 48) so as to reorient it towards essential quality and health parameters, leaving Member States free to add additional parameters if they see fit. It also updates, simplifies and consolidates the 1980 Directive (which was based on proposals made in 1975); and it brings the Directive into line with the principles of subsidiarity and precaution. It imposes an obligation to report annually to the Commission, and to inform consumers about the quality of drinking water.

**The Urban Waste Water Treatment Directive (91/271/EEC)**

This is emission-orientated legislation, designed to control emissions from sewerage and waste water from agglomerations of more than 2000 people, and from industrial discharges, including those from the agro-food industry (e.g. milk processing, fruit and vegetable products, potato processing meat industry, animal feed from plant products, etc). It also aims to produce sustainable disposal of sewage sludge. Generally it requires biological treatment of waste water, but with additional nitrogen and phosphorus

24. OJ No L 020 26.01.80, p.43.
removal in sensitive areas (i.e. water bodies at risk of becoming eutrophic). The deadlines for reaching the objectives depend on the size of the agglomeration and the character of the receiving water — from 1998 to 2005.

**The Nitrates Directive**

This Directive, which concerns the protection of waters against pollution caused by nitrates from agricultural sources\(^{25}\), was adopted in 1991 (91/676/EEC). It aims to reduce pollution of waters by nitrates from agricultural sources and to prevent further such pollution.

This Directive requires Member States to identify, on the basis of monitoring, waters affected by nitrate pollution from agriculture. These waters can be either groundwaters, or surface waters (including coastal and marine waters). Member States may choose to designate their whole territory as ‘Vulnerable Zone’. In these Zones Member States must implement Action Programmes which ensure that their farmers practice agriculture in conformity with certain mandatory requirements. The most important of these are the need to maintain a balance between applications of all types of fertilisers to land and the ability of plants to take it up; and a limitation on the maximum amount of animal manure that can be applied each year. Member States may choose to apply the Action Programmes throughout their territory. In territory that is not designated as a Vulnerable Zone there is an obligation to promote a Code of Good Agricultural Practice the measures in which are voluntary for farmers.

The Directive adheres to the Polluter Pays Principle in that it ensures that those farmers causing pollution have to bear the cost of changing their agricultural practices to comply with the Directive. It also conforms to the prevention at source and precautionary principles.

The implementation of the Directive is currently behind schedule in most of the Member States and as a result the Commission is currently conducting many infringement proceedings.

It is too early to judge the effectiveness of the measures in the Directive as some of the measures in the Action Programmes will not take force until the end of next year and in addition the nature of nitrate pollution is such that there is likely to be a significant time lag before the effects on water quality are noticeable.

**Pesticides Directives (79/117/EEC\(^{26}\) and 91/414/EEC\(^{27}\))**

Plant protection products are used in conventional modern agriculture principally to control the various pests, diseases and weeds that affect crop production and preservation. These products may present important risks for man and the environment when they are not used properly.

Given the possible risks, the Union has developed an extensive legislation covering in particular the placing on the market and use of these products, as well as their residues in treated agricultural products and the environment. In the framework of the CAP related measures, the following basic Council Directives should be mentioned in particular:

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26. OJ No L 033 08.02.79, p.36.
27. OJ No L 230 19.08.91, p.1.
a) Council Directive 79/117/EEC, prohibiting the placing on the market of plant protection products containing certain active substances, lists the active substances which all the Member States have to prohibit for marketing and use on their territories. These substances have been judged unacceptable because of their effects on human health and/or the environment. Currently 18 active substances have been listed, in particular all mercuric compounds and a large number of persistent organochloric compounds (DDT, aldrin, dieldrin, etc.).

b) Council Directive 91/414/EEC concerning the placing of plant protection products on the market, provides that plant protection products may only be placed on the market and used, when they have been authorised after an examination has been made showing that the product, when properly used, does not have harmful effects to human health or unacceptable effects to the environment. This Directive has laid down detailed rules on procedures, data requirements, evaluation and decision-making requirement both for pesticide active substances and plant protection products containing those substances. It provides for a gradual revaluation of all active substances on the market before the implementation date of the Directive as well an immediate evaluation of the active substances not yet on the market on that date. It provides further some general rules concerning the safe use of plant protection products as well as concerning control on placing on the market and use of such products.


The goal of the Directive is to achieve integrated prevention and control of pollution arising from a wide range of activities by means of measures to prevent or, where that is not practicable, to reduce emissions from industrial facilities to air, water and land, including measures concerning waste, in order to achieve a high level of protection of the environment as a whole.

All activities covered by the Directive require a permit. Among these activities are listed intensive rearing of poultry or pigs, treatment and processing of animal and vegetable raw materials, slaughterhouses, etc. Member States may issue a single permit for release to air, water and waste from an industrial facility, or issue multiple permits which are integrated through a co-operation procedure involving several permitting authorities. As well as imposing emission limits in environmental permits, Member States must ensure that the permits contain measures designed to ensure that following basic requirements are met:

- all appropriate preventive measures are taken against pollution, in particular through the application of Best Available Techniques (BAT);
- no significant pollution is caused;
- waste production is avoided; where waste is produced it should be recovered or, where that is technically and economically impossible, disposed of while avoiding or reducing any impact on the environment;
- energy is used efficiently;
- the necessary measures are taken to prevent accidents and limit their consequences;

– the necessary measures are taken upon definite cessation of activities to avoid any pollution risk and return the site of operation to a satisfactory state.

Permits must in particular include emission limit values based on BAT, taking into consideration the potential for transfer of pollution from one medium to another. Other requirements to protect soil and groundwater and concerning waste management must be laid down if necessary. In addition, permits must contain the supplementary requirements necessary to prevent breaches of any environmental quality standard.

The requirements apply to new installations from October 1999 and to existing installations from October 2007.


This Directive on the assessment of the effect of certain public and private projects on the environment has recently been amended by Directive 97/11/EEC whose provisions must be transposed and put into force by 14 March 1999. The changes are less an amendment and more a transformation which aim to overcome the weaknesses of the original, especially concerning the types of project to be assessed and the information to be included in the assessments. The Directive embodies the preventive approach to environmental protection by requiring that before consent is given by a governmental body, development projects likely to have significant effects on the environment, are subjected to an assessment of possible environmental impacts.

Some categories of projects listed in Annex I to the Directive are always subject to the environmental impact assessment requirement. Others, listed in Annex II, which may have significant effects on the environment are subject to assessment when certain criteria determined by the Member State are met.

The promoter must supply the competent authority with detailed relevant information about the project in the impact statement. Environmental authorities must be given an opportunity to comment before a decision on the project is taken. The public must be informed of the request for development and the impact statement and allowed to express its opinion. Decisions by the competent authority have to take the assessment results into account.

Information must be provided to other Member States likely to be affected by a project, and these may participate in the assessment procedure. This follows the main provisions of the United Nations Economic Commission for Europe Convention on the assessment of projects with transboundary impacts (Espoo Convention).

2. Restructuring European Water Policy

Introduction

A proposal for a Water Framework Directive was put forward by the Commission in February 1997, and is currently being considered by the Council and European Parliament. This is a major new departure, designed both to develop and rationalise existing water legislation described in Section 1 above. Its main features are set out below.

29. OJ No L 175 05.07.85, p.40.
Both surface water and groundwater covered

Unlike previous water legislation, the Framework Directive will cover both surface water and groundwater, as well as estuaries and coastal waters, in recognition of the natural interaction between surface waters and groundwaters in terms of quality as well as of quantity.

