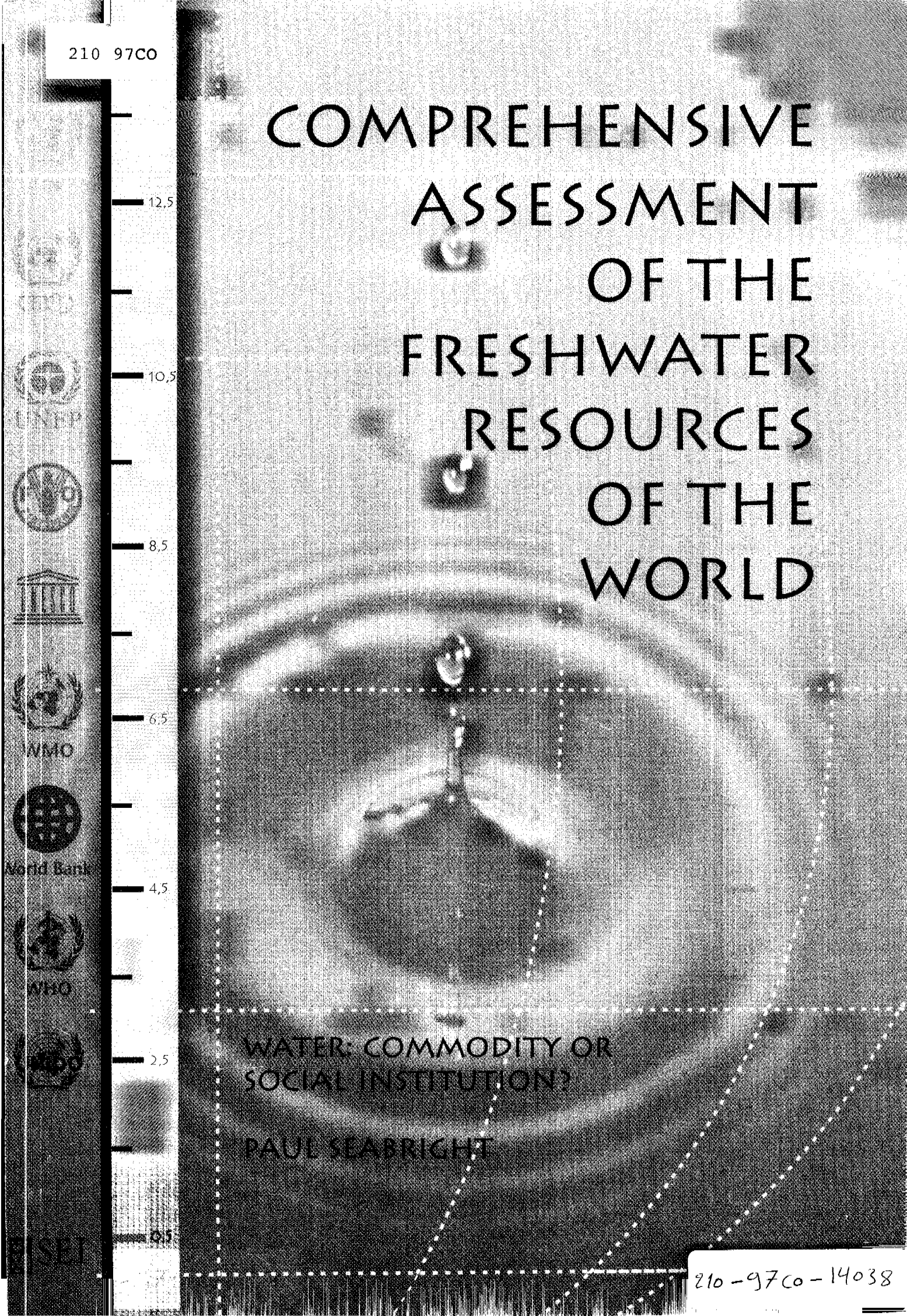
COMPREHENSIVE ASSESSMENT OF THE FRESHWATER RESOURCES OF THE WORLD



WATER: COMMODITY OR SOCIAL INSTITUTION?

