household, about 500 000 to one million people consume such food regularly in that megapolis. There may be 3–5 million such consumers countrywide as *Yamagishism* and *MOA* claim to have more than one million customers each (2).

Some schools and restaurants have also switched over to serving "chemical free" produce only, and a sake brewery proudly announces the use of only "organically grown" hops in one of its premium brands.

LOOKING AHEAD

In 1994, because of the growing demand for chemical-free produce, the Japanese Ministry of Agriculture, Forestry, and Fisheries introduced guidelines for labelling organically grown produce to protect consumers from fraudulent advertising. Whether one regards chemcial-free farming as a fad or a desire to restore past fundamental ideas and practices, it has evolved into a lifestyle for some farmers and consumers. However, the possibility of it becoming the major form of farming within the foreseeable future—in Japan or elsewhere—appears remote because of the physical limitations on the amount of compost that can be produced, the extra labor needed, and yields that are reduced by 10–30%. "Organically grown" produce generally costs 10–50% more in the market than its "chemically grown" counterpart. However, in contra-diction to conventional wisdom, *teikei* farmers obtain yields approximating those of their chemical-using neighbors, thanks to laborious methods of crop production and protection (5). In addition, both farmers and consumers accept responsibilities; farmers probably make more profit than their chemical-using neighbors and consumers get chemical-free produce at a lower price than that prevailing in the market. Thus, both come out ahead. Can the *teikei* system of alternative agriculture work elsewhere?

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Synopsis

Further Momentum to Water Issues: Comprehensive Water Problem Assessment in the Being

Scarcity and misuse of freshwater pose a serious and growing threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development and the ecosystems on which they depend are all at risk, unless water and land resources are managed in a more ecologically appropriate manner than they have been in the past. The problems are far from speculative in nature—they are here, and they affect humanity now.
Dublin Statement, January 1992.

A NEGLECTED WARNING

Leonardo da Vinci's statement that water is the driver of nature is more important than ever before in history, especially for developing countries which are located in dry climate tropical and subtropical regions. In countries ranging from Algeria to Zimbabwe, there is a widespread awareness of the critical importance of freshwater availability and quality for future survival and sustainable development. Although involving a serious warning of an impending water scarcity, the implications of the Dublin Statement above were not much ventilated in Rio.

The freshwater availability on the planet is finite, but the world population is growing in an explosive way, and is at present expanding by over 90 mill. individuals each year, i.e. equivalent to one new India being added each decade. All these new world inhabitants are dependent on water both for survival and for food.

As a consequence of population growth, society's freshwater needs, to support health, quality of life, and socioeconomic development are rapidly increasing. For all of these purposes, water is a nonsubstitutable resource. At the same time, the global water situation is characterized by widespread symptoms of past mismanagement: multicause water scarcity, multicause water pollution, multicause water-related land-fertility degradation (including so-called desertification), and widespread floods and inundations.

There are close linkages between water resources, population health and land use. Water is already a life and death issue in the South, and every year hundreds of thousands of people die, and will continue to die in developing countries, due to lack of clean water. Already today, the number of water-related diseases and their death toll are huge: the latter corresponding to one jumbojet crashing every half hour. Securing safe household water and sanitation in urban areas is, however, an almost insurmountable task. The future problems of megacities are beyond imagination. And drought-related famines represent an increasing threat.

In spite of the global scale of these problems, water problems have not been seen as global—they were seen as local or sometimes regional. The scale of the impending crisis makes it urgent to get water firmly onto the international agenda. To this aim, the UN Commission for Sustainable Development, in May 1994, took steps towards a comprehensive freshwater assessment in order to bring out the basic facts and make it possible to assess the severity of the pending crisis. This synopsis presents the rationale for such an assessment.

IMPENDING WATER CRISIS

Present trends and predictions indicate that the water crisis will become more pervasive and widespread in nearly all arid and semiarid countries in the early part of the 21st century. It is estimated that the number of people living in the countries with water stress or chronic water scarcity will increase from 300 mill. in 1990 to 10 times as much, 3000 mill. by 2025. While the world as a whole is likely to be affected by the water crisis in about 5 years time, for nearly all countries in the Middle East, this crisis is already an established fact.

The days when water could be considered to be an inexpensive and abundant resource are now virtually over for nearly all arid and semiarid countries, whether developed or developing. The impending water crisis can be predicted with considerable certainty.

