

This book contributes to the present discussion on climatic changes and the scientific advances needed from scientists, explaining clearly in conservative and

comprehensible terms, and conveying the major complexities and uncertainties. It is a good reference volume for anyone dealing with climate and water resources.

Mahmoud Abu Zeid
Water Research Center
Cairo, Egypt

Conference reports

Water resources in the next century

Report on the Stockholm Water Symposium, Stockholm, 12–15 August 1991

This symposium aimed at increased water awareness by addressing the strenuous measures needed all over the world to alter the tendencies to large-scale water quality deterioration and shortage of water, which have drastically affected living conditions.

The first issue addressed was water as a major constraint to development:

- In order to get access to food, fodder, fibre, fuelwood and timber, society has to develop strategies which allow successful balancing of the interactions society–soil–water–vegetation–other species, so that biodiversity of natural ecosystems, potability of groundwater, edibility of fish and fertility of land are protected.
- The limited rainfall and high evaporative demand of the atmosphere typical of the arid/semi-arid tropics and subtropics are acting as limiting constraints on development. Since population growth is rapidly depleting the remaining room for manoeuvre between water supply and demand, rational management of scarce water resources is supremely important.
- Rapid population growth raises the parallel issues of how to supply the new inhabitants with both water and crops that need water to grow. Water scarcity in many Third World countries makes it extremely urgent to stop population growth. It also forces us to start thinking in new terms: rather than transporting water from remote areas, food grown in those areas could be transported.

The second issue addressed was large-scale water quality degradation.

- The basic cause of the large-scale eutrophication now degrading fresh and coastal waters all over the world is population growth and the resulting

increase in food demand, which together lead to increased human waste and increased use of fertilizers.

- Metals are rapidly spreading also in the Third World environment as a result of modernization and industrialization. Acidification remains a major problem, leaching metals from soils, rocks and sediments in softwater areas of the world. Increases in mercury in fish illustrate the kind of problems produced.
- Persistent organic chemicals are carried around the globe by air and water. Once in the ocean, they are caught by sea currents, toxifying marine and coastal ecosystems, and locally threatening traditional fishing and seafood harvesting.
- Thus, two phenomena are at the core of the ongoing large-scale degradation of both freshwater bodies and coastal waters: on the one hand, industrial production and waste disposal, spreading persistent chemicals to air, land and water bodies; on the other the galloping population growth with growing food demands, which both contribute nutrients to water bodies and coastal waters. The evident way out of the world-wide water quality degradation is by stopping population growth and by closing the cycles, so that neither nutrients, nor persistent chemicals, nor industrial waste can escape to the environment, where they will be caught and carried by the water cycle, in the end producing severe biological damage.

The third issue addressed was watershed management, technical development and prosperity:

- Municipal waste water has to be treated so that it can be reused and nutrients

returned to the land, where they are needed for food production. Wastewater recycling, accompanied by health guidelines, is a technique already practised in several water-scarce countries.

- In a longer time perspective, the idea that it is possible to get rid of pollution is fundamentally wrong, since water – a unique solvent which is chemically active – is continuously on the move through all landscapes inhabited by people. Thus, pollution abatement at the source has to replace conventional end-of-pipe treatment technology.
- The production of drinking water from deteriorating freshwater cannot safely be left to sophisticated technology but has to rely on techniques imitating natural biochemical processes.
- The large-scale land degradation in Third World countries involves a severe threat to improved life quality in poverty-stricken countries with rapid population growth. The problem is closely linked to the management of water. Land and water have to be managed together locally on a watershed basis. Especially in water-scarce areas, it is fundamental that water be seen as an economic good, rather than as a freely available resource.
- There is today a call for a new statesmanship based on an acceptable understanding of Earth system realities. Solutions have to be found for the abatement at the source of all non-degradable substances by mitigating the barriers produced by current distortions of world markets by subsidies. Solutions also have to be found to socio-economic development under water scarcity without degradation of land fertility and water quality. The broad and well-integrated environmental education for which there is an obvious need has to include an adequate understanding of the functions of the water cycle. Every person, young or old, has to understand that life on Planet Earth takes place at the mercy of the water cycle.

