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**IMPROVED EFFICIENCY IN THE MANAGEMENT
OF WATER RESOURCES: AN OVERVIEW**

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the author and do not necessarily reflect those of the United Nations.

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More than two thousand years ago, a Tamil epic recorded the advice of a sage to his Indian King: "If you wish to establish your reputation among your people, store great quantities of water in the valleys of your kingdom: those who fail to store water will also fail to store their glory". The advice of the sage to store water to alleviate the effects of potential droughts, which implies more efficient water management, if anything, is more important today than it was some two millennia ago during the reign of the Indian King. The crisis that has affected Africa in recent years unequivocally indicates the urgent necessity and importance of more efficient management of water resources.

Anticipating the increasing importance of the role of water management to sustain and enhance the development processes in the future, the Committee on Natural Resources (CNR) considered in its first session in New York in 1971 the convening of a Water Conference under the aegis of the United Nations. The initial objective was to provide a forum where diverse experiences in water management from various countries as well as review of existing technologies could be profitably discussed in order that the future availability of water for humanity could be improved and that the process of international cooperation in the area of water management could be increased. CNR further elaborated the objectives of the proposed Conference during its second and third sessions to incorporate the formulation of water policies at national and international levels to cope with potential future shortages and to review the economic implications of the future demand and availability of water. Furthermore, it was agreed that the Conference would be directed primarily to water policy-makers and would consider not only specific economic and administrative aspects of water resources management and development but also technical aspects.

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In May 1973, the Economic and Social Council (ECOSOC) of the United Nations approved the holding of the water Conference and also endorsed the provisional agenda. This, in turn, was endorsed by the United Nations General Assembly in December 1975 in Resolution 3513 (XXX).

The main purpose of the Conference was to promote a level of preparedness nationally, regionally and internationally which would help the world avoid a water crisis of global dimensions by the end of the present century. It was to deal with the problem of ensuring that the world had an adequate supply of water, of good quality, to meet the needs of a global population which is not only growing, but is also seeking improved economic and social conditions for all people.

The United Nations Water Conference was convened at Mar del Plata, Argentina, from 14 to 25 March 1977. More than 1500 participants attended the Conference, representing 116 governments, the various United Nations agencies and organizations, intergovernmental organizations, international river commissions, 58 non-governmental organizations and observers from several national liberation movements.

The Conference Secretariat itself prepared many documents. Probably the two most important documents produced were Resources and Needs: Assessment of the World Water Situation and the Present and Future Activities of the United Nations System in Water Resources Development. The first document provided a comprehensive and up-to-date analysis of the world water situation in terms of resource availability, demand and use. The second document was the first and the most comprehensive and integrated review of its kind ever carried out by the United Nations system on any subject. It also identified a series of constraints which make the work of the United Nations system in the area of water less effective and thus should be rectified.

The Conference approved a final action plan, subsequently termed Mar Del Plata Action Plan, in two parts: recommendations that covered all the essential components of water management (assessment; use and efficiency; environment, health and pollution control; policy, planning and management; natural hazards; public information, education, training and research; and regional and international co-operation), and 12 resolutions on a wide range of subject areas.

The Conference produced a wealth of information on various aspects of water management as well as country- and region-specific data and information. Many countries prepared for the first time national reports on the availability and use of water as well as review of management practices. Several countries put in motion processes to assess the distribution of surface and ground-water resources, and patterns of water demand and use for various purposes, many of which have continued ever since. Numerous countries also prepared thematic papers highlighting their experiences in various policy-related themes covered under the agenda. Some 260 thematic papers were submitted to the Conference.

In addition, a parallel scientific meeting was held in Mar del Plata on technical aspects of water management. Distinguished international and national experts participated and presented numerous papers at this meeting. These as well as reports prepared by various non-governmental organizations amply supplemented the official documents of the Conference.

Comprehensive and realistic analyses of the Water Conference can be found elsewhere (M.R. Biswas, 1978; Fano, 1977).

