USO INTENSIVO DE LAS AGUAS SUBTERRÁNEAS
ASPECTOS ÉTICOS, TECNOLÓGICOS Y ECONÓMICOS

Serie A, N°5

WATER AND ETHICS
Special Issue

1. Ethical Issues in Spain's Water Management

M. Ramón Llamas (Coordinator)
Ricardo Aguilar
Pedro Arrojo
Vicente Carcelén
Emilio Custodio
Juan Mª Martí

2. Report of the UNESCO Working Group on the Ethics of Freshwater Use

Coordinators:
M. Ramón Llamas
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Fundación Marcelino Botín

PAPELES DEL PROYECTO AGUAS SUBTERRÁNEAS

BIOGRAPHICAL SKETCHES

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Ricardo Aguilar started collaborating with Greenpeace in 1984, first as a supporter and then as a volunteer. Between 1986 till 1993 he carried out some campaigns and scientific studies to protect the Mediterranean Sea. In 1993 he was promoted to the position of Marine Ecology Area Coordinator, managing campaigns related to fisheries, biodiversity loss, coastal damage and marine contamination. In 1994 he became the Biodiversity Campaigns Director, managing a team that works on marine ecology, habitats, forest ecology, biodiversity, biotechnology and ecotoxicology. In 1999 he was named Campaigns Director, consolidating the teams that work in the above mentioned areas, and the campaigns related to toxics, climate change, energy, disarmament, etc. He has published several scientific documents and has given lectures on marine biology and biotechnology.

Pedro Arrojo has a doctorate in Physics from the University of Zaragoza and is Assistant Professor of Economic Analysis at the same university. He has specialized in natural resource economics. His primary research focuses on economics and water resources management, having published various books on this subject as well as multiple articles in scientific journals.

He is president of the Iberian Congress on Water Planning and Management, member of the Spanish committee of UNESCO´s Man and the Biosphere program, and advisor to the European Commission in the drafting of the Framework Directive on Water Resources. He is a member of the editorial board of the collection "Nueva Cultura del Agua" and coordinates the Spanish research and development network on legal, social and economic aspects of water management.

Vicente Carcelén holds a degree in Agricultural Engineering from the Polytechnic University of Madrid and a graduate degree in Quantitative Methods of Management from the School of Industrial Organization in Madrid. For 15 years he worked as a consultant in the field of irrigation planning and project development and regional development analysis. He has been a civil servant since 1987, and has been working in the Ministry of Agriculture in the development of the Spanish National Irrigation Plan since 1996.

Emilio Custodio has a doctorate from the Technical School of Industrial Engineering, Barcelona, Spain. He was trained in Chemical and Nuclear Engineering and at the same time in Hydrogeology. He is full professor of Groundwater Hydrology at the Technical University of Catalonia, Barcelona. Currently he is at leave as Director General of the Geological Survey of Spain (ITGE). He is author or editor of 15 books and more than 300 papers, mostly on groundwater resources, hydrogeochemistry, environmental isotopes, coastal aquifers and groundwater behavior. He is correspondent member of the Spanish Academy of Sciences. Currently is member of the Council of the International Association of Hydrogeologists and has the President's Award.

Juan Mª Martí is a Civil Engineer that started his professional career in the Hydrographic Research Centre (CEDEX) of the Spanish Ministry of Public Works. Between 1984 and 1997 he worked as staff engineer for the Department of Hydraulic Works of the Regional Ministry of Public Works and Transport

in the Andalusian Regional government. For over fifteen years he was project consultant in the field of hydraulics, with wide-ranging activity in Spain and South America. Since 1997 he has been the Director General of the Directorate of Hydraulic Works of the Andalusian government.

Jerome Delli Priscoli is a senior advisor at the U.S. Corps of Engineers' Institute for Water Resources. Over the past 20 years, he has directed the Corps research, training and field assistance programs on Social Assessment techniques, Public Participation, and Alternative Dispute Resolution (ADR). He has designed, facilitated and served on a variety of special committees for the federal government, both nationally and abroad. He has worked extensively with the World Bank, UNESCO, WHO, UNTCD, UNDP, FAO, UNEP, ESCAP, other International Organizations and several Multilateral negotiations concerning water resources on every continent. Dr. Delli Priscoli has taught at Universities throughout the World and is currently adjunct Professor in the School of International water resources management at Colorado State. He has written extensively in the fields of water resources management, public participation and alternative dispute resolution. Dr. Delli Priscoli holds BA from Tufts University and a PhD from Georgetown University in Economics and Political Science as well as post-graduate work in Theology and Philosophy.

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FOREWORD

This special issue of the "Papeles del PAS" (Papers of the Groundwater Project) includes two sets of documents.

The first set is the text of five out of six papers presented during a special session on Spanish Ethical Water Issues, held on 31st July 1999. This special session was part of a larger meeting held on 31st July and 1st August 1999 by the UNESCO Group on the Ethics of Freshwater Uses. Both took place in Roquetas de Mar (Almería, Spain) and were sponsored jointly by UNESCO and the Fundación Marcelino Botín.

The second set of documents: Declaration of Ethical Principles, and Water and Ethics were prepared by the UNESCO Working Group on the Ethics of Freshwater Uses. The last meeting of this Group, held in Almería, proved crucial to complete both documents. The final version was finished three months after this meeting and sent to the UNESCO headquarters. These documents will be soon accessible worldwide via the UNESCO Web Page.

The Fundación Marcelino Botín decided publishing these papers in the series "Papeles del PAS". It may contribute to a wider diffusion of these ideas, in order to stimulate discussion and receive criticisms and suggestions

The names and addresses of all the members and invited experts of the UNESCO Working Group are given in the Annex.

M.Ramón Llamas

June 2000

1. ETHICAL ISSUES IN SPAIN'S WATER RESOURCES

INTRODUCTION
by M. Ramón Llamas

Spain is the most arid country in Europe. As a logic consequence the issues and conflicts about water are relevant in comparison with other European countries. The direct knowledge of the Spanish problems could be a useful input for the members of the UNESCO Working Group on the Ethics of Freshwater uses.

The Fundación Marcelino Botin, in agreement with the coordinator of the UNESCO Working Group, invited six Spanish experts to present their views on the Spanish Water Resources situation. The six experts represented different professional backgrounds, disciplines and Institutions.

The State Administration was represented by Prof. Custodio, Director General of Spanish Geological Institute, by Mr. Calixto Sánchez-Fresneda, from the Ministry of the Environment (text not included) and by Dr. Vicente Carcelén from the Ministry of Agriculture. Mr. Martí (Director General of Hydraulic Works of the Autonomous Government of Andalusia). presented the point of view of a Regional government. Prof. P. Arrojo, presented a view from the Spanish University and last but not least, R. Aguilar from Greenpeace-Spain, presented the point of view of an important environmental group.

Obviously, the points of view expressed by the five authors represent different perspectives as a logic consequence of the complexity and variability of water problems.

THE VIEW FROM A CONSERVATION ONG

The Ethics of Spanish Water Policy
Ecological issues in Water Policy in Spain

By Ricardo Aguilar
Campaings Director
Greenpeace Spain

Despite the title of the Conference is "Ecological issues in Water Policy in Spain", we must say that this does not exist. The Spanish Water Policy practically ignores the ecological issues. Water is seen as oil or gold: An inanimate resource to be exploited.

While in some countries of the similar economic and social environment than Spain (US, France), the news report that some dams are being destroyed in order to let the original life in the rivers recover without artificial obstacles, the Government of Spain plans to build more than 200 new big dams. The Government? Well, this is not the exact terminology as the main party in opposition – this is the socialist PSOE – is the one which drafted the plans so there is not a big difference in this sense between the conservative today in Government, and the socialdemocrats.

PLANS FOR WATER MANAGEMENT IN SPAIN

What are the plans?

The so-called Plan Hidrologico Nacional produced during the mandate of the former socialist minister, Mr. Borrell, and the actual Planes Hidrologicos de Cuenca approved by Ms. Tocino, are based on the same aim: connecting the main river basins of the Iberian peninsula through huge canals, as a way to move

water from the North and West to the East and South: basically connecting rivers to bring the water to the Mediterranean coast and Andalusia.

That is, instead of having rivers and taking into account the water cycle and its importance on the environment they are planning to convert these rich ecosystems into a *pipe and canal complex.*

For doing this a high number of new dams need to be built. Greenpeace has calculated that from the 200 new big dams planned, at least 60 have a significant environmental effect, and this is only considering the environmental value of the valleys that will be destroyed, and not taking in consideration other environmental damages of big dams.

Some of these dams are: Dam of Biscarrués (Gállego river –Ebro basin-, destruction of forestal areas of high value and with otter); Dam of Pozo de los Ramos (Sorbe river –Tajo basin-, with negative environmental impact assessment, holly trees, oak trees, alder trees, yew trees); Dam of Omañas Orbigo river –Duero basin- (4 villages, 120 protected species like bears, wolves, otter, capercaillies, desmans): Dam of Sierra Bermeja (Aljucén river, Guadiana basin. Natural park, with endemic species like jarabugo fish, and protected as black stork); etc.

The main water contributor would be the Ebro River, which is considered as the one having the biggest "surplus" of water. That "surplus" would be exported through these canals to the other river basin (from north to south Tajo – Segura –Jucar).

The first problem of this approach is that it is not clearly explained what "surplus" means. Due to the climate situation in Spain it is usual that water shortage happens at the same time at the Ebro regions that further south, therefore hardly any surplus will be available when drought comes.

A phrase repeatedly said but many representatives of the Spanish government clearly show what it is in the mind of the real aim of this policy and the ignorance of what a river system is: "We cannot leave the Ebro's water to get lost in the sea". This is especially paradoxical if we take into account that during most of the year the Ebro river is not reaching the sea

but it is "losing its waters" some kilometres upstream from the estuary or mouth.

A clear example of the failure of this policy is the Tajo-Segura river connection. It was build to export 1,200 Hm^3 a year but has never exceeded 400 hm^3, being the annual average 250 Hm^3.

The Ebro River is already a victim of the water policy based on managing water through big dams. At the mid-Ebro the dam of Mequinenza was built in the sixties – also called Presa del Ebro-. Scientists of the Barcelona University have calculated that up to 95% of the sediment in the waters, stays at the Mequinenza dam. This dam is an impossible obstacle for all the sediment that before used to go down all the way towards the Ebro delta. This fertile and ecologically very valuable delta is reducing its space and sinking at a rate of 5 mm per year, due to the lack of sediment.

Similar processes are happening in other Spanish rivers like the Guadalquivir, and will soon happen to the Guadiana with the construction of the Portuguese Alqueva dam.

Spain is already a very dammed country. It is hard to find a "virgin river" – a river without dams – More than 1.000 big dams have been built already (3.000 Km^2 –six times the water dam in France–). Therefore the new plans are projected at the places which have remained out of sight of the engineers or are remote and the price of damming them was to high up until now: many of the remaining more remote and pristine mountain valleys. Just as an example, the project of Janovas, if going ahead, would destroy the last remaining virgin river in the Pirynees – rio Ara – and would be built just at the entrance of one of the jewels of Spanish Nature: the National Park of Ordesa y Monte Perdido.

In summary, civil engineers want to transform the remaining of our rivers and valleys into a network of water pipes and taps. This is unacceptable for those who believe on the importance of the preservation of our nature.

WATER QUALITY

Meanwhile, what is done against the pollution of the water? This is an issue that hasn't been in the agenda of the politicians responsible of the water policy in our country. Even though Spain is a signatory country of many international agreements against pollution (such as OSPAR, Convenio de Barcelona) which include mandatory targets for the elimination of toxic discharges into rivers and seas, the reality is that those mandates are not taken seriously.

Up to 25.000 km. of Spanish rivers are highly polluted. This is one third of the total length of our river network. Many villages, including big ones, do not treat black waters before discharging them to the rivers. Therefore even public institutions fail to implement with national and European law. What is worst is that the situation doesn't seem to be improving.

Investment in water quality would be a much better one, even in the short term, if the aim of water management would be to improve the service to citizens.

EFFICIENT USE OF WATER

As with water quality, very few efforts are done in this field in Spain. This is especially true in agriculture, a sector that consumes 80% of the total and is therefore the main one when talking about water consumption (24.300 Hm^3/year).

It is know that world-wide 60% of the water "used" for agriculture never reach the land due to bad infrastructures. In Spain is not an exception on this but we have to ad the bad use of the water that do reach the crop's land.

While in many countries, specially those where the water resources are scarce, are developing ways of improving the irrigation efficiency, in Spain there are less that 10% of the land using these systems. In other countries, like could be the case of Israel –I am giving this example because of being a

Mediterranean countries also with water problems – the average is over 50%.

It is easy to see irrigation happening at the time when the sun is up in the sky, and evaporation is higher (almost no one drops reach the land); or fields widely covered by water without anything cultivated on them – barbechos – (we are already irrigating tree cultivation for producing timber, like is the case of poplars). Although these are extremes which I saw just a few days ago from the train, they are not exceptions.

No matter how difficult it is to get enough resources, once available they are used without considering efficiency. Experiences in Zaragoza or Madrid show that the potential to reduce water consumption in cities is also huge. Just a very timid governmental campaign promoting saving water during the draught period of 1992 got a 20% of water saved in Madrid.

IS DESALINITATION A POSSIBLE ALTERNATIVE?

Desalinisation is very intensive in the use of energy. This is the main obstacle for a technology that has the potential to provide abundant water. Even some countries – Morocco – are considering projects of building new nuclear power stations with the aim of use the energy for water salinization.

While this kind of projects are completely unacceptable, there is another way to understand desalinisation: small-scale projects propelled through the use of renewable energy. This is a way in which much more resources need to be invested, because it has the potential for a way forward.

OTHER FACTORS TO BE CONSIDERED

Perhaps now is the moment to look into the ethics of what is happening in Spain. Why is Spain moving towards a direction that other countries are leaving behind? There are a number of factors that justify this, and I will go through them:

The political promises versus nature capabilities.

Water is a limited resource. This is as clear as clean water, and everyone would admit it. But a short follow up of media reports on water issues in Spain, would show how many times politicians of different colours promise "abundant and cheap" water through all the country. Of course this is an easy way to tell people what they want to hear, but unfortunately something very difficult, even impossible, in reality.

Economic interest of building companies.

Dams are, together with highways, where the biggest companies in Spain get public funding. The projects are expensive, and take a number of years to finish. Therefore many times it is very difficult to understand why a particular project is being built...unless you think on the pressure of the big companies.

Some may think that this is just a demagogical assertion from an environmentalist, but take, for example, the Itoiz Canal de Navarra project. Altogether it is budgeted in more than 200.000 million pesetas and will take no less than twenty years to be completed – if it ever is –, due to the opposition that this project has generated, and which may very well gain a big victory by stopping the project because of its illegalities. And this is only one of many....

To be able to build this dam the local government has even changed the laws in order to allow them to destroy some protected areas.

Lack of interest in Nature preservation.

The National Park of Doñana is known as "the jewel of the crown of Spanish Nature". All the world knows by now that this National Park suffered immensely because of the dumping of more than 5 million tons of toxic sludge coming from a mine

nearby. The dike of the waste-containing dam broke, liberating all those toxic wastes.

