Article

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Avert Looming Hydrocide

Water is increasingly high on international and national agendas. Recent assessments show that the conventional focus on supply of water to users, without attention to how water is used or wastewater disposed, has led to serious degradation of water and environmental quality. "Hydrocide" is impending; the life-giving qualities of water are obstructed. Impairment to human health, destabilization of ecosystems, and repercussions on the economy are widely experienced. The challenge to avert hydrocide is significant. Investments required to deal with water-quality degradation are, on average, ten times higher, or more, compared to expenditures on structures for water supply. Financial requirements, and a tendency to see water services as free, and without reciprocal responsibility for the users, lead to heavy pressures on public budgets and policy makers. To avert hydrocide, a water ethic needs to be introduced together with incentives and sanctions for proper and responsible use of water.

Proper utilization of land and water resources require a combination of human ingenuity and adaption. Efforts to harness water resources in undulating landscapes, like the one shown on the picture from Sri Lanka, represent time-tested systems of community-based management. Photo: J. Lundqvist.

DEFINING "HYDROCIDE"

Water is the origin and symbol of life. It is indispensable for human health and well-being, for the functioning of ecosystems, for food production, and for a wide range of economic activities. It is one of the most invigorating, soothing, and at the same time, most dynamic elements of our landscape. Life without water is inconceivable and impossible. Yet, in many parts of our blue planet, this picture is becoming invalid. Anthropogenic assaults on water and other parts of our life-support systems, have led to a situation where water is not only the source of life or a prime recreational medium. As a logical consequence of pollution and heavy withdrawals from natural watercourses and waterbodies, it is also the cause of disease, ecosystem disturbance and societal disorder. An appropriate expression for this challenging situation is "hydrocide". The concept should be seen as an expression for a state where the life-giving qualities of water are obstructed and where human health, the continuous flow of ecological services, and socioeconomic development are threatened.

Attempts to conceptualize the adverse consequences for water quality from human activities, must consider a multitude of relationships, intentions and impacts. While some human activities are organized in a manner that minimizes the degradation of water quality, other activities ignore the same. Alternatively, it may be the case that impacts are acceptable and/or can be contained through technological and scientific applications. Some impacts are short-term while others are long-lived or practically irreversible. For the purposes of this article, the definition of the term "hydrocide" is based on the following considerations. Semantically, it refers to the Latin word *caedo*, which means 'I cut', 'I hew' and 'I kill'. The term "hydrocide" is partly derived from this verb which is the basis for the suffix -cide. Three principle interpretations are possible.

i) The use of *-cide* in homicide and genocide, refers to an *intentional act* to terminate life. In the case of homicide and genocide the acts are not acceptable, while in the case of pesticide and herbicide, the intended effect is sanctioned.

ii) The interpretation could also focus on the context within which an act or certain behavior is carried out. Most human behavior is subject to some kind of control and regulation. Behavior that leads to deleterious consequences can be averted or stopped. In cases where negative behavior is not prevented or allowed to continue, even if it could have been averted, the consequence is the result of a *wilful neglect* to prevent damage or injury.

iii) A third alternative refers to a situation where people *out of necessity* behave in a manner that causes harm to the environment or to a 'third party'. Poverty represents such a context.

The definition of the term "hydrocide" refers to the latter two categories. The first interpretation is not relevant. In many cases, it is possible to avert looming hydrocide through changes in human behavior which are practically, financially and otherwise realistic. If proper and adequate steps are not taken to prevent harm or injury, it is appropriate to talk about wilful neglect to avert hydrocide. In other cases, degradation of water and environmental quality is the result of human activities that are driven by acute needs.

The absence in our vocabulary of "hydrocide" is a sign of an oblivious attitude with respect to our profound dependence on safe water and the associated ecological services (1, 2). Apart from direct impacts on human health, the so-called in-stream functions in rivers, lakes and estuaries will be affected if the throughflow of water is reduced and/or if quality is degraded. Pollution of water sources, even if they are far away from settlements, will have a deleterious impact on society. The tendency to ignore human dependence on natural capital and ecological services may be contrasted with our concern for human relationships. We are well aware of the tragedies which are caused by misbehavior between humans. Violations of human rights and various atrocities, committed and justified in the name of political and religious ideologies are described in terms of homicide and genocide. Suicide reflects what harm we may inflict on ourselves. It is equally important that human sufferings caused through anthropogenic assault on our life-support systems are adequately addressed.