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FOREWORD

A rapidly growing demand on freshwater resources, resulting in increased water stress in several parts of the world, increasing pollution of freshwater resources and degraded ecosystems, made the UN Commission for Sustainable Development in 1994 call for a Comprehensive Assessment of the Freshwater Resources of the World. The final report (E/CN.17/1997/9), prepared by a Steering Committee consisting of representatives for UN/DPCSD, FAO, UNEP, WMO, UNESCO, WHO, UNDP, UNIDO, the World Bank, and Stockholm Environment Institute, is presented to the CSD 1997 and to the UN General Assembly Special Session June 1997.

Within the process of the Assessment a number of background documents and commissioned papers were prepared by experts with various professional background. The document *Water: Commodity or Social Institution?* is one of these. As a scientifically based document, any opinion expressed is that of the author(s) and does not necessarily reflect the opinion of the Steering Committee.

Stockholm, June 1997

Gunilla Björklund
Executive secretary
Comprehensive Freshwater Assessment

ABSTRACT

This paper begins with the idea that water is an economic resource, characterized by scarcity, and goes on to explore the many different economic characteristics that water has in different circumstances. It notes that while freshwater is not globally scarce, its scarcity arises from the fact that it is costly to make available in the right quantity and the right quality in the place where it is needed. Its uses are multifarious and the economic characteristic of systems of water use and management are correspondingly varied. Furthermore, the kinds of property right vested in water vary greatly according to circumstance: the degree of scarcity and the nature of the external effects between different users influence to a considerable extent the character of legal and social systems where water management is important for the overall economy. Although such systems have historically shown remarkable flexibility and adaptability to the needs of water use, they are far from being adequate to the changing demands on global water resources that will arise in the coming century.

Water: Commodity or Social Institution?

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Why do we value water and what do we value about it? Answers to this question are many, varied and paradoxical. The government of Mexico spends around four hundred million dollars per year providing drinking water to its population[2], of whom nearly half in rural areas still have no access to safe sources of supply. This is one fifth of what consumers in France (a country with three-quarters of the population) spend per year on bottled mineral and spring water[3], which (as magazine or television advertisements confirm) is primarily marketed as being beneficial to health. However, French tap water is of excellent quality and universally available, so the only possible benefit to health from drinking bottled water is that it may induce people to drink less alcohol. Mexico is a country very much concerned with health: a child born in Mexico City is more likely to receive immunisation than a similar child in a large American city. Yet although water from a standpipe in Mexico City is for most purposes chemically identical to water from a spring in the Massif Central, and although both answer to a deep human concern for health, as economic commodities they could hardly be more different.

There is a widespread agreement that the world in the 21st century will face major health, security or economic crises in the absence of a willingness to adopt what the Dublin International Conference on Water and the Environment called the management of water "as an economic good", a maxim that is also at the heart of the policies now advocated by the World Bank (World Bank, 1993). But what does this mean? What kind of economic good *is* water? The more we examine the evidence the more we see that water is not one kind of good, but many. These goods differ along the dimensions of physical and biological characteristics, but not only along these: they differ also in the way that human societies construct and evaluate them.

Perhaps the most fundamental characteristic of an economic good is scarcity; indeed, the canonical definition of economics itself is "the allocation of scarce resources among competing ends" (Robbins, 1936). Water is scarce in many parts of the world, relative to the physiological needs of the inhabitants of those regions. Around 1250 cubic metres of water per person are required every year for the supply of habitats and the production of subsistence crops, without counting the amounts necessary for industry or cash crops. Over 200 million people in Africa are in a position known as *water stress,* where more than 600

[1] I am grateful to Lisa Anderson, Gunilla Bjorklund, Partha Dasgupta, Isabelle Daudy, Malin Falkenmark, Geoffrey Hawthorn, Phoebe Koundouri, Jan Lundqvist, Vincent Requillart, Kay Sexton and Tim Swanson for help, advice and information.

[2] Government of Mexico: "Planned expenditure of the public sector budget by economic sector", 1994, p.460.