According to the Spanish authorities Nature was never in risk after this accident. Tocino, Minister for the Environment, stated from the very first day that "the national Park has been saved". Strange understanding of how ecosystems works...

This episode which I very briefly introduce, is just an example of the lack of commitment to protect nature.

A WAY FORWARD

This paper just presents very quick overview of the plans for water management in Spain, their shortcomings and possible alternatives.

We already pointed out that a diverse public investment into technologies of efficient use of water; alternative resources obtained through desalinisation using renewable sources, strong commitment to fight against water pollution, and public education about better use of an scarce resource, could drive Spain into the XXI century with a complete different of the problems associated to water management.

As said, the problem is not technological, in many ways it is ethical.

THE VIEW OF A PROFESSOR OF ECONOMICS

Pedro Arrojo
Departamento de Análisis Económico
Universidad de Zaragoza

Spain is one of the countries with more hydraulic infrastructures in relation with its surface area or population. It has more than 1.200 big dams (defined as being more than 15 m high), with more than 52.000 hm^3 of storage capacity. This situation is very similar to that of California, with similar surface area and climatic conditions.

The Mediterranean climate results in the predomination of semiarid areas in which the only way of guarantying regularity and capacity of agricultural production is relying on irrigation.

Until the middle of this century in Spain, hunger was a reality in many areas, particularly during the periodic droughts. In this context the *Regenerationist Movement* in the late nineteenth century and early twentieth century proposed, under the motto of "*Pantry and School"*, to use public funding for big hydraulic works as the key to overcome underdevelopment. The State had to assume the primary responsibility for financing and managing these big projects.

In a few decades, hundreds of big dams were built most of them for hydropower and others for irrigation projects. These big works have contributed to the economic development of the country, but at the same time have caused significant environmental impacts and have had grave socio-economic consequences in the villages and counties flooded by these reservoirs. In Aragón, my province, in the South of the Central Pyrenees, about 5.000 people have been forced to abandon their houses and villages for this reason.

The principle of " general or public interest" is used to justify these actions (as well as the enormous public investment effort) based on the idea that progress and the interest of the majority sometimes demands the sacrifice of some minorities.

There is no legal requirement to justify this principle, not even by a traditional cost-benefit analysis. The myth of progress linked with public works has generated the feeling that every dam is positive by itself. The State, according to this reasoning, has the "duty" of providing the "key of progress" to the people with these public works.

In the USA the progressive degradation of a very similar model gave origin to a new name for talking about the way of managing Federal funds for public works: it was called the "*Pork Barrel"*. In Spain, 40 years of dictatorship have accelerated this process towards a clear situation of corruption. "Public interest" has been biased towards "private interest" of big and powerful lobbies (essentially electric and construction companies).

This model is based on the management of surface water resources because, until the Water Act of 1985, groundwater was private. The new Water Act of 1985 included groundwater in the Public Domain, but the inertia and the pressures from powerful interests have caused that, in practice, aquifers continue to be managed as private. In this sense water policy is primarily designed for and applied to surface water. Surface water projects such as irrigation projects and big dams are heavily subsidised. The *"Libro Blanco del Agua" (White Book of Water)*, recently published by the Ministry of the Environment estimates that less than 1% of public investments in hydraulic infrastructures are recovered from the users. At present the price of water paid by the farmers in the new irrigation projects is no more than 1 PTA/m^3, when a full cost recovery policy would require a payment of between 25 and 40 PTAs/m^3 (1$ = 150 PTAs). To further exacerbate the problem, volumes are calculated indirectly by surface area irrigated and not through direct measurements of consumption. On the other hand, groundwater has to be pumped and the energy costs are paid by the user (costs for drilling the well are also usually paid by the farmer). That could be about 20 PTAs/m^3 as a mean.

At present about 1/3 of irrigated areas are supplied by groundwater. These areas are highly efficient in the use of water (generally 80-90% and even more). They usually can

obtain net benefits between 20 and 50 PTAs/m^3 in inland irrigation projects, and as high as 100 PTAs/m^3 or more in intensive agriculture in greenhouse production in areas such as Almería or Murcia.

New and traditional irrigation projects, using publicly-subsidised surface water sources, have in general a very low level of irrigation efficiency: around 40% on average. In the Ebro Valley, where there exist some of the biggest and better known big new irrigation projects, and where there is a weak tradition of groundwater irrigation, the average net benefit obtained from irrigated crops is about 5 PTAs/m^3 of water used. There are, nevertheless, very interesting experiences with modernisation of irrigation infrastructures. In the *Canal de Aragón y Cataluña,* for instance, with more than 100.000 ha under irrigation, in 15 years they have achieved a 70% efficiency rate and net benefits around 20 PTAs/m^3.

The economic failure of this model is a result of the changes in economic structure and the resulting dramatic impacts on the profitability of the agricultural sector, as well as the increasing monetary and non- monetary valuation of nature and environmental utilities.

a) The present water management model is based on a productivist approach, not properly on an economic approach. In a wide "neoliberal" international market framework, there is no guarantee of selling the goods produced at profitable prices. In fact, at present most agricultural production, even irrigated crops, are heavily subsidised by the EU. In this sense, nearly 50% of incomes for Spanish inland farmers comes from subsidies. However, this situation will not continue in the long-term, at least at this level of subsidies.

b) In a developed country such as Spain, the economic structure has relegated the role of the agricultural sector to a secondary level in the context of the national economy. The profitability of agricultural activities has decreased, even with the increase in productivity as a result of the "green revolution". From 1976 to 1994, agricultural productivity has increa-

sed 100%, but the gap between the inflation of agricultural products and the general inflation hovered around 250%.

c) While marginal costs have increased, marginal benefits have diminished dramatically [MARGINAL COSTS AND BENEFITS OF WHAT, AGRICULTURE?]. In this context most of the big hydraulic projects have a clearly negative economical cost-benefit balance. Taking only monetary values of goods recognised by the market into consideration –thus leaving aside many social and environmental values–, the result of several studies about multipurpose projects with large irrigation schemes as the main objective (Itoiz-Canal de Navarra, Biscarrues-Monegros...) is negative Actualised Net Values: -1 billion $ for Itoiz and about 0.5 billion $ for Biscarrues.

d) The challenge today is no longer in terms of quantitative production, but more in terms of qualitative issues in the context of competitive markets. Above all, the present challenge is achieving a new development model in the context of the paradigm of sustainability.

* This new paradigm has an ethical base with respect to intergenerational equity and justice
* This new paradigm has relation with interterritorial equitable opportunities.
* This new paradigm has relation with human rights of minorities and communities affected by big dams.
* This new paradigm has relation with a new approach of valuation of nature.

We are in time of deep changes in our water policy, but in times of crisis, the opportunism of powerful lobbies is more dangerous.

A new Directive on water is nearly ready in the EU. It will give a new legal framework for water management with stricter environmental measures and with "full cost recovery" as one of the main approaches for economic water demand management. At the same time the biggest and more impacting

big dam and transfer projects are being accelerated by the Spanish Government, affecting specially the Pyrenees. Now or never! seems to be the present motto.

In the last years, a wide movement is growing against most of the big projected dams and interbasin water transfers. Originally, it was a movement of affected people (COAGRET: Coordinadora de Afectados por Grandes Embalses y Trasvases). Today this movement involves a network of prestigious professors in about 20 Universities in Spain and Portugal working for a *"New Culture of Water"*. COAGRET also has the support of the main Ecological Groups (Greenpeace, WWF, SEO-Bird Life, Ecologista en Acción...), the main Trade Unions (CCOO, CGT, USO, STEs...) and a wide range of citizen organisations in urban and rural areas.

But the main and most important social movement is at present focused in the Pyrenees where thousand of people have participated in several demonstrations during the last few months, involving directly more than 50% of the population in the region. The last demonstration took place in Zaragoza in June, with 11.000 participants, after a three weeks-long hunger strike led by the majors of most of the affected villages (80 people) with 2.000 people in solidarity during the last day, "Dia Mundial del Medio Ambiente".

The main targets and challenges today from a new way of thinking in water issues could be summarised as follow in the next points:

- Modernisation of present irrigation systems, with special support to family farms, in the context of the new European Common Agricultural Policy.

- Protection of the last natural rivers and wetlands following experiences such as the "Wild and Scenic River Act" in the USA (could be towards the *Habitat Directive*).

- Quality improvement, water conservation and demand management strategies at every level (city, county, basin, national level).

- Water pricing using the "full cost recovery" principle as one of the keys (but not the only) for water management, integrating this approach in the global European agricultural policy and other sectarian policies.

- Strict application of the law to guaranty the sustainability of overexploited (or in the way to be overexploited) aquifers management

- Regeneration, reuse and desalination strategies, with special priority to employ renewable energies.

- Drought management planning at all levels (cities, counties, basins and national level). In this point more flexibility would be necessary for allowing Water Banks, as water markets under public control, for managing dry periods, following the Californian experience.

- A deep institutional reform of the Basin Authorities (Confederaciones Hidrográficas de Cuenca), towards a new interdisciplinary approach for planning and managing surface and groundwater resources in an integrated framework. In this new framework, it is important to give space for the new actors in water management in the Basin Councils, not just politicians, farmers and hydropower companies, but also ecologists, recreation users of rivers, fishers, trade unions, consumers and citizens organisations, independent experts, university professors, etc.

THE VIEW FROM THE MINISTRY OF AGRICULTURE

Ethics Aspects of Irrigation Planning

Vicente Carcelén López.
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Ministerio de Agricultura, Pesca y Alimentación.

1. INTRODUCTION. GENERAL FEATURES OF SPANISH IRRIGATIONS

The characteristics of the climate in the Spanish territory make the cultivation of a great number of plant species in arid areas, which cover a large part of the national land, very difficult.

Data concerning average annual rainfall show important areas with rainfall lower than 350 mm and very often fell as torrential rain, which, together with high average temperatures of the minima in winter, higher of course in summer, characterise a climate little favourable to agricultural activity.

In fact, a considerable area suffers severe aridity; 6% of the territory has an index of climatic potentiality of crops (L. Turc) lower than 5, and 74% between 5 and 20.

Such areas if irrigated reached potentialities between 40 and 55. Such differences mean in practice when talking about economic yields important income variations. The ratio of economic average productivity of the whole arid area of the national land compared with that of the irrigated area is 1:6.5, though in some autonomous communities is 1:40.

Taking into considerations the features above-mentioned it is not strange that in the past and not long ago, when self sufficiency policies were being put into practice and food deficit existed, arid areas were turned into irrigated ones at a quite fast rate, from 1950 to 1990 over 1.6 million hectares were transformed, and from then on the rate was slowing down,

mainly owing to changes in the agricultural policy, after the accession to the European Union and to market globalisation.

At present, the irrigated area is slightly over 3.4 million has, over 17% of the cultivated area, although the area having irrigation infrastructure is over 3.7 million has.

Irrigation development in Spain has had to surmount additional difficulties related to the seasonal and irregular nature of rainfall.

With a regular demand, only 9% water surface resources is serviceable but if we take into account that irrigation is an irregular demand then only 5% of the surface hydric resources is serviceable, which has given rise to great investments in hydraulic infrastructures to get water availability in Spain close to that in Centre European countries.

At present, surface waters, mostly regulated, supply over 2.3 million irrigation hectares, whereas ground waters supply almost one million irrigation hectares.

Sewage, from purifiers, are used to irrigate over 16,000 has, whereas waters from desalination plants are used to irrigate over 500 ha.

Transfers between basins make it possible to irrigate almost one hundred thousand hectares.

Another important aspect that allows us to explain certain actions in the laying out of the areas in relation to the promoter.

Public initiative accounts for 42% of the irrigation area compared to 58% from private initiative. However, such a laying out changes a lot if it is in respect of groundwaters or surface waters, since whereas public initiative represents 63% of irrigation with surface waters, that with groundwaters only represents 11%.

Another important characteristic to be taken into account is the application systems used, 59% of the areas is irrigated by flooding irrigation, 24% by high pressure irrigation, and 75 by low pressure irrigation.

2. ECONOMIC ASPECTS

2.1. Economic dimension (capacity to create labour incomes)

Spanish agriculture shows considerable deficiency regarding the size of agricultural holdings, ageing of agricultural population, inflexibility of land markets, and very little flexibility of inputs or inadequacy in the marketing organisation.

2.2. Laying out of crops

The laying out of irrigation areas regarding crops or crop groups is as follows:

Oil cereals and protein cereals	33 %
Animal feed	12 %
Citrus fruits, fruits and vegetables	30 %
Olive grove and vineyard	10 %
Industrial crops	7 %
Rice	3 %
Potato	3 %
Others	2 %

2.3. Economic indicators

The following ones have been taken into consideration:
- Gross income pesetas/ha
- Benefit plus income from family work
- Gross income per m^3 of water used

The general economic importance of irrigated land compared to that of arid land has already been stated.

A deeper breakdown has allowed us to summarise the main economic data of the agricultural holdings at agricultural district level

Limiting ourselves to analyse the main indicators abovementioned agricultural holdings show a wide range in the Spanish territory.

Areas having average gross income per hectare higher than 2,000,000 pesetas in some regions in the Southeast and Northwest of the Peninsula as well as in the Canary Islands. Such regions practically coincide with those with the highest value of the second indicator (benefit plus income from family work), over one million pesetas. On the contrary, the same regions in arid areas do not reach 50,000 ptas/ha.

The regions with the lowest gross income per hectare are located Northeast and South of the Duero basin and it is lower than 50,000 ptas. Such regions coincide to a certain extent with those with the second indicator lower than 10,000 pts/ha.

Productivity of m^3 of water is higher than 600 pts/ m^3 in some regions in Huelva, Almería, Cataluña and Valencia and is lower than 100 pts in large areas in Aragón, high basins of the Tajo, Guadiana and Guadalquivir Valley.

This indicator is not only influenced by the profitability of the productions but by the water economy as well.

However, the economic importance of irrigation does not lie in the economic profitability itself, but in its strategic importance as the foundation or support of the rural development.

The smaller territorial base, the continuity of productions, the diversification of the latter, the confidence irrigation inspires in the population allow the diversification of the economic activity in the rural environment.

3. SOCIAL ASPECTS.

If the economic importance of irrigation is undeniable at sectional level, the social importance is even greater.

Indeed, at macroeconomic level, agriculture itself can be lain on for its little contribution to the NGP, 3.5%, as well as for a considerable loss of labour force which places the share of agriculture in the labour force at 7.8% with a clear downwards tendency.

Nevertheless, the territorial importance of agriculture together with the problems derived from the depopulation of large areas (density lower than 10p/km^2) make depopulation and agricultural unemployment important problems that irrigation helps to fight through job creation and basic infrastructure creation aiming at the development of the food industry, handicrafts and services.

Irrigation by reducing the territorial base for job creation, it is estimated that one Hm^3 can give rise to 22 labour units (UTH) and have a multiplying effect of up to 40 times in the case of forced crops, allows the population concentration and, therefore, the existence of better and greater social services, which, together with the availability in time and space of agricultural raw materials, is capable of developing industry and services. Other aspects, such as agriculture as part-time activity, can be considered a positive fact when it comes to stopping depopulation.

