SOME RELEVANT ETHICAL ISSUES IN RELATION TO FRESHWATER RESOURCES AND GROUNDWATER

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Abstract - Freshwater resources are limited and the demand is steadily growing. In some areas a large part of available water resources are already committed. Then, some degree of concern is a logical position. But it has to faces. 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 and wasting badly needed economical and human resources. Evaluation of available and developable freshwater resources has to be carried out together with the uncertainty of natural situations and processes, and looking for the long term sustainability in a changing framework. This sustainability 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 clear economics, social appreciation and political will, all of them glued by ethical behaviour.

Key words - Groundwater, freshwater resources, ethical issues

SUSTAINABILITY OF NATURAL AND FRESHWATER RESOURCES.

There is a widespread appreciation on the limitation and the growing world-wide scarcity of freshwater resources (Shiklomanov, 1997; Brundtland et al., 1987; Biswas,

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1992; Gleick, 1993; 1998). They are assumed to grow in the future to the point of limiting human habitability in some World's areas and of creating social stresses leading to wars. But 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. Neo-malthussian and black and white (bad and good) fundamentalist thinking is a real danger behind many theories. They are mostly supported by poor, often wrong understanding of the water cycle and Nature. Often, there is also a blind support to what seems obvious solutions, but which may be expensive, burdening and unsupported by detailed studies using the best available data. A further failure is transforming purely local affairs into a widescale problem. 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). Situations which evolution was presented as leading to a final disaster, have been effectively overcome. Working and appreciating the situation at a global scale allows to define solutions and alternatives that are not apparent from the local perspective, and that sometimes may appear as going against common sense when the purpose is too narrow and other opportunities are missed.

But this optimistic viewpoint has to be conciliated with the present, unprecedented global-scale influence of many human activities. The Earth has limited space, resources and capacity to absorb wastes. This makes the new challenges more difficult to deal with and more serious the danger of overcoming the global limits. But leading circumstances are also changing, and what now seems obvious may be quite different in the future. Being concerned to some extent is beneficial, be prepared for action is wise, but introducing drastic measures to fastly redress uncertain situations may be much more detrimental and inhumane than healthy. Prudent evolution and flexible action is what history and mathematics show is the attitude to be recommended (Plate, 1993), especially when future sccenarios are uncertain (Azqueta and Ferreiro, 1994) and even continuous population growth is doubtfull (Pearce, 1999).

Doomsaying mostly relies on measuring quality of life by imitating the current demand and way of life of industrialised countries, which means developing new resources, looking for new space to dispose the wastes, invading pristine areas to use

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them as short-term leisure space for a few, and producing degradation-resistant products which are little compatible with Nature. 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, and spreading it to the whole mankind. This implies a new generous definition of sustainability, in a wide context, not restricted to local situations, in which some “degradation” may be an acceptable but a time-limited option to obtain global goals, which contribute a net benefit to human population. Sustainability has to be matched to improvement and evolution of science and technology, as well as development of ethics, socio-political objectives and behaviour (Plate, 1993). The coming future major issues have to be identified, and their characteristics may be quite different from present ones.

It is clear that the Earth is evolving and man is part of its evolution. It is not possible to freeze the time, but Mankind has to go with it, making the best use of existing resources at a rate that tends as much as possible to renewability. Any human activity looking for benefits involve some detrimental effects. A continuous trade-off is needed between the unrenounciable goal of improving quality of life by developing natural resources and producing some environmental damage. This damage has to be bearable and compensable in broad terms, although economic evaluation is not an easy task (Foster and Foster, 1989; Llamas et al., 1992; Galloway, 1997). Evolution, both natural or man-made, means an inevitable increase in the system entropy (Georgescu-Roegen, 1971), but our system is not a closed one at the time scale of mankind life, and exchange of energy with the exterior –the Sun and the space- is the way to sustainability in a more universal context.