[3] The size of the French market for bottled water is given in the decision of the European Commission in the merger case Nestle-Perrier (1992).

people share every million cubic metres of water available annually[4]. In other circumstances and in other parts of the world water can be in excess: floods in Bangladesh or in China regularly claim more lives than do droughts. There are also regions of the world in a happily intermediate position, with water in abundance, neither scarce nor in excess. Our entire attitude to water changes with its scarcity: water in conditions of scarcity is life-giving, but in excess it is life-threatening, one of the most terrifying of natural forces. The consciousness of having escaped from the threat of the sea was so central to the thought of the citizens of the early Dutch republic that they invented a gruesome punishment, the "drowning cell", for those convicted of unwillingness to work: "They are tethered like asses and are put in a cellar that is filled with water so that they must partly empty it by pumping if they do not wish to drown" (Schama, 1987)[5].

The value of water depends, in other words, on whether it is physically located where we want it to be, and in the right quantity. Royce Hanson has written that "taken as a whole, the United States has plenty of water, now and for the future. The problem is, of course, that no-one lives in the United States as a whole" (Hanson, 1988). This is no less true for the world as a whole: there are on average far more freshwater resources per head of the world's population than the most profligate use could ever require, but they are not where they are needed. Entire empires have been founded on the need to organise the movement of water from where it is naturally to be found to where it is required for human life. This is the consequence of an important technological fact: the cost of water to its users is dominated by the cost of transporting, storing and delivering it. The technology of doing so is subject to major economies of scale. This means that the control of water has historically tended to be a major monopoly - indeed, as the jargon has it, a "natural" monopoly (one due to the inherent character of technology rather than to artificial restrictions on trade). Water has always been controlled by emperors rather than merchants, and in our day that makes it almost everywhere the prerogative of states rather than on private markets.

Water's value depends also, and more subtly, upon its quality. Water is virtually never pure, and its biological or chemical contents can destroy us. Diarrhoea from water-borne diseases alone was estimated in the late 1980s to kill four and a half million people per year in developing countries excluding China, equivalent to thirty jumbo-jet crashes per day. Six million cases of malaria were reported world-wide in 1987, almost certainly a major underestimate of the true incidence. Onchocerciasis, or river blindness, infected over 18 million people world-wide in 1983. There were six hundred thousand reported cases of cholera in 1991, a similar prevalence to that of guinea-worm, which is also water-borne[6].

For millions of the world's inhabitants, even when water is in abundant quantity, what is scarce is water quality. Yet organic contents are in the long run

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[4] Information about water stress comes from Partha Dasgupta: An Inquiry into Well-Being and Destitution (Oxford: Clarendon Press), who cites M. Falkenmark: "The Massive Water Scarcity Facing Africa: why isn't it being addressed?", Ambio, 18 (1989).

[5] Schama concludes that it is uncertain whether the drowning cell actually operated or was a gruesome punishment myth. But even in the latter case, he writes, "would that obviate its historical importance?...As a punitive myth - and still more as an exercise in regulated terror - the drowning cell drew its psychological force from the watery depths of Dutch culture...the frightening experience inflicted, in extremis, on the "patient" was designed to be an intensive rehearsal of the primal Dutch experience: the struggle to survive rising waters" (p.24).

[6] World waterborne disease estimates are given in Gleick (1993); tables C.18,C.19,C.21,C.23,C.24; pp.205 ff.

less to be feared as pollutants of water than inorganic chemicals. There is a natural hydrological cycle, in which the organic contents of water are broken down by the processes of biological decay and an equilibrium established in which the stock of water is renewed. But chemical pollutants threaten this cycle, since many of them are stable over very long periods of time. Indeed, stability is in many respects a highly desirable quality of industrial and agricultural chemicals, since otherwise they would degrade into inert components and cease to perform the functions for which they have been synthesised. Much effort therefore is devoted in the world's laboratories to building longevity into chemical design, an effort that takes no account of the consequences of this longevity for the natural environment[7].