The discussion in this paper focuses on threats of water-quality degradation and its repercussions on human health, ecosystem functionings and socioeconomic development. This challenge, together with the tremendous task of providing the huge quantities of water needed to produce the food required for food security—from local to global levels—constitutes fundamental components of a global water crisis (3).

DIFFERENT KINDS OF POLLUTION

According to the *Comprehensive Assessment of the Freshwater Resources of the World*, which was presented to the UN General Assembly in June 1997, five major water pollution problems can be identified (3, p.11).

- The presence of micro-organisms in virtually all human and animal waste products. Bacteria, viruses, protozoa and other organisms are a common cause for the contamination of water. Unless proper treatment is applied to drinking water, they will affect morbidity and mortality.
- Growth of alga which are fertilized by phosphorus and nitrogen emanating from human and animal wastes, detergents and fertilizers. The growth of alga leads to a decline in oxygen content and suffocation of parts of the aquatic life. Originally, a problem experienced in lakes in Europe and the US, it is now felt on all continents and also in coastal areas.
- Nitrates from fertilizers and human and animal wastes, which constitute a significant threat of groundwater pollution. High nitrate levels in drinking water decrease the oxygen carrying capacity of haemoglobin in blood. This threat is particularly directed towards the health of infants.
- Presence of more than 100 000 chemicals, including persistent and toxic organic pollutants, like PCBs and DDT, in water, in society, in the environment, in food chains, etc. Many of the chlorinated organic compounds have been and still are widely distributed and used, with the result that they are found in tissues of people and wildlife everywhere on the globe.
- Heavy metals which have been extracted and produced for industrial, agricultural and other purposes. Some of them are toxic for human health, like lead, mercury and cadmium and others are toxic also for aquatic life, for instance, chromium, copper, silver and zinc.

Ongoing acidification is a determining factor for mobilization and chemical transformations of heavy metals and other toxic metals/substances. With increasing acidity, aluminum is transformed into inorganic forms which are toxic to fish. Acidification is also causing corrosion of metal pipes, buildings and statues.

MAJOR SOURCES OF POLLUTION

Of the five categories of pollution summarized above, some may be associated with poverty and the daily activities of human populations. Contamination of drinking water as a consequence of the lack of sanitary arrangements and improper disposal of

human and animal excreta is a problem that has been in focus for some time, particularly during the 1980s—the *International Drinking Water Supply and Sanitation Decade* (4). Faecal contamination *per se* is nonaccumulative and mainly local.

Water-quality degradation is also a side-effect of production in terms of mining, industry, transports and the application of chemicals in agriculture. Emissions of pollutants from production accumulate in soils, sediments, and biological material. Their effects are geographically much wider than pollution emanating from daily human activities. Even if emissions from production in the "old" industrial countries have been substantially reduced in recent decades, the legacies of past production activities, constitute chemical time bombs (5, 6). A chain of events triggered by, for example, a change in pH or erosion, could cause sudden harmful effects if substances that have accumulated over time and which have been absorbed in soils or sediments, are mobilized (6).

In the South, intensified agriculture and rapid industrial development are creating a new geographical pattern of pollution. Use of pesticides in India, for instance, increased fiftyfold between 1958 to 1975 (7). Measurements of the presence of harmful substances in waterbodies and the environment are generally lacking. Sample studies in the River Ganges indicate substantial threats. Concentrations of 171–862 ng L^{-1} of Aldrin and Dieldrin have been recorded, which are in excess of the WHO norm of 30 ng L^{-1} for drinking water (7). Rapid economic progress in the Major Developing Economies (MDE), which consist of 15 countries in the South, means that emissions of various harmful substances to air, water and the environment, are likely to grow substantially, as assessed by OECD (8).

Recent developments in the MDE indicate that the relative contribution of pollution from industrial, agricultural, and other production activities is on the increase, while many of the emissions in "old" industrialized countries have been reduced significantly; albeit with noticeable exceptions like carbon dioxide and nitrate.

Solid waste often ends up as landfills in the South. It also clogs waterways and creates a nuisance in the streets and living quarters. In the long-term, the major issue will not be production *per se*. It is already more relevant to worry about pollution which is only indirectly caused by production, but which is in fact the consequence of consumption patterns and lifestyles. Moreover, a large part of the pollution emanating from production as well as from consumption is made up of invisible particles. Even heavy metals are invisible in this context. We do not see chromium, nor do we see pentachlorphenols in leather goods. We do not see them, nor do we smell them, when they leak from the refuse dumps where old shoes and other goods end up (9). This latter type of pollution load is rarely discussed as far as the environmental situation in the South is concerned.