4. ENVIRONMENTAL ASPECTS

Negative impact on environment has been put on agriculture.

It is true that some cultivation practices of intensive agriculture are little friendly to the environment and in the long terms it results in profitability losses and even in the cessation of the agricultural activity. However, we consider it is not a problem related to irrigation but to some planners and farmers.

In a more general way, negative aspects are put on irrigation, such as the impact on biodiversity and landscape when carrying out transformations. This last aspect must be considered historic, since at present, when it comes to transformations an environmental impact assessment is required, both in national legislation and in regional legislation. The latter being very often more restrictive. Other negative aspects have been competition for water, diffuse pollution, overexploitation of aquifers and creation of dams

However, we consider the following positive aspects: an increase in biodiversity in dried areas, a complement to the depuration of sewage, a diversification of the landscape, the cases when creation of infrastructure is friendly to the environment, and mainly, to underline that before allotting water to irrigation the priorities are both the reserve of ecological flows and urban supplies.

5. IRRIGATION PLANNING

5.1. General remarks

Irrigation planning takes into account the above-mentioned statements, action schemes having been prepared in relation to:

- existent irrigations
- irrigations into execution
- new irrigations

5.2. Existent irrigations

Action planning in the existent irrigations is collected in the scheme "Consolidation and improvement of the existent irrigations".

The analysis of water demand of existent irrigations shows an important unbalance between water needs of crops and supply, although total figures show an apparent coincidence.

Indeed, the gross needs of crops have been estimated in 23,552 Hm^3 and the supply in 23,298 $Hm^{3;}$ nevertheless, if we consider the irrigable area, we see that 55% of the irrigated areas does not receive the amount of water estimated necessary by the crops sown, whereas 26% gets too much water and only 19% can be considered to be in balance.

The analysis of such water incomes shows an average efficacy of 50%, and in case we only consider surface water then it is hardly 45% since the greatest efficacy takes place in gro-

undwater irrigations when it reaches an average efficacy of 70%.

There are over 700,000 has with irrigation channels made of soil and 400,000 has with irrigation channels of concrete in bad conditions.

On the other hand, there is a considerable number of areas where an imbalance in the aquifer exploitation exists and such aquifers supply irrigation water, thus 420,000 has of irrigated land are affected and need regulation.

The planned actions, which would affect one million one hundred thousand hectares in a first stage, foresee a gross water saving of 3,355 Hm^3 which means an increase in efficacy of 10 percentage points and a remarkable reduction in irrigation water surplus which goes back to the channels.

As far as the economic aspects are concerned, the productivity of the labour force increases, the productive structure improves and the profitability of agricultural holdings also improves.

In respect of the environmental aspects, diffuse pollution is reduced, the quality of surface waters and groundwater improves, channels are liberated for other uses and depurated water will be favoured to be used again.

Regarding the social aspects, uncertainty decreases, productions are guaranteed and work conditions improve.

5.3. Irrigations into execution

This scheme tries to make, from the economic and social point of view, actions already put into practice profitable and in which important public investments have been made.

The economic and social assessments should not be carried out taking into account the project as a whole, but just what has not been made and taking into consideration the investment losses due to the lack of action.

In the year 2008, 138,365 has are expected to become irrigated land, 319,488 has are pending for a later stage, and its transformation pace will be set by the circumstances.

5.4. New irrigations

The schemes on new irrigation envisage the area transformations due to their social interest carried out by public initiative, and those carried out by private initiative.

The purpose of the transformations due to public initiative, 79,426 has, is the creation of jobs and they will be the hard core of rural development, balance the decrease in production of resources, and represent a useful tool to curb desertization.

Irrigation planning cannot limit private initiative, but it can condition the aids granted by the Administration to the fulfilment of its policy and, although the economic profitability required to irrigation of social nature includes aids and subsidies, the economic requirements for irrigation from private investment are much more rigid and so are the limitations to crops to be sown.

The granting of aids to 25,000 has of irrigated land due to private investment is foreseen.

Environmental requirements envisage the assessment of the environmental impact of the transformation, as well as the use of high efficacy application systems and the use of conduits with minimum losses, in short, the best irrigation techniques available.

5.5. Other schemes

To complete the actions regarding the infrastructures, the following schemes have been set:

- Training of technicians and irrigators
- Permanent assessment of irrigation systems
- Environmental surveillance
- Improvement of both the management and the use of irrigation water
- Monitoring, follow up, assessment and review of the National Plan for Irrigations (N.P.I.)

6. CONCLUSIONS. ETHICAL PROBLEMS

The National Plan for Irrigations tries, in the European and national agricultural policy framework and keeping the agricultural interests, with all respects due to the sectors and groups, which coincide and compete for the use and consumption of water.

Thus, as far as participation and decentralisation are concerned, the Autonomous Communities have been consulted and asked for cooperation for both the drawing up of previous studies and the discussions on the Plan draft.

The scheme for training of technician and irrigators insists on the participative matters.

The interrelation of policies tries to get a total co-ordination with other sectorial policies: energy, environment, economy, employment, rural development.

The answers to the complexity and variability of both framework and circumstances are present at the schemes of permanent assessment of the irrigation systems, environmental surveillance and in particular, at the monitoring, follow up, assessment and review of the N.P.I.

The analysis, diagnosis, and actions have been carried out at a certain level of irrigation area, avoiding generalisation and seeking to get the appropriate answers to specific problems.

The irrigations planning envisages redefining the needs and demands to make them suitable to real situations.

It looks for a balance in the infrastructure development, being aware of the uncertainty when it comes to making decisions.

It carries out an exhaustive analysis of the options and when making decisions, the environmental and social aspects take priority.

When being applied, it tries to get the balance in the development of the actions.

THE VIEW FROM THE SPAIN'S GEOLOGICAL SURVEY (MINISTRY OF THE ENVIRONMENT)

Some Ethical Issues on Water Resources and Groundwater

Emilio Custodio, Dr. Ind. Eng.

Key words: Groundwater, Water resources, Ethical issues, Sustainability

Abstract:

In some areas of the Earth a large part of available freshwater resources are already committed and the demand tends to increase. This is a concerning situation, which can be dealt with in two extreme ways. One consists on making more freshwater available, which means more interference with the environment, altering the social context and depleting groundwater resources. The other consist on correcting the current, often highly inefficient use of freshwater, protecting groundwater reserves and preventing further degradation by contamination. These are ethical issues to be seriously considered before creating a stressed environment, wasting badly needed economical and human resources and depleting non-renewable resources, and spoiling sites. Decisions have to be carried out under the uncertainty of natural situations and processes, and looking for the long-term sustainability in a changing framework. This is compatible with some kind of limited depletion of aquifer reserves.

Groundwater is still a poorly managed and to some extent misunderstood essential freshwater resource. Solving this handicap involves not only science and technology, but also sound economics, social appreciation and political will. Ethical behaviour should be the common background.

On natural and freshwater resources sustainability.

Many authors point to the limitation and the growing worldwide scarcity of freshwater resources (Brundtland et al., 1987; Gleick, 1998). However, all this depends on the form the figures are presented, how the demands are reckoned and forecasted, and how local problems are upscaled to global ones. Behind this there is an often poor and wrong understanding of Nature and the water cycle. The human capacity to solve problems and to produce new scientific advances and appropriate technologies has been able to clearly improve man's quality of life and to redress many of the problems related with mankind and Nature (Tierney, 1990). Part of the problem is poor use of resources and insufficient solidarity (John-Paul II, 1991). In fact, situations whose evolution was presented as leading to a final disaster have been effectively overcome. Working and appreciating the situation at a global scale allows defining solutions and alternatives that are not apparent from the local perspective.

But this optimistic viewpoint has to be conciliated with the present, unprecedented global-scale influence of many human activities. This makes the new challenges more difficult to deal with and more serious the danger of overcoming global limits.

There is a wide space for human creativity to change growing demand and for preservation, and at the same time maintaining and increasing quality of life. This needs a generous definition of sustainability, in a wide context, not restricted to local situations. A continuous trade-off is needed between the unrenounciable goal of improving quality of life by developing natural resources and producing some bearable and compensable environmental damage.

Sustainability has transient situations, whose asymptotically attainable final situations also change as humankind evolves. What now seems obvious and a common thing may be quite different in the future. Then, prudent evolution and flexible action is the attitude to be recommended (Plate, 1993), especially when future scenarios are uncertain and even long-term continuous population growth is doubtful (Pearce, 1999).

This may mean that "unsustainable" use of resources and some "degradation" may be needed for some time and under changing circumstances, but part of the derived net benefits should be spent in new developments for conservation, preservation and restoration. Also, the development which is directed to increase the offer of new goods to follow an unreasonable and poorly bounded demand, whenever possible should be changed for a clear policy of savings and reuse.

On hydrology, water resources and uncertainty

Hydrological principles are often poorly known by people, policy makers and even scientists, and hydrology is often negatively influenced by a series of myths and biased understanding (Custodio and Llamas, 1997). Decision making tend to look preferentially to some easy-to-see aspects. However, they are often wrongly interpreted in what refers to water cycle and the environment. Referring to renovation rate, time scale of fluctuations or changes, links with the environment, delayed effect of impacts, associated water storage, quality of water, vulnerability and risk of contamination, each part of the water cycle is characterised by very different values.

Wrong decisions are mostly due to looking only at one part of the cycle -generally surface water- and neglecting or oversimplifying the links with the environment. A major loser is groundwater, which is often ignored and neglected, unnecessarily wasted and contaminated. In addition, Nature may be deprived of the important environmental role of groundwater, without beneficial use.

Natural uncertainty of water resources quantity and quality is due to the stochastic component of rainfall and other natural processes, and to the non-exact knowledge and simplification of the processes. Uncertainly presents different aspects for the various parts of the water cycle. The greater the associated volume of water the less the uncertainty linked to the stochastic behaviour. In this sense, groundwater is usually more reliable and ready to use than surface water due to it very

long turnover time. This does not mean that one is superior to the other, but different, often complementary, amenable to joint use, and both necessary assets. The common attitude of disregarding groundwater as a reliable water resource may be a sin of ignorance and arrogance, if not of corruption, and it may imply a higher associated economical, social and environmental cost.

But viewpoints from Hydrology are not the only ones to be considered since obtaining water resources and using them have widespread influence on land use, population behaviour, economics, politics, and the environment. Some aspects are susceptible of quantitative analyses but others are not easily amenable to quantification, especially some externalities and intangible side effects (Constanza, 1991). Ethics play an important role in looking for feasible solutions that do not burden more than needed present and future generations, and especially for developing areas, in which poor knowledge, enhanced uncertainty due to lack of data and insufficient knowledge, inadequate institutions, poor general education and deeply rooted hydromyths make ethical decisions more difficult.

On freshwater shortage

Water scarcity is not necessarily a main problem for development since there are areas with a small annual volume of renewable freshwater per capita or per surface area which show an acceptable per capita gross economical product. The converse is true as well. Water used for direct human consumption is rather a small quantity, and if needed it can be complemented temporarily or permanently by developing more expensive sources such as brackish and salty water desalination, transport from far away areas, or by depleting groundwater reserves. But what is often acceptable for relatively rich human settlements and urban areas may not be bearable for rural communities and developing poor areas. There are no universal solutions but tailored ones according to local circumstances.

In many regions, problems of fresh water availability begin to appear when all domestic and urban water has to be of potable quality. This is the common policy in most developed and developing areas, disregarding actual freshwater availability. The situation worsens in water scarce areas when this water is also used for gardening, watering green areas and luxury uses. This may become a serious economic burden to water supply utilities, and to the whole population. The result is depriving society of economic resources, which are badly needed to foster development and welfare. What is already a concern for many water rich areas may become a dramatic burden for arid and semiarid areas.

A double domestic and urban water supply system is a possible solution to be experienced and developed (Pettersen, 1994). This low quality water should not be used for direct consumption, also should not present any serious health risk if accidentally drinked. Drinkable water needs a fully separated distribution system, which in small towns and rural areas can be as simple as the use of distributed drum water or public fountains. This implies dramatic changes in current habits, in architecture and in urban planning, and a serious commitment for not wasting effort and money in producing costly potable water –often in a non sustainable form and with important environmental and social damage- to be wasted in uses which do not need such high quality.

Similar considerations apply for industrial and commercial freshwater demand. It is a present day serious ethical sin using high quality water –sometimes non-easily renewable–and even fossil groundwater just for crude industrial processes and cooling, with no or little recycling. In this field there is much to be implemented in recycling and using low quality water resources such as moderately contaminated surface or groundwater, and water reuse, even if this adds to treatment costs, which have to be shared by all stakeholders, at least to some extent.

The worst water demand problems are created by widespread irrigated agriculture. This may be the result of trying to perpetuate local traditions, occupying untrained population

and pursuing self–sufficiency for food production state policies. Very often farmers receive subsidies for infrastructures, agrochemicals, agroenergy and production, which may deeply distort the economy, to the point the use of water may become a secondary issue for the farmers, but it is actually what produces much of the water scarcity, contamination, social stress, environmental destruction and depletion of strategically important groundwater resources.

On water needs and employment

Increasing water problems are often solved by new and expensive waterworks, which need progressively greater and greater public investments. This is a kind of subsidy, generally paid by the whole population, which is often economically unsound. Groundwater, alone or combined with other freshwater resources, may play a key role in providing feasible solutions (Sahuquillo, 1991; Llamas, 1999).

In most cases there are better uses of economic resources such as training people for other jobs, improving agriculture (more valuable products with less water and more employment per hectare), creating infrastructures to foster development (communications, roads and railways, factories), reducing water demand through technological improvement, optimising existing local water resources, protecting the environment, or developing trade and tourism. For sound management, a top level Institution is needed, overcoming the sectorial point of view of specialized organisations. Food can be imported cheaply and more efficiently than water. This also helps the development of other areas of the World which are richer in water resources and have favourable conditions for food production, but which need manufactured goods or other resources.

Often it is argued that abandoning agriculture means desertification. This is true in many areas and rural population is really needed in place. Nevertheless, these persons should be given the opportunity of a quality of life that makes the countryside attractive, confortable and socially rewarding. This

is not necessarily linked to intensive agriculture or animal raising but to landscape, historic heritage and Nature preservation.

On water contamination

Probably the greatest thread to surface and ground freshwater resources sustainability is contamination. Although some contaminants are natural, most man-made and man-introduced hazardous substances and saline components are the main concern.

They vary from agrochemicals to household products, and include a large list of industrial and energy production products, and even pharmochemicals. In addition, microorganisms, bacteria, and viruses often contaminate surface water and shallow gro-undwater.

Deep groundwater is normally free of them, although abstracted water may be not, due to poorly constructed and maintained groundwater wells. Since contaminants move sluggishly in the ground, groundwater and surface water fed by groundwater may seem protected, but contamination appearance may be only a matter of time, especially for non-degradable substances.

Control and correction of contamination sources is a worldwide primary goal and a key ethical objective. Action means not only treating water and wastes before discharging them into the environment, but also isolating or destroying wastes, and controlling the production and use of substances that represent a contamination risk to freshwater resources quality.