There is no question that if the international organizations and the world community took the threat of the water crisis half as seriously as that of global warming, the potential adverse impacts of the former could be significantly reduced. Untold misery in developing countries due to serious water scarcities during the next few decades might be prevented.

Many interrelated factors contribute to the impending water crisis.

- The global population increasing steadily with attendant implications for water quantity and quality. As a result, total water requirements for all different uses will increase as well. As the standard of living increases, so will per capita water requirements. As current poverty eradication programs succeed in developing countries, water requirements are likely to accelerate even further as more and more people achieve middle-class status.
- The amount of water that can be made accessible, through new water-resources development on a cost-effective basis, in any country, is limited. Since in the dry-climate countries nearly all the easily ac-

cessible resources have already been developed or are in the process of development, the unit costs of future projects can only become higher. The cost of next generation of projects is often two to three times higher than the present generation.

- As human activities increase, more and more waste is produced, contaminating available sources of freshwater. Among the major contaminants are untreated or partially treated sewage, agricultural chemicals, and industrial effluents. These contaminants are seriously affecting the present quality of water in aquifers and rivers. In rapidly industrialized developing areas, the potential urban water source may in fact already constitute a cesspool.
- Increasing delays in project initiation time are likely in the coming decades in implementing new water-development projects, due to escalating project costs, lack of investment funds, increasing technical and management complexities, and growing attention to social and environmental implications.

All these issues, when considered together, mean that while the demand for water in arid and semiarid countries would continue to increase steadily in the foreseeable future, countries are unlikely to have many new sources of water which could be mobilized and made accessible economically and quickly. For a large number of such countries, international water systems, shared by two or more countries are the only major new sources that could still be economically developed. Thus, as water scarcities in individual countries escalate, international waters would become an increasingly critical issue during the latter part of the 1990s and beyond. All the indicators point to increasing tensions between neighboring countries. Like the energy crisis of some two decades ago, a serious water crisis is now looming over the horizon, a crisis that has the potential of becoming more pervasive and affecting more lives than the energy crisis ever did in the past.

HOW MUCH DO WE KNOW ABOUT THE RESOURCE?

As already indicated, water problems have traditionally been seen as local or possibly regional. In order to find out whether a global approach is really called for, it is necessary to find ways of quantifying the crisis. How incompatible are the growing demands against the existing resource? How polluted is the resource, and in what regions?

The information available for this purpose is surprisingly poor, because of large data gaps, especially in the developing world. Thus, the present overview of the water crisis is limited. The information gaps start already with how much water there is in circulation over the different continents that can be made accessible for use as a basis for socioeconomic development. The lowest income countries are mainly located in water-deficit areas, in the sense that the evaporative demand of the atmosphere exceeds precipitation. Water deficit areas cover 60% of Asia and 85% of Africa. The present level of knowledge of water-balance components, i.e. precipitation, evapotranspiration and runoff generated at global and regional levels is imprecise and or inadequate. the discrepancies in water balance for South America and Africa amount to over 50 mm yr^{-1}.

We still have only a limited idea about the quality of the circulating water, due to even larger data gaps in the extent and magnitude of water-quality problems, especially on a global scale. Moreover, the information that we have is concentrated on a few select water-quality parameters with no information on other important parameters.

Until 1987, when the Global Environmental Monitoring program (GEMS) started to collect data from different parts of the world, no attempt had been made to assess, globally, the quality status of regional freshwaters. A first assessment, based on data from about 50 countries, indicated that some pollution problems seemed to have reached global proportions. There is practically no more pristine water—even the Antarctic waters are polluted. Heavy-metal pollution problems are widespread all over the world; pollution with disease pathogens is common in all regions where urban sewage is discharged into rivers and more prevalent in the developing regions of Central and South America, Asia, and Africa where huge populations lack proper sanitation.

The most reliable water resource is groundwater, accessible through springs and wells on a year round basis. While we have some information on surface water, the extent of our knowledge on groundwater contamination and depletion, regionally and globally, is pathetic. Groundwater salinization is already widespread. It is associated with inadequate drainage and high evaporation in irrigation systems, and by overexploitation of groundwater close to the coast, allowing saline water to intrude into freshwater aquifers. Salinization from these sources can be found in all regions. Nitrate pollution of groundwater is another widespread problem, emerging from the use of fertilizers in agriculture. In Western Europe, nitrate concentrations in agricultural regions are above the health limit for drinking water. Pollution from faecal coliforms and dissolved mercury are serious. In certain industrialized regions in the South, the groundwater is so polluted that it cannot be used even by industry.