It would, however, be an error to consider the Water Conference as an unique event of the Seventies. It was an integral part of a series of mega-conferences sponsored by the United Nations during the period 1972-81 on critical global issues. All of these intergovernmental conferences

were aimed at the highest policy-makers in their respective fields. The Water Conference was preceded by the Conferences on the Human Environment in Stockholm in 1972, on Population in Bucharest in 1974, on Food in Rome in 1974, and on Human Settlements in Vancouver in 1976. Three more similar conferences were held following the Water Conference, on Desertification in Nairobi in 1977, on Science and Technology for Development in Vienna in 1979 and on New and Renewable Sources of Energy in Nairobi in 1981. In retrospect, as one of the 3 or 4 people who were privileged enough to attend all these World conferences, it is clear that each were affected by the conferences preceding the event, and each in turn had an impact on the conferences that followed. This, however, is proper since the primary foci of all the conferences are interrelated: environment-population-food-human settlements-water-desertification-science and technology-renewable energy. For example, it would be a comparatively simple task to show water as one of the major interconnecting links that has a direct influence on all the other subjects of the world's conferences.

ACHIEVEMENTS OF THE WATER CONFERENCE

The Water Conference was held exactly a decade before this Inter-regional Symposium. In a sense, the present Symposium can be and should be considered as an important event to commemorate the 10th Anniversary of the Water Conference which can rekindle the spirit of Mar del Plata, and by so doing strengthen the commitment of the governments to water management and also simultaneously to indicate to the people of the world the importance and relevance of efficient water management.

Viewed from any direction, the Mar del Plata Conference was an important bench-mark in the field of water management. Accordingly, during its tenth anniversary, it is appropriate to analyse what impacts

it has had on water management practices of national governments and international organizations and also to review what it has achieved.

Before we attempt to analyse the impacts and review the achievements, it is useful to ask what were its hopes and aspirations. Here it is worth quoting from the opening statement to the Conference of its competent Secretary-General Yehia Abdel Mageed (1977) of Sudan:

"It was hoped that the Water Conference would mark the beginning of a new era in the history of water development in the world and that it would engender a new spirit of dedication for the betterment of all people - creating a new climate for a wiser appreciation of these critical problems, generating a greater flow of funds through the channels of international financial assistance towards the cause of development and in general making a finer commitment, on the part of all concerned, to establish a real breakthrough, so that our planet would be a better place to live."

There is no doubt that the Water Conference sensitized the international community on the problems and complexities of efficient water management (Biswas, 1983). Its timing fortuitously turned out to be right. When it was first proposed in 1971, its proponents little realized the severity of emerging food and energy crises - the first natural due to widespread droughts and the other man-made - and the global problem of the availability of clean drinking water to all people. The full implications as well as the magnitudes of these three difficult issues could not have been readily realized in 1971. With the beginning of the ending of the era of cheap energy in October 1973 and the occurrence of severe droughts in several countries around that period, many nations started to view water development in new lights. Since hydropower generation and irrigation are compatible uses of water (hydropower generation does not consume water but globally agriculture accounts for 80 per cent of all water used) and both the uses can be satisfied concurrently with appropriate reservoir operation policies, countries quickly

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realized the importance of water management as an important input to their development process under the changing economic regime.

What did the Water Conference actually achieve? If we want to answer this question in terms of rigorous scientific analyses of facts, no comprehensive answer is possible. Conceptually it can be argued that the impacts of the Conference can be identified by the difference between what has happened during the decade 1977-1986 and what would have happened if no such Conference took place. Unfortunately no methodology is available which can state with any degree of reliability as to what would have happened without the Conference. Under these circumstances, probably a better and certainly more meaningful approach would be to review the extent of implementation of the Mar del Plata Action Plan, irrespective of whether these actions had directly stemmed from the Water Conference. This is the approach that has been taken in the following section.

IMPLEMENTATIONS OF THE ACTION PLAN

During the preparatory process and at the Conference itself, several delegations highlighted the issue of "implementation gap". Fears were expressed that the results of such a mammoth effort could be impaired in the absence of an effective mechanism for implementation (Maged, 1982). The various delegations and officials were unanimous in their views that every effort should be made to eliminate the implementation gap in order that the commitments made at the Conference could be fully realized. Thus, during the reporting of the results of the Conference to the fifth session of CNR in May 1977, it was emphasized that the litmus test of the earnestness with which the resolutions of the Conference were considered and adopted would lie in the vigour and promptness with which they would be implemented by the various concerned parties.

We now have a reasonably good information base on the progress in the implementation of Mar del Plata Action Plan. The following analysis is based on a questionnaire survey carried out by the Inter-secretariat Group for Water Resources of the Administrative Committee on Co-ordination (ACC), supplemented by own personal observations and discussions during numerous missions to various countries.

The 30-page questionnaire was transmitted to the governments by the Secretary-General of the United Nations by a note verbale of 1 November 1983. 91 governments returned this questionnaire, and their analysis was presented to CNR during its Ninth Session in April 1985 (Report of the Secretary-General, 1985a).