Objectives of the Framework Directive

Its objectives are threefold:

i) to prevent further deterioration in and to protect and enhance the status of aquatic ecosystems;

ii) to promote sustainable water consumption based on the long-term protection of available water resources;

iii) to contribute to the provision of a supply of water in the qualities and quantities needed for its sustainable use.

How the Framework Directive will achieve its objectives

The Framework Directive will achieve its objectives in four main ways:

1. By creating an overall framework within which Community, national and regional authorities can develop integrated and coherent water policies. An important element is that it is flexible enough to accommodate wider regional differences in water situations;

2. By providing a “safety net” for identifying water issues that are not adequately addressed at present, requiring remedial action to be taken at the appropriate level;

3. By establishing a sound basis for collecting and analysing a large amount of information on the state of the aquatic environment and the pressures upon it. This will provide the essential information base upon which competent authorities in the Member States can develop sensible and sustainable policies; and

4. By requiring transparency through the publication and dissemination of information and through public consultation. It will also establish a network for the exchange of information and experience between water professionals throughout the Community.

“Good” water status required by 2010

The Directive’s overriding requirement is that Member States ensure that “good” status is achieved in all waters by the end of 2010. For groundwater, good status is measured in terms of both quantity and chemical purity; for surface waters ecological quality is an additional criterion. “Good status” has not yet been fully defined in terms of technical scientific details. There is little doubt, though, that in many cases the Directive will require Member States to improve on the situation today. Member States will need to establish programmes for systematically monitoring the quality and quantity of their groundwaters and surface waters. The detailed technical specifications for monitoring have yet to be drawn up, however.
River basin management

One of the Framework Directive’s innovations is that rivers and lakes will need to be managed by river basin — the natural geographical and hydrological unit — instead of according to administrative or political boundaries. Several Member States already take a river basin approach but this is at present not the case everywhere. For each river basin district — some of which will transcend national frontiers — a “river basin management plan” will need to be established and updated every six years. This plan will have to include an analysis of the river basin’s characteristics, a review of the impact of human activity on the status of waters in the basin, and an economic analysis of water use in the district. Groundwater and coastal waters would be assigned to the nearest or most appropriate river basin district. The Directive will help the Community to implement the United Nations Economic Commission for Europe’s Convention on the Protection and Use of Transboundary Water Courses and International Lakes.

Programme of measures

Central to each river basin management plan will be the requirement for each Member States to establish a programme of measures addressing all the measures which need to be taken within its territory to ensure that all waters in the river basin achieve good water status by 2010. The starting point for this programme is the full implementation of any relevant national or local legislation as well as of 11 items of Community legislation on water and related issues, including horizontal measures such as the Directive on Environmental Impact Assessment and the Directive on Integrated Pollution Prevention and Control (IPPC). Amongst these 11 Directives, the Nitrates Directive, the Pesticides Directive and the IPPC addressing discharges are of greatest relevance. Further, the Birds and the Habitat Directive also rank amongst important Directives in so far as these cover habitats and species associated or dependant on water, both in terms of designation of protected areas and general land planning and in terms of potential restrictions on emissions to these areas. The full implementation of these pieces of existing Community legislation will form an obligatory part of the basic measures in any programme of measures for a river basin district. If this basic set of measures is not enough to ensure that the goal of good water status is reached, the programme must be supplemented with whatever further measures are necessary. These might include stricter controls on polluting emissions from industry or agriculture as well as from urban waste water sources, voluntary agreements, codes of good practice, various economic instruments etc. Supplementary measures as a part of a programme of measures in this way leaves the necessary flexibility to allow for the taking into account of regional and local circumstances. Integration into one programme of measures should ensure a better co-ordination of the individual measures required by the existing legislation as well as of any supplementary measure required.

Combined approach

The Directive takes a “combined approach” to pollution control, requiring Member States to lay down in their programmes of measures both limit values to control emissions from individual point sources or other appropriate control of emissions at the source, and environmental quality standards to limit the cumulative impact of such emissions as well as of diffuse sources of pollution. The emission limit values will be set in line, inter alia, with the IPC Directive and the Urban Waste Water Treatment Directive for installations and discharges covered by these Directives. Where environmental quality objectives have been set for particular dangerous substances under the five daughter Directives of the 1976 Directive on Discharges of Dangerous Substances to Water, these will be incorporated into the Framework Directive. Member States will be required to set environmental quality standards for each significant body of water that is used for the abstraction of drinking water or that may be in future. The quality standards must be
designed to ensure that, under the expected water treatment regime, the abstracted water will meet the requirements of the Drinking Water Directive. Where Community standards have been established such as the limit values for pesticides, biocides and nitrate, those quality standards have to be complied with.

**Water quantity addressed**

The Framework Directive is the first piece of Community water legislation to address the issue of water quantity. It stipulates that the programme of measures established for each river basin district must aim to ensure a balance between the abstraction and recharge of groundwater. Moreover, all abstraction of surface water or groundwater will require prior authorisation except in areas where it can be demonstrated that this will have no significant impact on the status of the water. Periodical or long-term shortage of water is occurring across the Community and measures to curb consumption encourage saving of water etc. will have to be taken. The Water Framework Directive encourages this and will provide a general framework for a sustainable management of water. As part of the supplementary measures required if good water status cannot be achieve through implementation of existing legislation alone ranks demand management measures, *inter alia* promotion of adapted agricultural production such as low water requiring crops in areas affected by drought and efficiency and re-use measures, *inter alia* promotion of water efficient technologies and water saving irrigation techniques.

**Full cost recovery pricing**

The need to conserve adequate supplies of a resource for which demand is continuously increasing is also one of the drivers behind what is arguably one of the Directive’s most important innovations — the introduction of “full cost recovery” pricing. By 2010 Member States will be required to ensure that the price charged to households, farmers and industry for water services — such as the abstraction and distribution of fresh water and the collection and treatment of waste water — reflects the true costs. In a number of Member States this is currently not the case. Moreover, where methodologies have been established (on the basis of a Commission proposal that will come later), the full cost will also have to include the costs of water use in terms of the damage to the environment it can cause and the depletion of water resources for future generations.

The Directive further requires that cross-subsidisation between the household, industrial and agricultural sector does not take place. Governments would, however, be able to make an exception to ensure that households are charged at affordable prices for a basic level of water use. But for agriculture in many countries it would mean a considerable change.

**Rationalising Community Water Policy**

Six old Directives of the “first wave” will be incorporated into the Framework Directive rationalising Community water legislation: the Directive on surface water intended for drinking water production and its two related Directives on measurement methods and sampling frequencies and exchanges of information on fresh water quality; the Fish Water and Shellfish Water Directives, and the Groundwater Directive. The operative provisions of these directives will be taken over in the Framework Directive, allowing them to be repealed once the measures of the Framework Directive will be fully implemented, approximately around 2010.
**Complementing newer legislation**

The Framework Directive will complement and complete other key pieces of water-related legislation: in particular, the 1991 Directives on urban waste water treatment and nitrates pollution, the body of rules governing the authorisation and use of pesticides, and the 1996 Directive on integrated pollution prevention and control (IPPC). For their part, the Drinking Water Directive, whose revision is under active consideration by the Council of Ministers and the European Parliament, and the Bathing Water Directive will be little affected and will continue to exist in their own right.

