WATER MANAGEMENT IN ALPINE REGIONS

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I – HISTORICAL ANTECEDENTS

I.1 Hydraulic Structuralism in the 20th century.

A comparison of Spanish and American hydraulic history may seem pretentious given the vast size difference between the two countries. Nevertheless, it is quite interesting to observe how since the end of the 19th century, despite different cultural and historical realities, parallel processes exhibiting profound similarities emerged. Therefore, we will use the experience of both countries as a reference for a water management model which has dominated the entire world over the course of the 20th century (Arrojo et al - 1997).

The fascinating history of the colonization of the North American west showed water to be one of the main protagonists in how the colonization process was organized. The first colonies introduced by Spanish missionaries along the California coast between Los Angeles and San Francisco benefited from the introduction of Arab irrigation methods with their refined drainage techniques.

Later, in the American Midwest, Mormons used their legends and beliefs to make the introduction of irrigation a centrepiece of their colonization strategy. Their vocation as "*God's chosen people*" was to transform the desert between the *Green River* and *Snake River* into a new American Promised Land. At the end of the 19th century, they controlled approximately 2,500 hectares of irrigated lands in the middle of the desert. (M.Reisner-1993). After successfully irrigating alluvial areas (with good natural drainage), they met with failure in the steppe regions where salinity and

drainage problems sorely tested their scarce knowledge of irrigation. But they were soon applying the Arab drainage techniques used in the irrigation systems of the Spanish missions in California.

The repeated failure of private initiative to construct the great water works made possible by civil engineering led to the application of Powell's thesis to the effect that the projects should be implemented using the financial and management capacity that a modern, well organized state could offer. In 1902, the United States Federal Government launched the first public program of great irrigation works through the newly formed Bureau of Reclamation. In less than half a century, thousands of great dams were built, generally in mountainous regions, along with tens of thousands of kilometres of large canals through the most rugged topography and inhospitable deserts, the result being that millions of hectares were irrigated on behalf of the "public interest" through public financing.

Another use which would justify the construction of large dams in the general interest was hydroelectric power. Beyond its economic value, hydroelectric power production became a military priority due to the aeronautical industry's need for aluminum. In fact, American military supremacy during World War Two is largely attributable to its capacity to produce hydroelectric energy in order to satisfy the voracious aluminum industry's appetite for aluminum to build combat aircraft.

In Spain, hydraulic engineering traditions have their historical roots in the ancient Roman Empire, although it is in Medieval Muslim Spain where cultural developments in Al-Andalus would foster the most advanced engineering, drainage and irrigation techniques of the era.

By the 18th century, the French "Enlightenment" would lead to more advances in civil engineering in the area of grand navigation canals which, in Spain, would stimulate progress with regard to

irrigation-related objectives. Important projects such as the Imperial Canal of Aragon, the Castilla Canal, the Murcia Canal and the construction of important dams permitted the implantation of irrigation systems over tens of thousands of hectares. But it is during the 19th century when the development of hydraulic engineering establishes the foundation for modern hydraulic structuralism. A range of laws encouraged the private sector to take the initiative with regard to irrigation and regulation works (V.Pinilla -1997). Nevertheless, the few attempts that were made failed in Spain as they had in the United States. These projects required large investments and long term amortizations which rendered the private finance model untenable.

Costa's *Regenerationist Movement*, except for multiple contextual differences, would generate theories, approaches and projects similar to those proposed over the same time period by Powell in the United States. In similar fashion, Costa defended the introduction of public initiative as a key to promoting large scale irrigation and water control works. In 1902, the same year in which the first public, large-scale irrigation plan was drawn up in the United States, the National Plan for Hydraulic Development ("*Plan Nacional de Aprovechamientos Hidráulicos")* was approved in Spain. Soon, water management was organized by catchment basin, and the Hydrographical Confederation of the Ebro River became the first Catchment Basin Agency in the world.

Nevertheless, in 1936, the civil war and the victory of fascism marked a hiatus in Spanish social, cultural and political life preventing the implementation of regenerationist hydraulic plans for almost two decades. In the 1950´s, these plans would be reintroduced thus giving rise to a sort of "Hydro populism" in the service of the regime which became quite popular.

After the death of Franco, cultural inertia combined with existing interests would prolong both the existence of a hydraulic bureaucracy and its attendant power structures as well as that of old ideas, conceptions and structuralist strategies. (Diaz Marta-93).