When threatened by sufficiently persistent chemicals, water ceases to be a renewable resource and becomes a non-renewable one. It is possible to make a comeback from the destruction of water quality by inorganic chemicals only in certain environments such as rivers (from which today's stock of pollutants can be washed out to sea, where they become someone else's problem) . And even here the cost can be great, as shown by the many billions of dollars spent on cleaning up the Rhine. The Rhine Action Plan agreed in the mid 1980s set as its main goal the return of salmon and other higher aquatic species to the Rhine; since the annual salmon catch was around a quarter of a million fish in the late 19th century, this implies that the DM1,362 million spent by one firm (BASF) alone in 1991 was equivalent to an implicit valuation of nearly $3000 per fish (Begg, et.al., 1993, p.143). But the impressive technical success of the plan (Malle, 1996) shows at least that rivers can recover from chemical pollution. Groundwater sources are more vulnerable to pollution and much harder to decontaminate. There is growing evidence that the quality of groundwater in the USA is deteriorating due to both toxic materials and salination: in 1983 the US Office of Technology Assessment estimated that 29% of the groundwater supplies of 954 towns and cities with populations over 10,000 were contaminated, and the situation has certainly continued to deteriorate.

Another of the highly variable physical characteristics of water is the extent to which it impedes or facilitates movement. Water can be a barrier: the English Channel preserved the British Isles from invasion during the Second World War, and even today many political frontiers are marked by rivers, which explains why so many river basins (which are natural economic units) have to be managed by negotiations between a number of sovereign political authorities. But water can also be a carrier, of good things or bad. Rivers, canals and the sea have supported the world's most efficient long-distance trade routes, and the great overland routes such as the Silk Road flourished only where waterborne alternatives were too lengthy or dangerous. Inland seas such as the Mediterranean and the Black Sea have been the hub of the world's most dynamic civilisations[8]. But the same water that brought prosperity has also brought disease: rats bearing the Black Death travelled by ship to Europe. The great cholera epidemics were transmitted by contaminated drinking water supplies, and it was by examining the spatial pattern

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[7] Persistence of inorganic chemicals is discussed in Timothy Swanson: "Optimal Policies for Regulating Persistent Chemicals", in Swanson (ed.): The Regulation of Chemical Accumulation (Dordrecht: Kluwer, 1997 forthcoming).

[8] The focal role of inland seas has been emphasised in Braudel (1972) and, more recently, in Ascherson (1995).

of cases around a water pump in 1854 that Dr. John Snow was able to end the central London cholera epidemic that had claimed over 500 lives[9].

The very invisibility of the dangers transmitted by water means that our perception of them is prone to powerful cultural manipulation. The ideological foundation of the Hindu caste system is the fear of pollution transmitted from members of lower castes, and water is the most potent symbol of such transmission (Dumont, 1973): even today millions of Hindus will not accept water unless from members of their own caste. In the Northeast and Far West of the United States, recreational activities involving bodily contact with the water have traditionally been forbidden on domestic water supply reservoirs (in spite of the absence of any objective health risk), because water managers and public opinion view such activities as contaminating; in the remainder of the country, such activities are not only allowed but encouraged (Baumann, 1969). There is little doubt that the power of nuclear and industrial pollution to move public opinion has to do with the pervasiveness of the dominant mechanism of transmission, and the intimacy of its physical contact with us: "what have they done to the rain?"

It is precisely this intimacy which explains the ambivalence of water for us. The change in sexual behaviour and conventions in industrialised countries since the second world war may have been accelerated by the Pill, but enhanced opportunities for personal hygiene have also been a major factor: aristocracies have always treated sex as a recreation and an art, with or without contraception, but only with widespread indoor plumbing has sexuality been democratised. The spread of AIDS means water has come to seem menacing as well as liberating: bodily fluids are the vector, and the San Francisco bathhouses are the icon of the epidemic's arrival. But water as the universal solvent has always had powerful and ambivalent poetic force. W.H. Auden begins his melancholy tribute "In Praise of Limestone" with the words:

> *"If it form the one landscape that we the inconstant ones*
> *Are consistently homesick for, this is chiefly*
> *Because it dissolves in water. Mark these rounded slopes*
> *With their surface fragrance of thyme and beneath*
> *A secret system of caves and conduits".*

Water in the poem comes to symbolise balance and familiarity (for it creates landscapes "of short distances and definite places"), but also the mysterious (like music it "can be made anywhere, is invisible and does not smell"). And of course it stands as well for death, the dissolution of life. Its omnipresence gives it a multitude of symbolic properties.