But sustainability has transient situations, whose asymptotically attainable final situations also change as mankind evolves. This means that “unsustainable” use of resources are needed for some time and under changing circumstances, but part of the devived net benefits should be spent into new developments for conservation, preservation and restauration. Also, the development which is directed to increase the offer of new goods to follow an unreasonable, and poorly bounded demand should be changed for a clear policy of savings and reuse, whenever possible.

HYDROLOGY AND WATER RESOURCES

Water play a key role in Nature and at the same time it is essential to human life and man’s economical activities, such as producing food, improving health conditions, generating energy, acting as communication or transport ways, diluting and transforming wastes. In practical terms all water in the Earth is included in the water cycle, which is a complex system interacting with the physical, chemical and biological environment. This water cycle, from the point of view of fresh water resources has five main components: the water in the atmosphere, the water in the surface of the Earth (rivers, lakes and pedologic soil humidity), water in the ground pores and fissures, sea water and solid water (ice and snow). All of them are closely linked and interrelated, both at local, regional and global scale, and explain many of the specifities of the Earth evolution and the possibility of life. They play a key role on climate and its changes. All of this is the subject of Hydrology, an important branch of Science. But hydrological principles are often poorly known by people, policy makers and even scientists. Hydrology is often negatively influenced by a series of myths and biased understanding (Custodio and Llamas, 1997). Often decisions makers on water resources take or have to take poorly founded and hydrologically unsound decisions. Decision making tend to look preferentially to some easy-to-see aspects, but which are often poorly observed and even wrongly interpreted, and which do not consider the water cycle as a whole and its relationships with the environment. Each part of the cycle has a completely different behaviour with respect conditions such as renewability, 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.

Most of wrong decisions are due to only looking at one part of the cycle -generally surface water- and neglecting or oversimplifying the links with the environment. A major loser is groundwater, often ignored and neglected, unnecessarily wasted and contaminated, and deprived without beneficial use of its important environmental role. All this is unethical behaviour which may grade into a deviated and irresponsible attitude when ignorance is conscious. This may happen in order to promote some projects without looking for alternatives, disregarding sound socio-economical analysis, at least in regional terms, and without taking into account the short and long-term consequences in a global context.

Some authors forecast that water in dry areas will be a cause for near future wars. This is a real danger, but so much things are at the stake that tame the risk. There are examples which show that solutions and agreements precede political arrangements, and water may a future element of cohesion rather than war (Llamas, 1999b).

UNCERTAINLY AND WATER RESOURCES

Hydrology is the basis to evaluate the role of water in the Nature and how this water can be transformed into a water resource to supply human needs. It is both a Science and a Technology. Water resources are defined by its quantity and its quality with respects the intended use, taking into account when and where water is needed. All these are terms that can be modified by Man using scientific principles and applying technical means, but always under the uncertainty inherent to all natural processes and situations. Natural uncertainty is due to the stochastic component of rainfall and other natural processes, and to the non-exact knowledge and simplification of the physical support –land, river, soil and aquifer system- and the physico-chemical behaviour of solutes, colloids and micro-organisms, and their interaction with environmental gases, solids and biota. This uncertainty has very different characteristics for the different parts of the water cycle.

The greater the associated volume of water –reserves- of a part of the water cycle the less the uncertainty linked to the stochastic behaviour. In this sense groundwater is usually more reliable than surface water due to the very long turnover time. Similar or smaller investments in studies are needed in the case of groundwater to get comparable physical and chemical understanding, and it can be made available with less structural investment. This does not mean that one is superior to the other, but shows that they are different, often complementary, amenable to joint use, and both necessary assets under different contexts. The common attitude of disregarding groundwater as a reliable water resource may be a sin of ignorance and arrogance, which may imply a high associated economical, social and environmental cost. Besides it may be a sin of corruption when obscure goals are sought. They include increasing short-term benefits for a few -charging the associated direct costs and especially the indirect ones the whole population- maintaining privileges of some powerful groups, unduly supporting a profession, and getting political benefits associated to large works which attract the attentention of poorly informed people and mass media which are not able to understand and evaluate less attractive and rewarding but more efficient and less expensive undertakings.