Consequently, as a result of having made the development of large hydraulic works a priority irrespective of the political ideology of the government in power, Spain is currently one of the countries with the most hydraulic infrastructure per habitant and per square kilometre in the world with 53,000 hm^3 of reservoir capacity, the same as that of California which is similar in size (Arrojo et al-1997).

I.2 The crisis of the structuralist model and of supply strategies.

By the 1960´s in the United States, congressional representatives of the Eastern States (who contributed the major part of public funds) began to protest against the large investments in hydraulic mega projects in the Western States. As a result, cost-benefit analyses and the refilling of government coffers depleted by these investments within reasonable time periods became requirements. Nevertheless, repeated failures to comply with these commitments called into question a management model which had held sway for half a century.

Throughout this period, the Bureau of Reclamation (as a civil institution) along with the Corp of Engineers (as a military institution which promoted civil works projects) became all powerful lobbying and pressure groups. The large-scale and frequently shady dealings involving construction, and hydroelectric power, along with agricultural and urban land speculation in connection with large-scale hydroelectric projects led to the invention of the term "*Pork Barrel*" to refer to the system of public financing of large-scale hydraulic works in the United States.

The disappearance of salmon in the great rivers along the Pacific coast and the flooding of emblematic natural areas began to weigh on the public conscience. Public pressure, for example, blocked the construction of "Echo Dam" on the upper Colorado River, but did not, on the other hand, prevent the construction of "Glen Canyon Dam." In 1963, millions of Americans reacted with consternation to images of the flooding of 320 km of the emblematic Grand Canyon of the Colorado and its tributaries in order to produce electricity.

Tenacious criticism of the financial accounts, on the one hand, and increasing ecological sensitivity, on the other, would make the system totter on its foundations. In 1978, President Carter, confronting powerful lobbies dominating the capitol, vetoed the projects on the so-called "*hit list*" which was essentially a long list of large-scale hydraulic projects that were to be definitively abandoned. Thus, the heralded change in the approach to water management strategy was made explicit. Dozens of large dam projects intended to supply Los Angeles, such as the Klamath River or Columbia project with its 2000 kilometres of canals and 450 km of tunnels, etc…, were set aside (Reisner- 1993).

In Spain, while Franco was in power, the regime's ruling families, along with large electric and construction companies turned large-scale hydraulic projects into private business opportunities based on the use of public funds. In an authoritarian regime in which criticism was impossible, bureaucratization and corruption profoundly degraded the model.

Unlike in the United States where major urban areas above a certain size were never flooded (with the exception of Hispanic and Indian settlements), in Spain, the construction of more than 1300

large dams resulted in the flooding of numerous inhabited valleys leaving hundreds of towns, especially in mountainous regions, under water (Arrojo et al-1997).

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In addition, a large number of fluvial ecosystems experienced serious ecological degradation resulting in the extinction of species as emblematic as the sturgeon, salmon or eel. Furthermore, water quality and the regenerative capacity of fluvial ecosystems was seriously compromised as a result of which the consequences of a clearly unsustainable water management model became manifest.

In the decade of the 90´s, the announcement of a National Hydrological Plan (PHN) which would involve the flooding of two hundred valleys gave rise to a public protest movement against the construction of new dams which gained momentum as a result of the proposal to construct large dams along the Ebro River. Beyond the directly impacted, this movement mobilized more than a million citizens against the PHN and in favour of a New Water Culture (Nueva Cultura del Agua) between 2001 and 2002. This massive mobilization resulted in the blockage of European funds intended to make the execution of these proposed large-scale works possible. After the elections, under the new Government, and within legal framework of the new EU Water Framework Directive, the repeal of the Ebro dam project closed the process in a way similar to the Hit List veto in the United States (Arrojo-2003).

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II- VALUES AT STAKE IN ALPINE REGIONS.

Water and aquatic ecosystems management implies the management of resources which change in depending on the characteristics of the fluvial ecosystems and surface area of the catchment basin in which they are found. In headwaters regions, which usually coincide with alpine areas, the most important values which come into play with regard to water management are:

- The regional value of the valleys for population settlement.
- Environmental values tied to landscapes and mountain ecosystems.
- The hydroelectric potentiality of high elevation waters.
- Values and uses tied to high water quality
- The opportunity value inherent in the orographic potential for constructing control works.
- Recreational and emotional values frequently connected to the development of services.
- The value of downstream irrigation.
- Values, environmental uses and services downstream, along with their economic benefits.
- The relationship between ethical values and the maintenance of an equitable distribution of socio-economic resources at the inter-regional level.