The questionnaire did not consider progress in the implementation of the recommendations in the area of community water supply since WHO had developed a monitoring system based on information provided by the Governments in the form of country report digests. So far two post-Conference surveys have been conducted by WHO, one in 1980 to establish the baseline data for the International Decade and the other for 1983. Information on China was not included, and the surveys suffered from nearly all of the problems associated with similar earlier WHO surveys which have been discussed in detail elsewhere (Siswas, 1981). Because of the quality of data, the extent of general conclusions that can be drawn from WHO database is somewhat limited (Report of the Secretary-General, 1985b). In addition, there is some discrepancy between data provided in the Secretary-General's report (1985b) and by WHO (1986) based on the same surveys.

Planning, management and institutional aspects - The Action Plan recommended that each country should formulate and keep under review a general statement of national water policy in relation to the use,

management and conservation of water, as a framework for planning and implementing specific programmes and measures for efficient operation of schemes. On the basis of the questionnaire survey, currently some 75 percent of developing countries and 65 percent of developed countries have national water policy statements. Little more than 50 percent of developing countries reporting acknowledged the existence of national master plans, but the situation is unsatisfactory in Africa, where only 18 percent of the countries have such plans. It is, however, heartening to note that a large proportion of countries not having master plans have now embarked on their preparation.

Preparation of national master plans is not enough. Many of the plans the author had an opportunity to review have been poorly formulated due to a variety of reasons, among which are lack of adequate indigenous expertise, poor choice of foreign consultants who have assisted to develop such plans, too much emphasis on engineering aspects and not enough on social, economic, environmental, legal and institutional aspects, and their theoretical rather than practical orientations. Accordingly, some of the master plans formulated thus far are likely to be of limited use unless they are modified significantly. It is probably high time to objectively review some selected national master plans to identify their strongest and poorest components, so that the countries that are now considering their formulation do not make the same mistakes again. Preparation of practical guidelines to formulate national master plans for use by developing countries would be a step in the right direction.

Some countries are also periodically reviewing the master plans and adjusting priorities and targets in order to keep pace with changing national and international conditions. This is a process that was advocated by the Action Plan.

With respect to cost recovery from water projects, the general experience appears to be that only a fraction of the total capital and recurrent costs are being recovered in developing countries. In many instances, cost recovery does not even account for the total operation and maintenance (O & M) expenditures, which often means that the systems are not being efficiently maintained due to lack of resources. This reduces performance of the projects, and thus anticipated benefits are often not occurring. Inadequate generation of financial resources often has meant deferral of O & M activities to future years. The information available at present unambiguously indicates that it is neither a viable policy nor an economic proposition since it not only reduces the efficiency of water management systems but also the final cost of rehabilitation is significantly higher than the cumulative O & M costs, had these been properly carried out. Experience from Mali indicates that after 10 years of neglect, the rehabilitation costs for major water projects is roughly equivalent to 10 times the combined appropriate annual O & M costs (Biswas, 1986a).

When national water legislations are considered, the questionnaire survey indicated that around one-third of the African countries, 40 percent of the Latin American and Caribbean countries and two-thirds of the Asian and Pacific countries felt that the existing legislations are adequate and compatible with the long-term objectives of their national economic and social development plans. Furthermore, whereas in the Latin American and Caribbean region, nearly all countries are at present amending or revising their legislations, only about half the African countries reported similar progress. All the European countries expressed a high rate of satisfaction with existing legislations and their status of revision.

The Water Conference emphasized the need for "real co-ordination" among all bodies responsible for the investigation, development and management of water resources as well as the establishment of efficient water authorities. Overall 73 percent of developing countries now have central bodies or mechanisms to co-ordinate activities at the national levels. In contrast, only 61 percent of the developed countries responding to the survey indicated the existence of similar national co-ordinating mechanisms. The Latin American and the Caribbean region had the highest percentage of countries (87 percent) having such mechanisms whereas the Western Asian region had the lowest at 50 percent. Nearly all developing countries that currently do not have such mechanisms have plans to establish them in the future, but similar interests cannot be witnessed in developed countries. What now needs to be done is to review the performance of these mechanisms in order to identify appropriate measures to improve their efficiency.