Malin Falkenmark
Swedish Natural Sciences
Research Council
Stockholm

Planning, monitoring, appraisal and control

African Regional Symposium on Techniques for Environmentally Sound Water Resources Development, Alexandria, Egypt, 30 September–2 October 1991

This symposium was particularly concerned with techniques for planning, monitoring, appraisal and control. Needless to say techniques have to be viewed in the context of other relevant policy considerations.

Focusing on techniques for the moment, has there been progress in developing appropriate techniques? During the opening session one speaker mentioned that techniques have not progressed for the past 20 years. He felt that we are not asking the right questions and that new ideas are needed for the 1990s. Is there evidence from this symposium that efforts are being made to remedy this situation?

I tried to look at the papers presented at this symposium in a matrix format; on the one hand, different physical concerns related to water resources development like catchment hydrology, health, etc and, on the other, techniques relevant to various aspects of project development like gaining an understanding, planning, monitoring, appraisal, etc. Placing papers in this matrix is to some extent a matter of subjective judgement but the overall pattern provides useful insights even if the location of individual papers could be debated. No doubt there are some papers that do not appear to offer a technique or understanding, which will assist other professionals in their work. However, there are others that do offer positive contributions in more than one area. If a paper makes a contribution in more than one area it has been counted once for each area in developing this matrix.

Let me quickly highlight some of the strengths and weaknesses which this matrix illustrates and at the same time pinpoint a few of the contributions which for me were particularly interesting. Taking first the horizontal lines of the matrix:

1. We were fortunate to have had sponsorship from PEEM which enabled us to give particular emphasis to health. Ten contributions addressed health

issues in one form or another. Of particular note were the large number of papers (five in all) concerning techniques for control; the control of schistosomiasis in Tanzania and Zimbabwe; study of guinea worm highlighting the need to support engineering solutions with education; and two approaches to the control of pathogens in sewage reuse schemes. The paper describing methods for forecasting vector-borne diseases also made an important contribution towards improved health planning methods.

2. In contrast to health, other aspects of the human situation, which I have called socio-economic impacts, did not feature strongly in the symposium. This is not surprising since the discussion of these effects broadens the scope of the debate considerably and could have justified a full symposium on its own. We should, however, note the concern voiced by a number of delegates that there were no sociologists at our symposium and bear this in mind in future.
3. I have picked water conservation as a category because it is an area of increasing interest in a world where competition for finite resources is increasing. Three papers described technologies which improved utilization of the resource for irrigation: the development of shallow aquifers, the use of clay pots and introduction of piped irrigation. Other papers also described methods used in planning for and monitoring the conservation of the water resource.
4. Paper were presented under all of the columns in relation to catchment processes (hydrology, sediment movement, flood control). Two very different situations were described in which effective methods of control have been developed; water and sedi-

ment management methods were described for the 3H Plain in Northern China and a novel approach to sizing flood control embankments in Bangladesh was presented.

5. Although a few papers touched on techniques for planning, monitoring and appraising soil fertility, principally in relation to soil salinization, this area was fairly weakly represented particularly in relation to the magnitude of the soil salinization and waterlogging problems that developing countries face. An interesting discussion of the complex relationships between fertilizer use and its overall environmental impact was, however, presented.
6. Water quality is of increasing importance, particularly in countries such as Egypt where there is need to maximize the use of scarce resources. We were presented with methods which can be used to assess the overall salinity balance in the Nile Delta and to study water quality changes in a coastal lagoon in Tunisia. The field test of a hydroponic system of water treatment provided an interesting example of a control technique.
7. No techniques for improved planning, monitoring or control for biological conservation were presented. This category appears to be a weak area at present.
8. I have called the final row of the matrix 'biological interactions' by which I mean any interaction, either positive or negative, between human activity in water resources development and the biological domain. The main interest in this category at the symposium centred around the management of aquatic weeds. Techniques currently in use in European drainage channels were commended for consideration by irrigation professionals in Africa.