II.1 The regional value of valleys for population settlement.

The World Commission on Dams, in its final report, published in London at the end of the year 2000 recognized that, although they had precisely calculated the millions of cubic meters which could be stored in more than 50,000 large dams constructed in the world over the course of the 20th century, they had been unable to calculate how many people had been forced out of their homes and towns when regions were flooded by these dams: *"… The overall global level of physical displacement could range from 40 to 80 million…"* (WCD-2000)

From my perspective, what impresses me most about these figures is not so much their magnitude, but rather the lack of knowledge and level of imprecision surrounding them. Declaring "*from 40 to 80 million"* involves the recognition that it is simply not known…A "*hydrocaust"* carried out stealthily and silently.

The major part of these displacements occurred in mountainous regions where the affected populations are usually considered marginal. The WCD report itself underscores that such calculations refer only to those people directly affected by flooding of their homes, while it is noted that the number of people forced out of their homes as an indirect consequence of dam construction is much higher than the number forced out as a direct consequence.

The greatest affliction borne by the mountainous regions as a result of the impact of large dams is, without a doubt, the loss of social networks, both in the flooded valleys themselves and in other areas connected to and dependent on the flooded regions. Frequently, the flooded valleys integrated entire regions as a result of having constituted central cores with their attendant health services, schools, commerce, etc... Although we are discussing water management in mountainous regions, the most precious and scarce resource is usually the habitable regions themselves, in other words, the valley-bottoms rather than the water.

Mountain populations often consist of socially and politically vulnerable minority groups. Difficult communications and hard living conditions have created distinct and relatively closed ways of life which have favoured the conservation of identity markers and cultural values whose preservation is extremely important not only for the communities themselves but for society as a whole. Nevertheless, these elements of social and cultural identity are as fragile as they are valuable. The

breaking up of regional valley settlements usually results in a Diaspora and in the destruction of the community as such and, therefore, in the irreversible disappearance of those values. For this reason, economic compensations and resettlement in other areas (which are not even guaranteed in many cases) do not guarantee the continuing cohesion and survival of these communities.

In many cases, as we shall see below, the ecological impact of hydraulic policy on rivers located in headwaters regions has had the most severe socio-economic consequences on riverbank communities downstream.

II.2 Environmental resource values connected to mountain landscapes and ecosystems.

Mountain regions have historically been poor. Severe climates and rugged relief combined with transport difficulties have hindered both agricultural, economic and other development (for example in industry, commerce,…) while keeping populations low. For thousands of years, nature set limits to growth and the land's inhabitants respected and wisely managed these limits in a sustainable way. This permitted the conservation of ecosystems in their unspoilt state, while in other regions, such as in grassland areas, human settlement was characterized by a harmonious and sustainable relationship with the natural environment.

With industrial and urban development, these lands were abandoned by migrants leaving for the cities. Mountain regions came to be considered as inhospitable areas with little value to society as a whole. Nevertheless, the accelerated environmental degradation experienced in urban areas, and even in a large number of rural areas, has generated a growing appreciation for the role of mountain areas in conserving environmental quality and promoting health. In summary, the contradictions inherent in the unsustainability of our development model have led to the emergence of an

appreciation for ecological and aesthetic values related to mountain landscapes in regions which until recently were marginalized and abused.

In many countries, mountain areas constitute a priceless repository of pristine natural heritage, as a result of which nature and national parks, biosphere reserves and other entities set up to protect the integrity of this heritage from the encroachments of our destructive consumer-society abound. A large number of these threats are connected to water management in high elevation basins: the wholesale construction of large dams to regulate water flows, the proliferation of hydroelectric miniplants or the construction of ski resorts with artificial snow are examples of these.

In this general context of relatively well preserved natural environments, rivers, lakes and wetlands in the headwaters of catchment basins tend to be the best preserved aquatic ecosystems. The obvious dependence of middle and lower elevation river sections on high elevation river flows means that the conservation of headwater regions has ramifications which extend far beyond the importance of conserving the ecosystems which they host.

When we discuss the importance of conserving headwaters, we are referring not only to water quality or to aquatic ecosystems in their unspoilt state, but also to resource values connected to the conservation of regions, forests and vegetative cover taking into account their interconnectedness with rivers, lagoons and aquifers. The extent to which these regions are conserved will influence erosion intensity, run-off and the rate of percolation which feeds aquifers in their role as natural river regulators.