The damage to water resources in developing countries may seriously hamper the environment and the possibilities for development since the income they may generate will be soon or later spent for protecting the population and its activities (including tourism), for compensating the loses from rejected goods, and to cope with future costs to correct or to substitute damaged water resources and soil.

On aquifer protection and groundwater users' associations

Protection of aquifers as a highly valuable resource and reserve of freshwater, and at the same time the preservation of a part of their environmental role (Custodio, 2000a), is a complex but feasible issue. The major difficulties are the lack of experience on sound management, and the need for new methods to deal with their extensive characteristics. Aquifers are or can be scientifically and technically well known.

Aquifer systems have a large number of actors with economic and even sentimental interests in wells, springs, river base flow, gallery forests, wetlands, drainages and so on. These actors are generally small, unrelated stakeholders who are unaware of receiving benefits from the aquifer system, which is an infrastructure provided by Nature.

There is also the common pool resource problem (Young, 1992; Aguilera, 1996; Azqueta and Ferreiro, 1994). This means that there is no incentive for water savings or protection since doing this will only increase the benefit of the others which have access to the resource. Without regulation, the final situation is reserve depletion or quality degradation. In addition, uncontrolled development of surface water has similar problems, except for the time delay contributed by groundwater reserves.

To try to find a solution, an effective water institution is needed, which has to be supported by adequate legal instruments and working together with the aquifer system's water stakeholders. Stakeholders should be organised for sound action. There are already a few real experiences of water users' associations (Aragonés et al., 1996; Galofré, 1991), but more are needed before a good under-standing and practice is gained, especially in the rural environ-ment.

There are several key factors in aquifer protection. From a technical point of view abstraction works have to be correctly designed, constructed, operated, maintained, and abandoned. An adequate monitoring system of abstraction, recharge, discharge, groundwater use, groundwater head and water quality

has to be constructed and operated, and the data integrated into data bases. Monitoring should consider the three-dimensional na-ture of groundwater flow and reserves.

From the point of view of land use, recharge areas have to be preserved and even improved and extended. Contamination sources must be put under control. All this means some power to enforce land use plans. These land use plans should be based on a large consensus of all the involved parts. Not only well-trained people is needed but also effective institutions (Lloyd, 1994).

An aquifer system is a natural infrastructure provided by Nature. But obtaining and developing water resources need investment, maintenance, and operation. This has a cost, which should be paid by the water abstractor. However, to compensate for indirect costs, especially those related with the environment and for implementing decisions, economic funds have to be collected. Funds are also needed for monitoring and studies, as well as to restore adverse situations such as those related with recharge reduction, contamination issues, forced changes quantity and pattern of abstraction, to control the displacement of poor quality ground-water, and for implementing some treatment facilities.

Destroying aquifers by contamination, including diffuse contamination from agriculture, by deteriorating recharge areas, by permitting contaminated or low quality water to penetrate good quality aquifers through poorly constructed wells, by unduly disposing liquid or solid waste, or by many other activities, is ethically inadmissible. The cost of destroying or degrading existing infrastructures can be measured through the cost of another one providing the equivalent service.

A temporal use of reserves is admissible and sound in a scenario of future new developments to be paid by the net benefits which will be obtained (Collin and Margat, 1993; Custodio, 2000b); In arid lands mining groundwater resources is a possibility (Lloyd, 1998; Margat, 1990), but it may be unsound if only short-term benefits are considered (Howe, 1987). Aquifer intensive development -often called overexploitation- is both a misfortune and a blessing, depending on they

way and circumstances under which it is carried out (Llamas, 1992; Custodio, 2000b).

Often natural poor quality groundwater, generally brackish and salty water, is considered not useful at all. Then aquifers containing them are assumed of lacking economic value and permits to store waste water are often granted. With the reduction of desalination costs, this may be not true in water scarce areas. This poor quality groundwater is often free of hazardous man-made contaminants and thus a possible interesting source to produce potable water.

In any case, good water quality aquifers, especially those containing old water, which is free from man-made contaminants, should be reserved for drinking purposes and not wasted in uses that do not require high quality standards. This has to be combined with optimum use of water resources and the preservation of at least a part of the environmental role of groundwater. Deep confined aquifers are good candidates for special protection. Preparing and implementing protection plans is an ethical issue.

Final note

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THE VIEW FROM A REGIONAL GOVERNMENT (AUTONOMOUS GOVERNMENT OF ANDALUSIA)

Water Problems in Andalusia

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1. TERRITORIAL SCOPE

The Andalusian territory has two distinct hydrographic sectors, on the one hand a big river, the *Guadalquivir*, flowing into the Atlantic ocean, and on the other hand a system of minor rivers, some of them flow into the Atlantic -*Tinto, Odiel, Piedras, Guadalete and Barbate*-, and the remaining ones into the Mediterranean - *Guadiaro, Verde, Guadalhorce, Guaro, Guadalfeo, Adra, Andarax* and *Almanzora*- as the most important.

From the management viewpoint, the region is framed by three Hydrographic Confederations (river-basin agencies): *Guadiana* basin including the first three rivers (*Tinto, Odiel* and *Piedras*) aggregated into the so-called *Guadiana II* basin; *Guadalquivir* basin, which includes the river that gives its name, as well as *Guadalet*e and *Barbate*; and *Sur* basin comprising all the rivers that flow into the Mediterranean in the Andalusian shore.

Their extension and population is shown in the enclosed Table N.1

It is worth to note that this limited spatial context holds, in a nutshell, all the situations that can be observed in the whole of the Peninsula, since the pluviometric values range from the upper Spanish extreme in *Grazalema*, to the absolute minimum in *Almería*.

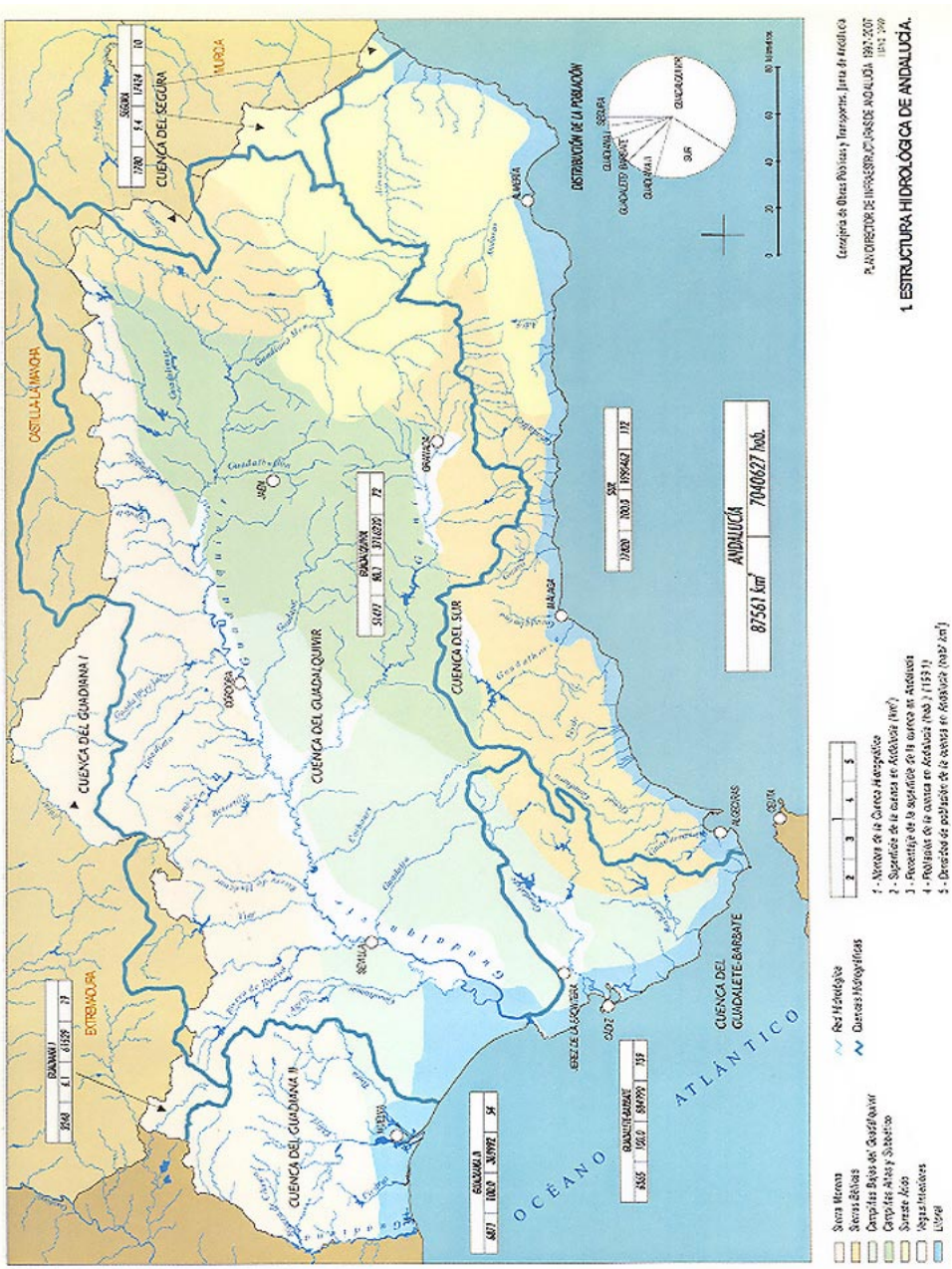

TABLE 1. AREA AND POPULATION OF THE HYDROGRAPHIC BASINS						
	Area			Population (2)		
	Km² Andalus.	% of Andalus.	% of basin	Populat. Andalus.	% Andalus.	Hb/km²
Guadalquivir	51.477	58,8	90,1	3.716.230	52,8	72
Sur	17.820	20,4	100	1.990.462	28,3	112
Guadiana II	6.871 (1)	7,8	100	369.992	5,2	54
Guadalete/ Barbate	6.365	7,3	100	884.990	12,6	139
Guadiana I	3.248	3,7	6,1	61.529	0,9	19
Segura	1.780	2	9,4	17.424	0,2	10
Andalusia	87.561	100		7.040.627	100	80
Spain	17,3 %			17,9 %		77
Source: Hydrological Plans (1995) and General Direction of Public Works						
(1) The Sub-basin of Guadiana and Chanza rivers –2219 km²– is an intracomunitaire basin from an administrative point of view.						
(2) The information about the population belongs to the census conducted in 1991.						

2. WATER RESOURCES

The main feature of water resources in Andalusia is that they are limited, not only in terms of quantity, but also on account of their irregular distribution, both in time and in space (see Table N.2).

Relative water scarcity in Andalusia is even more perceptible if account is taken of the available resources per capita, an indicator hinting at demographic pressure and -indirectly- at economic activity. It is surprising to know that the average Andalusian share of water is about half that of the average Spaniard, be it that natural resources are considered -1.735 m³

per person and year versus 2.946 in Spain- or the available ones (the amount that is physically available for use thanks to the existing infrastructure) -745 versus 1.406-.

The spatial distribution of these indicators is, in turn, quite unequal. For instance, natural resources per capita are generally in inverse relation to demographic density: it is specially noticeable in the case of inhabitants of the *Guadalete/Barbate* and *Sur* basins, whose water availability, according to international ratings, can be considered as belonging to a situation of scarcity.

TABLE 2. AVERAGE WATER RESOURCES IN HM³/YEAR (1997)

			Available (2)				
	Natur. resour. (1)	mm/y runoff	Reserv. control	Flux of base	Extract from aquif.	Return.	Total resour.
Guadalquivir	6.663	129	2.255	219	437	351	3.362
Sur	2.483	139	414	166	630 (3)	10	1.220
Guadiana II	1.293	188	275	10	60	5	350
Guadalete/ Barbate	860	135	258	4	85	29	475
Guadiana I	727	224	1	3	6	2	12
Segura	186	104	1	-	5	-	6 (4)
Andalusia	12.212	139	3.304	502	1.223	397	5.426
% of Spain (5)	10,7	59,3	10,7	4,7	22,5	5,0	9,8

Source: Hydrologic Plans (1995), National Hydrologic Plan (1993), General Direction of Hydraulics Works.

(1) Within the intracomunitaire basins it is includes only an approximation of the resources created in Andalusia.

(2) Returns included.

(3) It is taken into account the quantity of 184 hm³/year coming from the aquifers over-exploitation.

(4) Sur and Segura Basin together haver, as the average, 7 hm³/year from the By-pass Tajo-Segura.

(5) Information about Spain in 1993.

There is one last indicator of Andalusia's hydric scarcity, showing the high irregularity of its rivers and the considerable costs associated to their hydraulic control. This indicator is the average rate between the reservoir capacity and the yearly yield, i.e. the yearly demand they can supply while in Andalusia, this rate is 3.07, and the Spanish average is 1.59.

TABLE 3. WATER DEMAND (1997)

	CONSUMPTIVE DEMANDS				TOTAL DEMAND		M³ PER HABITANT AND YEAR			
	hm^3/year	% water input	% industrial	% irrigation	% (1) envir & wat. cool.	hm^3/year	Water input	Industrial	Irrigation	Consumptive demand
Guadalquivir	3.350	12,5	1,7	85,8	6,4	3.578	112	16	773	901
Sur	1.350	18,4	2,4	79,2	2,0	1.377	125	16	538	678
Guadiana II	221	17,2	24,0	58,8	5,6	284	103	143	351	597
Guadalete/ Barbate	383	27,4	3,1	69,5	6,4	409	119	14	301	433
Guadiana I	16	31,3	6,2	62,5	-	16	81	16	163	260
Segura	47	10,6	-	89,4	-	47	287	-	2.410	2.697
Andalusia	5.367	15,3	2,9	81,8	5,2	5.661	116	22	624	762
Spain (2)	30.494	14,1	6,4	79,5	17,8	37.092	111	50	624	785

Source: Hydrologic Basin Plans (1995), National Hydrologic Plan (1993), General Direction of Hydraulics Works.

(1) % over the total; hydroelectric demand is not included.

(2) Information about Spain in 1993.

3.- DEMANDS

The specific traits of the Andalusian use of resources are shown in appended table 3.

As for Spain as a whole, the agricultural demand for irrigation is clearly the main one, but in Andalusia, irrigated lands are a specially important activity from the economic and territorial point of view. First -and in reference to 1992- they occupy 7,6% of the Andalusian territory, in comparison with 6,7% in the rest of Spain, or, in other words, irrigated land amounts to 16% of the Andalusian cultivated land in comparison with the 13% of the rest of the nation, which means 95 hectares of irrigation for each 1,000 Andalusians, as compared to 88 hectares for each 1,000 Spaniards. On the other hand, the irrigation accounts for approximately 3,75% of the Andalusian GDP, more than double of the Spanish irrigation in opposition to the Spanish GDP; finally, the active agricultural population is 14,3% of the active population, against the national 8,5% one. Thus, if it is possible to admit the same relationship between the Andalusian and the Spanish magnitudes of the irrigation, the percentage of population dedicated to the irrigation is almost 70% higher in Andalusia than in Spain.