Assessment of Water Resources - This is probably one of the important areas where progress since the Water Conference has been most disheartening. On the basis of available information, it is "doubtful whether there has been any net improvement in the overall situation" (Report of the Secretary-General, 1985a). Shortage of funds and trained manpower and related resources has made it difficult even to sustain earlier assessment programmes, let alone improve them. This is especially true for many sub-Saharan countries where droughts and other catastrophes have played havoc with national economies. For example, climatological data collection in Chad came to a halt for several years for all practical purposes, and many stations have been closed in recent years (Biswas, 1986b). Without reliable assessment activities, it is difficult to see how water resources can be efficiently managed.

The adequacy of collection of time-series data in developing countries and their perceived reliability varied from one parameter to another as shown in Table 1.

Parameter	Adequacy (%)	Reliability (%)
Precipitation	55	69
Surface water	40	60
Evaporation	31	43
Water quality	30	55
Groundwater	25	52

Table 1. Percentage of developing countries responding to adequacy of networks and reliability of data collected

All developed countries and 76 percent of developing countries now use computers to process, store and retrieve data on precipitation and surface water. Computer usages drop to 78 percent for developed and 58 percent to developing countries for groundwater: corresponding statistics for Africa is 36 percent. On dissemination of data collected, results are somewhat mixed. The Latin American and Caribbean region leads with respect to the existence and adequacy of mechanisms to disseminate data on precipitation and surface water (Western Asia is the worst), but ranks lowest with respect to groundwater. Most countries are planning to improve their processes for data processing, storage, retrieval and dissemination.

Community water supply - Undoubtedly the issue that has received the maximum publicity from the Action Plan is community water supply

because of the launching of the International Drinking Water Supply and Sanitation Decade by the General Assembly on 10 November 1980. The Decade was recommended by the Conference.

The Action Plan had recommended that each country should develop national plans and programmes for community water supply and also identify intermediate milestones. According to WHO, only 9 countries had developed Decade plans by early 1981, but this number had mushroomed to 59 by the end of 1983. Another 31 countries stated that their plans are at various stages of preparation. All the 59 countries and 17 of the 31 countries preparing plans had stipulated their Decade targets by the end of 1983. It should, however, be noted that by this time 22 countries had modified the targets, and had mostly downgraded them since the original targets were too ambitious. It is equally clear that on the basis of progress made thus far, many other countries will find their targets are also over-ambitious and thus cannot achieve them by 1990. Hence, many more countries will either have to scale back their target to more realistic levels or accept the fact that the targets are unlikely to be realized.

On the basis of information available from WHO for 1980 and 1983, and general comparison of data from all countries reporting at any of the surveys conducted, a picture of global coverage can be drawn as shown in Table 2. Because of the problems associated with the data collection processes of WHO (Biswas, 1981), the figures given in Table 2 should be taken as indicative rather than authoritative. On the basis of this Survey, following statements can be made:

- Even though the percentage of people in urban areas that had access to clean water supply increased by only one percent from 1980 to 1983, from 70 percent to 71 percent, it still meant that some 90 million additional people were covered because of rapid population increases in urban areas of developing countries.

Regions	Population in millions					
	Total		Coverage			
	1980	1983	No.	%	No.	%
Africa (ECA)						
Urban	135	160	89	66	91	57
Rural	334	356	73	22	103	29
Total	469	516	162	34	194	38
Asia and the Pacific (ESCAP, excluding China)						
Urban	428	493	278	65	330	67
Rural	1064	1109	277	26	488	44
Total	1492	1602	555	37	818	51
Latin America and the Caribbean (CEPAL)						
Urban	234	254	183	78	215	85
Rural	124	126	52	42	62	49
Total	358	380	235	66	277	73
Western Asia (ESCWA)						
Urban	27	30	25	94	29	95
Rural	21	24	9	41	12	50
Total	48	54	34	69	41	76
Totals above						
Urban	824	937	575	70	665	71
Rural	1543	1615	411	27	665	41
Total	2367	2552	986	42	1330	52

Table 2. Water supply service coverages by regions, 1980 and 1983
(Source: Report of Secretary-General, 1985b)

- Percentage of people receiving drinking water supplies in rural areas increased from 27 percent in 1980 to 41 percent in 1983. Some 250 additional people were covered during this period.
- Above statements hide major regional disparities. For example, percentage of people having access to clean water in urban areas of Africa actually declined from 66 percent to 57 percent during the period. This is the only decline in any region.
- A major issue, however, has to be the operational effectiveness of water supply provided. From personal visits to several countries and other studies,⁽¹⁾ it is evident that many sources have broken down, even though the countries concerned have continued to claim that they were operational. Unfortunately published data available provide no information on the present status of the projects, a shortcoming that needs to be rectified.