Lastly, it is necessary to underscore that ecological dependence is not one directional, from the headwaters down to the middle and lower elevation river courses; in fact, the way in which these

lower courses are managed also has an important impact on higher regions, especially with regard to the conservation of migratory fish species such as salmon and eel.

II.3 The hydroelectric potentiality of water at high elevations.

Above and beyond their ecosystem and environmental functions, river flows in fluvial headwater regions store high levels of hydroelectric potential energy. This high level of energy results, first of all, from the potential energy which these waters have with respect to sea level, and, in addition, from their low contamination levels and low concentrations of dissolved salts. We will analyze the ramifications of these characteristics in the next section. This potential energy can be exploited as hydroelectric energy which offers a renewable energy source with high opportunity value. It can be characterized as high-quality energy for three fundamental reasons:

- **Greenhouse gases are not produced;**
- **it is renewable;**
- **it is a variable source whose production is concentrated during peak hours.**

Nevertheless, although this energy source is characterized as clean, the infrastructures required to produce it create an environmental impact which is not generally seen in this positive light. In many cases, at issue are large reservoirs whose societal and environmental impact is well known; in other cases, what is at issue are the miniplants which frequently result in the drying up of long stretches of riverbeds in mountainous regions, or, at least, in their ecological degradation and the loss of many uses such as white-water rafting, fishing, bathing, etc... .

II.4 Resource values and uses connected to high water quality in mountainous regions.

In the upper reaches of fluvial basins, water quality tends to be high because it has not yet received contaminating spills or saline drainage. In arid regions, such as the Mediterranean, the saline content of river flows is particularly important. Declines in water quality related to salinity, resulting from both human intervention and natural processes such as salt leaching in the drainage from brackish water areas, negatively affects the use-value of this resource. This progressive decline in river-flow quality from its essentially pure state in headwaters regions down to its final mixing with sea-water in estuaries involves a measurable decrease in energy in all cases due to the energy required to restore the water to its pristine state using reverse osmosis.

The productivity problems engendered by saltiness in irrigation waters are well known; in addition, the range of possible uses presented by such water is drastically reduced. Without a doubt, the extent to which water quality is an important resource value reaches its maximum expression in the willingness of consumers to pay for drinking water. The high market value attached to mineral waters (payed for at more than ***€/m3), reflects the increasing importance of health as a value. As is well known, these high quality waters generally originate in fluvial headwater areas. The tendency of multinationals to appropriate springs is indicative of a business approach which revolves around marketing these high quality waters.

II.5 The opportunity value of orographic potential for setting up control works.

The rugged relief found in mountainous regions has constituted a value which has played an extremely important role in hydraulic policy as practiced over the course of the 20th century.

As one would expect, it is in these territories where the reservoir basins and closed drainage basins exist which permit the highest ratio of dam regulatory capacity to unit price invested. Along with these factors, the fluvial regime itself and the intended uses of the river flows constitute key determinants of control efficiency. In sum, what is involved is an *opportunity value* derived from the *minimization of unit regulatory costs*.

As one would expect, the construction of more than 50,000 large dams over the course of the 20th century in the most suitable closed drainage basins has resulted in the imposition of the law of *diminishing marginal returns as marginal costs increase*. The study on the evolution of the *control efficiency* of dams in the United States published in 1984 by the United States Geological Survey is highly significant. After undertaking a detailed study on 100 largest dams in the United States constructed between 1920 and 1960, the report concluded that the volume of flow regulated as a function of the physical capacity of these reservoirs decreased by a factor of 35.

In this sense, the opportunity value of alpine regions as areas favourable for this type of regulation projects has been decreasing as new project costs have increased and control efficiency continues to decrease.

II.6 Recreational and emotional values frequently connected to the development of tourist amenities.

The increasing appreciation of environmental and scenic values in mountainous regions centres particularly on rivers which have become key areas for the construction of tourist infrastructure. Activities such as canoeing and white-water rafting, along with others such as canyoning or sports fishing have changed realities and perspectives for many mountainous

regions. In many cases, beyond this type of activities, rivers are coming to define regional identity while becoming key tourist attractions.