I turn now to look briefly at the spread of papers in relation to the columns of the matrix.

Planning methods and, particularly, control techniques received considerable attention. It has been encouraging to me as an engineer that so many new ideas for managing environmental change have been proposed and, more importantly, tested in the field. The number of ideas in these areas has not been matched by

developments in methods for monitoring and appraising environmental changes associated with water resources development. Having said that, the rapid appraisal approaches tested in both Ghana and Nigeria generated considerable interest.

Monitoring seems to be an area where further work is required. A number of delegates drew attention to the fact that environmentally sound development of water resources can only take place if effective systems of monitoring can be established so that changes due to unforeseen circumstances or new situations can be rapidly identified and corrected. In this way the achievement of environmentally sound water resources development becomes a dynamic process of adjustment and response.

Development of techniques by themselves will not influence practice. Appropriate techniques are a prerequisite to proper action but they need a suitable policy framework and climate. Mr Le Moigne referred to 'technicians as a vanishing breed' in the World Bank, reflecting the sense of frustration felt by the profession in our inability to influence policy matters. He may have some satisfaction from the fact that this sense of frustration is not confined to the professionals in the Bank alone. However, we as a technical community have a responsibility to try to influence policy makers.

We are all pleased that in recent times environmental concerns have been voiced by the people and this is being reflected in policies. This could in some circles create a false impression that anything and everything will be acceptable under the name of environment. The techniques we develop have to be affordable and the methods we recommend reliable, and to this end they need to be monitored and evaluated in the field. I was therefore

pleased that during the sessions a number of contributors referred to 'affordable environmental techniques', 'environmental audit', 'evaluation and monitoring', 'softer, environmentally pleasing engineering', etc.

Once the need and the priorities are clearly understood, there is little doubt that specialists such as those at the symposium will be well placed to develop the appropriate techniques. As mentioned earlier, there are clear signs from this symposium that this is already happening. These techniques need to be translated into action and for this we rely on the consultants, whether they be national or international. Here, like John Hennessy, I am thinking not of individual consultants but groups who undertake project implementation. Their task is not easy. John Hennessy referred to the complex nature of the client body comprising the owner — usually the government of the country concerned — the funding agency, the operators, the managers, the farmers and the executing agent. The techniques one develops and expects the consultant to use should be capable of inspiring confidence in this complex client body. John Hennessy referred to the need for consultants to keep abreast of new developments. Equally, there is a need for researchers to ensure that the new techniques they develop are made known to potential users and, more importantly, that the techniques inspire confidence.

Environmental degradation is often caused, and certainly exacerbated, by the overuse of water. I was pleased to see some papers presented on water-saving techniques. Tony Allen was right to draw our attention to the competition for water from sectors other than agriculture and the necessity to use water in agriculture effectively according to principles of maximum

returns of water. When such competition exists, many developing countries are feeling the need to assign priorities. They need techniques, possibly economic, reflecting social concerns to assist them in this. This is another area that did not receive much attention at this symposium.

Such techniques are particularly difficult to devise when benefits such as health have to be included in the equation. Robert Bos introduced a set of research priorities that need urgent attention from the health standpoint. It was again clear from his presentation that the relevant research issues are not merely to understand the links between diseases and the water environment, and control of vectors, but that a number of policy issues are involved.

Professor Biswas drew our attention to the unsatisfactory state of our current practices both in environmental impact assessments and evaluations of water development projects. I do not think that any of the participants would argue that the state of affairs had changed during the three days. However, there is no doubt in my mind that this symposium clearly demonstrated that there is the will to face the challenge posed by Professor Biswas to develop new techniques to help design, construct, operate, assess and evaluate projects paying proper attention to environmental concerns. If the contributions to the symposium are an indication of the type of things to expect in the future, we can look forward with confidence.

One of the striking features of this symposium was the level of attendance: the hall appeared to be full all of the time.