The importance of assessing water resources as a prerequisite for rational and sustainable management of the resource is self evident. The widespread lack of reliable data on this the most limiting resource is a fundamental pitfall for sound development planning under rapid population growth.

WHAT CAN BE SAID ABOUT DEMAND?

At the same time as information on the resource side is evidently too limited, the demand for this nonsubstitutable resource is increasing. Looking back, water demand has grown three times faster than populations have grown—a symptom of increasing wealth and quality of life. If this trend continues a doubling of the world population would carry with it a sixfold increase in water demand. Present efforts in the international community to cope with the growing water demand are largely centered around avoiding wasteful demands by water pricing. Compared to the implications of the population explosion, this basically means no more than buying more time.

Both industrial production for socioeconomic development and agricultural production for providing food security to a rapidly growing world population depend on water. Looking to the future, this increase will thus have to continue due to the ongoing population increase, and to increasing quality of life as a response to rapid urbanization. The near future population growth can be seen more as a life support obligation than as a population issue, due to its direct consequences for water-demand increase. Mothers are already borne and the possibility to bring down the number of children per woman dramatically is limited on a 10–20 year time scale.

FROM WATER ALLOCATION TO SHARING A SCARCE RESOURCE

How then can this incompatible situation be met? It seems evident that the conventional water-management models are not effective enough, with their fragmentarized administration and their inability to cope with water's enormous complexity. Water has at least six different functions which have to be coped with all at the same time.

- The health function, reflected in water supply and sanitation programs.
- The habitat function, reflected in aquatic ecology and the importance of protecting waterbodies from pollution.
- The psychologic/religious functions, reflected in water as a symbol in religion, and as a major component in architecture and recreation.
- The carrier function of both solutes and sediments, manifested in water's role as the bloodstream of the biosphere and the actor in erosion and sediment transport.
- The biomass production function, involving water flow in through the roots and out through the foliage as a basic condition for photosynthesis.
- The socioeconomic production function, manifested in the importance of water for industry and urban life.

The escalating water scarcity is growing into a massive problem. Waste-handling problems are growing out of hand and the water supply of growing megacities implies gigantic problems by its competition with water needs for rural development and food security.

The fact that the world is approaching new problems will force a water-management revolution. The world community has to enter a new water-management epoch. The escalating population pressure on this finite resource in already water-scarce regions, will call for development of a new strategy; water sharing. The water passing through any landscape will have to be shared between all those living within the river basin. More-over, all water cannot be withdrawn for use, since a certain amount has to be left in the river to sustain aquatic ecosystems.

Water ethics needs to be urgently developed on how to share the mobile resource between those living upstream and those living downstream, and between urban/industrial needs on the one hand and rural/food production needs on the other. Since land use, besides depending on beneficial use of water, has impacts on the amount and quality of water moving through the landscape, downstreamers can be said to be the prisoners of the upstreamers. Upstream forestry and agriculture influences the flow, seasonality, and quality of the water moving downstream and therefore the water-dependent opportunities in downstream societies. Large-scale projects for intensified biomass production upstream, reducing the runoff feeding the river system, will imply futures foregone downstream.

The new management model has to be a combination of *efficient allocation principles* for locally competing demands, and *rules for fair regional sharing* between upstreamers and downstreamers.

CONCEPTUAL PROBLEMS

In view of the fact that water is the basis for life, the worldwide neglect of this almost existential, but galloping problem is difficult to understand. The innocence and near illiteracy among world leaders—even the Brundtland Commission—regarding this fundamental life resource is surprising. Outdated and highly simplistic mental images of water need to be corrected and further developed. More modern concepts are needed to address the increasingly complex problems of managing the water as it passes through a particular landscape in a river basin, above and below the ground.