In some ways the intimacy of our awareness of water has increased as societies have grown richer, partly because of its increased domestic availability but also because education brings greater knowledge of its invisible properties. Water has always had ambivalent chemical functions - sometimes as a catalyst, sometimes as an extinguisher - but we have always known about the latter whereas we learn ever more about the former. In richer societies we are aware of water not just as part of the ambient environment but also as part of the internal substrate of things, a fact which may go some way towards explaining evidence

[9] The map used by Dr. Snow to identify the source of the London cholera epidemic is reproduced in Edward R. Tufte: The Visual Display of Quantitative Information (Cheshire, Connecticut: Graphics Press, 1983) p.24.

suggesting a systematic difference in perception of water issues between public opinion in rich and poor countries. Not only are environmental issues generally ranked as much more important in relation to other matters of political concern in rich countries, but water *quality* typically ranks as one of the top two environmental issues cited there by poll respondents. In poorer countries water quality often appears far down the list: in a 1990 opinion poll in Lima (Peru), pollution of drinking water and pollution of rivers and seas were each cited by a mere 1% of respondents as the main environmental problem facing the country, well behind "rubbish in streets and public places" (42%), air pollution from vehicle exhausts (30%) and "air pollution from power plants and industry" (12%)[10]. Paradoxically, access to adequate *quantities* of water is the concrete concern of the poor - but water quality is a much greater objective threat to the poor than to the rich. Only the literal invisibility of water quality can explain this[11].

Alongside scarcity as a major determinant of the kind of economic good we consider water to be, is the nature of the property rights that can be vested in water. Property rights are, above all, rules that determine how water may be used, and water use is simply a social institution whose rules we collectively invent. Throughout the world, we create such rules in many ways, constrained both by the scarcity of the water itself and by the direction and nature of the interactions between its different users. Rules are worth making only if we can afford the expense of enforcing them. So water is sometimes a purely private good, as when it is bottled for drinking. But for it to be a private good its owner must be able to prevent others from having access to it. Its high weight and volume relative to its value make this unusual: only when users are willing to pay enough to make it worth the expense of physically sealing it from the outside world, and when nobody else benefits or suffers from the use made of it, is water strictly a private good. At the other extreme, some water resources are available to all users, like the world's oceans, where the prohibitive cost of enforcing rules of access means there are, effectively, no rules. In between lie two types of property which include most of the interesting cases. Water is sometimes common property, when a whole community has collective jurisdiction over its use. Communal irrigation systems, inshore fisheries and many aquifers are of this kind. Alternatively, water use may be characterised by unilateral external effects, when one group of users has control, while another group is affected significantly by the use made of the water, but must rely on persuasion to influence this use since it has no formal rights. The relationship between upstream and downstream countries along an international river is the most striking example of such a system. It is now becoming fashionable to see the greatest threats to the world's security in the

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[10] McGranahan (1993) points out that "in poor cities and especially their poor neighbourhoods, environmental problems tend to stay cloe to home. Inadequate household water supplies are typically more critical to people's well-being than contaminated waterways. Air pollution in the kitchen is often far worse than outdoors" (p.105).

[11] Opinion poll evidence comparing perceptions of general environmental issues across countries is given in Robert Worcester: "A Comparative Examination of Green Activism in 22 Countries" (London: MORI, 1995, esp. pp.20-24). Evidence on the high ranking of water issues within general environmental issues in Britain appears in Michele Corrado & Miranda Ross: "Green Issues in Britain and the Value of Green Research Data" (London: MORI, 1990, table 6). The Lima opinion poll is cited in Robert Worcester & Michele Corrado: "Attitudes to the Environment: a North-South analysis", (London: MORI, 1991, p.11). I am most grateful to Robert Worcester and Michele Corrado, both of MORI, for making these sources available to me.

twenty-first century as coming from "water wars", prompted by the tensions that arise between such upstream and downstream users, and by the inadequacy of international legal and arbitration mechanisms to deal with them.

The various technologies of exclusion will influence the nature of property rights in water, and they will do so in far from simple ways. For one thing, exclusion is not an all-or-nothing matter: someone who can be prevented physically from withdrawing water from an aquifer for use may still be capable of polluting the source. Again, the impossibility of creating private rights to the water itself may not prevent there being clearly defined rights to something in the water, such as fish or mineral deposits. This means that we should expect rules that adequately govern all the uses we may make of water to be extremely sophisticated, continuously evolving as technological and other circumstances change, and highly sensitive to the particular natural context in which the water is found.