The major constraints for not implementing the Decade more effectively, as identified by the countries through the WHO monitoring system, are funding limitations, inadequate operation and maintenance, lack of trained personnel, both professional and sub-professional, insufficient cost recovery, use of inappropriate technologies and poor planning. Naturally the priorities of these constraints vary from one region to another. For

(1) An example of this can be seen from Maharashtra, India, a state that has consistently claimed to be the best in terms of handpump installation and maintenance, and where India Mark II handpump programme began about 20 years ago. During my evaluation of the Bhima Command Area Development Project for IFAD, it was found that nearly one-third of the pumps were not operational, no government maintenance personnel could be found at the village level, average delays of six months to repair the broken handpumps, and 9 out of 10 handpump sites either had no drainage or extremely poor drainage (Biswas, 1983).

example, the African countries consider lack of available funds as the most important constraint whereas Western Asia ranks lack of trained personnel to be the most critical.

Agricultural Water Use - According to the documents prepared for the Water Conference, agriculture is the largest user of water, accounting for some 80 percent of the world consumption. The urgent necessity of instituting proper water control to sustain and enhance agricultural production has been graphically illustrated by the catastrophic impacts of the recent droughts in many sub-Saharan African countries.

The importance of irrigation can be clearly identified by the fact that some 50-60 percent of the increase in agricultural production during the period 1960 to 1980 have been estimated to have come from either new or rehabilitated irrigated areas. On the basis of the responses received to the questionnaire survey from 54 developing countries, nearly half (25 countries) believe that new and improved irrigation will contribute to less than 25 percent of the total planned increase in agricultural production, another 15 countries expect the corresponding estimate to be 25-50 percent, and the rest (14 countries) expect it to be 50-75 percent.

The perception of constraints to irrigation development faced by various developing regions varies significantly from one another. The percentage of countries of a region that consider various listed constraints as very severe or severe is given in Table 3.

Constraints to irrigation development	Africa	Asia & Pacific	Latin America & Caribbean	Developing Europe
Shortage of financial resources	100	79		67
Lack of equipment	86	64	58	20
Lack of qualified manpower	75	42	25	0
Institutional deficiencies	55	33	50	20

Table 3. Percentage of countries in various regions that consider respective constraints very serious or serious (Source: Report of Secretary-General, 1985a)

An interesting post-Conference development has been the trend to establish targets for the various facets of agricultural water use, even though these were not specifically recommended in the Action Plan. Table 4 shows the percentage of developing countries that have established targets in the fields of new and rehabilitated irrigation, flood protection, drainage and reclamation, and aquaculture.

Targets	Percentage of Governments		
	1977-1980	1980-1985	1985-1990
Development of new irrigation	73	84	88
Rehabilitation of existing irrigation	65	74	79
Flood protection in relation to agricultural development	43	60	67
Drainage and reclamation	47	69	75
Introduction to aquaculture	42	59	63

Table 4. Percentage of developing countries establishing targets in specific areas, 1977-1990 (Source: Report of the Secretary-

Shared Water Resources - Rational management of shared water resources is probably one of the most difficult tasks in the area of water management because of their inherent additional political, institutional and legal complexities. In a retrospective analysis of the Water Conference, its Secretary-General Yehia Abdel Mageed (1982) said:

"If time and budget had permitted, two other documents would have proved most useful in placing, more forcefully, before the Conference the questions of financial arrangements and shared water resources. It was felt that both these areas were not tackled satisfactorily at the Conference."

In terms of general co-operation concerning development of water resources shared by more than one country, much progress can be reported since several bilateral and/or multilateral agreements have been concluded in the area of surface water, e.g. rivers and lakes. Commensurate progress has not been made in the area of groundwater, e.g. shared aquifers.

Of the countries returning the questionnaire, 67 percent of developing countries and 86 percent of industrialized nations reported successful completion of bilateral and/or multilateral agreements on the management of shared water resources. In addition, some three-quarters of the African countries and two-thirds of the Asian and European countries reported that further bilateral and/or multilateral negotiations are now taking place.

There are several instances of multi-country collaboration in Africa which consider river basin as a unit for development. For example, an agreement to establish an organization for the management and development of Kagera River Basin was reached in August 1977, and similarly a convention in 1980 created Niger Basin Authority. Work is now under way for a development plan for the Zambezi River Basin.