**Protection of groundwater**

The Commission in February 1996 presented a proposal for an action programme for integrated groundwater protection and management to be adopted by the European Parliament and the Council. The Groundwater Action Programme looks at the whole range of problems associated with groundwater and sets out actions required at local, national and Community level. With this proposal the Commission committed itself to ensure a further integration of sustainable water protection and management and agricultural policy, including projects and actions affecting fresh water resources when initiated and/or funded by the Community. The Groundwater Action Programme recognises the particular importance of protection of groundwaters in the countryside where the largest quantities of high quality groundwater are found and formed, constituting the greatest challenge for Community water policy. It also recognises that one of the greatest threats to this groundwater comes from diffuse sources and in particular from nitrates and pesticides from agricultural sources. While the GWAP encapsulates the general policy and strategy lines, the Framework Directive introduces some of the most important instruments to meet this challenge, including the obligation to ensure control of abstraction of fresh water and the designation of particular areas holding present and future drinking water resources along side the above mentioned co-ordination of controls at the source or development of practices to prevent diffuse sources of pollution from agricultural origin. Apart from being an instrument to prevent over-exploitation of water resources, such abstraction controls should prove a forceful instrument to prevent or reduce potential conflicts between different users in situations of water shortage, not least in the future with increasing scarcity of and increasing demand for water.

Since the presentation of the Groundwater Action Programme it has become clear that long-term challenges facing groundwater are increasingly related to diffuse pollution and not least to unsustainable levels of water abstraction, neither of which is adequately covered by the existing Groundwater Directive. It became clear that the present Groundwater Directive needed a complete revision and it was decided to do this by letting the proposed Water Framework Directive take over the essential requirements and repeal the original Groundwater Directive. In addition to the provisions aimed at the protection of groundwater quality, the Water Framework Directive introduces provisions on protection of groundwater quantity through controls on abstraction, in order to ensure a greater integration of groundwater and surface water protection. Direct discharges of dangerous substances into groundwater will be prohibited and more specific monitoring requirements will be introduced for groundwater through this integration.

**Diffuse sources of agricultural origin.**

Nitrates and pesticides and their derivatives are the major pollutants from diffuse sources of agricultural origin in the countryside. In recognition of this, Directives have been adopted setting controls on the use of nitrates and pesticides — the Nitrates Directive and the Pesticides Directive respectively. The measures of these Directives aim at ensuring compliance with the limit values laid down for groundwater
for nitrates of maximum 50 mg/litre and the limit value for pesticides and residues of maximum 0.1µg/litre. As mentioned above, these Directives will be complemented and completed by the Water Framework Directive.

3. Conclusions

After 25 years of water legislation, the current restructuring of European Water Policy constitutes one of the great challenges for the European Union, as it approaches the new millennium. Through a number of proposals addressing agricultural sources of pollution and water use along side other sources, and in particular through the proposed Water Framework Directive the Commission has taken up this challenge to provide a set of instruments within the field of environment legislation to ensure a better integration of measures to protect and manage surface water and groundwater resources in a sustainable way. The Commission is committed to a further development of Community Agriculture Policy which is based on a sustainable use of water resources.
by Rainer E. Enderlein, Secretariat of the United Nations Economic Commission for Europe, Geneva, Switzerland

Summary

The activities of the UN/ECE aimed at the harmonisation and convergence of policies and strategies to prevent, control and reduce the pollution of inland waters, including transboundary watercourses, lakes and groundwaters in Europe. Intensive negotiations and co-operative actions have led to reach agreements on a number of non-binding and binding instruments, including the ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (also referred to as the Water Convention). These instruments also relate to the prevention and control of water pollution from agriculture.

1. Introduction

Much progress has been made in Europe to prevent, control and reduce water pollution from industrial, agricultural and municipal sources. However, the consequences of past and present economic development are still felt. Insufficiently treated waste water, inappropriate agricultural practices, seepage from landfills, leaching of hazardous substances from decommissioned industrial sites and former military areas do not only threaten the quality of waters and related aquatic ecosystem, but also have an adverse impact on human health, to such dimensions that only concerted action by all European Governments can help to overcome these problems.

Much has been said about the adverse impact of improper agriculture on groundwater. Only recently, the direct and indirect impact of agricultural activities on human health and safety have become much better known, due to the lifting of the ban on environmental data, for example, in the former USSR. 120 million Europeans (or one person out of seven) do not have access to safe drinking water; nitrate and pesticide pollution in drinking water sources, are among the reasons.

Effective solutions will require significant changes in production and consumption patterns to optimise the use of water resources, minimise waste-water production, and prevent, control and reduce water pollution from agriculture.

Water pollution problems cannot be resolved at the local, provincial or national levels only. Measures taken unilaterally may in some cases distort competition and trade patterns. Region-wide co-operation
can ensure that the national water policies in the various catchment areas are effectively co-ordinated. Consequently, there is also a need for international co-operation, co-ordination and the convergence of environmental and agricultural policies among countries.

2. **ECE activities linking agriculture and environment**

To promote policies for the prevention, control and reduction of adverse impacts of agricultural activities on water resources, the Economic Commission for Europe has organised jointly with other international organisations a number of seminars, symposia and other meetings. These activities were at the root of policy recommendations to ECE governments, such as the 1989 Charter on Groundwater Management, the 1995 Guidelines on the prevention and control of water pollution from fertilisers and pesticides in agriculture, and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

**Convention on the protection and use of transboundary watercourses and international lakes**

The prevention, control and reduction of the transboundary impact of water pollution from agricultural sources is one objective of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, which was adopted in Helsinki on 17 March 1992. The Convention is intended to strengthen national and international measures aimed at the protection and ecologically sound management of transboundary waters; both surface water and groundwater. In order to achieve these goals, the Parties to this Convention will be obliged, *inter alia*, to undertake comprehensive measures for the prevention, control and reduction of the pollution of water, particularly by hazardous substances, from point and diffuse sources.

The precautionary principle and the polluter-pays principle have been recognised as guiding principles in the implementation of such measures, together with the requirement that water management should meet the needs of the present generation without compromising the ability of future generations to meet their own needs. This will prevent adverse effects on human health and safety. It will protect and conserve not only water resources but also soil, flora, fauna, air, climate, landscape and cultural heritage. The Water Convention also addresses such issues as monitoring, research and development, consultations, warning and alarm systems, mutual assistance, institutional arrangements, exchange and protection of information as well as its provision to the public.

As concerns non-point sources of water pollution, the Parties shall ensure that appropriate legal, administrative, economic and financial measures are taken and best environmental practices are developed and implemented to reduce inputs of nutrients and hazardous substances from agriculture. Furthermore, the Water Convention provides for the total or partial prohibition of the production or use of hazardous substances. It also obliges the Parties bordering on the same transboundary waters to develop concerted action programmes for the reduction of pollution loads from diffuse sources.

To implement the Water Convention, both the Parties and non-Parties agreed to examine measures to prevent and control water pollution from fertilisers and pesticides, to draw up guidelines on the prevention and control of water pollution from fertilisers and pesticides in agriculture, and to examine at regular intervals how these guidelines are being implemented in the region. The joint ECE/FAO workshop on water pollution and protection in agricultural practice held in Zagreb in 1996 was one of the steps taken. Other activities relate to the monitoring and assessment of transboundary waters which include agriculture as a specific problem area, licensing waste-water discharges which covers relevant agricultural entities
and sustainable water management. The latter activity also covers the interrelationship between agriculture and water.

**ECE Convention on Environmental Impact Assessment in a transboundary context (EIA Convention)**

The 1991 EIA Convention specifies the procedural rights and duties of Parties with regard to the transboundary impact of proposed activities, including agricultural activities. It provides procedures, in a transboundary context, for the consideration of environmental impact in decision-making procedures.

The application of the provisions and procedures of the EIA Convention may be useful when carrying out an environmental impact assessment of agricultural projects, plans and programmes as recommended by the ECE Guidelines on the prevention and control of water pollution from fertilisers and pesticides in agriculture. It is interesting to note that some studies were made under the EIA Convention related to environmental impact assessment for agricultural and forestry projects which also provided information on the environmental impacts of activities that significantly alter the landscape. Moreover, recent publications refer to the need to carefully study the linkage between environmental protection and agriculture in the planning, decision-making and implementation process of projects. Criteria are being specified for determining the environmental significance of projects.