A. G. Colley
Deputy Chief Engineering Advisor
Overseas Development Administration
London

Promoting cooperation on international water systems

Workshop on 'Environmentally sound management of international water systems', Sophia Antipolis, France, 28–30 April 1992

This workshop was organized by the International Office for Water (CEFIGRE), co-sponsored by the United Nations Environ-

ment Programme (UNEP) and the French Ministry of Cooperation and Development. Participants included 30 experts

from 11 countries and six international organizations.

After reviewing various aspects of the question of environmentally sound management of international water systems, the workshop unanimously concluded that there is a growing urgency to promote and heighten awareness in the public and private sector about international water shortages and to conceive international programmes to mitigate this serious threat to global socio-economic development. In addition, all the indica-

tions are that the problems are likely to be more complex as well as more extensive unless the challenges are faced squarely at present. This problem arises from the rapidly increasing demands for water for municipal, industrial and agricultural use, as a result of growing world population and increasing standards of living, exacerbated by the serious threats to the integrity of water quality as a result of pollution. Nations sharing international bodies of water are particularly vulnerable to this issue. The workshop noted that there are well over 200 shared surface water basins and an unknown number of shared aquifers, more than half of which are in the developing countries and many of which require urgent international

assistance in helping to solve their problems. This situation provides a unique opportunity to develop programmes of inter-country cooperation with a potential to generate huge socio-economic benefits to promote sustainable development.

The workshop reviews a number of examples of potential water conflicts over shared international water systems which are rapidly becoming critical. Various initiatives to mitigate these conflicts include:

- sustainable development of international water systems;
- environmental perspectives of international water systems;
- development of databases for the

purpose of promoting cooperation on international water systems;

- support for the initiative to strengthen and codify international water law;
- possible organizational structures for international cooperation on shared water systems; and
- identification of mutual benefits to facilitate transboundary water cooperation.

The workshop recommended that the international community initiate studies, action programmes and financial support to come to the assistance of countries facing serious transboundary water conflicts.

Asit K. Biswas
Oxford, UK

The Dublin Statement on water and sustainable development

International Conference on Water and the Environment, Dublin, 26–31 January 1992

Scarcity and misuse of fresh water 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 more effectively in the present decade and beyond than they have been in the past.

Five hundred participants, including government-designated experts from a hundred countries and representatives of 80 international, intergovernmental and non-governmental organizations attended the International Conference on Water and the Environment (ICWE) in Dublin, Ireland. The experts saw the emerging global water resources picture as critical. At its closing session, the conference adopted this Dublin Statement and the Conference Report. The problems highlighted are not speculative in nature; nor are they likely to affect our planet only in the distant future. They are here and they affect humanity now. The future survival of many millions of people demands immediate and effective action.

The conference participants call for fundamental new approaches to the assess-

ment, development and management of fresh water resources, which can only be brought about through political commitment and involvement from the highest levels of government to the smallest communities. Commitment will need to be backed by substantial and immediate investments, public awareness campaigns, legislative and institutional changes, technology development and capacity building programmes. Underlying all these must be a greater recognition of the interdependence of all peoples, and of their place in the natural world.

In commending this Dublin Statement to the world leaders assembled at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992, the Conference participants urge all governments to study carefully the specific activities and means of implementation recommended in the Conference Report, and to translate those recommendations into urgent action programmes for Water and Sustainable Development.

Guiding principles

Concerted action is needed to reverse the present trends of overconsumption, pollu-

tion and rising threats from drought and floods. The Conference Report sets out recommendations for action at local, national and international levels, based on four guiding principles.

Principle No 1: fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment. Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater aquifer.

Principle No 2: water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels. The participatory approach involves raising awareness of the importance of water among policy makers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects.

Principle No 3: women play a central part in the provision, management and safeguarding of water. This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources. Acceptance and implementation of this principle requires positive policies to address

women's specific needs and to equip and empower women to participate at all levels in water resources programmes, including decision making and implementation, in ways defined by them.

Principle No 4: water has an economic value in all its competing uses and should be recognized as an economic good. Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

The action agenda

Based on these four guiding principles, the conference participants developed recommendations which enable countries to tackle their water resources problems on a wide range of fronts. The major benefits to come from implementation of the Dublin recommendations will be the following.