Often, these values are intangible and difficult to measure in monetary terms in a consistent way. Nevertheless, in many cases, the activities and services promoted around mountain rivers permit the painting of an accurate portrait of economic activity through an analysis of the *profits* generated by these activities, or through a calculation of the *consumer surplus* achieved using methods such as "*cost of trip*." The scientific-technical articles quantifying these environmental intangibles related to recreational and emotional values published over the last two decades reflects an increasing appreciation of their importance as society has become more aware of these values.

In many cases involving large dams, the monetary quantification of this type of impacts has resulted in calculations of environmental costs similar to the size of the investment budgeted for the construction of the dam itself (Arrojo et al- 2000).

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II.7 The resource value of irrigation downstream.

Especially in arid and semiarid basins, irrigation possibilities have fomented economic and social development. As was explained in the beginning, since the beginning of the 20th century, the technical capacity to control massive river flows by means of large dams has (McCully 2004) made possible the cultivation of approximately 300 million hectares according to the FAO. (Another 130 million hectares are irrigated using subterranean water) (Llamas et al 2005).

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Irrigation in these regions and climates not only doubles crop production, but also guarantees harvests (freeing them from the effects of variations in rainfall) and permits crop diversification.

However, the introduction of new irritation works, which until a few decades ago was considered an engine for development, is now being questioned for a variety of reasons:

- The law of *diminishing marginal returns as marginal costs increase* calls the profitability of this type of projects into question.
- The steep decline in the profitability of agriculture, accelerated by processes of market liberalization, has caused the negative inflationary differential in the sector to surpass the growth in productivity (Arrojo-1998).
- The sustainability crisis affecting aquatic ecosystems and its grave social and environmental consequences as a result of the construction of large dams in mountainous regions
- The degradation and salinization of the soil in irrigable regions which now affects 20% of the world's irrigable land area according to calculations published by the *World Commission on Dams* in its final report (WCD-2000).

In addition, the "*up for bid*" models characterized by massive public subsidies upon which has depended the development of large-scale irrigation has promoted inefficient use with the result that these projects have lost economic rationality.

Lastly, in each case it is necessary to carefully analyze the societal values at play, beyond the increases in productivity associated with irrigation. In many cases, these transformations have involved land redistribution, thus generating profound changes in social and economic structures. In other cases, under the guise of the common good, the interests of rich and influential corporate sectors have been favoured. This is illustrated in the case of the Dez dam (McCully-2004), the largest dam built in Iran during the 60´s. The project aimed to irrigate 80,000 hectares and benefit thousands of small-scale growers. However, the Sha decided that foreign agriculture and livestock companies (Chase Manhattan Bank, Bank of America, Shell, John Deere&Co, Transworld Agricultural Development,...would achieve more efficient production for export. 17,000 peasants were driven from their lands.

II.8 Values, tasks and social-environmental services at stake downstream.

Due to the reign of Hydraulic Structuralism throughout the 20th century, there has been a tendency to disregard the social and environmental impact produced downstream by the large hydraulic infrastructures. Rivers have been viewed as simple H_20 canals instead of as living ecosystems. What was overlooked from this perspective is that rivers not only direct vast quantities of water draining out of basins, but also direct large solid and nutrient flows. In addition, there has been a tendency to ignore the importance of the biodiversity harboured by riparian environments. And lastly, there has been a tendency to underestimate the grave socio-economic impact produced downstream by these hydraulic works, especially on poor communities whose way of life is strongly connected to ecosystems and fluvial cycles.

The direct and indirect impact of the unsustainable exploitation of rivers, lakes and wetlands on food producing regions worldwide have been and continue to be serious, especially with regard to the natural productivity of protein-rich foods. It should be noted that fish is one of the principal sources of protein in the majority of underdeveloped or developing countries. It is often said that fish is the poor man's protein. In Africa, this source accounts for more than 20% of animal proteins, on average; in Asia it accounts for almost 30% (ICLARM-1995). For many poor, inland communities around the world lacking access to coastal fisheries, the availability of fresh water fisheries is a key to their survival.

Throughout the 20th century, the construction of large dams has been one of the key factors contributing to the drastic reduction of river fishing grounds with the resultant extinction of many species of fish and molluscs essential to the diets of riverbank communities. Some well documented cases, amongst many others, worth mentioning are the Urra river in Columbia (WCD 2000), the Singkarak project in Sumatra, Lingjintan in China, Theun Hiboun in Laos or Pak Mun in Thailand (Dave Hubbel 1994). In all of these cases, large reservoirs created serious obstacles to nutritional subsistence for thousands of persons in poor riverbank communities.