While it is accepted that creation of a multi-country river basin management institution is generally a less complex and time-consuming task than preparation of a basin-wide management plan and then to get the countries to accept them, it is still an important and many times an essential step to successful treaty negotiations.

The Intergovernment Working Group of Experts on Natural Resources Shared by Two or More States, convened by the United Nations Environment Programme, has prepared principles of conduct for the guidance of Governments for the conservation and harmonious utilization of shared natural resources. Much of these guidelines are based on experiences on the management of shared water resources. Fourteen countries have used these principles for negotiations, and another 8 countries plan to use them in the near future.

Environment and Health - Much progress can be reported during the past decade on the environmental and health aspects of water management. Provision of clean drinking water and better sanitation to a constantly increasing number of people, which has been discussed earlier, naturally has immeasurably positive environmental and health benefits.

Since 1977, many developing countries have made it mandatory to prepare environmental impact assessments before specific water development projects can be authorized. Thus, for the first time in history, a developing country - India - rejected the proposal to build a dam in Silent Valley only on environmental grounds, since it would have inundated an unique tropical forest. Similarly, in 1986, People's Republic of China decided against the construction of a major dam at Three Gorges mainly because of environmental concerns.

Either through institutional machineries set up during the past 10 years to consider environmental issues or through appropriate water-related ministries, increasingly more and more developing countries are giving environmental issues due consideration in the decision-making process. In this regard, the attempt by the United Nations Environment Programme to prepare practical guidelines for environmental-sound water management for developing countries is to be welcomed, since the lack of such appropriate and authoritative guidelines is seriously hindering work in most developing countries.

Steady progress can be reported in developing countries on controlling water pollution during the past decade through better water quality data collection and legal-institutional steps like setting and enforcing water quality standards and increasing public awareness of the environmental and health costs of water pollution. This is demonstrated by the fact that some 60 percent of all pollution control spendings at present, on a global basis, is in the area of water pollution. India's recently launched highly public campaign to clean up the River Ganges is a spectacular attempt to control water pollution in a large river.

Reliable data on water pollution control expenditures by countries or regions are not available at present, but attempts have been made to estimate them. One such estimate is shown in Table 5 (Gross, 1986). Such estimates should be taken as indicative rather than authoritative. They generally show increasingly more expenditure, both in developed and developing countries to control water pollution.

Other recommendations of the Action Plan - Mar del Plata Action Plan, in addition to the aspects discussed earlier, made recommendations in a variety of other areas ranging from fisheries, inland navigation, industrial water use to the question of Panama Canal Zone and water policies in the

occupied territories. Because of space constraints, only the achievements in selective aspects of the Action Plan have been discussed here. The other issue that would be briefly discussed is the progress in the area of education, training and public information, a topic which now warrants immediate further attention as would be discussed later.

Regions	1976	1979	1985	1990
North America	11,535	13,880	15,855	17,770
Latin America	1,584	1,887	2,717	3,848
European Community (EC)	8,364	9,190	12,280	14,309
Non-EC Western Europe	2,467	2,365	3,189	3,726
Eastern Europe	5,621	6,691	9,111	11,157
Africa - Mideast	1,301	1,587	2,495	3,473
Asia	7,985	9,095	12,876	16,593
Oceania	576	668	883	1,079
Total, World	39,433	45,363	59,406	71,995

Table 5. Water pollution control capital expenditures by major regions, in millions 1975 dollars, 1976-1990

During the past decade, there has been gradual improvement at all levels of skill and expertise necessary for water management in most developing countries but there have been deteriorations in certain countries as well. Overall, in all areas of manpower, 54 percent of countries replying to this issue reported that the manpower situation has improved, whereas 11 percent felt that the situation has deteriorated. The rest of the countries indicated that the situation has not changed significantly. The responses are summarised in Table 6. In spite of the gradual improvement shown in Table 6, nearly 1 in 5 of all developing countries indicated that

availability of adequate manpower is still critical at all skill and expert levels, and especially so for skilled workers, higher technicians and research scientists.

SELECTED AREAS REQUIRING IMPROVED EFFICIENCY IN MANAGEMENT

In spite of the impressive progress that has been made in water management during the past Water Conference era, much still remains to be done in several important areas. Only five selected areas will be briefly discussed here.