RAPID URBANIZATION IMPLIES HOT SPOTS

Water and environmental quality degradation is often associated with poverty, rapid population growth, congestion, poor private and environmental sanitation, and inadequate water supply. It is also correlated with growth of industry and the economic progress, which may be the only possibility to alleviate poverty. In both cases, urbanization plays a prominent role.

Most probably, there will continue to be a rapid increase in people moving into urban areas. The change is particularly noticeable in the Less-developed Regions (LDR) (10). Between 1995 to 2025, for instance, the increase in the urban population is expected to be about 2000 mill. people out of a total increase of 2300 mill., or about 88%. The share of urban increase in the LDR is also dominant in a global perspective, i.e. ca. 94%. The staggering figure of 2000 mill. people is almost at the same level as the current total population in India and China together (about 2200 mill. in 1996). The 21st century will mark a historic change with regard to the balance of urbanites and rural people. The previous rural majority will become a minority and the previous urban minority will become a majority. For the world as a whole, about half of the population will be living in urban areas around 2006. In another decade, half of the population in the LDR will be living in urban areas (10).

Urban areas are the sites for industrial activities, and thus a major source for the emissions of various pollutants. Huge quantities of organic and inorganic compounds are emitted to air and water recipients, some of which are persistent and toxic. The result is accumulation in soils and in biological material. The consequences of urbanization in terms of the geographical pattern of resource demands and environmental impacts are likely to be significant as a result of changes in lifestyles and political and economic orientation. Positive as well as problematic changes and impacts are to be expected.

THREE TYPES OF CONSEQUENCES

Apart from congestion and intensive human activities, threats of water and environmental quality degradation are most severe in areas where water is scarce, simply because the dilution effect is inversely related to the amounts of water that circulate in the area. Three important consequences of water-quality degradation can be identified.

i) Morbidity and mortality are affected. The World Health Organisation reports that every 8 seconds a child dies of a water-related disease. Annually, more than five mill. human beings die an early death as a result of illnesses linked to unsafe drinking water, unclean domestic environments and improper excreta disposal (11, 12). The majority of these tragedies occur in the South and among the poor. This kind of degradation of water quality could thus be associated with the third interpretation of hydrocide. In most of these areas, absence of proper sanitation in combination with small amounts of water means that the concentrations of substances hazardous to health are high in drinking water. Problems are aggravated in densely populated areas, i. e. where people live and work.

ii) The loss of ecological services is most probably considerable, although difficult to assess. Very significant values are potentially at stake. In a recent article that has aroused a great deal of attention, including critical remarks, Costanza et al. (13) estimated that the value of the world's ecosystem services could be almost twice as large as the global gross national product (USD 33 trillion (10^{12}) per year as compared to about USD 18 trillion per year). To what extent the degradation of water quality has affected ecosystem services can only be assessed in a fragmentary manner with our current level of understanding. Various reports do, however, show that damage is substantial.

The threats to large waterbodies of the world, e.g. the Aral Sea, the Black Sea, Lake Victoria, are reasonably well documented. For the Aral Sea, large-scale upstream diversions for irrigation of about 8 million ha of land, has reduced inflow of water to the lake to the extent that the shoreline in some places has retreated more than 120 km. The water in the Aral Sea has been reduced to 25% of its former volume. At the same time, drainage from vast irrigation areas into the rivers emptying into the Aral Sea, has resulted in drastic increases in the salinity of the waterbody, and on land. Extensive areas previously under water are now covered with toxic salt particles that are picked up by the wind and spread to surrounding areas. Fish catches have dropped to virtually zero. Flora and fauna in the region have been affected through substantial reductions in wetlands, etc. (14, 15).

For other big lakes, heavy pollution, in combination with dramatic declines in their ecosystems, has taken place, also in recent times. Wastewater from 17 countries and 160 mill. people is poured into the Black Sea through some of the major rivers of Europe like the Danube, Dnieper, and Don. A massive increase in nutrient discharge as a result of attempts to improve the standard of living in the basin countries resulted in destabilization of the entire ecosystem. Lack of treatment facilities has resulted in outbreaks of cholera. Oil spills from the shipments of oil from huge reserves in the Caspian Basin are additional threats (16, 17). For Lake Victoria, the impact can be traced to changes and intensification of land use in areas relatively close to the lake.