But it is not only river fisheries which have been seriously affected; coastal fisheries, whose dependence on rivers has been definitively established, have suffered as well. The case of Aswan dam on the Nile River is paradigmatic. A year after having closed the overflow weirs of the dam, the sardine and anchovy harvest fell by over 90% in the eastern Mediterranean. Today it is known that theses species, amongst others, spawn in the estuaries of large rivers, taking advantage

of the high concentrations of continental nutrients which result from the increased springtime river flows. These nutrients fertilize marine life, especially in enclosed or semi-enclosed seas, which are generally poor in plankton. A similar breakdown occurred in the Sea of Cortes (in Baja California) as a result of the diversion of the Colorado River to irrigate the Imperial Valley and buttress urban development in the Los Angeles-San Diego corridor in the United States (Sandra Postel-1996).

We find another example of this in Southeast Asia where Thailand's accelerated industrial growth is motivating the construction of a system of large dams and interbasin diversions from the Upper Mekong in order to provide cheap electricity and water resources to the new giant Indochina. This group of mega projects threatens to cause serious ecological breakdowns with disastrous impacts on riverbank communities. It is estimated that 52 million people depend on the Mekong, from which they derive both agricultural products and fish, for their nutritional sustenance. (Moreth 1995).

Serious modifications in the natural cycle of many of the world's great rivers due to the construction of headwaters dams have eliminated traditional forms of agricultural production tied to fluvial cycles which raised water levels at low elevations. This has seriously compromised basic food production for thousands of people. Such impacts have been particularly significant in African countries such as Niger, Chad, Nigeria, Sudan, Senegal or Mali, amongst others. In the north of Nigeria, the construction of the Bakalori dam over the Sokoto river led to the disappearance of 53% of traditional crops linked to the cycles of river flooding in the plains of the middle and lower basins, destroyed the grazing lands that served as a base for livestock in the zone and seriously

affected the aquifers, depleting vital water reserves during periods of drought. (Adams – 1992). Similar cases have occurred, as indicated in reports published by the *World Commission on Dams),* along the Senegal River, as a result of which nearly 800,000 people experienced difficulty with traditional crop cultivation, near the Sobradinho reservoir in Brazil with negative consequences for 11,000 peasant families; and near the Tarbela and Kotri dams in Pakistan with the resultant loss of traditional grazing lands along nearby floodplains (WCD-2000).

As shown in a large number of studies (Abramovitz-1998), traditional systems of food production in which fishing, livestock, forestry and agriculture are wisely combined are not only more sustainable, but also produce more food than systems dependent on large dams in high basins.

In spite of its seriousness, much of the socio-economic impact does not emerge in official statistics. The reason for this is that the harvests derived from these food sources, wisely managed in a sustainable relationship between rural communities and their surroundings, traditionally goes to local markets and self sustenance. From the point of view of market rationality, it is usually claimed that such modes of production suffer from low levels of economic efficiency. Nevertheless, if the social and environmental values at stake are taken into account, and if we adopt objectives which include sustainability and fairness, that so-called inefficiency becomes a high level of ecological-social efficiency. It is necessary, in short, to discern objectives when it comes time to define parameters of efficiency. When the objective is to *resolve social and environmental problems* rather than to produce *more market value*, it is necessary to define indicators of **ecological-social efficiency.** In this sense, the preservation of the social fabric and of traditional forms of production in the rural environment while, in general, offering these communities opportunities that permit them to evolve without losing their identity and cohesion tends to be highly efficient (Arrojo-2005).

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II.9 Ethical values promoting inter-regional equity in relation to socio-economic development.

As previously indicated, mountain regions have been considered poor areas with scarce potential for economic development and demographic growth. From this perspective, the decision has often been made to sacrifice entire valleys, even when still inhabited, in order to exploit these regions as simple storage areas for regulating volumes of water destined to promote the development of regions and cities downstream.

Hydroelectric production has rarely been used to generate industrial development in mountain regions themselves. The establishment of unified tariff models has even prevented lower energy transport costs from leading to lower costs in the vicinity of turbine locations. As a result, primacy has been given to the concentration of industrial development in remote urban areas.

With regard to agrarian development, it is evident that rugged relief offers few opportunities while the plains located in middle and low elevation basins have traditionally offered favourable areas for implementing large-scale irrigation works.

Lastly, the need for vast quantities of water for urban-industrial uses has turned mountainous regions into high quality water storage areas for this urban development.