1) Mobilization of financial resources - If the Action Plan is to be satisfactorily implemented, developing countries must mobilize adequate financial resources through internal and external means. However, with competing demands for all types of financial resources by a variety of worthwhile causes, only certain amount of internal and external resources are available for water management.

It should be noted that shortly after the water Conference, the world economy witnessed a serious recession. Both developed and developing economies suffered varied degrees of recession. The situation was more serious for developing countries, which as a group suffered per capita decline in output in each of the first three years of this Decade. It was worse in Africa when compared to other regions. From 1970 to 1984, public and publicly guaranteed debt for the sub-Saharan African countries increased from \$5.426 billion to \$58.828 billion, and the combined external debts of Africa now exceed \$125 billion. For people of 25 countries of low income Africa, they are poorer today than in 1980, and thus for the first time since the Second World War, a whole region has suffered retrogression over a generation.

Investment required for water management, both capital costs and subsequent operation and management costs, are significant. In a paper prepared for the Water Conference, WHO, with initial assistance from the World Bank, estimated that the investment necessary to meet the target set for community water supply of clean water for all by 1990 would be \$92.2 billion. In 1980, the World Bank estimated that assuming complete urban and rural coverage with the urban population to be "served at commonly accepted levels of house connections for water and sewerage and the rural population at a lower standard of service", the total costs would be more than \$600 billion. Using a "wider mix of service levels and the use of more appropriate technologies", the Bank provided a second option of \$300 billion or less.

This \$300 billion cost is only for new installations: it does not include any estimates for operation and maintenance. In addition, like earlier estimates, it will again prove to be a serious underestimate. However, even if it is assumed to be correct, it means an investment of \$82.2 million every day of the Decade for only new drinking water installations: other aspects of water management are not included.

Similarly, the paper on irrigation development prepared for the Conference, FAO estimated investment requirements for irrigation for developing market economy countries at \$97.8 billion. This again is a serious under-estimate, since it is no longer uncommon to find irrigation development costs in Africa in the range of \$15,000-\$20,000 per ha, if infrastructural development costs and technical and production support services costs are included. If official rates of exchange are used, some irrigation projects in Ghana have cost as much as \$40,000-\$50,000 per ha.

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Similarly, the paper on irrigation development prepared for the Conference, FAO estimated investment requirements for irrigation for developing market economy countries at \$97.8 billion. This again is a serious under-estimate, since it is no longer uncommon to find irrigation development costs in Africa in the range of \$15,000-\$20,000 per ha, if infrastructural development costs and technical and production support services costs are included. If official rates of exchange are used, some irrigation projects in Ghana have cost as much as \$40,000-\$50,000 per ha.

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and requiring low investments have long been practised at suitable locations, introduction of large-scale water development projects requiring simultaneously formal irrigation for crop production, hydro-electric power generation and flood control necessitates extensive physical and social infrastructures, efficient construction and management practices and use of appropriate technology. Trained people are necessary at all stages of such projects.

On a long-term basis, training is probably one of the most important requirements for efficient water management. Current evidence indicates that lack of trained and experienced personnel has tended to increase the cost of water projects and at the same time reduced their efficiency. For example, if irrigation projects are considered, lack of trained management personnel and the absence of farmers experienced in irrigated agriculture have not only tended to increase the irrigation costs but also have reduced benefits expected of the schemes. In addition, lack of technicians and other similar trained personnel of lower levels of expertise is creating serious management bottlenecks.

Use of expatriate staff has been mixed blessings to developing countries. On the positive side, they have considerably contributed to the planning, construction and management of water projects. On the negative side, they are not only very expensive but also in most cases training of indigenous personnel who were supposed to have taken over from their expatriate counterparts have not been satisfactory. In many cases such training and manpower development has not taken place at all, as in the 1,250-ha Kou Project in Burkina Faso, where at one time there were 60 expatriates but in 5 years not even a single African staff had received any training (Biswas, 1986). Consequently, when the expatriate staff members leave, project performances start to decline rapidly.