Summing up, irrigation has a much higher territorial and economic importance in Andalusia than in the rest of Spain, and this without taking into account the existing internal differences; in this way, the highest importance of irrigated agriculture from an economic point of view is focused on the *Guadalquivir* -two parts out of three in the Andalusian irrigation in 1997-, followed by the *Sur* basin; in the rest of the basins, the weight of the totality is much smaller, although the productivity can be very elevated, as it is the case of *Huelva* or the zone of *Pulpí*, in the *Segura* river.

The importance of irrigation is partially reflected into the sectorial distribution of water demand, where irrigation is the main component -81,8% of the consumed demand-; this percentage is superior to the national average -79,5%-, but this difference of 2,3% does not express very accurately the priority

that irrigation really has in Andalusian water use in comparison with the totality of Spain.

Certainly, the Andalusian irrigated surface amounts to approximately 20% of the total surface of Spain, while water demand is only 17,2%, which means that the annual average dotation of the Andalusian irrigated lands -6,214 m^3/ha- is 13% less than the Spanish one -7,131 m^3/ha. In fact, this unbalance is even larger, because water needs for some plants are bigger in Andalusia due to atmospheric reasons; all this points to the lack of regional hydrological resources, which has compelled to an efficient use of water that is significantly more efficient here than in the rest of Spain.

TABLE 4. DEFICIT EVOLUTION IN HM^3/YEAR

	Demands			Net resources (1)			Deficit without addit. transfers		
	1997	2007	2012	1997	2007	2012	1997	2007	2012
Guadalquivir	3.578	3.775	4.182	3.337	3.857	3.886	-241	82	-296
Sur	1.377 (4)	1.612	1.704	1.036	1.398	1.551	-341	-214	-153
Guadiana II	234	435	568	350	754	780	116	319	212
Guadalete/ Barbate	409	557	580	471	605	627	62	48	47
Guadiana I	16	18	18	12	42	42	-4	26	26
Segura	47	47	47	13	13	13	-34	-34	-34
Andalusia	5.661	6.444	7.099	5.219	6.669	6.819	-620 (5)	-248 (5)	-483 (5)

(1) Without aquifers over exploitation and with the current transfers.

(2) Information about Spain in 1993.

(3) Top previsions of resources and demands.

(4) Irrigation demand included, nowadays under-endowed.

(5) Deficitary basins only.

However, very different situations may be observed, ranging from high-tech irrigated lands, with a very high productivity of water, to old fashioned irrigated lands.

The efficiency analysis at a basin level helps us to make some considerations, though each basin, at the same time, has local conditions that may be very different. Thus, *Sur*- and *Guadalquivir*- basin water allocations -5,319 and 6,488 m^3/ha every year: notice the greater scarcity of resources in the *Sur*- combined with 120,000 hectares of irrigated land which are under-resourced and show a severe over exploitation of aquifers in their eastern part. On the other hand, a relative water abundance is available in the *Guadalquivir*, and the agricultural modernization of the coastal area contrasts with the marked obsolescence of the *Guadalquivir* Valley. Irrigated land in the rest of the basins is, as in the *Sur* basin, mainly of the shore land type, but there are other additional factors to bear in mind, such as a greater abundance of water in the *Guadiana II*, the intense obsolescence of some of the main public irrigated lands in *Guadalete/Barbate* and the very high productivity of agriculture in the coast of *Almería.*

4. PRESENT AND FUTURE WATER BALANCE

From the comparative analysis of water needs and of available resources, emerges the idea that Andalusia suffers a deficit of 620 hm^3/year. This deficit has two components, the main one is the lack of guarantee in the supply and the situations of under-allocation in supply and irrigation, which have come to the surface dramatically with the last drought; the other component, though less noticeable in a direct way but well-known as well, is the excessive exploitation of aquifers which affects very seriously to the development of a large area of the Andalusian coast.

Only the basins of *Guadiana II* and *Barbate* are free from the territorial bottleneck caused by the structural hydraulic deficit; the rest, in proportions varying from the 6% of the

demand in the *Guadalquivir* till 37% in the *Sur,* need radical and rigorous policies to solve the situation.

To correct this situation for one and ever and to face the increase of the future needs oblige to consider the possibilities of increasing the availability of new resources and to work on the demand through: an infrastructure renewal, a bigger efficiency in management, the encourage in sparing and a price policy.

The Hydrological Planning of the basin proposes, in this sense, to increase the natural resources regulation to a higher extent than in the total of Spain (36% and 41% in 10 and 20 years, versus the 10% and 16%), because Andalusia is the region with the highest deficit. This effort, which -under the hypothesis of a maximal demand- would mean a regulation rate of 54% of the natural resources, is expected to be very important for all basins, while being of course bigger in those basins with more potential -*Guadiana II* specially-, and it is based on the coordinated progress of both types of resources, surface and groundwater.

It is important to underline that, as it is necessary to correct the excessive exploitation of the aquifers, in the same way it is obligatory to control the increment in the water availability to compensate these hydro-geological extractions that are not presently balanced by natural recharge. An interesting option to be considered -most of all, in the basin of *Sur* and *Guadalete/Barbate-* consists of the production of non-conventional resources, to reach 178 hm^3/year in 20 years, through techniques of desalination and reuse of treated urban waste water for its application in the agriculture and in urban and leisure uses or in aquifers recharge.

It is necessary to underline the high cost of production for these alternative sources of supply, very superior to the cost of natural resources and transferred water. In particular, with reference to desalination, it is a must to avoid the hidden subsidisation of the produced water by means of electrical cogeneration systems; as well as to take every precaution in the use of salt water, due to the risk of accelerating the salt intrusion of the aquifer. Reuse faces two problems: high costs and the tech-

nical difficulty of regulating across different seasons; this is not the case, however, in hydrogeological recharge. For all of this, these resources have to be preserved, first, for areas suffering a high deficit, tourist areas where a special supply guarantee is required -as far as desalination is concerned-, or for areas demanding basic resources for irrigation -as far as reuse is concerned-, or for an strategic use in the global management of the supply criteria.

If the contributions of external hydrological resources are not increased, all these demand forecast and future resources being taken into account, the structural deficit will be stable. Exogenous contributions are presently limited to a 7 hm^3/year transfer *Tajo/Segura* to the regions of *Pulpi* and *Almanzora* in *Almeria*, and the recently completed transfer *Guadiaro/Majaceite*. Even if the structural deficit might be stabilised in the next 10 years, it might undergo an important increase in the 20 following years. This situation would still be the same even if the most moderate scenarios of demand growth in the Guadalquivir are confirmed.

In conclusion, to overcome the hydric deficit of Andalusia requires, apart from all the measures of demand management and the increase of the own available resources, the incorporation of external resources to the basins under greater stress, not only from areas external to Andalusia but also from internal, water-rich basins of the region.

5.- PROBLEMS AND SOLUTIONS

A.- Competences

The Administration of the resource is assigned to the State by the action of the Hydrographic Confederations (Basin agencies), which do not have the capability to fulfill their responsibility; and, as Professor Llamas stated, they lack the background that would be needed to take over the management of groundwater as is required by the Water Law of 1985. These services of the Administration have to be reinforced with a

multidisciplinary staff (engineers, economists, lawyers, hydrogeologists, and so on) which would be qualified for this function.

In the execution of hydraulic infrastructure too many administrations are involved, from the Statal Government itself, the Autonomies (several *Consejerías*) and Local Corporations (City Councils, Provincial Councils, Associations, and so on). Therefore, activity planning is too disperse.

There are two types of Hydrographic Basins in Andalusia: intra-community (within the region: *Tinto, Odiel, Piedras, Guadalete, Barbate* and all the *Sur* Basin) and intercommunity (shared by several regions: *Guadiana, Guadalquivir* and *Segura*), with the legal option at hand that the administration of the intra-community basins be overtaken by the Autonomous Community.

If it is expected that resources be managed by Users Communities, it is necessary to provide them with the most exact knowledge available of the supply sources linked to the system. There is an intense lack of knowledge on the ground-water; in order to solve these problems we have to begin with specific studies, repeatedly proposed, to have that knowledge and thus be able to act in consequence.

B.- Non-satisfied demands

The annual deficit is evaluated at approximately 800 hm^3/-year. As Professor Llamas or Professor Arrojo stated, these figures, taken from the Hydrological Plans or the White Book, may be extremely fluctuating depending on the evolution of agriculture (an example is the phenomenon of olive tree irrigation in the province of *Jaen*) in connection with the CAP - Common Agricultural Policy- or depending on the reliability of the estimates, which are generally elaborated without much background information.

But we know for sure that demands in general cannot be satisfied in many occasions, and that sparing programs, system modernization, improvements in the management and so on

will not be able to satisfy them. Indeed, we estimate that the required increase in annual capacity of hydric regulation is of 1,300 hm^3, and that it must be complemented with the integration of groundwater and surface water, the elimination of severe cases of aquifer over exploitation, the systematic reuse of treated wastewater, and the desalination resource.

The infra structural deficit in Andalusia in comparison with the national average has already been mentioned, joined to the extra difficulty in resource regulation due to the irregularity of the contributions (precipitations).

Besides, it is necessary to remember that purified waste water reuse only provides a new resource in coastal locations.

As far as supply is concerned, in Andalusia a new law is being created. According to this law the Regional Government of Andalusia will be responsible for the guarantee in the quantity and quality of the resource as well as for the correct exploitation of the waste water purification plants; all this will have a homogeneous price for all customers. In this way the resource is going to be managed optimally, based on a program or an exploitation rule operating on an infra structural network with all necessary connections and clearly established allocations and standard performance rates.

During drought periods and even without this problem, as Professor Arrojo stated, the revision and flexibilization of leases are necessary as well as the creation of Public Water Banks.

In some parts of Andalusia, agriculture is profitable and requires a classification into: a) socially beneficial irrigated lands, which anchor the population to the land: a *full-cost recovery* is not feasible; b) irrigated land requiring modernization: this type of agriculture would either allow a demand reduction in order to guarantee water allocations, or, alternatively, the creation of new, modern, efficient and profitable irrigated lands, wherein *full-cost recovery* would be at hand. It is not possible to forget that lack of equity may result from the fact that some regions have already achieved all of these improvements by means of financial exception regimes.

Even so, it is possible that the region may be forced to transfer resources between Andalusian basins as an extreme expedient, an estimated 210 hm^3/year (100 *Guadiana II-Gaudalquivir* and 110 *Guadiaro-Guadalete*) and, even more, 600 hm^3/year from external basins.

Here too I share the opinion of Mr. Arrojo based on the fact that before transferring from external basins, it is necessary to exhaust the possibilities of internal transfers through the redefinition of leases, swapping rights of use in the frame of a controlled market, and so on. In short, leases and water uses can be re-structured in the frame of a Territorial Organization Plan articulating a Sustainable Development model.

Some concretion and examples:

Almeria and *Roquetas*. The human input is supplied from the aquifer *Campo de Dalías* with an over exploitation of almost 100 hm^3/year. The consumption was out of proportion with quantities of 600 l/hab and day, because there were not any meters. The city councils did not have economic resources to install them nor to reduce the leaks in the distribution network. From the Regional Government of Andalusia an aid was offered to guarantee the supply with the condition of concession of service management to a private enterprise to which they could demand the installation of meters and the reduction of leaks. In *Almeria*, they passed from an annual consumption of almost 30 hm^3 to half of this. In addition, even to eliminate these extractions from the aquifer they decided to build up a centre to desalinate salt water with the capacity to supply the quantity they need annually, i.e. 12 hm^3. In this way, they could cede or transfer the surface water they had from the *Beninar* reservoir to the irrigated land of the western area, in order to improve the hydraulic balance of the system, considering that supply could afford the high cost of this non-conventional resource better than irrigation cost.

The excessive exploitation of the aquifers of *Campo de Dalías* is one of the cases quoted by Professor Llamas where it is

allowed to use non-renewable water during a period of time in order to obtain a benefit, provided that a recuperation program is planned or at least a program to equilibrate the balance.

It is necessary to provide the Users Community of *Campo de Dalías* or to those of the western area (*Poniente*) and to any Association of this kind with enough information to make them able to manage the resource being conscious of it.

C.- Improvement of the Hydraulic Public Domain

An appropriate management of the natural resources needs industrial and urban refuse to be returned to the medium that receives them in the proper conditions of quality, in order to avoid surface water and groundwater pollution. Therefore, it is necessary to focus the interventions according to the following criteria:

1. To complete the local sewerage network and wastewater purification plants

2. To adopt the administrative measures needed in order to guarantee the correct use and preservation of purification plants and other infrastructures.

3. Restoration and preservation of the public hydraulic domain and the corresponding forest areas.

4. Management of the public hydraulic domain by environmental integration of resources and hydraulic infrastructure.

5. Aquifer protection from nitrates pollution

2. REPORT OF THE UNESCO WORKING GROUP ON THE ETHICS OF FRESHWATER USE

Coordinators:
M. Ramón Llamas
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INTRODUCTION
By M. Ramón Llamas

This document is the result of four meetings held by the members of the Working Group on the Ethics of the Use of Fresh-water Resources (WG), appointed by UNESCO. The WG had four meetings: Paris, 28 October 1998; Paris, 10 January 1999; Oslo, 26 April. 1999; and Almería (Spain), 31 July and 1 August, 1999. This last meeting was sponsored by the Spanish Foundation "Marcelino Botín". Two more meetings were scheduled by UNESCO for October and December 1999. However, due to economic difficulties the last two meetings were not possible, therefore the task of the WG had to be finalised in a shorter timeframe.

The WG was a multicultural and interdisciplinary group. Several invited experts participated also in the meetings and contributed with their suggestions and comments,. The list of the WG members and invited experts is included in the Annex.

The report, or book, planned originally had to be reduced. Therefore, the basic result of the WG has been an Executive Summary or "Core Document" which is presented hereafter. In this "Core Document" the main ethical issues in freshwater problems have been identified and recommendations have been put forward. The Declaration of the Ethical Principles in Water Management contains the main ideas of the "Core Document". It was prepared in the Almería meeting.

This "Core Document" was sent in November 1999 to the UNESCO World Commission on the Ethics of Science and Technology. It was presented and discussed in the UNESCO International Congress on Regional Aquifers, held in Tripoli, Libya, 20-24 November 1999.

This document was the basis for the presentation and debate in the Session on Water and Ethics, which took place during the Second World Water Forum (The Hague, 17-23 March 2000).

According to a letter of 25 February, 2000, from the Director of the Division of Water Sciences of UNESCO, this document will be accessible world-wide via the UNESCO Web page. Therefore, it has the character of a public document.

What is now presented can be considered as the "Core Document" of the longer report that was initially considered. Since the originally planned report might not be available in the near

future, it was considered appropriate to submit this "Core Document" to a wider public through the series *Papeles del PAS*.

DECLARATION OF ETHICAL PRINCIPLES FOR WATER MANAGEMENT

Water is vital for human lives and development. According to the Universal Declaration of Human rights (UN 1948) every human being has the right to life sustaining resources, including water for drinking, food, industry and well being. Access to safe drinking water and sanitation, as well as, water for economic development, is essential for alleviating poverty and sustaining peace and stability.