For decades, all of these demands have guided water management strategy and planning models favouring large regional imbalances. Mountainous regions have ended up being sacrificed for the benefit of others in the name of the omnipresent "*general interest*."

Currently, as we have been putting forth, these management models and approaches have entered into crisis not only for ethical reasons related to inter-regional equity, but also because social, environmental and economic values which we are currently beginning to apply in mountainous regions and in river basins require new models of *sustainable management* and of *participative government* quite different from those that were the norm over the major part of the 20th century.

III- THE NEED FOR A NEW ETHICAL APPROACH.

It is evident that the values which come into play are quite diverse. Because of this, when the value of water is spoken of in generic terms, we run the risk of opening an obscure and confusing debate in which, assuredly, fertile ground for demagoguery will be created. Although water is a well-defined chemical compound, H_2O, what is important is to distinguish its diverse roles, clarifying the values which come into play and the diverse ethical categories which such values give rise to (Arrojo 2005).

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III.1 Functions, values and rights involved.

If we think about other natural renewable resources, such as wood, we do not encounter as many problems. Beyond clarifying under what circumstances we should extract it from nature so as not to destroy the health of the forest, the management of the lumber obtained does not cause controversy. Once we have determined the restrictions imposed by the need to manage a forest in a sustainable way, it seems reasonable to manage the lumber extracted in accordance with the exigencies of the

market. The key to this relative simplicity lies in that the value of the wood is consistently exchangeable for money whether it is used to build ships, manufacture chairs, table or closets.

Nevertheless, in the case of water, the roles and values involved are more complex and affect ethical categories at a different level. The *European Declaration for a New Water Culture,* signed in Madrid by 100 scientists from different *European Union* countries at the beginning of 2005 proposes the establishment of four ethical categories (FNCA 2005):

* Water-life: *water for life,* related to basic survival functions of both human beings and animals in their natural habitat, which should be recognized and prioritized in such a way that ecosystem sustainability is guaranteed, with universal access to adequate amounts of quality water constituting a right.

* Water-citizenry: *water for the common good*, as an instrument for safeguarding health and social cohesion, related, for example, to water supply and sanitation services in connection with *the social rights of citizens*.

* Water-business: *water for economic growth,* for legitimate economic activities, connected to productive work, in connection with the right of every individual to improve his standard of living. This water use is to be granted a third level of priority given that it would be unethical to allow such uses to interfere with water rights and uses pertaining to previous categories.

- **Water-crime: *water for* illegitimate *business activity* with consequent destructive withdrawal practices, toxic spills and other socially unacceptable practices; such uses should be avoided and prosecuted to the full extent of the law.**

If we reflect on the diverse set of values and rights at stake which stem from each of these categories, we will understand that they correspond to different spheres from an ethical point of view.

III.2 Deficiencies and errors associated with the current neoliberal approach.

In our opinion, Daly is right when he argues:

" Some claim that human-created capital and natural-resource capital can be exchanged, and that, consequently, the idea of a limiting factor (for production) is not applicable. Nevertheless, I think it is quite obvious that human-produced capital and natural capital are essentially complementary and only marginally exchangeable."

Using less technical language, the Spanish saying that *"only fools confuse value and price" encapsulates the same judgement using different words.* In summary, unlike wood, water engenders uses and values which are not manageable by way of simple economic exchange relations because these uses and values can not be consistently replaced by capital goods. In this sense, it is essential to differentiate these uses and to distinguish the diverse ethical categories with respect to value and right which are connected to them in order to set priorities and establish suitable management criteria.

Nevertheless, based on the neoliberal principles which substantiate the reigning model of globalization, different water uses tend to be seen as economic utilities which can be replaced by capital goods and, therefore, expressed in monetary values to be managed within the context of market dynamics. Despite the fact

that this is the reasoning applied in general by the World Bank (BM) and the World Trade Organization (OMC), their water policies are, in fact, filled with serious contradictions. On the one hand, in the name of economic rationality, developing countries are subjected to intense pressure to privatize their water supply and sanitation services thus giving rise to serious social and political conflict. Nevertheless, on the other hand, the World Bank maintains the basic components and scripts associated with its old strategies of "up for bid" in the area of general water management of its diverse productive uses (related to agriculture, industry and energy). Without a doubt, vested interests behind hydraulic mega projects around the world are still very influential, both at the level of large multinational construction and hydroelectric companies, and at the level of domestic political and business networks. For this reason, the World Bank itself, despite the contradictions entailed, is still willing to finance this type of "*up for bid*" strategies based on the subsidized promotion of large-scale hydraulic projects, thus flying in the face of economic rationality.