There is much historical evidence that our social institutions have adapted in remarkably flexible ways to the physical circumstances influencing our need and our capacity to control water use. One telling example is the difference in the forms of law relating to surface water use between the states in the East and the West of the United States of America (Rogers, 1993; Clyde, 1989). Broadly speaking, the Eastern states have laws based on the doctrine of "riparian rights", which give no absolute right of ownership of water resources to any party, but a circumscribed right of use to parties located on the bank of a river or lake. The Western states, by contrast, have laws based on the doctrine of "prior appropriation", which essentially grants a more or less unqualified right to the first established user of a water resource. (There exist also some hybrid legal variants in a number of central states.) The difference between the two systems is that riparian rights emphasise the community of water users, and restrict what any one member of the community may do with a source of water because of possible external effects on other members. The cost of this more detailed regulation of water management in its current use is a restricted incentive to direct water resources towards their most productive applications. Prior appropriation, however, leaves the interactions between different users of a water resource more to resolution by collective negotiation, but also frees a user to adapt applications (for example by transporting water to an alternative location) if it is profitable to do so. Neither system is perfect, but the former is one whose virtues will be more important when there are significant community interactions and difficulties in co-ordinating a community-level response to these. The latter will be better suited to situations where there is a real need to direct scarce water resources to productive uses. Indeed the 19 states that employ a version of the prior appropriation doctrine (9 of them strictly) are located in the West of the country. Here water is much scarcer than in the East, and the law evolved originally to deal with the high water-intensity of hydraulic mining techniques, on claims that were remote from rivers (at a time when the impact of inorganic pollutants on water quality had yet to provoke public concern). The picture is somewhat more complex with respect to groundwater rights, where issues of users' interdependence are more likely to arise, but a similar East-West division is visible here too.

The notion that the underlying physical constraints on water availability and use might influence the evolution of social and legal practices that define the nature of water as a commodity was taken to an extreme and ambitious conclusion by the historian Karl Wittfogel in his book *Oriental Despotism*, which used the

nature of water to explain not just parts of a legal system but an entire structure of social and political authority. Wittfogel sought to explain the fact that earlier historians, "contemplating the civilisations of the Near East, India and China...found significant in all of them a combination of institutional features which existed neither in classical antiquity nor in medieval and modern Europe...the common substance in the various Oriental societies appeared most significantly in the despotic strength of their political authority" (p.1). Wittfogel argued that all of these societies were created in response to the need to organise what he called "hydraulic agriculture" - large-scale irrigation works transporting water from its natural location to where it could most enhance the fertility of the soil. In contrast to the opportunistic exploitation of rainwater resources *in situ* ("small-scale irrigation farming"), which could be achieved by merely local forms of co-operative organisation, hydraulic agriculture "involves a specific type of division of labour. It intensifies cultivation. And it necessitates Cupertino on a large scale" (p.22). The division of labour required to build large irrigation works not only required a degree of political authoritarianism unnecessary for self-sufficient city states, but then provided the political authorities with the human resources to build palaces, temples and other public works, and to maintain the control over the population which had been necessitated by the requirement for forced labour in the first place. In other words, from an analysis of specific physical attributes of water ("Water is heavier than most plants. It can nevertheless be much more conveniently managed...", p.15), Wittfogel went on to derive a complex and ambitious thesis about the differences between societies that happened to find themselves in a different relation to this vital natural resource. He disclaimed any intention of hard historical determinism, in that he cited numerous cases where the tendency implied by the underlying physical relationship to water was outweighed by other factors. But whether or not the substance of his thesis is ultimately convincing, the underlying idea remains a powerful one: that water as a resource takes many forms, some of which are due to its varying physical characteristics and some to the varying rules and customs governing its use; these rules and customs can be so central to the organisation of society that they come in turn to influence many of society's other features.