**ECE Guidelines on the prevention and control of water pollution from fertilisers and pesticides in agriculture**

The long history of policy guidance to ECE Governments developed under the auspices of the Economic Commission for Europe culminated in 1995 in the adoption of the Guidelines on the prevention and control of water pollution from fertilisers and pesticides in agriculture. These guidelines are intended to assist regional governments in developing and implementing plans, practices and other measures to prevent, control and reduce water pollution from fertilisers and pesticides in agriculture. They aim to promote sustainable agriculture based on integrated farming. They are primarily addressed to relevant public authorities in ECE countries responsible for water management and agriculture, rather than to farmers. Therefore, they take up those aspects that have a high priority in the region as a whole, and also offer a choice between different options.

**Policy integration**

The most important recommendations refer to policy integration. The guidelines advise, for example, that a new policy in agriculture should be strongly promoted to combine the application of strict legal and regulatory measures and appropriate economic instruments for the protection of water resources against pollution by fertilisers and pesticides with voluntary actions to pursue good agricultural practice. It should encourage farmers to apply less intensive agricultural methods, and cut the use of fertilisers and pesticides.

This requires a better co-ordination and ultimate integration of agricultural policy with environmental policy, land-use planning, and economic policy. It also requires competent administrative authorities and associations to co-operate closely to promote the development and use of sustainable farming practices and technologies, which do not adversely affect waters and the environment in general, and to promote extension services. Such co-operation should also aim for responsibility sharing among policy makers, planners, managers as well as farmers and other users of water.
Ecosystem approach and environmental impact assessment

The guidelines also take up and further develop measures related to the ecosystem approach in water management. River-basin management, for example, which guides all forms of land use within a catchment area, and environmental impact assessment of agricultural projects, plans and programmes should be promoted to prevent or minimise adverse effects on water resources and the environment in general. Set-aside and extensification policies should not give rise to the intensification of agricultural production elsewhere.

The guidelines also require that the impact on the environment of proposed agrarian development strategies, policies in plant and livestock production, as well as relevant plans, programmes and regulatory proposals in the agricultural sector should be assessed. The scope and effects of such proposals on water, soil, air and the living environment should be examined in an integrated manner, rather than separately. As discussed above, procedures laid down in the EIA Convention may be of help when examining possible environmental impacts of these policy instruments.

Precautionary principle

The precautionary principle, which is one of the basic principles of the Water Convention has led to some specific recommendations in the guidelines. Most of them refer to the use of pesticides. They call, for example, for the establishment of a set of clearly defined environmentally-based criteria, which pesticides, or their main degradation products, should meet before being authorised for use. These criteria should be established according to the precautionary principle, to account for uncertainties, long-term effects, combined toxicity of a number of pesticides and its ecological effects, rather than exclusively on the basis of the acute toxicity of pesticides. These sets of criteria should be harmonised at the regional level, i.e. within the ECE region.

Moreover, the guidelines underline the need for taking specific precautions to use the correct pesticide and the correct application rate. The aim should be to use only pesticides which do not degrade into harmful metabolites and are not persistent. Anyone wishing to work with pesticides should provide proof of his relevant skills and knowledge before receiving authorisation. Preventive pesticide applications should be the exception, rather than the rule.

Legislation should provide either for the approval of pesticides for a limited period of time only, or for a regular review of the approval. The authorisation of a new pesticide and the renewal or the review of older products should be based, inter alia, on the assessment of the risk that a pesticide causes to groundwater, surface water, biota and related ecosystems as well as to human health and safety. Those pesticides with a proven adverse effect on water should be phased out.

Economic instruments

Recommendations on economic instruments to prevent, control and reduce adverse impacts from agricultural activities on water resources have a central place in the guidelines. Most important is the recommendation that the polluter-pays principle should be effectively applied in combination with other measures to control pollution from point and diffuse sources in agriculture.

This has however led to some specifications in the guidelines: While the polluter-pays principle should play a central role in environmental and agricultural policies, there are cases in which payments to farmers
for environmentally friendly behaviour are justified, or even necessary. This may be the case where environmental regulations affect clearly defined property rights related to land use, and where incentives prove to be more acceptable and thus more effective than measures which shift the cost burden to the farmers. Subsidies for agricultural practices should not give rise to adverse impacts on the aquatic environment.

However, good agricultural practice should be adhered to by all farmers without any financial compensation. Farmers should be compensated if they are required to make more substantial changes in agricultural production, extending beyond good agricultural practice, such as restrictions in water protection zones and sensitive areas, extensification, and the restoration of flood plains and former wetlands, in order to meet specific environmental objectives. Direct payments and other financial incentives should be made to farmers on condition that they comply with these environmental protection requirements.

Legislation and Regulations

The guidelines strongly advise that sewage sludge should be looked on as a resource of nutrients, not as a waste. Moreover, quality standards for sewage sludge should be adopted and monitored. All sewage sludge of appropriate quality, should be envisaged for fertiliser in agriculture. Efforts should be made to standardise the fertiliser value per unit volume of slurry and per unit weight of solid farm manure. The production and use of solid manure, which is less likely to cause pollution than slurries and liquid manure, can be considered as a better solution to protect the environment in general and water resources in particular.

The guidelines also recommend that the regulatory framework should cover in an integrated manner the major aspects of the use of solid and liquid fertilisers, including slurry and solid farm manure, and pesticides in agriculture, horticulture and greenhouse farming. The implementation of these regulations should be adequately monitored. Appropriate legal sanctions should be instituted for non-compliance.

In addition, the guidelines recommend that the use of pesticides, all kinds of fertilisers and organic wastes should be restricted in water protection zones and sensitive areas. Stricter requirements or even a ban, should be imposed if water or ecosystems within these areas is already of poor quality. These substances should not be used near to surface water bodies; on water-saturated and flooded ground; nor in vegetation strips which are established along surface waters to prevent inputs of substances through surface run-off. Moreover, there should be no application of fertilisers and organic wastes on frozen and snow-covered ground.

Finally, the effectiveness of regulatory and economic measures to protect waters and the environment in general should be regularly assessed.

3. Future prospects

When drawing up the ECE Action Plan to Implement Agenda 21, Governments decided to take up further activities related to agriculture and environment under the auspices of the ECE. In this respect, the outcome of the third meeting of the Ministers of Environment from the ECE region (Sofia, Bulgaria, 23 to 25 October 1995) was most important. In their Declaration, the Ministers endorsed the Environmental Programme for Europe which highlights a number of long-term environmental priorities at a
pan-European level. They also adopted key recommendations for action related to good agricultural practice and the development of appropriate, “best practice” guidance.

This key recommendation was taken up by the Parties to the Water Convention at their first meeting (Helsinki, Finland, 2-4 July 1997). The Parties decided to examine progress made in the application of the 1995 Guidelines on the prevention and control of water pollution from fertilisers and pesticides in agriculture, with a view to deciding at a later stage whether codes of good agricultural practice on local, national and pan-European scales should be developed and implemented to protect waters, soils and the environment in general. Co-operation with the Food and Agriculture Organisation of the United Nations (FAO), the United Nations Development Programme (UNDP), the Organisation for Economic Co-operation and Development (OECD) and other relevant international organisations will be sought.