The water crisis is primarily one of uneven distribution of water in time and place, and of sharing knowledge and resources. Water scarcity is primarily site specific and due to lack of knowledge and capacity. Current water shortfalls are site specific, must be addressed with the meaningful participation of community, regional, governmental and international constituencies

Water can be put to may uses such as for drinking, sanitation, generating energy, recreation, navigation, irrigation and others. Flood mitigation and management and the maintenance of ecosystems are also two important issues in water management. These varied uses have created usually a great fragmentation of the public agencies dealing with water management, leading to waste, low value uses, conflict and relative deprivation. Societies must seek means to integrate these uses around river basins and watersheds so as to help create and to build cooperation.

Water is the lifeblood of nature. Water pollution, water diversions, hydrological changes in general, and other activities related to land use may introduce significant changes in the ecosystems. These potential changes are not always negative but need to be assessed adequately.

Ecological sustainability or wise use of resources is not equivalent to preservation or to lack of action. Many present land-

scape and ecosystem are not really natural or pristine but cultural, i.e. co-designed by humans with nature

Today, the solution to water problems must be addressed with the participation of the local communities, regions and provinces / states. A better balance between bottom-up and top-down approaches is needed. More bottom-up approaches can bring more economic efficiencies and aligns with the UN Declarations. Commitment of funds and knowledge from out-side, as well as, inside the community should be integrated to resolve local water problems. International agencies and transnational corporations, must play an active role in that regard. They must serve local and regional needs rather to dominating those needs. Joint ventures and new forms of partnerships among international organizations, NGO's, public and private entities are needed.

Better pricing is one of several solutions to current water problems. Better pricing of water is needed. Perverse subsidies must be reduced. However, in an un–regulated market economy, pricing may lead to severe hardships for the poor, and undermine development projects. Water markets and pricing depend on legitimate and effective public sector governance for such regulation.

Water is a shared common good. It should be seen as held in trust by legitimate forms of governance which oversee rights to use and not ownership.

New technologies for conserving, harvesting, transporting, recycling and safeguarding are needed, in combination with new food technologies, to meet the needs of growing world population, urbanization, and industrial development. The demands of industry should be harmonized with the needs to utilize water for domestic use and staple foods. Traditional water management and technologies, wherever feasible, should be promoted to supplement or to be combined with new water technologies.

Transparency and accountability must be integral elements of water management, as well as, the acquisition and dissemination of water-related information. The relations of the flow of money, benefits and costs must be more transparent in all

aspects of water management. This is especially true since financial cost is the major determinant of water projects and programs. This transparency and accessibility of all water management data should apply to private as well as public water agencies. Under no circumstances should water data obtained through public expense be used or considered private property of administrators.

Public(s) who will be impacted by water management programs must be informed and engaged in all decisions related to water policies and projects. They must participate early, when options are being formed, and not informed after basic decisions on options have been taken. This is especially true in discerning and accepting levels of risk and vulnerability to natural hazards and investments to prevent disaster and to mitigate their effects. Education is necessary to transmit information to all concerned parties, as well as for providing the basis for active participation in finding solutions and implementing them.

Women and children require special educational programs. Water is a common symbol of life, spirituality, and the regenerative and creative powers of nature. Water is to be valued, not solely as a commodity but as the very substance of life. Water as such can serve as the medium for cooperation rather then conflict.

WATER AND ETHICS (CORE DOCUMENT)

INTRODUCTION

The control of water is the control of life and livelihood. Over the last two decades, several important International Conferences have called for an ethical commitment to provide for humanity's basic water needs: Mar del Plata in 1977: the Rio Earth summit in 1992; the UN sponsored comprehensive assessment of world's freshwater resources in 1997, and others. Linkages between water policy and ethics are increasingly found throughout the World.

For example, the recent South African constitution links water access directly to human dignity when its background speaks of how the failure to provide access to sanitation and water to many in the majority significantly impacted on the right to dignity and the right to life. Indeed, recent challenges to traditional engineering approaches to water management have gained prominence primarily through ethical and moral appeals, usually driven by ecological or environmental values.

World water statistics are becoming familiar. According to Water Supply and Sanitation Council, roughly 1.4 billion people (25% of the World) still have no access to water supply and 2.9 billion people (50%-60% of the World) have no access to sanitation services.

World Bank estimates show that current spending on water and sanitation in developing countries based on present strategies and approaches is approximately $28 billion per year. Based on present approaches, estimates, by various International Organizations, for additional needed funds are between $9 billion and $24 billion per year. The costs of not fixing this are real but hidden, being about three times this figure in health and diseases alone. In the developing world 90% of such diseases are related to water. The UN agencies collective declaration on occasion of the last World Day for Water (22 March, 1999) stated that the amount of donors

money necessary to bring low cost safe water and sanitation to who need it over eight to ten years was equivalent to the money spent in pet food in North America and Europe.

Floods and droughts kill more people and incur more costs then any other disaster and their damages are rising especially among the poorest of the poor. Irrigation produces one third of our food from about one sixth of our land. However, as population and food needs grow, irrigated land per-capita decreases, and irrigated infrastructure degrades thus raising the importance of reaching food security. And we could go on.

The UNESCO Working Group on Freshwater Uses Ethics has been looking at the ethics of: managing various water uses; water and food security; water and health and sanitation; water and natural disasters; decision making and water management; water and ecology; the special role of women in water; water history and broader social ethics; challenges of technology and standards of professionalism; special issues related to the recent intense use of groundwater in arid countries; water and conflict, and elements of a new ethic of water.

The following summarizes the committees views on these broad issues. It is the result of 11 background papers and 4 meetings of the working group. This summary report has been agreed to by all members of the working group. Differences in their emphasis on individual aspects of the general problem or in their judgment on the balance in reconciling principles or factors are reflected in the individual background papers.

This report is intended for informed and interested publics as well as decision and policy makers. However, its main purpose is to raise awareness that almost all decisions around water, even those often couched in purely scientific terms, have important ethical implications. Many ethical issues are raised in the background papers as well as this. Nevertheless, the Working Group has recognized and agreed on several important aspects of this topic.

The main messages of the Working Group are clear. The water crisis is mainly one of distribution of water, knowledge and resources not one of absolute scarcity. As such the ethics of

distribution and relative deprivation underlie most water decisions. While difficult to define an actual number, there is a human right to water to sustain life. And there is a fundamental human ethical responsibility for managing that water along with this right. Meaningful participation of stakeholders, especially women, in many parts of the world, is a necessary condition to realize these rights and responsibilities. So too are transparency of decision making and participation in that decision making. Water management is regional. Most responses to water require finding a balance among uses, among traditional and technological solutions and will differ among regions. However, many actors influencing regional management are powerful international corporations whose agendas must be adjusted to serve rather than dominate these regional needs. More data, better use of the data and public access to water data is an ethical imperative. This is particularly true for the anticipation and mitigation of floods and drought and to prevent these natural hazards from turning into humanitarian disasters. While conflict over water can lead to violence, the history of water management is far more of forcing humans to build practical communitarian ethics. This subsumes both the public and private aspects of water management. A new sense of water ethics at the personal and social level is needed. Most of the earth has been built and rebuilt, and today the fundamental need of water managers is for an ethic of ecological design and not just preservation.

ETHICS, WATER USES AND NATURAL DISASTERS

There are profound ethical implications in the management of all aspects of the traditional water uses such as: flood control and management; drought contingency planning and management; irrigation; hydroelectric power and agriculture; water supply and sanitation; navigation; ecological maintenance and health; public health and disease control and others. Ethical considerations concerning water uses tend to revolve around;

the distribution of benefits and costs of the services; who gets how much of the water and who pays; the distribution of risks, who is vulnerable and to what degree. Today, this includes service for nature and ecology as well as people. Ethical considerations also depend on whether the uses are seen as an end in themselves or a means to some other ends such as economic development.

The perception of water problems as absolute versus distributive or relative scarcity lead us to different ethical norms. Often the perception of absolute scarcity comes with prescriptions of conservation, efficiency, and reuse. These are critical. However, these technical terms can hide what distributional perceptions lead us to: relative deprivation, redistribution, reallocation, social unrest and even violence. Thus, to frame the water crisis in absolute terms is ethically insufficient. We must also describe and commit to dealing with the distributional consequences of prescriptions emanating from such description.

Multiple Uses

Traditionally, many countries and External Support Agencies have looked at water as it relates to goals of other sectors and not comprehensively as sector itself. This has reduced the capacity, especially in countries which are vulnerable to natural disasters, for early warning and monitoring of potential water related emergencies. It has also skewed the cost and value estimates of water and generally hidden some of the realities of risk and uncertainty behind management measures.

Water use always accompanies water pollution or qualitative degradation of water; that any impact on the process of the hydrological cycle propagate downstream of a basin and down to the sea, and; that sometime the source of water pollution cannot easily be identified. This is often the case with groundwater pollution given the usual long time (decades to millennia) that elapses between the containment activity and the appearance of the containment in springs and wells.

Natural and Humanitarian Disasters

Hazards can be man made or natural. All hazards are not disasters and all disasters are not the result of natural hazards. The link between hazards and disasters is the degree of vulnerability. The poor, because they lack options, often live where the natural hazards occur and are the most vulnerable to natural hazards. In the case of water management we are concerned with vulnerability to either too much water - floods - or too little -drought-. The difficult but growing ethical imperative, is to assess and share the risk or vulnerability to hazards and disasters as well as the responsibility to take measures to prevent and mitigate disasters resulting from hazards. Unfortunately there are many parts of the world where natural hazards can trigger broader humanitarian disasters.

Attitudes are determined and decisions made on the basis of perceived risks. But there are frequently large gaps between perceived and real risk especially in the case of rare events. Thus, there is a need for guidelines on the moral responsibilities of experts to define risk as clearly as possible and of decision makers to raise and communicate such risk and for publics and groups to actively participate in choosing acceptable levels of vulnerability. Nevertheless, it is necessary to have in mind that sometimes the poor are in the way of floods because they cannot find other better place to live.

We have obligations to keep projects from encouraging the phenomena they seek to protect against encroachment on the flood plains. We have obligations to find beneficial uses of flood plains which minimise risks while enhancing productivity when proposing projects.

We must deal equitably with asymmetries in flood management planning: especially between short term concentrated interests and long term dispersed beneficiaries. We must assure equitable mitigation of those bearing immediate costs for the benefit of those reaping long term gains.

Investments in water policy offer great potential for enhancing community infrastructure which is critical to keeping natural hazards from becoming broader humanitarian emer-

gencies and for mitigating and adapting to emergencies. Indeed, there is much room for rearranging our "plumbing" system and prospects for managing water without world catastrophe or water shortage are good. But we are beginning to understanding that explicit policies are needed to encourage or direct these change processes. And, it is these policies which could either cause, mitigate or avert humanitarian disasters.

The problems associated with droughts and floods are integrated: that are they emerge as a result of a system of behaviour around the river basin. However, institutions to deal with them, even in the developed world, are fragmented. Thus solutions tend to be ad hoc, fragmented and reactive. A more seamless web between the anticipatory and sensing agencies, reacting and planning agencies and the mitigating and relief agencies needs to evolve. Perhaps this is most clear in the collecting, processing and use of hydro meteorological data. The sensing and monitoring water organizations need to be seamlessly linked to planning, operations and disaster relief water organizations. Professionals in these organisations need to be sharing and discussing the same real time precipitation, hydrologic data, and climatic change and on disasters.

Floods and droughts are usually dealt with together because: a) both are extreme hydrological events; b) both create almost every year thousands of deaths and relevant material damage. Never the less, prediction and mitigation procedures are different: 1) today flood prediction is much more reliable than drought prediction; 2) floods are usually a short duration phenomena, from hours to a few days but drought is a longer process, usually the disastrous droughts are several years long. Mitigation of floods is related to structural solutions (dams, dikes, etc.), non - structural approaches, (water markets, insurance, restriction regulation, etc.,) or mixed conjunctive uses of surface and ground water. In some countries, the lack of planning to mitigate floods and droughts is a blend of lack of institutional capacity, improvisation and corruption. Many "normal" floods and droughts (e.g. in the semiarid countries) are considered usually catastrophic in order to obtain public

money to build emergency works which in some countries may easily be prone to bribery and corruption.

Irrigation and Agricultural Uses

Agriculture is by far the largest user of water worldwide. Agriculture is also frequently among the least efficient users of water. However, 40% of global food production stems from irrigated agriculture. The world is dependent on irrigated water and irrigation has been a major reason why the world can feed as large a number as we can.

However, agriculture can accommodate some degree of reallocation to other sectors and reallocations to higher value use are needed. But depriving the poor of sustenance to build a large reservoir is ethically not defensible. Better trade-offs need to be found which allow the general progress of the country to proceed in a more equitable manner.

While there is too much irrigation in some parts of the world, there I too little in other parts of the World. Exclusive attention to meeting food needs can exert a very high, perhaps irreversible toll on the environment and make it more difficult to meet food needs in the future. Similarly a sole focus on preserving the natural resources base can condemn millions to hunger and poverty. We must develop more strategic calculus for the balanced use of irrigation. Reducing poverty will require supplementing rained yields with irrigation through various forms of water harvesting.

Producing food is a main role of agriculture and thus ethically highly significant. Food security is a moral imperative for leaders. Ultimately food security comes from the elimination of extreme poverty. Indeed, some of the poorest countries with food security issues have hardly initiated their water development potential because of lack of resources. Food security does not mean self sufficiency for that could lead to human induced disasters.

Food can be traded and thus virtual water can be imported or exported if stable trade relations exist. When competition

sharpens farmers usually sell to the cities rather then grow food. This raises the ethical question of taking land out of production for cities.

Mechanized farmers are a thousand times more productive then subsistence farmers. Subsistence farmers need protection to have a chance to improve their productivity or jobs or provide them with other viable options.

The opportunity costs for irrigated crops must become more explicit in national water policy. Can irrigation practice remain unchanged and justified in situations of scarcity where the economic return to industrial water use is often 200 times higher then irrigation, or where upwards of 70% of available freshwater accounts for around 1-3% of the GNP?

According to experts, rapidly growing urban and industrial demands, in the developing world, will need to be met increasingly from water transfers from irrigated agriculture. The management of this reallocation could determine the world's ability to feed itself.

Without mitigating the effects of such transfers, the prices of staple cereals could increase sharply and negatively impact low income countries. There is an ethical obligation to mitigate the negative effects from this transfer.

They should be mitigated through: establishing secure water use rights; transferring small amounts from a large number of irrigators; promoting irrigation water efficiency and inducing conservation measures; reinvestment of gains from trade in the rural communities and adequate compensation of sellers and affected third parties.

One of the most important current problems in irrigation, water logging, and salinization, is usually caused because of excessive use of water and a poorly designed drainage system and not lack of water.

We must encourage more equitable distribution of water in irrigation networks because this will allow more land to be irrigated with the same amount of water.

Industrial Uses

Users should not use more water than necessary, users have to discharge waste water only after treating it to environmentally safe qualities, the water and related land use upstream should consider the propagation effects downstream and in the sea, polluters should pay for the remedy themselves, pollution control should be exercised on the precautionary basis rather than the verified basis.