Certainly, more modest analogues to Wittfogel's argument have been amply documented. There is considerable evidence that local communities have been able to evolve sophisticated informal systems of collective management of irrigation resources; systems that can overcome incentives for the individual to "free ride". One study of South India by Robert Wade (1987) showed that "villages located towards the tail-end of irrigation systems and with soils fertile enough to support a high density of livestock show a larger amount of corporate organisation than villages elsewhere", because these features create a higher risk of crop loss if water is poorly managed. There is therefore a greater incentive to internalise the economic interdependencies between farmers through a system of rules, collectively determined and collectively enforced. The fact that these communities are local is not accidental: it is easier to evolve systems that govern the interdependencies between farmers when farms are close enough together for monitoring and enforcement to be relatively easy[12]. Wittfogel claimed that the sheer scale and geographical extent of the water systems he described necessitated correspondingly grander solutions.

[12] Other studies include White & Runge (1994); Ostrom & Gardner (1993).

Over the course of history, our social institutions have adapted remarkably to the resource constraints imposed by water availability, but this is hardly a ground for optimism about our immediate future: just as nobody lives in the United States as a whole, nobody lives through the course of history as whole. There are several reasons why the social institutions that have adapted well to past constraints may prove cumbersome and ineffectual in the face of future challenges. One point is common to all forms of evolutionary adaptation: past adaptation has no capacity to foresee the needs of the future. The overwhelming majority of all the organisms ever born have died without leaving any offspring, even though every single one of their ancestors had successfully reproduced. One impressive by-product of the hydraulic civilisations described by Wittfogel was the development of water clocks, which were probably far more accurate than the early mechanical clocks developed in Europe. Yet the historian David Landes has described this technology as "a magnificent dead end", because the rival mechanical clock developed in Europe, "aside from its usability in all times and weather...was susceptible of miniaturisation, to the point of eventual portability...The clock made possible, therefore, private as against public, general as against hieratic or royal time". This led, Landes claims, to a notion of productivity and its enhancement that was to underlie much subsequent technological advance. "That the mechanical clock did appear in the West, and with it a civilisation organised around the measurement and knowledge of time, is a critical factor in the differentiation of the West from the Rest and the rise of Europe to technological and economic hegemony" (Landes, 1983, pp.22-3).

A second point about the imperfection of adaptation is more specific to water. A pervasive and intractable problem of water management is that upstream users of a water-course have a capacity to affect the welfare of downstream users without being subject to a reciprocal dependency. Optimists about the ability of informal bargaining to overcome the effects of environmental externalities (an optimism embodied in the famous Coase Theorem - see Farrell, 1987) would expect that downstream users can nevertheless negotiate efficient water management solutions with those upstream. By definition of efficiency, they can offer inducements to upstream users that cost less than the benefits gained from the arrangement. What such arguments ignore is that such bargains, even if desirable, may not be credible: promises made today (even in good faith) may be impossible to resist breaking tomorrow, especially over the long time-spans needed for planning water use and especially given that political regimes cannot bind their successors.

If every individual living along a trade route were empowered to extract a toll from commercial traffic, such traffic would soon dry up. Agreements between individuals about efficient levels of tolls would crumble in the face of the incentive to raise tolls unilaterally, in the knowledge such agreements are hard to monitor, and the individual benefits of breaking them exceed any likely cost imposed by a retaliation on the part of those who suffer further along the route. So just as the great land routes through Central Asia became economically important only once the Mongol emperors established a centralised monopoly of force along the way, so a formal centralised control of water systems has proved the only way to overcome the lack of credibility associated with informal solutions once water systems extend over a wide enough area. Indeed, among water systems rivers pose even more severe problems for decentralisation than land routes, since the fact that water flows in one direction means downstream users have no reciprocal power to

enforce undertakings made by those upstream. Centralised control does not, of course, guarantee efficient outcomes: in one of the world's great modern ecological disasters, the surface area of the Aral Sea in Central Asia has fallen by 40% and its volume by 65% between 1960 and 1989 as a result of diversion of the inflow to water the cotton fields of Uzbekistan, a diversion instituted by the central planning authorities of the Soviet Union (Gleick, 1993, Table F.20). But decentralisation alone may not help: a recent water accord between the independent republics of Uzbekistan, Kazakhstan and Kirghizstan has improved the prospects for trade in hydroelectricity but has been unable to do anything to increase flows to the Aral Sea (*Financial Times*, 9 April 1996).