The Parties also decided to prepare an international instrument aimed at preventing, controlling and reducing water-related diseases in Europe. Elements of this instrument are now being drafted by ECE, WHO-Europe, UNEP and the European Commission together with experts from Hungary, Kyrgyzstan, Russian Federation, Ukraine and United Kingdom. The intergovernmental negotiation meetings will start early 1998 with the aim to finalise the international instrument for adoption at the 1999 London Conference of the Ministers for Environment and Health. In this instrument, water-related disease refers to any significant and widespread adverse effects on human health, such as death, disability, illness and disorders, caused directly or indirectly by the condition, or changes in the quantity or quality, of any waters. It will apply to surface fresh water, to groundwater, to estuaries and to coastal waters which are used for recreation or the production or harvesting of shellfish, as well as to any water in the course of abstraction or supply, and to any waste water in the course of treatment or re-use.

4. Bibliography

Summary

Consumption of fresh water for domestic, agricultural, energy and industrial purposes is expected to greatly increase by the end of the century for a number of reasons: population growth; the extension of irrigation to increase agricultural output; the foreseeable development of water distribution systems; and the expansion of water-consuming industrial activities.

Although, water resources are globally well in excess of foreseeable demand, they are unevenly distributed. Some regions are already experiencing severe water shortages which may worsen in the future. This can have serious repercussions on the economy and the environment. In many cases, the situation is further aggravated by the poor quality of water which makes it unsuitable for various purposes.

The solution to the problem of water resources lies in rational management which should be concerned both with supply and demand, and built on solid scientific and technical foundations, and rely on an interdisciplinary approach to the ecological, economic and social problems. Such management should aim at promoting the use of water resources in such a way as to ensure the satisfaction of society’s needs while preserving them for the future.

Economic and social changes necessitate the development of water resources based on sound environmental principles. A sound scientific understanding should be the foundation upon which rational decisions regarding water resource management should be taken.

1. Introduction

Review of current trends indicates that we are approaching a “water crisis” in several regions, most notably in the Middle East and North Africa, and in an increasingly large number of countries in world-wide. In the near future, availability of water rather than land will be the main constraint to

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agricultural development of arid and semi-arid countries of the Mediterranean. In most of those countries with erratic rainfall pattern, many of all available sources of water which can be economically used have already been developed or are currently in the process of development. There is no doubt that, without an efficient control and proper water management, self-sufficiency in food and energy will continue to be a mirage for most of those countries.

The major challenge facing water planners and managers in the 1990s is that while the physical availability of water to each country is constant, demand for water will continue to increase steadily in the foreseeable future. Accordingly the problem is how to balance demand and supply of water under these difficult conditions.

There is really only one solution that is to manage the available water resources in each country in an efficient and environmentally-sound manner. In the Mediterranean region the way in which water resources are being managed has increasingly severe environmental implications, including the accelerated soil and water degradation, the degradation of natural ecosystems and fresh water pollution.

Our attempts to develop and manipulate the earth for social and economic well-being have resulted in wide-ranging environmental damage that we are only now beginning to appreciate.

The lessons learned by the past decade are that technical solution alone cannot provide the increasing population with safe water supply and proper environmental sanitation. An integrated management of water resources is needed including technical, institutional, managerial, social and economic aspects.

The future requires new mechanisms to protect the water resource and allocate diminishing water supplies to increasing and competing uses. Anticipatory and preventive approaches should be developed for managing the quality and quantity of arid regions water resources in a way that acknowledges their use in social, economic and environmental terms.

In the Mediterranean, we need a new ethic, one that promotes efficiency and protection of water system in all we do. Efficiency must be the option of first choice. Part of that ethic is an acceptance of the obligations that accompany the rights we assume to have to water, obligations to protect water’s many ecological functions, to get as much as possible out of each litre we take from its natural course, and to help others to receive its benefits.

**Mediterranean countries and the water problem**

Water shortage is not a new phenomenon in the Mediterranean countries. What is new, however, is that it is occurring in an increasingly changed environment and this makes it more serious and long-lasting. The most recent drought in the summers of 1989 and 1990 marked a turning point. They highlighted the vulnerability of water supplies even in the industrialised northern Mediterranean Countries which had always relied on adequate per capita of rainfall. The water crisis is endemic or permanent in some southern Mediterranean areas, but it has now even reached towns and villages in France, Spain, Italy and Greece, obliging them to impose temporary restrictions. The shortfall in quantity has been compounded by a decrease in quality due to contamination of surface or groundwater.

There are many interrelated reasons which are contributing to this crisis and only major ones will be discussed herein.
**Limited information on water resources**

A basic problem in the Mediterranean region as well as in many regions of the world is adequate knowledge both of the natural and potential water resources and of present and forecasted water demand. Water resources occurrence is defined by a set of stochastic variables. It is thus essential to know not only their average values but also their space and time distribution. Measurements of these variables should meet the following conditions: (i) suitable geographical distribution and density of measurement points; (ii) suitable frequency of measurements; (iii) sufficiently long periods of measurements; and (iv) accurate measurements. The collection, processing and analysis of good quality data on surface water and groundwater resources in terms of quantity and quality are vital to efforts directed towards planning to meet present and future demands for water. Efforts must be intensified to gather fundamental water data, organising them into usable and accessible forms and disseminate them to those who may need them.

**Population trends and explosive urban growth**

The population of the Mediterranean basin countries as a whole, currently being around 360 million, would reach between 520 and 570 million in 2025. The difference between the two figures is equivalent to the current populations of Egypt and Turkey. The northern countries of the basin, from Spain to Greece, will account for only about one third of the total population in 2025, whereas, on the contrary, the countries south and east of the basin, from Morocco to Turkey, will contribute by nearly two-thirds of the total Mediterranean basin population in 2025, i.e. twice their current number.

The sequences of this high population growth rate with an average of 3 per cent yearly in the southern countries of the Mediterranean will, as well, increase the total water requirements. Furthermore, past experience indicates that, as the standard of living increases, so does per capita water requirements.

Rapid population is always linked with a fast urbanisation. Urban growth will be explosive in the southern and eastern countries where it is, on average, five times faster than it was in Europe in the previous century. The rate is not the only factor to be considered. The size of urban population will be very large: 200 million more urban inhabitants in 2025 in the south and east of the basin, i.e. as much as the total urban population in the Mediterranean region at present. The urban population of the Mediterranean basin could, in fact, number between 380 and 440 million compared to a little over 200 million today. Generally, the annual growth of urbanisation is high in the Mediterranean region, but it is much higher in the south (4.5 per cent) with respect to the north (2.8 per cent).

This population increase with high urbanisation rate, will impose serious stress on the fresh water resources particularly with consumptive uses in the developing countries of the Mediterranean region. This will be normally reflected on the sectorial water distribution and its use. Under such conditions, southern and eastern Mediterranean countries will experience difficulties in ensuring self sufficiency in meeting agricultural, domestic and industrial water needs. The supply of drinking water to urban areas will be one of the most critical problems in those countries.

**Water scarcity**

Scarcity of water is a major constraint of arid and semi-arid countries of the Mediterranean. In many countries, all available water resources which can be economically used have already been developed or are in the process of development.
The overall prospective analysis focusing on future draw-offs as compared to available resources, “exploitation index” indicates that the Mediterranean countries could be roughly classified into three groups:

- The first group consists of countries where water availability will remain adequate up to 2025 and beyond, and where there is even a fairly comfortable margin for increased per capita draw-offs. This group includes some with low population growth (France, Italy, ex-Yugoslavia) and some with stronger population growth (Albania, Turkey, Lebanon). Maintaining this margin will require efforts to develop and manage water, and to preserve appropriate quality, which will be necessary in any event.