But the basic 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 externalities and non-tangible side effects (Constanza, 1991). Here ethics play an important role in looking for feasible solutions that do not burden more than needed present and future generations. This is still more important for developing areas, in which poor knowledge, enhanced uncertainty due to lack of data and insufficient knowledge, lack of institutions and deeply rooted hydromyths make ethical decisions more difficult.

FRESHWATER SHORTAGE

Freshwater is scarce in arid and semiarid lands. In principle its scarcity tend to be considered one of the main problems for development. But this is not necessarily true since there are areas with a low volume of renewable freshwater per capita or per surface area with acceptable per capita gross economical product, and the converse as well. Water used for direct human consumption -drinking, cooking, food processing- is rather a small quantity. Basic needs can be complemented, when they are really needed, by sources such as brackish and salty water desalination, transport from far away areas and use of groundwater reserves, even if the unit cost is high or very high. The total cost is often a small amount of living expenses. If needed, it is something that can be supported by socially oriented subventions which are ethically sound, do not burden excessivelly the economy and appear as politically acceptable, as a general policy. But what is acceptable for relatively rich cities and human settlements may not be bearable for rural communities and poor developing areas. As often happens there are no universal solutions but tailored ones according to local circumstances.

Problems of fresh water availability in many regions, even in the rich ones, 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 freshwater availability. Really most of the water demand is used mostly for other uses than direct human consumption. The situation worsens in water scarce areas when this water is used for gardening green areas and luxury uses such as swimming pools. The cost to the consumer may become too high. This also creates sometimes serious problems for the water supply utilities. They have to invest to expand the water source areas and often have to fight bitter conflicts with neighbours and rural areas and abandon progressively contaminated areas. The early decommissioning or abandonment of investments made in them increases water costs as well as the need to introduce increasingly expensive water treatment to get and guarantee potability. Also geothecnical and water-logging problems related with groundwater table rebound in and around urban areas are not a rare situation (Chilton, 1997).

What is a bearable problem for water rich areas -although a growing concern even for them- 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). The condition is that this low quality water, which should not be used for direct consumption, should not present any serious health risk if accidentally drinked. Regulations have to be developed and enforced. It seems necessary to ban acute toxic components but to relax current limits on salinity, nitrate and some components such as some natural heavy metals, fluor and total organics. 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 water made available at 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 does 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 (palaeowater)- just for crude industrial processes and cooling, with no or little recycling. It is not rare finding this situation while domestic supply has to relay on poor quality water and even do suffer quantity deficits. 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.These costs are the price of protecting and making a sustainable use of drinking water, and have to be shared by all stakeholders.

The worst problems of water demand in arid and semiarid areas -even in relatively humid areas- are created by irrigated agriculture when it occupies large surfaces. In some cases this agriculture is so intensive that it is close to be a food producing industry. But in many other situations it is the result of continuing with local traditions, untrained population, pursuing state policies of self-sufficiency in food production at any cost, maintaining an isolation on grounds of fundamentalist political ideas and irrational fears and aversions, or trying to prevent very uncertain future trade conflicts.These conflicts are wrongly base on the historial background of conditions which will not come back in the future, at least in the same form. Often this refers to agriculture, and especially irrigated agriculture -including cattle and animal raising- which heavily subsidised and protected, especially when the source is surface water. Subsidies are for infrastructures, agrochemical, agroenergy and production. This distorts the economy, sometimes in a deeply way (Mayers and Kent, 1998). The use of water becomes a secondary issue when really they produce much of the water scarcity, contamination and social stress, and destroy the environment and the strategically important groundwater resources by wasting slowly renewable reserves of much needed freshwater.

WATER NEEDS AND EMPLOYMENT

The unsustainability of many of the irrigated agriculture in arid and semiarid lands is the result of excess irrigated area, low efficiency of water use, distortion by subsidies, inadequate vegetal and animal products, little environmental concern, short-term goals, political manoeuvring, poor hydrological knowledge, lack of efficient water management institutions, poor information of farmers, and the difficulty of finding other jobs for these relatively untrained persons.