III.3 The need for a New Water Culture based on new ethical principles

The surmounting of the *"domination of nature"* paradigm by way of the *"sustainability"* paradigm will require profound cultural changes. It requires that we accept the challenge of managing the biosphere based on ethical principles of equity for the sake of posterity. This means recovering the holistic perspective embodied in the Aristotelian concept of "economy," and going beyond the narrow mercantile approaches which dominate the reigning model of globalization.

But, above all, it means recognizing the diversity of values and different ethical levels which come into play. Within the range of values identified, those, such as the right of a community to its traditional living areas or society's right to conserve the ecological integrity of it aquatic ecosystems, which are connected to fundamental ethical principles should be given priority

In fact, the third generation of human rights currently being debated includes communities´ rights to peace and healthy ecosystems. The World Commission on Dams, in its final report, acknowledged that many of the community evictions carried out to construct large dams have amounted to transgressions of human rights.

Beyond respecting these basic ethical principles, another goal is to recover emotional and identificative values connected to the landscape, as well as to recover environmental services, along with values related to enjoyment and quality of life which are offered to us by rivers, lakes and wetlands when they are in an ecologically healthy state.

IV- NEW ECOSYSTEMIC MANAGEMENT MODELS AND THEIR REPERCUSSIONS IN FLUVIAL HEADWATERS AREAS

The most advanced water laws, such as the EU *Water Framework Directive,* incorporate the challenge of implementing new models of *ecosystem management*, thus advancing beyond traditional approaches to water management in which water is seen as simply a resource. Going back to the comparison with wood, in the same way that we have progressed from the simple exploitation of forests to new policies of sustainable forest management, we can extend this sustainable management approach to rivers, lakes and wetlands as live ecosystems.

The restoration and conservation of the ecological health of our river courses becomes a paramount objective. This involves the imposition of severe restrictions on traditional hydraulic policies, especially in mountainous regions with regard to the conservation of fluvial biodiversity and the maintenance of consistent river flow cycles.

In addition, an ethical commitment to respecting mountain peoples´right to live in their valleys correlates strongly with notions of democratic government. This commitment is buttressed by our moral obligation to redress a long history of injustices and imbalances that mountain regions have suffered as a result of our historical hydraulic policies.

Beyond the restrictions imposed by the need to respect the aforementioned ethical principles, the old strategy of "*up for bid*" associated with enormous public subsidies is now tending to give way to strategies which involve *management of the demand* in keeping with the New Water Culture which is so necessary at this time. Without a doubt, this is another argument which renders the construction of large-scale hydraulic infrastructures less important. In fact, the majority of new projects only demonstrate viability when they count on enormous public subsidies because a cost benefit analysis always brings up a negative balance sheet (Arrojo 2004).

In conclusion, the aforementioned arguments in favour of sustainability, economic rationality and democratic governability tend to close a loop and open another one based on new objectives and strategies.

Mountainous regions have come to be perceived as natural areas of great value in which conservation policy plays a growing economic role in the form of a developing tertiary sector. Fluvial headwaters regions have been acknowledged as highly valuable parts of our natural heritage with the result that they are now protected by specific laws such as the American *Wild and Scenic River Act.*

Even from a strictly economic point of view, rivers whose headwaters basins are well conserved become much more valuable as rivers than as water in the same way that a tourist beach is more valuable as a beach than as a sand quarry for construction.

There is increasing social pressure to limit miniplant turbine rights while requiring the maintenance of minimum flow volumes along watercourses in order to guarantee not only riparian habitat conservation, but also the viability of other activities such as white-water rafting which become more advantageous than hydroelectric production from both an economic and social point of view.

Adopting a perspective based on new management models, the scarce availability of water resources for economic uses should be seen as an *unavoidable property to be managed* rather than as a *tragedy to be avoided* by way of public subsidies and ecosystem degradation. In the water-business category, criteria with regard to *economic rationality* should be imposed based on the principles of *full cost recovery*. The *opportunity value* of the resource should be included amongst the costs to be borne by the user.

Lastly, the value of water quality in headwaters basins is increasing the value of their springs as strategic resources for drinking water. This is leading to processes of privatization which need to be carefully evaluated.

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