Even basic concepts tend to remain fuzzy and unclear. Below are some examples:

- *Water supply*: This word is used with two completely different meanings—even in the same articles: i) provision of water for households and/or industry; ii) water availability, i.e. the amount of water naturally available from which a fraction may be used for water provision purposes;
- *Water availability* is generally understood as the availability of "blue water" i.e. water in aquifers and rivers with no attention to the "green" water in the root zone, i.e. the water available for plant growth.
- *Availability contra accessibility*: Water availability is generally given as an aggregate number, composed of the rainfall over an area plus the inflowing water from upstream countries or regions, but is seldom accompanied by information on how much of the flow that may be put in storage to increase the dry season flow in the rivers.
- *Water quality*: A quite diffuse concept referring to the chemical composition of the water accessible for a certain use; principally the same water would have different quality ratings depending on its intended use; when water quality is being defined, it is however generally characterized by a certain setup of components, like coli-bacteria, nutrients, oxygen content, content of oxygen-consuming organic pollutants, etc.
- *Evaporation*: Representing the return flow to the atmosphere from a certain precipitation, is often given without information on whether the amount refers to the actual or the largest possible, so-called potential evaporation. Ecological texts too often limit information to just precipitation; this only raises highly relevant questions like, is 1000 mm of rainfall little or much? The answer evidently depends on the evaporation.

There are at the same time a number of misleading more general concepts which still remain to be developed.

- *Environment* is an anthropogenic concept, originally referring to the surroundings of a human individual, exposed to deleterious influences from those surroundings. On a somewhat larger scale it basically refers to the landscape where he/she lives. As soon as what is referred to is a large number of individuals living in a finite world, the concept is diffuse, tends to have a more abstract meaning, and is difficult to analyze and discuss due to its diffuseness. Thus, different people tend to give different meaning to the word, making discussions highly inefficient.
- *Environmental problems* is a related and widely used and equally diffuse concept. Conventionally, it tends to be thought of as referring to pollution phenomena. When discussing Third World problems, the concept was used in Rio to cover additional problems such as global warming, ozone depletion, desertification and deforestation. What was, for some reason, neglected was an environmental problem of even larger relevance to the near future problems of the world; i.e. the environmental vulnerability caused by human activities in certain hydroclimatic zones—water scarcity, high evaporative demand, recurrent droughts, soil vulnerability, etc.

Many misconceptions and myths have developed on water issues in recent years, adding to the present dilemma.

First is the actual *environmental impact* of water development projects. Absence of systematic monitoring and evaluation of the side-effects of projects has meant that very often hypotheses are accepted as facts. For example, a detailed evaluation of the actual environmental impacts of the Assuan High Dam in Egypt indicates that many of its currently believed impacts are erroneous. Similarly, the linkages between schistosomiasis and irrigation are significantly more complex than widely believed. Thus, for a rational environment/development dialog on water-development projects, we urgently need a clear and unambiguous understanding of the real facts in terms of both positive and negative environmental impacts.

Second, it is often believed in water-scarce arid coastal areas that *desalination* can resolve the scarcity problem. The economic cost of seawater desalination and its associated environmental costs mean that this technology can be effectively used only under very special conditions. Brackish water desalination could be economically viable, depending on the salt content, but the proponents rarely consider the sustainability of such an action, since brackish groundwater is often a limited resource. Thus, desalination is unlikely to be a general solution for arid countries for several decades to come.

Third, the concept of *arable land*, i.e. "land fit for ploughing or tillage" is an amorphous and misleading issue. Land will produce crop yields only if there is enough "green" water available to satisfy the evaporative demand of the plants. In arid and semiarid countries, it is water and not land which is the main constraint for expansion of crop lands. Such expansion will become increasingly difficult because municipal and industrial water demands in developing countries are increasing steadily. Since these are higher priority water uses, irrigated agriculture will continue to be the steady loser. Thus, significant expansion of agricultural land—as many governments of water-scarce countries now believe—is unlikely to take place. There simply is not enough water. It would be erroneous to assume agriculture will maintain even its present total share of water use in the 21st century.

PROPOSED GLOBAL FRESHWATER ASSESSMENT

In view of the water crisis, and especially its close relation not only to poverty eradication, but also to the development potential of the South, it was proposed to the Commission for Sustainable Development in May 1994 that something radical be done to bring this critical issue onto the international agenda so that it can be addressed in a resolute way by the international community. As already indicated, CSD took steps towards a comprehensive freshwater assessment, in which UN organizations will participate as well as interested governments. The project is presently in an early phase. Stockholm Environment Institute plays a key role. The results of the rapid assessment will be presented to the UN General Assembly in 1997 in its follw-up session to UNCED.

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