During the last two or three decades, in many industrialised countries, the water volumes used for industrial uses and the related pollution have dramatically diminished and no significant economic impact in the industrial sectors has been detected. In many developing countries the same may happen if the social awareness about it is created. The hydromyth that to have polluted rivers or aquifers is almost a requirement to develop industry has to be abolished. Moreover, the poor countries can today more easily use the clean industrial technoogies developed in the industrialised countries during the last decades.

Water is so precious that in the long run pollution should approach zero. Products may be a bit more expensive but the consumer benefits from a better environment and seems also willing to pay for this benefit. Industry should be prevented from exporting pollution to developing countries. International markets may very well deny access to products that are cheaper because in some countries they can escape environmental discipline.

Municipal Uses, Water, Sanitation and Human Health

In 1955, 68% o f the global population lived in rural areas and 32% in urban areas. In 1995 this had changed to 55% rural and 45% urban. By 2025, it will be 41% rural and 59% urban. In almost all of the developing world, the rate of water supply and investment falls behind urban growth. The per capita, simple water supply investment in many parts of the world ranges

between $10, for hand pumps, to $200 for piped water delivered to houses. Simple sanitation services cost about $100 per capita and piped sewage with treatment about $3500 per capita. About three times the number of people relying on water vendors have no access to sanitation. About 90% of the wastewater in the developing world is left without treatment. In other words lack of access to safe drinking water and sanitation is directly related to poverty and poor health. At a minimum drinking water standards must be established and enforced and water sources must be protected from pollution and industrial residue.

Expansion of water supply should occur with parallel plans for sanitation. Financing for supply should be more directly linked to financing for sanitation. We must look to innovative treatment approaches beyond dilution systems. We also know that the very poor actually pay high prices for water but these are often hidden. However, while the poor pay a high unit cost as individuals, it is not clear whether or how they could pay high capital cost for large supply systems which in turn reduce their individual unit costs. We also know that huge social dislocations will occur as water is priced differently. Ethical guidelines are necessary to deal with these issues.

Water and Ecology

Ethical norms for water policy need more explicit debate on their underlying assumptions of nature and history. Since nature is constantly changing, we must avoid blindly following equilibrium and status quo notions of nature. We need to engage in active and conscious co-design of what we think nature and the water resources should be and the criteria used to describe such ends or goals.

Ecological processes keep our planet fit for life. Ecological sustainability must be a major objective in all freshwater uses. Over abstraction and water pollution must be minimised to maintain the integrity of the ecological system of which water is a vital part.

Maintaining ecological systems is not simply an additional newly identified use or need. Ecological systems function as cycling systems between the earth and the atmosphere and can perform what are often the most cost effective solution to water management. By the same token water control can benefit ecological systems by regulating flows, sustaining fish and managing multiple uses. Indeed, very little of earth is natural or completely unaffected by human influences and almost all is managed, intentionally or unintentionally. A new awareness of how humans are co-managing ecosystems with traditional methods is needed. This requires better integration of ecological values with traditional economic values which themselves are often distorted by subsidies for uses. Claiming to preserve a state of nature or to separate human interventions from a perceived state of nature can be as unethical as ignoring human impacts on the ecosystem.

Ground Water Use

Ground water development has substantially increased during the last half of this century all over the world especially in arid and semiarid regions. Underground storage does not have evaporation losses, does not flood land and is clean. More then 50% of municipal supplies comes from groundwater. Irrigated use of groundwater is often more efficient then irrigation using surface water. Indeed the long term sustainability of groundwater use can often be better then that of surface water structures such as dams, particularly in arid countries because of soil erosion.

In most countries it is urgent to create adequate institutions to manage aquifers. Most aquifers of medium or large size have thousands of independent stakeholders (mostly private farmers) and they must be made aware that if they pump permanently in excess to the renewable recharge of ground-water they may run into serious problems. They have an ethical imperative to consider the aquifer as a "shared common good"

that has to be managed in a participatory way to avoid the "tragedy of the commons."

Groundwater abstraction produces more dollars and jobs for cubic meter then surface water. Groundwater development should not be rejected or seriously constrained if it is well planned and controlled. Indeed, it is one of the keys to cheap potable and irrigated water and continues to improve public health and to alleviate malnutrition and famine. However, it is generally poorly planned and monitored. And as such can lead to land subsidence, pollution, wetland loss and over depletion. Better data, more integrated management and better legal linkages between surface and groundwater rights are must be instituted.

In a few arid countries endowed with huge aquifers the use of non-renewable groundwater, water mining, may be a reasonable and ethical option. But it is necessary to be sure that the following conditions are met:

1) Hydro geological evidence is available showing that the foreseen pumping rate can be maintained for a long period of time (e.g. one century);

2) The negative impacts of such groundwater development in springs, wetlands, subsidence, etc., are clearly smaller then the benefits provided by the "mined" groundwater; and,

3) Groundwater users and decision-makers are clearly aware that the resource will be depleted at a certain point, just as an oil field or an ore mine.

ETHICS AND WATER MANAGEMENT DECISION MAKING

Ethical implications are also clear in all aspects of water management decision making such as: planning, regulating, operating, financing and investing, designing and implementing; and, others. Ethical considerations concerning decision making and management tend to revolve around the following

questions; who participates; what are the decisions they participate in; do they have access to formulating options or only to reacting to options already formulated; how and what type of opportunity costs are considered; what is the basis of valuing, implicit or explicit, in trade-off decisions; level and type of information open to the public; to what extend are impacts included or how are they characterised; in what way do professionals interact with non professionals and the use, as well as misuse, of technical and professional information.

Decision-makers must understand the linkage between development strategies and conflicting issues of water allocation, supply and pricing and water must be seen in the context of macro-economic national and regional strategies. Decision-makers must also understand that their decisions have hidden implication for people that do not possess full rights because of poverty. They have an ethical duty to understand such implication and to equitably mitigate effects of their decisions.

Water Institutions and Financing

The current debates over private versus public roles in water management is too narrowly focused and ignores important historical realities of the developed countries which are advocating them. Today, privatisation is seen as a way to increase efficiency and to bring more water to more people, i.e. to democratize water and sanitation. However, privatisation also raises question of open information flow and transparency. Organisations, which operate to seek a profit, are frequently not as prone to share critical information on water flow or water quality as public counterparts, particularly where there is a weak regulatory environment.

Privatisation of the vendable aspects of water can lead to older notions of single purpose planning and management of water and directly contradict the ethic of integrated water resources planning. Some water services such as flood control cannot be privatised. Others, such as navigation, can only be

privatised to some degree. So pushes to privatise may encourage the fragmentation which integration seeks to overcome.

The debate over organising for water must move beyond choosing at the poles of privatisation and public bureaucracy to the myriad of possibilities between these poles. For example there is a difference between public good and a common property under public trust. The evolution of water law and water institutions historically have been inspired far more by the latter then either private or pubic ownership. Indeed, the debate in Europe is moving from private versus public to one between public regulation on the one hand and common property based forms of governance on the other. That history has been one of considering water as common property, held in trust by the State, but managed at more adapted subsidiarity levels. It is often called Municipalism and it moves from the concept of ownership rights to that of user rights. Even under this concept, state intervention is needed to ensure equity among users and to introduce needs outside the municipality such as those demanded by the river basin or watershed. International water law, the least developed of all water law, is also moving in this direction by increasingly referring to transboundary and international waters as common waters and thus subject to ethical and legal norms beyond those generated by the nation state.

Often privatisation occurs not for positive reasons but because public procurement could not generate important investments or because elected officials do not want to appear responsible for water price increases. But other options exist such as managing utilities services together and pooling financing needs or temporal averaging of interest rates to lower the cost of money. Essentially, it is the cost of money that determines water investment. In this regard, we should not forget that the initial infrastructure investment in Europe was based on massive subsidies. Thus, in those places such as southern Europe and the developing world where the initial infrastructure is not yet complete full cost recovery takes on a different ethical meaning and raising serious questions of equity then in those places with already heavily subsidised and

developed infrastructure. We must be careful in prescribing, for good reasons, policies based on experiences not shared by those for whom we are prescribing them.

Markets and Pricing

Recognising water as an economic good, now part of many declarations on water and of policies of major lenders and donors, has generated heated political debate, much fear and revealed fundamentally differing values associated with water among various cultures. Some claim that fostering the notion of water as a commodity moves public perception away from the reality of water as a common good and from a sense of common duty and responsibility toward water. In other words, there are profound ethical implications in perceiving ourselves as water citizen versus water consumers. Water as a common good focuses us on the former while private as well as public ownership rights focuses us on the second. Responsible water use depends as much on assuring fair shares of water as pricing. We should also bear in mind that in most cases what is charged is not water per-se but the services, the instruments necessary to bring water from its natural source to the user.

Of course the reality is that water is used as a factor of production and managed as a commodity, in some degree, by all societies. Whether explicit or not it is valued and it clearly incurs opportunity costs. However, all the costs and benefits are not and cannot be reduced to quantifiable currencies. Water is priced in some way by all societies. The poor often have no choice but to pay high prices. Buying water on the streets can result in the poor spending between 5-10% of their income, and some places as much as 20% of their income, on water. In contrast, in most industrialised countries low-middle class families only spend 1-3% of their income in potable water and sanitation.

Clearly, if water is not priced correctly it will be wasted. However, the reverse is not true. If water is consumerised it will also become too expensive. Proper management requires

good data on use and this has come to mean metering in many places. However, if pricing and allotment is put on a meter and not per capita basis we can easily end up subsidizing the rich with the poor. In fact, water demand is actually falling in many developed societies for a variety of reasons.

However, when this happens unit prices are often raised so as to cover debts. But for the public to accept such a situation requires that authorities be legitimate, trusted and accepted by the public. It requires confidence that transaction costs are being kept as low as possible.

Unfortunately the opposite can happen as the public sees both prices and profits and salaries going up simultaneously. At the same time funds are raised and not used for water investments. Indeed, during droughts in Britain since privatization many people have been less inclined to save water because they perceive it is for the private gain of the water companies.

Market allocation requires secure user rights and low transaction costs. However, value in use is much higher when it is controlled in terms of both time and space which usually means hydraulic structures with public subsidies. Indeed, the power to use water for economic development or as an avenue to redistribute income and wealth is really a significant political and social tool.

Thus, effective government or legitimised governance is central in any use of markets. It provides for secure user rights; assures low transaction costs; assesses and assures mitigation of third party impacts; provides means for consensus building and resolution of conflicts not solved in the market.

All variations of public and privatisation policies to deal with water require significant ethical responsibilities for enhancing the public institutional capacities. Just as we need better water pricing, we must realise the role that subsidies have played and are realistically going to play in the future. In this light, transparency of information and in decision making and broad user participation in decisions are the key ethical imperatives for water management.

Procedures, Analysis and Decision Support Tools.

In the coming years the number of people without water is likely to grow. How will they get it? Projects, in addition to conservation, will be needed. Today they can be planned in an ecologically sensitive way. But, if we wait, the pressure to quench the thirst of the poor people may force the building of ecologically unsound projects.

We must produce data commensurate with the emerging needs for decision making. As we increase efficiencies and operate water systems (urban and irrigated) closer to their margins, risk based management will become more prominent. However, such management requires good hydrological, social, economic and other data, and such data is sparse. Today the quantity and quality of hydrological data is worse than two or three decades ago. The cost to develop an acceptable database is often less then building a medium sized dam.

The relation of the flow of money and flow of benefits and costs must become more transparent. To the best of our ability, we must know the consequences of our actions. This is a precondition to ethical action. Thus, impact assessments are crucial for both informed technical and good moral decisions. However, we must move beyond being paralysed by either our understanding of such consequences or the uncertainties surrounding them. This can lead to unethical delay. We must also assure that meaningful participation occurs in the early stages of formulation of options rather then at later stages of discussing already formulated options. At this point much money has been spent and proponents are compelled to spend more time defending than creating options. Often this results in wasted capital, bitterness and no service for legitimate needs.

Traditionally benefit cost analysis and more recent risk assessment have been central to procedures for deciding on water investment. Since these tools favour quantified data, they can inadvertently be biased. We have an ethical responsibility to discern such bias and to make such analytical tools more balanced. For example, benefit cost analysis for flood

control has often only included direct benefits and costs and these are often property based. Thus, those without property become less valuable to protect and public money expenditures begins to favour the rich. So too, ecology cannot be easily quantified so it can be relegated to secondary importance. Of course, the opposit phenomena when all ecology is considered equally important and cannot be prioritised leads to biases and extremes in opposite directions! New investment decision tools, which take such bias into consideration and help us to compare incommensurate must be developed and used.

Special Role of Women and Water

Women, being increasingly the poorest of the poor, carry a disproportionate burden of inequity. Women often do not have access to property, whether land or water rights. Not addressing inequity against women, especially in Africa and parts of Asia, is a major cause of hunger. For example, because of poverty-induced malnutrition, a large percentage (over 50 percent in Bangladesh) of children is growing up stunted and with impaired learning capacity. Gender biased poverty is at the root of high demographic rates which drive water scarcity and the so-called water crisis. Promoting literacy, information, education and jobs for girls and women can go a long way to overcome water scarcity. A narrow line of argument on women and water management results in ineffective action proposals.

De facto women are the key water managers in many small villages and communities. As such they become the keys to maintenance and operations of facilities and frequently have the greatest direct interest in and bear the greatest direct impact of water procedures. Women are rarely involved in strategic decision making process regarding water resources management. Studies continually show that participation of woman is both the ethical approach and also the pragmatic approach. Those projects with women participation are more likely to be sustained and to generate expected benefits. This importance was formally recognised in the Dublin principles and clearly

implied in many other UN declarations. Guaranteeing women's rights to freshwater has a direct impact on the community. Thus, participation of women in water management decisions becomes an ethical imperative for social development.

Transboundary and International Decision Making

We should realise that everyone lives downstream. We must find ways to better co-ordinate upstream and downstream activities. Most of the world's population live in areas that depend on rivers that cross national or other jurisdictional boundaries. After many years the UN has passed a convention on non-navigable waters which outline important principles for transboundary water management such as: prior notification must be given before action; no appreciable harm should be incurred by projects, and no inequitable actions taken. These are good principles for activities on all transboundary waters and for upstream and downstream entities. But, in reality, in practice situations the principles can actually conflict with each other. Also, there is no international enforcement mechanism to assure their implementation. Thus, creating incentives for cooperation, co-ordination and joint planning and management of upstream and downstream activities is an ethical imperative. International lenders and donors must create such incentives for cooperation, co-ordination and joint actions without dictating site specific solutions. River Basins should be more of a norm for social organisation in many parts of the World. Agenda 21, as many previous documents, calls for river basin and/or watersheds to have more influence on development decisions

We have an ethical responsibility to ask how do global actors, often more powerful then countries, become accountable to such principles and regulations. This is especially true if we are advocating policies for greater intervention of those entities.