Increasing water problems are often solved by new and expensive water works and by extending the catchment area by developing -sometimes abusively- far away aquifers or by the often conflictfull water transfers among river basins. All this needs public investments which are progressively greater and greater. This is a new kind of subsidy, generally paid by the whole population, which is economically unsound in many cases. Often these projects are not supported by socio-economical studies of alternatives. What sometimes is called study of alternatives reduces to variations around a basic project, decided on grounds of hydraulics and with some political orientation, or just to solve project implementation difficulties of pure engineering nature. In many cases, but not always, a market approach help in solving conflicting situations and in allocating water resources (Howitt, 1993; Delli Priscolli, 1998). Groundwater, alone or combined with other freshwater resources, often play a key role in providing feasible solutions (Sahuquillo, 1991; Llamas, 1999a).

Probably, in most cases a better use of economic resources is 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 by technological improvement, optimising existing local water resources (conjuntive use, reuse, complementary desalination), protecting the environment, developing trade and tourism, and so on. To implement this a top level Institution is needed, superseding 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 with more water resources and favourable conditions for food production, but needed of manufactured goods or other resources, such as oil or minerals.

Often it is argued that if agriculture is abandoned there is desertification. This is true in many areas and rural population is needed in place. But 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 historial heritage, and Nature preservation. This role is economically compensable by the tax payer by improving local services, promoting tourism, providing educational facilities and paying for conservation and restoration projects, instead of direct subsidies which are prone to mismanagement and corruption, and contemptuous to persons who like and are proud of their condition, role and place of living.

WATER CONTAMINATION

Probably the greatest thread to surface and groundwater freshwater resources sustainability is contamination. Although some contaminants are natural (saline water, sea water intrusion, displacement of groundwater bodies with dissolved substances which represent a health risk, such as arsenic, fluor, boron, some heavy metals, radon, radium), most of the damage and risk come from man-made and man-introduced hazardous substances and saline components. Many of them do not exist in Nature. They very from agrochemicals (mainly nitrogen and phosphorous compounds, and pesticides and their solvents) to household products (phosphorous and boron compounds, surfactants), and include a large list of industrial and energy products (salts, organic solvents, petroleum products and derivatives, phenols,...) and even pharmochemicals which in very small concentrations may affect humans and animals, especially if water containing them is part of the dayly intake.

Also surface water and shallow groundwater are often contaminated by microorganisms, bacteria and viruses. Deep groundwater is normally free of them, but abstracted water may be not, due to poorly constructed and maintained groundwater wells.

Contaminants move sluggishly in the ground, especially if they are adsorbed on the surface of solids. Retention favours degradation of reactive, unstable or radioactive substances. So, groundwater and surface water fed by groundwater may seem protected, but contamination appearance is only a matter of time for non degradable substances.

Control and correction of contamination sources is a primary goal and a key ethical objective, both in developed and developing countries, both in arid and humid areas. There are specific situations to be taken into account, depending on local circumstances. Action means not only treating water and wastes before discharging them into the environment, and isolating or destroying wastes, but controlling the use of substances that represent a contamination risk to the sustainability of freshwater resources and the persistence of good quality groundwater reserves.This is not a problem limited to developed countries and a consequence of their development, but a problem to developing countries as well, which use the same newly invented products, sometimes in larger quantities and in a less careful and uncontrolled form. The damage to water resources in such developing countries may seriously hamper the environment and the possibilities for development since the income they may generate will be soon or later spended for protecting the population and its activities (including tourism), for compensating the loses from rejected, exported goods, especially food, and for future unavoidable cost to correct or to substitute damaged water resources and land.