Other large-scale impacts are recorded for coastal zones and aquifers. As a result of overexploitation of coastal aquifers, saltwater intrusion is a common phenomenon in several parts of the world, which is rendering groundwater sources in many coastal regions unfit for use. Coastal waters, lagoons, and estuaries are exposed to drainage from terrestrial systems. Periodic toxic algal blooms in northern parts of the Adriatic Sea near the Po delta and the Lagoon of Venice, for instance, have been recorded. The synergy of massive and uncontrolled inputs of agricultural nutrients and pesticides, part of which ends up in the coastal waters, together with urban sewage and industrial wastewater, has led to a situation where the natural capital and the ecological services are exploited and utilized in excess of their assimilative potential. To remedy the situation, significant alterations in land and water use are necessary, particularly since the region is subject to increasing aridity (6).

iii) Pollution in combination with growing water demand, means that expenditures for additional supplies and treatment of water are soaring. Equally important, degradation of water quality tends to have a negative impact on the economy. Representatives of political and economic organizations in Asian countries, and probably also elsewhere, now admit that degradation of water quality, as a result of previous and current abusive practices, could very well put a brake on continued economic progress. Officials in China, for instance, are now openly concerned about negative economic consequences of poor water quality (Edwin, O., Director of the Global Environmental Monitoring System (GEMS)/Water, pers. comm.). Water quality degradation is a recurrent problem in many countries, which are able to show boosting economies. In South India, heavy pollution of surface as well as ground water sources in and around the city of Tirupur, as a consequence of the successful growth of textile industries, has been documented (18). The concern about water resources and environmental degradation has grown appreciably in the matter of a few years. Thus, pollution in the South is not only a poverty-related phenomenon, but is also a result of rapid economic growth.

POLITICAL AND FINANCIAL CHALLENGES

The wilful neglect to prevent pollution and/or to remedy its consequences is seemingly giving way to a concerned attitude. Steps are being taken to avert hydrocide. Concerning the situation in Tirupur, the Green Bench of the Madras High Court has recently ordered the close down of textile units that are not connected to public effluent-treatment plants or who do not build their own treatment plants (19). For the small enterprises the cost for treatment could very well be higher than investment and the running costs of production. The Tirupur Exporters' Association explained that the various steps taken for treating the effluents would cost 2.52 billion Indian rupees (about USD 60 mill.) for about 800 units (19).

Although treatment plants do not remove all the harmful substances from wastewater—salts used in the dying process are not removed—it is important that the awareness of the environmental impacts is growing and that rules and regulations are being enforced. Political and financial challenges to deal with the problem are also quite substantial. While typical investments for simple water-supply systems in various parts of the world on a per capita basis, range between USD 10 (handpump or standpump) to USD 200 (piped water delivered to house connections), the most simple sanitation measures cost about USD 100 and piped sewerage with treatment will be about USD 3500, all according to World Bank calculations (20). Since about 1 billion people, or almost one fifth of the world population, have to rely on natural water sources or water vendors, and about 3 billion do not have access to safe sanitation, the scale of the challenge to build or facilitate safe water and sanitation is, indeed, awe-inspiring. Of those who have access to some kind of water supply, only a small fraction are connected to wastewater treatment. About 90% of the wastewater in the developing world is left without treatment (3). Thus, it is then important to promote alternative methods in sanitation. Dry systems have been tested in a large number of places and offer an ecologically-sound alternative (21).

One must also consider the escalation of costs over time. On a global average, the real cost of new water-supply projects is two to three times that of investments in existing schemes (22, p.14). Nearby sources are usually already exploited and additional supplies have to be transported great distances. Similarly, the easily exploitable sources are already developed. The strain on national budgets from building and running public-water utilities is considerable since the financial autonomy in the water sector is quite low, or about 25% in the developing countries (22, p. 7).

Even if industry has not assumed responsibility for environmental and other externalities as a result of the disposal of untreated wastewater, they themselves increasingly face the consequences of water and environmental pollution. Expenditure to secure water supplies is increasing, and many industrial units have to build treatment plants or co-finance such plants. Apart from court orders and other clamp-down measures, the polluters face quite an efficient control agent. The application of 'green labelling' in the EU and other parts of the world, implies that access to markets is being conditioned by environmental criteria. Consequently, impacts on water quality from production are not only felt by people and the environment, but are beginning to hit the polluters themselves. Evidently, economic repercussions are a forceful argument, which anybody can understand.