- Secondly, there are countries where water availability, although still adequate at present, will drop considerably (Spain, Morocco, Algeria, Cyprus). Any significant growth in the per capita draw-off would put these countries quite quickly in the critical situation being faced by the countries in the next group and would call for solutions other than conventional hydraulic works.

- Finally, there are some countries where current water availability is already limited or negligible. As from the year 2000, the exploitation indexes will exceed, or will have already exceeded, 100 per cent. These include countries where population growth is low (Malta), average (Israel, Tunisia) or high (Egypt, Syria, Libya). In order to meet demand, per capita draw-offs on conventional resources will probably have to be reduced through various incentives, or else the country will have to fully use particularly in agricultural sector the non-conventional water resources.

The analysis clearly indicates that in the approaching year 2000 and beyond in the southern Mediterranean countries, the water demands will fast approach the limit of resources and the majority of these countries could enter a period of chronic shortage during the nineties. These countries will be facing several similar problems at the top of which we will find: declining water resources per inhabitant both in terms of water availability and water withdrawals. It is expected that the available water/capita will be reduced by nearly 50 per cent of the present one.

Exploitation of water at a relatively high rate with the risk of water quality deterioration. Excessive reduction in water withdrawals per capita, which will impose its significant effect on the water sectorial use, creating notable competition and conflict among users in the various sectors and of the irrigation and domestic sector in particular. Priorities will be given to satisfy the drinking water demands on the expenses of the available water allocated for the irrigation sector with the consequence of less irrigated surface and more land degradation.

Progressive degradation in the quality of available water resources because of increasing waste load discharged into water bodies and the atmosphere.

*Inefficient water use*

Water resources problems are often associated with a lack of efficiency in water use in agricultural, industrial and domestic supply. Agriculture is by far the most important water use activity, and is also probably the least efficient sector in water use. The failure to recognise the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic commodity is an important way of achieving efficient and equitable use and of encouraging conservation.
and protection of water sources. It should be realised that, if we want to have enough water of a sufficiently good quality, we have to pay for its true value.

There is much room for increased efficiency in water sources use. In this respect, irrigation is a major concern, as water is often supplied to farmers at a cost well below the cost of supply, this being a particularly important issue in developing countries. If we could significantly improve the equity in water resources use and the reliability of the irrigation projects in the developing countries, the food production of these countries would greatly benefit. Achieving such goals is primarily a subject of a proper and environmentally sound water management of the available water resources in each country.

**Water quality degradation and water pollution**

In nearly all the developing countries, including the Mediterranean ones, water quality programmes are either in their infancy or even non-existent. A reasonable clear and detailed picture of environmental issues confronting the land and water sectors does not exist, nor any accurate estimates on the cost of land and water degradation to the national economy. The cost is already significant at present, and if no drastic actions are taken, the existing trends show that it is likely to become even higher during the 1990s. In addition, the status of water pollution and the extent to which water quality has been impaired for different potential uses simply are not available. On the basis of anecdotal and very limited information available, it can be said that the problem is already very serious near urban centres, especially for groundwater and lakes and for some rivers as well. It should be noticed that, once the groundwater is contaminated, it cannot be easily decontaminated.

Nowadays, water pollution is already a serious problem in the majority of the developing countries: a large percentage of wastewater is untreated, and this is directly discharged in the water courses, irrigation canals and drainage ditches. While one can question the actual percentage figures, there is no question that a very high proportion of domestic and industrial effluents are untreated at present. Increased pollution from industrial and domestic sources, if allowed to grow unchecked, is likely to reduce the amount of water available for various purposes used in the future.

At our present state of knowledge, we simply do not know the extent of contamination that has already occurred and which may render some water sources unusable in the future without expensive treatment. Protection of water resources, if not receiving a priority consideration, will be a major cause for water scarcity in the region. In addition, the total economic and health costs to the country due to unchecked pollution would be unbearable.

**Poor irrigation and drainage systems performance**

In the Mediterranean countries, irrigated areas currently cover more than 16 million hectares and have increased over the past 15 years by 3 million hectares at an average rate of 200 000 hectares per year, entailing additional water requirements in the order of 2 000 million m$^3$ per year. In the Mediterranean area, irrigation represents 72 per cent of the total water withdrawals.

In spite of this rapid expansion in gross irrigated areas, irrigation and drainage have undergone little technological change over this period. Principally as a result of inadequate technologies, management practices and policies, most irrigation systems around the world in both developing and developed countries of the Mediterranean are performing far below their potential. This is true in virtually every dimension of performance, efficiency, productivity, equity, sustainability and impact on rural livelihood.
In the Mediterranean region, irrigated agriculture is globally characterised by the following features: the overall performance of many irrigation projects is much less than expected. Inadequate operation and maintenance and inefficient management of an increasingly scarce water resource contribute to problems; the priority is always given to the water quantity with minimum consideration to its quality; the quantity and quality are not inter-linked; large irrigation projects have been given high priority, while small-scale water programmes for agriculture have received inadequate attention.

Poor management practices, inefficient water use failure to place a high economic value on water have undoubtedly had a profound impact on the earth’s physical environment. Water-logged and salted lands, declining and contaminated aquifers, shrinking lakes and destruction of aquatic habitats combine to hang onto irrigation a high environmental price.

2. Environmentally-sound water management

Environmentally-sound water management implies that: development be controlled in such a way as to ensure that the resource itself is maintained and that adverse effects on other resources are considered and where possible ameliorated; options for future development are not foreclosed; and efficiency in water use and in the use of capital are key criteria in strategy selection.

Recognising these ideas is one thing, translating them into action is another. More specifically, what is required to foster the adoption of the three elements noted above in planning and policy making are: the recognition of concepts of environmentally-sound development and resilience, the incorporation of a more comprehensive perspective and the pursuit of higher levels of efficiency.

Preparation for water management requires planning, design and implementation of water control systems, including operations and maintenance, regulatory oversight and co-ordination. The management of water shortages integrates all facets of water resources management, including water supply, water quality management, irrigation and farm drainage, energy generation, fisheries enhancement, recreation and general aesthetics, as well as flood control.

In such a complex task, there is confusion about who should do what in order to be ready to handle the problem.

Constraints to environmentally-sound management

A comprehensive and critical analysis of existing literature on environmental aspects of water development in the Mediterranean region indicates that there are many constraints which limit the potential application of available knowledge by water professional and decision-makers in developing countries. On the basis of this analysis, the following four major constraints can be identified:

1. Incomplete framework for analysis.
2. Lack of appropriate methodology.
3. Inadequacy of knowledge.
4. Institutional constraints.
It should be noted that the four major constraints identified are not independent. On the contrary, they are often closely interrelated.

**Incomplete framework for analysis**

The framework currently used for analysing and considering various environmental impacts associated with water development projects is overwhelmingly biased towards assessing only the negative impacts.

What is thus needed is a balanced framework for analysis which will identify both positive and negative impacts. The next step should then be how to maximise the positive impacts and minimise the negative ones. A framework that considers only the negative impacts and ignores the positive ones is both incomplete and counterproductive.

**Lack of methodology**

A review of the process currently used by developing countries to incorporate environmental issues in water management indicates that the methodologies available at present do not appear to satisfy the special requirements of those countries. While the environmental impact assessment (EIA) process was made mandatory in several industrialised countries, its actual use so far in developing countries has been somewhat slow. The reason for this slow acceptance is the lack of an operational methodology that can be successfully applied in the developing countries with limited expertise, resources, data and time. The EIA methodologies that are being used in industrialised countries are not directly transferable to developing countries for various socio-economic and institutional reasons (Biswas and Kindler, 1989).