WATER AND SOCIAL ETHICS

Debates around water resources management also mirror broader debates of social ethics. The social context of ethical questions concerning water tend to revolve around: notions of water as a common good: water and its connection to human dignity and basic needs for life: water as a facilitator of well being of people: rights and responsibility toward water access: water and social justice: and the wealth generating and development roles of water infrastructure. One way to look at the close connection of water to broader social ethical concerns is to look at how water management concerns relate to what many consider universal ethical principles such as the U.N. Universal Declaration of Human Rights of 1948. For one example, the Principle of human dignity means that all persons are worthy of respect and the human person is an end and not a means. So too with water. There is no life without water and those to whom it is denied are denied life. Water for all and meeting minimum basic needs are vitally tied to the principle of human dignity. The ethical principle of association means that the person is social as well as sacred. The principle of participation means that individuals, especially the poor, must not be shut out from participating in those institutions, which are necessary for human fulfilment. Both these ethical principles mirror a major theme; namely, that those whom are impacted and who would benefit from water (which is vital to their fulfilment as humans) must participate in its planning and management.

The ethical principle of solidarity, or that we are all connected, teaches that we are our brothers keepers and loving our neighbour relates directly to our growing sense of interdependence. More than almost any other resources issue, water continually confronts humans with their upstream and downstream interdependency and calls humanity to more solidarity. Indeed, the current call for integrated water management could be seen as a direct subsidiary teaching of this principle. Solidarity is supported by the principle of human equality, which appeals to the almost primordial sense of

fairness found in humans. This is commonly taken to mean rendering to each person his or her due. In a sense this describes perfectly our challenges in river basin management today.

Both ethical principles are furthered buttressed by the ethical principle of the common good. The common good is understood as the social conditions that allow people to reach their full human potential. By almost everyone's definition water is a common good. Our arguments are mostly about how to manage this common good - water. This principle reminds us how ethically important the management of water really is. It is a vital facilitator to reaching full human potential and realisation of human dignity. Without good water management or with poorly skewed water management human potential and dignity are diminished for all and denied to some.

The ethical principle of stewardship teaches respect for creation and moral responsibility to that creation. However, it also calls for wise use of creation and not extreme reverence for nature. Indeed, much of water management is about finding an ethical balance among using, changing and preserving our water resources and land. The World consensus on sustainable development can be seen as an ethical norm directly descendent from this principle. For what is sustainable development, if not achieving balance among the wise use (utilitarian) and respect for intrinsic value of the resources? Indeed, many of the policy recommendations for sustainable development are couched as ethical norms for actions.

Christianity, Islam, Buddhism, Hinduism and most other faith traditions throughout our world mirror these principles. For example, Hindu tradition considers water as a powerful media of purification and as a source of energy. In the Regvada, a water prayer is offered; "The waters in the sky, the waters of rivers, and water in the well whose source is the ocean, may all these sacred waters protect me". In Islamic tradition, the Shariah, which many feel is a better term to use than law, literally means the "source of water." The Shariah is the source of life in that it contains both legal rules and ethical principles. It tells people water is: proof of God's existence, unity and

power; proof of God's care, and; proof of resurrection as water restores life every day. In the Qur'an there are sixty references to water and over fifty references to rivers. There are many references to distribution of water. It's statements on life preserving water for the individual and sharing small quantities of water such as obligations to give water to visitors are well known. It says less about what might be called its macro economic uses. However, obligations at such level can be implied. For example, the Qur'an states that water should be divided among people and that the resources should not be monopolized by the powerful against the poor.

Water is one of our enduring human symbols of life, regeneration, purity and hope. It is one of our potent links with the sacred, with nature, and with our cultural inheritance. It offers a medium for a global project that unifies humanity in a single cause for peace, stability, amity, and ecological sustainability. The healing powers of water. The simple pleasure of drinking pure water and the awesome power of waterfalls have the potential of bringing us together as one with each other and as one with nature. Water offers a medium for creating a culture of peace.

ETHICAL ISSUES OF PROFESSIONALISM AND TECHNOLOGY

No doubt, technology will change how we look at water. Some futurists predict that in the next twenty five years, falling energy cost are likely to reduce the cost of desalinizations to about one third of what it is today; research into genetic foods are likely to reduce water needs significantly in the short term; the technology of dry composting now allows us to separate the need for water from sanitation.

Together if these three trends were to come true, they would effectively eliminate much of the water supply problem often driving public 'gloom' and "doom" scenarios. This is good. However, we must remember that they will not eliminate the

needs for multipurpose management and integration of flood management, agricultural uses and many of the other ethical issues brought up earlier. Nor would they eliminate water mismanagement driven by institutional inertia. Indeed, such blessings might actually compound some problems by making it OK to continue with some bad consumptive and other habits.

It is unethical to discard technological solutions, based primarily on unidimensional concerns, just as it is to discard traditional approaches. Both are needed. Water policy should not let the controversies over dams colour major needs for technology. As water systems begin to reach their limits, authorities face the immense ethical imperative of managing residual risk to society. As societies begin to operate water, sanitation and irrigation infrastructure close to their limits of efficiency they may also reduce their capacity for flexible response to extreme hydrological events.

The ethical basis of professionalism is changing. We are moving from a traditional paternalism, often found in engineers in the past and in environmental regulators today, to a newer notion of informed consent.

Ecological disputes must overcome the syndrome of advocacy science if we are to preserve the legitimacy of the scientific enterprise which is so necessary for water management. It is unethical to use adversarial science to persuade publics especially under conditions where there is fundamental disagreement among scientists and where even the models and data themselves are weak.

We must ask the question, What are the ethics of making the price of agreeing with new ecological perspectives a denial of the relevance of a water managers past work and a often moral indictment of his/her "historic sins'? We must move beyond simple impugning the motives or ethics of past water managers behaviour based on today's knowledge.

New ethical codes for professional water resources engineers and manager need to established. National, regional and state and local governments, in partnership with consumers, users and NGO's all have a role in this. One example of this is the NGO initiative of ISO which shows how such partnership can

work in cases where industry itself is establishing its own constraints.

The Special Case of Dam Construction

Dams were among the first targets of recent growing environmental awareness. For many years structures and dams were the solutions employed for most water management needs. Indeed, dam construction and control of nature became synonymous with civil engineering and water management. In short a means, dams and structures, became ends in themselves. Dams were also symbols of the 19th century's triumph of machines and technology and they provided an important symbol beyond their impact and performance. Indeed, the mirror image of this "ends–means" confusion now appears in some extreme ecological appeals in many current debates. In this instance, any proposal which includes taking out a dam becomes good: in other words, the –taking a dam out– becomes the end.

There were 36,235 large dams (defined as higher then 15 meters) in the world in 1986. The average number of dams built during 1983-86 was 267 annually. The number under construction in the world was about 1,242 in 1994. Many dams provide clean and renewable energy, enhanced ability to manage extreme fluctuations, greater capacity to generate economic development and multiple use of the water and greater predictability to and protection of the lives of many. However, they come at socio-economic and environmental costs which are sometimes unacceptable. While many criticisms are valid, the focus on cost without consideration of social trade-offs and benefits is unethical. So too is the all too familiar pattern where constructors proceed without meaningful participation of those impacted by the dam and sometime even with intimidation. The negative impacts of development on traditional communities and the poor must be clearly defined and fairly dealt with. Arguments must move beyond either a dam or no dam. The discussions need to broaden into the size, site selection,

managerial procedure and efficiency which actually have more decisive impact on society.

Despite the opposition to dams in developed countries, more dam construction is needed and warranted in some places. The ethics of dam construction call for minimising adverse effects, environmental and social effects of the construction and for withdrawal of the maximum efficiency from the existing reservoirs. Deciding on structures should follow ethical procedures such as: 1) assuring that existing reservoirs are fully utilised; 2) alternatives are exhaustively examined; 3) selection of a reservoir option is made under sustainability criteria; 4) reservoir size is determined using the least marginal environmental impact rule; 5) democratic decision making processes and social care are followed; 6) mitigation measures are followed; 7) reservoirs is post audited over the full life cycle of its existence; and systems approach is taken and current information technology is utilised.

WATER AND CONFLICTS

Conflicts over water can and have caused violence. If water stress increases so too will social violence. However, violence at the personal and local level does not generally translate into the broader regional and international levels. In fact water has been far more a medium of building community than a cause of war. Water management also confronts us with the reality of conflicting human rights. For example between preserving a traditional way of life and creating new opportunities for growth and reduction in malnutrition.

Conflicts over water arise from a variety of reasons. Although the problems associated with water crises are usually integrated around a watershed or river, those institutions both affecting them and responding are not usually integrated. Incompatible goals regarding the access to, control over and unsustainable use of transboundary water systems themselves.

Problems created by maximising single purpose uses without co-ordination.

Water is forcing us to rethink our notions of security, dependency, and interdependency. Increased interdependence through water sharing plans and infrastructure networks is often viewed as increasing vulnerability and dependence and reducing security. However, there is an alternative way to look at interdependence. They can be seen as networks, which will increase our flexibility and capacity to respond to exigencies of nature and reduce our vulnerability to events such as droughts and floods and thereby increase security.

This flexibility addresses the fear and insecurity that have driven humans to reduce the uncertainty and to build predictability and safety into what was often experienced as a harsh environment. While often challenging the engineering mentality, this same fear, that we are destroying life, inspires environmental concerns. Both carry the ethical right to life even though they produce conflicting views of what we should do. Somehow water forces us to go deeper than familiar adversarial positions and confront what we really share - this respect for life and well being.

Water can be a superordinate ethic or value, the appeal to which, is capable of coalescing conflicting interests and facilitating consensus building within and among societies. The symbolic content of water as cleansing, healing, rebirth and reconciliation can provide a powerful tool for cooperation and symbolic acts of reconciliation's so necessary to conflict resolution in other areas of society. In a sense, negotiations over water use, itself, could be seen as a secular and ecumenical ritual of reconciliation and creativity

In a world of increasing austerity and in an international system where incentives are crucial because of the lack of international enforcement mechanisms, what are the ethical guidelines for international lenders and donors, especially regarding the conditioning of water resources lending on cooperation among stakeholders among and within countries? In addition the strategic focus should be on anticipating and acting to prevent, rather then simply reacting.

TOWARD A NEW ETHICS OF FRESHWATER MANAGEMENT

The Working Group agrees with the call for ethics to help guide water resources management into the next century. We must make commitments to: provide for basic human water needs; to provide for basic water needs to maintain ecosystems; to set and maintain minimum water quality standards; to prevent pollution; take precautionary action to prevent possible tragedy; to take responsibility for downstream users; to save water and use it efficiently; to minimise or not impair the renewability of freshwater stocks and flows; to better and more accessible water data; to prevent and manage water conflicts peacefully, to avoid "perverse subsidies" which are noxious for the economy and the environment, and; to make all aspects of water management more participatory.

In the longer run, we need social ethics which help to bring a new balance around water decisions; that helps us guard against "gigantism" and "technological triumphalism" on the one hand but equally important, against an unwarranted reverence to over romanticised past, a deification of nature and a "technophobia."

Here are three elements for such ethics.

First, the ethics we require is not simply one of preservation. They should be built teleologically; on a sense of purpose and on an active co-designing with nature. Even restoration and preservation have come to mean conscious intervention or partnerships with nature. We are intervening to create some preferred state of co-existence with nature. Nature is not static, it is in continuous evolution. The destructive powers of nature can be greater than anything that humans could dream up.

Second, new ethics must be based on a balance between traditional human values regarding conservation and the use of new technological advances. Rarely have either worked alone and it is time to stop characterisation them: one versus the other.

Third, new ethics, even in our advanced technological age, should be based on finding a new balance of the sacred and utilitarian in water. We need to rebalance the sanctity and utilitarian; the rational and emotional; in water resources management. Water resources, managers need to understand the wisdom encoded in traditional religious and secular symbols and rituals surrounding water.

Throughout history, water has been treated as both an end and as a means. In truth it is both. In arid areas, water is more likely to become an organizing principle for society. If thought of as a means, it is easy to see water as a factor of production and in utilitarian terms. But as an end water often takes on a sanctity and value beyond utilitarian exchange.

Talking of such a balance means to appreciate the intrinsic and broad value of water that is not captured in traditional utilitarian calculus of transactions. It is to recognise that water is not only a means to other goals, it is also important as an end in itself.

Balancing the sacred and utilitarian in water is not new; although our era's balance point is. From the ancients respect for sanctity of water, to Thales' and Hippocratic notions of water as source of life, to the Christian fathers notions of water as producer of life, to Herodotus' inventing geometry to predict flooding on the Nile, to Mayan, Khmer and other priests who intervened into the uncertainties of planting and harvesting, to the Renaissance Fontianeri's (men who combined knowledge of hydraulics, physics, science and hydro-mythology), to 19th century technologies "conquest" and democratisation of water; humans have been constantly rebalancing the sanctity and utilitarian in water.

CONCLUSION

Today, our technology tells us that there is enough water - if we cooperage-. One of the most important elements for cooperation is something negotiations experts call superordinate values. These are values beyond immediate utilitarian values to which competing parties can identify. Rekindling the sense of sacred in water, a superordinate value, is one way to facilitate the escalation of debate on water cooperation to higher levels and thus impact the capacity to reach cooperation and to manage conflict. This balancing is not new: it is what we humans have being doing throughout history as we constantly learn how to deal with environmental uncertainty.

ANNEX

Names and Addresses of Participants.

I.- Names and meetings attended.

Members of the **COMMISSION ON THE ETHICS OF SCIENCE AND TECHNOLOGY** who attended meetings

Mrs. Vidgis Finnbogadottir (Paris 1998 and 1999)
Prof. Mr. Kuniyoshi Takeuchi (Oslo 1999, Almería 1999)
Prof. Barry Ninham (Paris, 1999, Oslo 1999)

Members of the **WORKING GROUP ON THE ETHICS OF THE USE OF FRESHWATER RESOURCES**

Prof. Ramón Llamas Madurga (all meetings)
Coordinator of the Working Group
Dr. Jerome Delli Priscoli (all meetings)
Assistant Coordinator of the Working Group
Dr. Alice Aureli (all meetings)
Dr. Bernard Barraqué (Paris 1998, 1999, Almería 1999)
Miss Asmahan El Batraoui (all meetings)
Prof. James Dooge (all meetings)
Prof. Fekri Hassan (Paris 1999, Oslo 1999, Almería 1999)
Mr. George Kutukdjian (Paris 1998 and 1999 and Oslo 1999)
Miss Medha Patkar (Paris 1998)
Prof. Monica Porto (Paris 1998, Oslo 1999, Almería 1999)
Dr. Andras Szöllösi-Nagy (Paris 1998 and 1999)
Prof. Martin Trolldalen (Paris 1999, Oslo 1999)

Invited Experts

Dr. Michael Acreman (Almería 1999)
Dr. Chris Barnes (Almería 1999)
Mr. Wulf Klohn (París 1999, Almería 1999)
Prof. Ruben Porto (Almería 1999)

Spanish invited experts to the meeting at Almería

Mr. Ricardo Aguilar Rubio
Prof. Pedro Arrojo
Dr. Vicente Carcelén
Prof. José Javier Clúa
Prof. Emilio Custodio
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