Alleviation of poverty and disease. At the start of the 1990s, more than a quarter of the world's population still lack the basic human needs of enough food to eat, a clean water supply and hygienic means of sanitation. The conference recommends that priority be given in water resources development and management to the accelerated provision of food, water and sanitation to these unserved millions.

Protection against natural disasters. Lack of preparedness, often aggravated by lack of data, means that droughts and floods take a huge toll in deaths, misery and economic loss. Economic losses from natural disasters, including floods and droughts, increased threefold between the 1960s and the 1980s. Development is being set back for years in some developing countries, because investments have not been made in basic data collection and disaster preparedness. Projected climate change and rising sea levels will intensify the risk for some, while also threatening the apparent security of existing water resources.

Damages and loss of life from floods and droughts can be drastically reduced by the disaster preparedness actions recommended in the Dublin Conference Report.

Water conservation and reuse. Current patterns of water use involve excessive waste. There is great scope for water savings in agriculture, in industry and in domestic water supplies.

Irrigated agriculture accounts for about 80% of water withdrawals in the world. In many irrigation schemes, up to 60% of this water is lost on its way from the source to the plant. More efficient irrigation practices will lead to substantial fresh water savings.

Recycling could reduce the consumption of many industrial consumers by 50% or more, with the additional benefit of reduced pollution. Application of the 'polluter pays' principle and realistic water pricing will encourage conservation and reuse. On average, 36% of the water produced by urban water utilities in developing countries is 'unaccounted for'. Better management could reduce these costly losses.

Combined savings in agriculture, industry and domestic water supplies could significantly defer investment in costly new water resource development and have enormous impact on the sustainability of future supplies. More savings will come from multiple use of water. Compliance with effective discharge standards, based on new water protection objectives, will enable successive downstream consumers to reuse water which presently is too contaminated after the first use.

Sustainable urban development. The sustainability of urban growth is threatened by curtailment of the copious supplies of cheap water, as a result of the depletion and degradation caused by past profligacy. After a generation or more of excessive water use and reckless discharge of municipal and industrial wastes, the situation in the majority of the world's major cities is appalling and getting worse. As water scarcity and pollution force development of ever more distant sources, marginal costs of meeting fresh demands are growing rapidly. Future guaranteed supplies must be based on appropriate water charges and discharge controls. Residual contamination of land and water can no longer be seen as a reasonable trade-off for the jobs and prosperity brought by industrial growth.

Agricultural production and rural water supply. Achieving food security is a high priority in many countries, and agriculture must not only provide food for rising

populations, but also save water for other uses. The challenge is to develop and apply water-saving technology and management methods, and, through capacity building, enable communities to introduce institutions and incentives for the rural population to adopt new approaches, for both rainfed and irrigated agriculture. The rural population must also have better access to a potable water supply and to sanitation services. It is an immense task, but not an impossible one, provided appropriate policies and programmes are adopted at all levels – local, national and international.

Protecting aquatic ecosystems. Water is a vital part of the environment and a home for many forms of life on which the well-being of humans ultimately depends. Disruption of flows has reduced the productivity of many such ecosystems, devastated fisheries, agriculture and grazing, and marginalized the rural communities which rely on these. Various kinds of pollution, including transboundary pollution, exacerbate these problems, degrade water supplies, require more expensive water treatment, destroy aquatic fauna and deny recreation opportunities.

Integrated management of river basins provides the opportunity to safeguard aquatic ecosystems, and make their benefits available to society on a sustainable basis.

Resolving water conflicts. The most appropriate geographical entity for the planning and management of water resources is the river basin, including surface and groundwater. Ideally, the effective integrated planning and development of transboundary river or lake basins has similar institutional requirements to a basin entirely within one country. The essential function of existing international basin organizations is one of reconciling and harmonizing the interests of riparian countries, monitoring water quantity and quality, development of concerted action programmes, exchange of information and enforcing agreements.

In the coming decades, management of international watersheds will greatly increase in importance. A high priority should therefore be given to the preparation and implementation of integrated management plans, endorsed by all affected governments and backed by international agreements.