The complex, lengthy, expensive and time-consuming EIAs as practised in developed countries, are not the right tool to assess the impact of water development projects in developing countries. It is also important that in addition to being appropriate to local circumstances, they should be affordable in terms of cost and maintenance. Many hydrological services in the developing Mediterranean countries have not been guided on these latter aspects. It is not uncommon to find that equipment has been acquired without ensuring that it can be operated and maintained properly. Hence, the life span of equipment is unduly shortened, thereby wasting scarce resources. Also, it is necessary to develop guidelines which can actually be used by professionals for water management in planning and managing projects.

**Lack of adequate knowledge**

The results presented so far show that there is some available working knowledge about the Mediterranean countries water. However, as it can be seen from a comparison of the various estimates, differences exist with regard to the water balance components and the water resources at the various levels.

Those scientists who have made contributions to this knowledge, pointed to the lack of adequate data on the hydrological cycle, the lack of sufficient area coverage of the data and their representativeness, the gaps in data, the quality of data, and in some cases problems of access to data even if they are available. In addition, there are questions raised about the adequacy of the scientific basis, methods and techniques used in making the assessments.
There are many areas where adequate technical knowledge may not exist for getting reliable answers. Equally, there are areas where “conventional” knowledge can at best be dubious and at worst totally erroneous.

**Institutional constraints**

A sectorial approach to water development is a major institutional constraint in all developed and developing countries, and this has an important bearing on the sustainability of projects.

There are many reasons for this situation, but one of the most important is the division of responsibilities between the various water-related issues. Because of long-standing rivalries, the co-ordination and co-operation between the various ministers leave much to be desired and yet in any large-scale water development project all these issues must be integrated within the project area. While it is easy to point out this necessity, how this integration can be really effected in the field is a very complex and daunting task.

3. **Approach to integrated water resources management**

The “Integrated” approach is not really new. It was already recommended at the 1977 United Nations Conference in Mar del Plata that led to the declaration of the 1980s as the Water and Sanitation Decade with objective of providing drinking water and sanitation for all by 1990.

This was analysed at length during numerous regional and international conferences most notably at New Delhi in 1990, Delft in 1991, Dublin in January 1992 and Rio in June 1992. All of these conferences stressed again the importance of an integrated approach to water resources planning and management. For example, the Dublin Conference Report states: “... The effective management of water resources demands a holistic approach linking social and economic development with protection of natural ecosystems including land and water linkages across catchment areas or groundwater aquifers ....”

The Rio Earth Summit’s recommendation given in its Agenda 21, chapter 18 entitled “Protection of the quality and supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and Use of Water Resources” states: “As population and economic activities grow, many countries are rapidly reaching conditions of water scarcity or are facing limits to economic development. This scarcity, accompanied by aggravated pollution of freshwater resources..., demands the integration of sectorial water plans and programs within the framework of national economic and social policies .... This integration should be carried out at the level of the catchment or sub-basin ....”

The Rio conference further clarified that, integrated water resources management was based on the perception of water as a natural resource, a social and economic commodity whose quantity and quality determine the nature of its utilisation.

The analysis of the aforementioned statements starting from the U.N. Mar del Plata (1977) and ending with the Rio Earth Summit (1992), recommended the integrated approach for an effective management of water resources as its objectives are to achieve the social goals of equity, efficiency and environmental quality. However, in spite of the investments and the efforts made during that decade, this objectives were not met and today more than one billion people do not enjoy access to clean water and almost two billions are without adequate sanitation. This is the general situation, the question is what should be done to improve it and be ready to overcome future shortage of water.
It is very difficult to speak generally, but some improvement can be done using past-experience and accumulated knowledge. To alleviate the problem of water shortage, the following is needed:

- Improve information activities, generally the most neglected ones, including: Data collection and management.
- Analysis and Planning.
- Co-ordination and technical assistance.
- Research, training and public information education.

Data management is a critical information activity in a situation of shortage of water. To be successful, data management must be integrated with regulation, water supply assurance, water allocation, planning for development and comprehensive water management.

The management of water resources scarcity should be a continuous process and not a project which starts when a drought occurs and finishes when water supplies are back to normal.

Improve water supply by the improvement of existing water resources through: efficient uses, construction of surface reservoirs, conjunctive use of surface and groundwater, conservation and protection of water resources and rain harvesting.

The re-use of unconventional water resources on a relatively large scale in the Agricultural sector through the set-up of new management strategies which are, technically, environmentally and economically applicable.

**Priority actions**

Preventing water scarcity from undermining food security, ecological life-support systems, and social and political stability will not be easy. In much of the world, particularly arid and semi-arid regions, expanding the water supply to one user now means taking it away from another. New dams and river diversions will rarely offer sustainable solutions, since in most cases they would involve taking more water from freshwater systems that are already overtaxed. The key challenges now are to establish priorities and policies for allocating water among competing uses and users, to encourage more efficient and productive use of water, and to reshape institutions to better suit the new era of water constraints. These are not challenges that water managers can meet alone. They now belong in the portfolios of diplomats, on the agendas of cabinet meetings, and high on the priority lists of development banks and international support agencies.

In front of the water scarcity situation in the Mediterranean region and the water related environmental threats, it is necessary to review at national and regional levels and set a priority ranking of problems of physical and technical nature that affect the development and management of the water resources.

A top priority is to ensure that both people and ecosystems get at least the minimum amount of good-quality water they need to remain healthy and to function productively. Especially with competition for scarce water increasing and strong pressures to treat water more as a commodity, governments have an important responsibility to ensure that water’s most fundamental supporting life, is fulfilled.
Satisfying these basic human needs is thus not constrained by water availability per se, but rather by inadequate investment by governments, external support agencies, water providers, and community groups in the technologies, infrastructure, and institutions needed.

In this regard, a number of issues concerning necessary actions are outlined and discussed in the following.

**Water resources assessment**

Many efforts have been made in the different countries of the region with regard to the assessment of water resources. However, due to the complex nature of the arid and semi-arid climates and the sharp variabilities in magnitudes and distribution, still more efforts are needed in this respect. Many of the data have not been adequately researched and more important, the heroic assumptions are involved in the estimates of groundwater. The assessment of water resources is required for a number of purposes apart from assessing the quantity and quality and distribution in space and time, it should also include monitoring variations caused by climate variability or by climate changes, assessing environmental impact of water resources management and socio-economic systems and water related hazards.

**Management of water resources**

In the Mediterranean region, current trends demonstrate that we cannot continue on the present path where water resources management is characterised by policies that are unsustainable from any perspective: economic, social or environmental. There are multitudes of problems, however; they all stem from four principal failures:

- refusal of treated water as an economic good;
- excessive reliance on the government for water and wastewater services;
- fragmented management of water between sectors and institutions;
- inadequate recognition of the health and environmental concerns with current practices.

**New approach**

We must adopt a new approach to water resources management in the region that overcome the failures, reduce poverty and conserve the environment all with a sustainable development framework, having the following characteristics:

- addresses quantity and quality concerns through an integrated approach;
- integrally links land use management with sustainable water management;
- recognises water as an economic good and promotes cost effective interventions;
- support participatory and innovation approaches.
In realising the new approach, the essential elements for action have to be taken, emphasising:

- **Strategies**: from Segmented to Comprehensive. Water issues need to be treated in a systemic manner. We must stop managing water sectorially by its separate uses, and instead develop a comprehensive framework for water resources management. Co-ordination between different sectorial users is critical for successful long-term water resources management. In addition, physical and institutional infrastructures must be complementary.

- **Interventions**: from curative to preventive. To prevent expensive problems from occurring and to achieve an effective application of water resources, interventions in the water sector should move from curative to preventive ones. Through preventive interventions, the fragile water sources characterising the region could be sustainably used, beside, minimising the requirement and costs for remediation, mitigation and restoration.