BOTH SOUTH AND NORTH ARE AFFECTED

The pace of water and environmental degradation is most pronounced in the South where a combination of quite rapid population growth and poverty—sometimes in juxtaposition with rapid economic growth, and problematic hydoclimatological circumstances—are interacting in a negative, synergistic pattern. The situation is often compounded by the lack of institutions that would be conducive to progress (23). In the North, the situation is generally less dramatic, although considerable threats have been identified. Accumulation of various harmful substances over centuries has created chemical time bombs, as already mentioned (6). Concentrations of nitrates are rising in Europe in both surface- and groundwaters (7, p. 52). Twenty-six countries have high levels of nitrate in groundwater and for 18 of these countries, the situation is described as serious (24, p.70). More than 85% of groundwater located beneath agricultural land exceeds the EU level of nitrate concentration for drinking water (10 mg L^{-1} NO_3-N). According to WHO and UNEP (7), nitrate pollution is likely to be one of the most pressing water-quality problems in Europe and North America in the coming decade. If present trends continue, nitrates are likely to be a serious problem also in the South, for instance, in India and Brazil.

Since many compounds that were previously emitted are long-lived, the risks for environmental and human damage are not al-

ways reduced, even if current depositions are cut down. Heavy metals do not decompose. Many chemicals are also toxic long after application. The use of persistent pesticides has been reduced in Europe, but since breakdown of these chemicals is very slow the situation may get worse before it can get better.

IRONIC PARADOXES

Ironically, many of the problems discussed above can be related to commendable efforts to overcome water problems. During this century, the increase in the supply of water has been about two and a half times more rapid population increase (25). The building of dams and conveyance structures has been extraordinary by any standard (26). But there is a reverse side of the coin. With less water remaining in natural waterbodies the dilution effect is reduced and with intensified use, load and concentration of pollutants tend to increase. At some stage, the self-purification capacity of natural waterbodies and the resilience of ecosystems is overtaxed. Health risks from using the water will increase and the use options will be curtailed. It is not rare to find rivers, once with a year-round stream flow, but now devoid of water in downstream sections for part of the year as a result of intensified abstractions and use upstream. The example of the Aral Sea has already been mentioned. Significant reductions have been recorded for many other rivers, for instance, the Colorado River (15).

Little concern has been shown for how water is actually used. Discussions about what kind of responsibility and what criteria that should be associated with the use of a finite and vulnerable resource have, by and large, been lacking. It is more common to hear about the (human) right to water than to hear how rights and responsibilities should be balanced in order to reach equilibrium in the overall use of this 'liquid gold' (27, 28). It is a paradox to assume that the lack of clear rules and signals of how valuable water should be used and disposed, would foster efficient, equitable and ecologically sound use. The prevailing *laissez*-faire attitude with regard to water use, is remarkable with respect to the rapid rate of exploitation of freshwater resources and in view of obvious signs of stress. According to recent estimates, the amount of water appropriated for various uses in society, out of the total volume that circulates in the hydrological cycle, is slightly more than 50% (29).

In view of rapid population growth, the share of the already appropriated water is quite high. The situation is most serious in poor countries. They are faced with rapid population growth and are located in hydroclimatological regions where the natural availability of water is highly erratic and limited. In some countries, for all practical purposes, there is simply no more freshwater to develop, apart from desalinization of saline water, which is not feasible on a large scale. Overexploitation especially of groundwater is already noticeable, for instance, in many parts of North Africa and the Middle East, western USA, and the northern China Plains. The extreme scarcity of water in the Middle East, where it is also a key component in the pending conflict *versus* peace process, the provision to certain use(r)s is likely to be reduced, with agriculture being the most affected sector (30). Scarcity and threats of pollution of aquifers, have led to a strategy of treatment and re-use of wastewater in the region (31). Treatment and re-use of wastewater form a central policy also in a few other areas in the South, for instance, in Windhoek, Namibia (32).

The concurrent growing scarcity and dramatic declines in water quality in short periods of time, and difficulties to record these changes, imply that documentation about the levels and trends of water and quality degradation is weak and mostly outdated. For anyone who has paid a visit to areas in the South and the East, and for those who reside there, it is all too obvious that quality of life is at stake, if not life itself. Paradoxically, it is difficult to quantify the problem through scientifically acceptable measures. The magnitude of the problem can be seen, smelt, felt and literally grasped, in agglomerations, outside industries, and in congested settlements, where people, cattle and other domestic and wild animals, transport means, etc. are crowded together. Yet, it is difficult to measure the gravity of the situation. However, on the basis of the precautionary principle (33, pp. 706–707), strategies that counter degradation should not await detailed statistical information.