The enabling environment

Implementation of action programmes for Water and Sustainable Development will require a substantial investment, not only in the capital projects concerned, but, crucially, in building the capacity of people and institutions to plan and implement those projects.

The knowledge base. Measurement of components of the water cycle, in quantity and quality, and of other characteristics of the environment affecting water are an essential basis for undertaking effective water management. Research and analysis techniques, applied on an interdisciplinary basis, permit the understanding of these data and their application to many uses.

With the threat of global warming due to increasing greenhouse gas concentrations in the atmosphere, the need for measurements and data exchange on the hydrological cycle on a global scale is evident. The data are required to understand both the world's climate system and the potential impacts on water resources of climate change and sea level rise. All countries must participate and, where necessary, be assisted to take part in the global monitoring, the study of the effects and the development of appropriate response strategies.

Capacity building. All actions identified in the Dublin Conference Report require well-trained and qualified personnel. Countries should identify, as part

of national development plans, training needs for water resources assessment and management, and take steps internally and, if necessary with technical cooperation agencies, to provide the required training and working conditions which help to retain the trained personnel.

Governments must also assess their capacity to equip their water and other specialists to implement the full range of activities for integrated water resources management. This requires provision of an enabling environment in terms of institutional and legal arrangements, including those for effective water demand management.

Awareness raising is a vital part of a participatory approach to water resources management. Information, education and communication support programmes must be an integral part of the development process.

Follow-up

Experience has shown that progress towards implementing the actions and achieving the goals of water programmes requires follow-up mechanisms for periodic assessments at national and international levels.

In the framework of the follow-up procedures developed by UNCED for Agenda 21, all governments should initiate periodic assessments of progress. At the international level, United Nations

institutions concerned with water should be strengthened to undertake the assessment and follow-up process. In addition, to involve private institutions, regional and non-governmental organizations along with all interested governments in the assessment and follow-up, the conference proposes, for consideration by UNCED, a world water forum or council to which all such groups could adhere.

It is proposed that the first full assessment on implementation of the recommended programme should be undertaken by the year 2000.

UNCED is urged to consider the financial requirements for water-related programmes, in accordance with the above principles, in the funding for implementation of Agenda 21. Such considerations must include realistic targets for the time-frame for implementation of the programmes, the internal and external resources needed, and the means of mobilizing these.

The International Conference on Water and the Environment began with a Water Ceremony in which children from all parts of the world made a moving plea to the assembled experts to play their part in preserving precious water resources for future generations. In transmitting this Dublin Statement to a world audience, the conference participants urge all those involved in the development and management of our water resources to allow the message of those children to direct their future actions.

Technical note

ENSICNET

Since 1978 the Environmental Systems Information Center (ENSIC), located at the Asian Institute of Technology in Bangkok, has been offering information services to the developing countries, specially those in Asia. ENSIC's subject scope falls directly on one of the most important issues of today's concern: environmental pollution. It covers the broad fields of water supply, solid wastes management, wastewater reuse and treatment, and low-cost options for sanitation in urban and rural areas.

To make information accessible to its users, ENSIC collects, repackages and disseminates technical literature selected from over 300 journal titles, proceedings, research reports and books. The ENSIC database contains about 8000 references, and every document that goes into the database has been duplicated on microfiche. This particular characteristic makes ENSIC unique, in that it is truly replicable at any time and anywhere. Its database can be downloaded to any other computer and the full text of all ENSIC

documents can be provided on microfiche.

This facility enabled ENSIC, with the financial support of the Asian Development Bank (ADB), to set up ENSICNET in 1988. ENSICNET attempts to strengthen the information capabilities of the countries participating in the network, through a systematic approach to identifying, processing and disseminating the information they produce on environmental pollution, water and sanitation.

In real terms, the six focal points participating in ENSICNET have become new ENSICs. So far, new 'ENSICs' have been set up in China, Indonesia, Nepal, Pakistan, the Philippines and Vietnam. These focal points were given the complete ENSIC bibliographic holdings on microfiche, computer equipment and train-