- **Investments**: from incremental to strategic. Addressing water resources management issues under the new approach requires that a broad range of investments, both large and small, be made on a continuous basis. Investments that maximise benefits can be of a variety of scales and types. Complementarity and cost-effectiveness are important determinants in making investment decisions. Equally important is the ability to operate and maintain investments effectively. However, it must be recognised that investments are not the only solution for the sustainable management of water resources. While infrastructure improvements remain critical, they must be complemented with measures to strengthen institutions, develop human resources, and promote public awareness.

Given the need to mobilise resources, improve efficiency and increase the quality of services for users, the participation of the private sector in water management should be encouraged. Equally, to ensure the internalisation of measures to promote the use of economic incentives, increasing user participation in programme and project design should be supported.

**Supply and demand water management**

The questions of demand side versus supply side water management are important issues that require special attention in a water scarce zone like southern countries of the Mediterranean. For long time the supply management concept has dominated actions in the region. During this century the region witnessed major water supply projects including large impoundments, long distance transfer and mining fossil water. These driving forces are met with many economic and environmental limitations that require a combination of the supply management with demand management through minimisation of wastes, efficiency improvement and conservation works.

**Irrigation water charges**

The introduction of irrigation charges is a very important prerequisite to good management of irrigation demand because it is noticed that despite the observed water shortages, misuse of water in agriculture is widespread in current irrigation management practices. This is due mainly to the failure in the past to recognise water’s economic value and the real cost of water services provision. It is therefore now widely believed that managing water as an economic good is an important tool of achieving efficient and equitable water use as well as encouraging the conservation and protection of scarce water resources. Yet,
for many Arab States in the region, it is difficult to reconcile the concept of water as an economic good with the traditional idea of water as a basic necessity and human right.

Food security and available water resources

Agriculture will continue in many parts of the region to be the main consumer of water resources and consequently region wide over 85 per cent of the resources are consumed by agriculture. To realise food security of the developing countries of the region, the water gap will be about 50 per cent resulting from increasing population and deterioration of productivity due to the poor water management. Two approaches need to be debated among scientists, policy makers and the end users of water for agriculture. First on the formulation of short-term strategy for water and sustainable agricultural development, large amounts -nearly 50 per cent of the whole water volume already used in agriculture- could be made available to meet new agricultural demands by improving the efficiency in this sector, only 40 per cent through better systems of farm water management, reducing irrigation water distribution losses, changing cropping pattern, improving irrigation scheduling and adopting irrigation efficient technologies. In this regard, a part of the increasing agricultural water demands could also be supplied through the use of unconventional water resources, the saline and treated sewage water. This brings us to the second approach of long-term strategy to satisfy future food demands taking into consideration the water burden and the availability of food self-sufficiency in terms of the prevailing local economic, trade and environment conditions.

Sectorial water use and allocative efficiency

In the region, there is argument now on the adoption of the principles of allocative efficiency which leads to the utilisation of water first in the economic sectors which bring the best return to water -that is industry and service rather than agriculture- and secondly, within each sector, in the productive activities which generate sound economic returns, for example the production of crops which get a high price on world markets rather than those -such as sugar, wheat and rice- for which other producers have access to free or nearly free water. Such an approach does not create new water but it does provide a sound basis for both policy and practice in the utilisation of the region’s scarce water.

The possibility of gaining water from the existing systems to provide supplies for additional users in other sectors where higher economic and social returns exist, will be an increasingly important strategy but it has not yet entered the policies of national governments or water institutions of the developing countries in the region. Following the analysis of the traditional place of water in the economies and cultures of the region, such policies are difficult to adopt and deploy. For those who consider that new water is the only solution and that the political problems of re-allocation are insurmountable, the approach of re-allocation is not yet a relevant option. On the other hand, for those who consider that serving the interests of as many effective water users as possible is the major issue, the re-allocation of water will be a major feature of their future water policies. What is obviously needed is initiative and managing in terms of the solutions being put forward. In this regard, a much more controversial issue is how a society regards its water resource base and the use it makes of it. This depends, to some extent, on the overall level of economic development of an individual country. The more economically advanced a society becomes the more it needs to question its water resource policy.
Sharing the waters

The transboundary water resources shared between the countries of the region or with countries outside the region constitute the majority of the water resources, both surface resources and groundwater bodies. The competing demands for water in the absence of conflict resolution mechanism may lead to severe consequences in the water scarce zone. Urgent actions are needed in this respect to promote basin-wide co-operation between the riparian states. This can only be achieved through recognition of the interests and the concerns of all the riparians through comprehensive, integrated and environmentally sound water management of the entire water basin.

Water programmes implementation

Implementation means of the water programmes in this region at national and regional levels including funding, capacity building and human resources development are important issues that require attention. Existing water institutions need to be restructured to undertake multi-disciplinary functions.

National laws and regulations pertaining to the protection and development of water resources need to be elaborated and enforced. Supporting measures need to be undertaken to promote public awareness and participation, education, training and information systems. The mobilisation of applied research centres, the scientific communities at national and regional levels and enhancement of the regions, science and technological capacity are important requisites to implement the water programmes for water resources development and management, particularly for addressing the future environmental threats to the integrity of these resources.

For the foreseeable future, reining in demand and distributing water more equitably -between people and between nations, as well as between people and nature — offer the best hope for preventing scarcity from leading to more hunger and poverty, greater political and social instability, and more widespread ecological decline. Efficiency gains can go a long way toward squeezing more out of the existing supply. But water strategies alone will not be sufficient. Living within the limits of nature’s water supply will require reduced consumption among the more wealthy social groups and reduced family size among all groups and stepped up efforts to create the conditions needed for population stabilisation must be at the care of any successful strategy to achieve a sustainable and secure water future for all.

4. Concluding recommendations

It is becoming clearer and clearer that, continued rapid growth in population together with socio-economic changes are exerting increasing pressure on policy-makers and on the public to find viable and realistic water management strategies that can deal with the following four issues:

- How to safeguard water to meet basic needs for difficult uses.
- How to minimise water losses.
- How to allocate scarce water for desired socio-economic development.
- How to protect the environment from degradation and loss of productive capacity.
The common requirements in all practical responses to the solutions of all these major issues must include greater investments, better institutions, more technology and expertise, and intensified co-operation.

The water crisis, coupled with the many existing environmental stresses (including, for example, land and water pollution, erosion and sedimentation, natural and man-caused hazards) emphasise the need for continued development of human potentials, education and public understanding as an essential element in a major international effort.

Particular weight has to be given to capacity building within national research institutions in order to increase the capability within individual countries to address issues of sustainable development with adequate attention to environmental constraints.

Here, international co-operation can play a very important role. Combining international experience of countries with different levels of development may also be mutually beneficial as the developing countries can learn from the experience of the more developed ones, taking the lessons of their successes and failures, and the more developed countries have the opportunity to use their skills to help sustainable water resources development in developing countries.

Concerning the interdisciplinary and inter-sectorial character of water resources problems, it is essential for the achievement of a sustainable development of water resources that adequate institutional framework for water resources management, be established in each region and each country. Water management can be rational only if the institutions responsible for such management are efficient.

The present situation calls for strategies based on a new water awareness, founded on basic understanding of the particular role played by water for life and civilisation. Those strategies have to address the multi-cause environmental challenges emerging from water scarcity, water pollution and water related-land fertility degradation respectively and have to be multi-sectorial in character. In addition, those strategies should take an integrated approach to land productivity and water resources in order to strive for sustainable land productivity.

5. Bibliography