ETHICS AND PRAGMATISM IN A STRATEGY TO AVERT HYDROCIDE

Complex problems often do not have simple solutions. Basically, the challenge is not one of technological fixes or financial means, although their significance is not doubted. The basic challenge is rather one of human attitudes and behavior. Respect for the profound importance of water and nature for life and society, but also their vulnerability, constitute the basis for proper environmental stewardship. The hydrological cycle and hydroclimatological pre-conditions are not up for negotiation. Lifestyles must be questioned, even if arrogant declarations at high political level state the opposite. Irresponsible lifestyles and the consequences of rapid demographic change cannot be held sacrosanct.

In an era in which technological progress has been extraordinary, it has been easy to abandon the old association between water and a humbleness towards Nature, an association that springs from the observation that water seeks the lowest position on earth. Parallel to that notion was the recognition of the inherent force of drops of water that can hollow the hardest stone. If water is reduced to a technical issue and a ubiquity, its true value and significance are overlooked and the risk of a continuous crisis remains imminent.

Incentives for proper use of water are important, together with sanctions against its mismanagement and abuse. A few components are repeatedly emphasized in this connection.

Users of water and other stakeholders, must be brought much more firmly into the management process. What is required is something more specific than conventional attempts to decentralize decision making and community participation. Users must assume responsibilities alongside rights and benefits. Codifying rights and responsibilities in relation to management functions into a coherent and transparent system is urgent. The ongoing review of water law and water management in South Africa represents an interesting effort in this direction (34). Many countries have sophisticated laws and regulations concerning water and the environment, but their enforcement is weak. In other countries, this part of the legal framework is poorly developed. Populist rhetoric even at high levels of policy-making about the human right to water without hints about what is required in terms of reciprocal responsibilities, is not constructive. It is often nothing more than a mirage, and creates frustration on the part of those who will not enjoy what has been promised.

As noted in a UN Report (3), it is theoretically possible to remove virtually all pollutants from water, but the huge expenditure and the sophisticated techniques that would be required, mean that various approaches must be tried, where end-of-pipe solutions constitute only one approach. In the long run, it makes sense to try to reduce pollution at the source, i.e. within industries, in agriculture, and in households.

Another crucial component refers to the central role of water in overall development. The inclination to perceive water as a technical supply problem, on the one hand, and as something which is mainly of interest in connection with human health and well-being, on the other, is gradually being replaced by a recognition of its importance for social and economic development as well as for environmental sustainability. The role of water in the 'income-generation-equation' and in the functioning of ecosystems, has been ignored. In a calculation on the economic return per unit of water in Namibia, it was shown that the return per unit water in industry and commerce, as compared to irrigated agriculture, was 14: 0.07, i.e. the economic return to water in industry is about 200 times higher compared to irrigated agriculture (35). Shuval (36) argued that agriculture receives about 70% of the water being allocated in Israel, but agriculture only contributes about 3 to 5% of the GNP. These simple calculations do not consider the impact from water use on quality, nor do they consider the consequences on in-stream functions from withdrawals for societal water uses. Allocating large volumes of water to various sectors in society implies that correspondingly less water is left for the functioning of ecosystems, at the same time as intensified use may impair quality (2). As discussed in Gleick et al. (37), California reserves a certain fraction of the natural flow of water to safeguard in-stream functions, i.e. ecosystem services.

The points mentioned above are components of the much acclaimed strategy of Integrated Water Resources Management (38). However, a weak point is obvious in the insufficient efforts to combine issues related to quantity, e.g. development of water sources and provision, with aspects of quality. The prevailing strategy is to first, single-handedly, develop water sources and arrange provision for socioeconomic purposes. Only at a later stage, are the negative side-effects from pollution and associated externalities addressed. Policies dealing with quantitative and qualitative issues in a compartmentalized manner and the lack of temporal coordination between these two issues remains a challenge for integrated water-resources management.

NO FREE LUNCHES AND NO FREE WATER

An often repeated phrase is that 'there is no such thing as a free lunch'. Even if humans, through arrogance, indifference or ignorance, tend to behave in a manner that negates this dictum, its message has never been more valid. Production of food and feeding a large and rapidly growing population remains a real challenge (39). At the turn of the century, it is appropriate to add a similar message; "there is no such thing as free water". Pristine sources of water are rare. Water scarcity, competition, and pollution are felt by a growing proportion of the world's population. Concerted efforts are required to deal with various problems and threats in this connection. Perhaps most important; humans must recognize the non-negotiable character of the hydroclimate and the life-support systems on which we all depend, and respond accordingly.

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