Contaminating chemicals should be substituted by less hazardous products, users have to be trained, effective control and licensing on distribution and use is needed, and the risk has to be make known to all users and exposed people. Protected areas will be probably needed to secure drinkable freshwater resources for towns and especially large urban areas. These protected areas -which may coincide with natural parks- must include large springs and the headwaters of pristine rivers, as well as major aquifers containing high quality water reserves, and especially deep confined aquifers and is coastal areas (Custodio et al., 2000). This water should be reserved for drinking purposes.

AQUIFER PROTECTION AND GROUNDWATER USERS' ASSOCIATIONS

The 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 issue, but a feasible one. 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. But they have often been erroneously considered from the managerial point of view as an extension of surface water. This is a major error, worsened by the fact that some of the surface water techniques also fail when the system becomes complex.

Aquifers and aquifer systems have a large number of actors with interests in wells, springs, river base flow, gallery forests, wetlands, drainages and so on. These actors are generally small, non-related owners and users –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, 1991;1996; Azqueta and Ferreiro, 1994). This means that when part of the reserves are used there is no incentive for water savings or protection since doing this will only increase the benefit of the others. Without regulation the final situation is reserve depletion or quality degradation. Long-term development is reduced to a part of recharge at a high cost due to accumulated water head drawdown. But this is not a new situation since uncontrolled development of surface water has similar problems, except for the time delay contributed by the groundwater reserves.

All this can be redressed by legal regulation, which include an effective water institution with adequate legal instruments, working together with the aquifer system water stakeholders. They should be organised into an association or a similar structure.This association should have a technical office for management and monitoring.There are already a few real experiences (Aragonés et al., 1996; Galofré, 1991), but more are needed before a good understanding and practice is gained, especially when farmers and rural water users and stakeholders dominate.

The groundwater users' association has to be really representative of all interests, effectively participate in water management under the guide of the institution, responsible for water management and the water law administration. The association has to have the power to correct and punish deviations, and should collect funds from the members and from the water authorities, to carry out its job. The institution should responsible for incentives to foster agreed policies (Schaible, 1999).

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 quality has to be constructed and operated, and the data integrated into data bases. Monitoring must consider the three-dimensional nature of groundwater.

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 sides. All this is part of groundwater management, which is not an easy task, but a feasible and rewarding one provided adequate training exists and hydromyths and deeply entrenched barriers are abated. Not only people is needed but institutions, and they are in shortage in many countries, but especially in developing ones (Lloyd, 1994).

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

The origin of the economic funds is variable, from the responsible of the damage to the whole community, or from the possible new abstractors, or from general taxes provided by the water administration. This last is something to be limited to special situations such as general-scope improvements or coping with serious contamination from unknown sources.

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 or poorly constructed wells, by unduly disposing liquid or solid waste, or by many other activities, is ethically inadmissible. This has the cost of destroying existing infrastructures which often are very costly to substitute, if it is possible at all.

A temporal use of reserves is admissible and sound in a scenario of future new developments payed by the net benefits obtained (Collin and Margat, 1993; Custodio, 1993; Foster, 1992; Margat, 1993). This has especial aspects in arid lands (Lloyd, 1997; 1998; Margat, 1990), where mining groundwater resources is a possibility (Llamas, 1999). But this should not be admitted if only short-term benefits are looked for, simply leaving restoration, substitution and supporting the negative results to the coming generations, at their own expenses and without passing to them the appropriate means to cope with these expenses (Howe, 1987). Aquifer intensive development -often called overexploitation- is both a misfortune and a blessing, depending on they way and circumstances it is carried out (Llamas, 1992; Custodio, 2000b).

A common point of view is that natural poor quality groundwater, generally brackish and salty water, is not useful at all, and that the aquifers containing them have no economic value and can be used to store waste water. With the cost reduction of desalination this becomes inadmissible in water scarce areas. This poor quality groundwater is often free of hazardous man-made contaminants and thus a possible source of 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 standars. This has to be combined with optimum use of water resources and the preservations 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 must.

FINAL NOTE

The ideas and assertions contained in this paper are the author's ones and have not to be shared by the organisation to which the author is linked.

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