The evolution of centralised systems may respond in part to ecological and economic imperatives, but it is dependent upon so much else - the stability of political structures, the balance of military power between rival contenders for control - that it would be foolish optimism to put great faith in our capacity to resolve conflicts over water resources in the 21st century. Some of the most important international interdependencies in water management (to be increased by future developments in damming and irrigation) occur in the basin of the river Jordan, and the Tigris and Euphrates system; two of the world's most politically volatile regions (McCaffrey, 1993). The institutions of international law are weak and of disputed legitimacy; there is no mechanism of centralised control and no agreed criterion of fairness. One of the lessons of successful collective management where it occurs is that it needs stable and accepted norms: individual incentives to break an agreement are hard enough to overcome even within a generally accepted and legitimate system. Where there is no legitimacy, no agreed norm, efficiency and equity in the use of water resources may be almost impossible to attain.

The variety of the social institutions that have evolved to deal with water, testament though it is to the flexibility and adaptiveness of human society, implies also that the norms and values that characterise our attitudes to water will be many and conflicting. The very idea of treating water as an economic commodity is open to dispute, and not just because notions of fairness in distribution are strongly involved: metering water use and charging for consumption has been strongly opposed in many countries where water has traditionally been treated as a "basic good" that should be, and often is provided free by the state. Such arguments are usually based on a false analogy between situations in which water has historically been plentiful and those in which it is now scarce. Nevertheless, they gain superficial plausibility from the fact that household water consumption is relatively insensitive to both price and income: a study of the city of Austin, Texas, showed that per capita water consumption has changed little since the 1950s and not at all since 1970, although the city and its consumption habits have changed dramatically in every other imaginable respect (Herman et.al., 1988). But though direct household consumption is relatively insensitive to circumstances, *indirect* consumption through agriculture and industry has highly variable implications for water use. The "green revolution" in agricultural technology since the 1960s has dramatically increased the water intensity of agriculture, and alternative methods of producing everything from cotton to cars may consume very different amounts of this scarce resource.

There is no serious alternative to treating water as an economic commodity; it is locally even if not globally scarce, and its local scarcity may eventually prove globally threatening. But calling it an economic commodity begins rather than

ends the argument. What would it mean to do so? First, it would mean acknowledging the fact that water's scarcity requires users to be given incentives to use it efficiently. These need not always be price incentives, but we know that price incentives often have desirable features that other kinds do not. In particular they make possible the decentralisation of important economic decisions in circumstances which lack the detailed knowledge and mutual trust required by incentives based on direct coercion moral persuasion. Secondly, treating water as an economic commodity would mean a willingness to give up trying to manage water in similar ways across the whole range of circumstances in which it is found in the world. It is quite natural that arid zones and humid zones should have different systems of law, different institutional arrangements, even different attitudes to pricing and regulation. Thirdly, it would mean looking closely at the solutions appropriate to different technological constraints. For example, the scale economies involved in transmission and storage of water make a degree of monopoly almost inevitable. Water treatment technologies, on the other hand, are less dependent on large scale (indeed, it often makes sense to treat water contamination close to the point of discharge rather than wait until water has collected in large quantities); the result is that more decentralised solutions may be appropriate to water treatment than to water distribution. Fourthly, treating water as an economic commodity means acknowledging trade-offs: different uses of water involve different costs and benefits, and different distributions of these costs and benefits across different parties. Potentially explosive international conflicts over water resources may be rendered less dangerous by being brought explicitly into the daily arena of horse-trading over other resources that is the daily currency of relations between states.

We saw at the start of this discussion, in the comparison of Mexican piped with French bottled water, that cultural perceptions may make two quite different economic commodities out of chemically interchangeable substances. Different systems of law, different criteria of fairness, different structures of political authority, have for centuries characterised institutions that govern the management and distribution of water. These differences are explicable in terms of the different conditions to which they were a response. They are differences that will need increasingly to be reconciled if conflicts over the world's water resources are to be avoided in the coming century.

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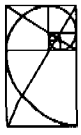

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