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An important aspect of the development and mobilization of human resources that has not received adequate attention thus far is the underemployment and ineffective use of trained manpower in several developing countries. In these countries, generally speaking, an adequate pool of trained manpower exists, but because of lack of incentives, inability of the management to motivate staff, excessive institutional red tape and other related reasons, staff members often do not develop, or seldom work at their full potential. While multilateral and bilateral organizations have now mostly started to give increasing attention to training requirements, commensurate interest in improving the overall managerial skills is generally lacking. If the managerial skills can be improved - and the scope for such improvement is substantial - there is no doubt that more can be achieved in most countries with the currently available financial and human resources. Strengthening of managerial skills require urgent attention of all parties concerned.

iii) Development and application of appropriate technology - Efficient water management depends not only on people, but also on the resources and technology they have access to, and the socio-cultural-institutional framework within which these are utilized (Biswas & Biswas, 1985; Fano, 1981). By itself, technology employed in pursuit of rational water management is neutral, but how it is used can determine the success or failure of projects. Choice of technology depends on many factors, and many times what may be considered to be the most appropriate technology in one country could turn out to be the most inappropriate for solving almost identical problems in another. A typical example is the failure of septic tanks in Bhutan, due to socio-cultural reasons, even though the same designs have successfully been used in India for decades (Biswas, 1986c). This means that while South-South technology transfer in general may make a great deal of sense, it should not be axiomatically assumed that such direct transfers will present no serious problems. Developing countries are not all the same: they are at different stages of development and may have different social, cultural and institutional backgrounds.

Many instances can be cited where inappropriate technology is being imported to developing countries from industrialized countries, through either bilateral or multilateral aid programmes, without critical appraisal by either the donors or the recipients. Foreign consultants and contracts are often used to plan, design and implement the projects. In a large number of these cases, they are not fully familiar with the prevailing social, economic, institutional and cultural norms of the developing countries concerned, and accordingly they often use criteria which are based on experience and knowledge gained in industrialized countries which may not be applicable locally. A typical example is the design of waste stabilization ponds in many middle-eastern countries, where evaporation losses are neglected. While this makes sense in temperate climates of developed countries, neglecting evaporation losses in the arid, hot climates of middle-east means not only unnecessary increase in project costs but also creation of a host of other problems.

Some attention has been paid during the past decade on elaborating the concept of appropriate technology, studying the problems and methodology for producing such technology, and developing criteria and methodologies for selection of the optimal results. In spite of these efforts, there are some serious problems. As a recent World Bank (1986) analysis has bluntly stated: "most observers agree that the technology shelf in sub-Saharan Africa is nearly bare". Accordingly more attention needs to be given to developing and using appropriate technology for efficient water management under site-specific conditions.

iv) Conservation and enhancement of water quality, particularly groundwater - As a general rule, nearly all developing countries have better expertise, data base and institutional capacity for the management of water quantity than water quality, even though water quantity and

quality aspects are closely interrelated. While there are some signs that interest in water quality management is increasing, much progress remains to be made.

Many developing countries still have not formulated water quality standards to control discharge of effluents to both surface and ground waters. Even in those countries where standards are in existence, monitoring and enforcement of standards leave much to be desired. Use of policy alternatives like accelerated depreciation and tax incentives to encourage investment in pollution control facilities require further attention. Similarly acceptance of "polluter pays principle", and ensuring that polluters do actually pay will go a long way to control water pollution.

In some developing countries considerable debate is now taking place on the trade-offs between benefits accruing from pollution control and the increased cost of economic activities. A rational analysis of any such trade-off is somewhat complex since the health and environmental costs of water pollution are neither easy to quantify nor are they necessarily paid by the polluters and their immediate customers. Since the environmental benefits of pollution control are often long-term and intangible but the costs are short-term and tangible, they are not easy to be handled within traditional economic tools like benefit-cost analysis. While the enforcement of stringent water pollution control measures can under certain circumstances prevent the continuing operation of a few old industrial concerns, it can equally be responsible for spawning a new industry on various aspects of pollution control, and thus create new employment opportunities. The environmental, economic, social and political implications of each case often need to be reviewed separately.

Groundwater has been a special problem in terms of management.

There are fundamentally two major problems with respect to groundwater management: higher rate of extraction compared to the rate of recharge

and thus contributing to groundwater mining, and pollution of groundwater due to uncontrolled effluent discharges. Both are serious problems in many developing countries, which have serious long-term repercussions in terms of supporting development activities.

v) Mitigation of natural hazards, especially droughts and floods -

Two of the important objectives of any water development project are flood control and reducing the impacts of droughts. The untold human sufferings due to recent droughts in many sub-Saharan countries is well known. Similarly devastations due to periodic floods can be witnessed in all developing countries. Efficient water management can alleviate much of these problems.

The impact of droughts, mid-season droughts and low and unreliable rainfall on food production, and thus ultimately to human and livestock survival, can be significantly alleviated by the introduction of proper water control through irrigation. Food and forage production can be stabilized at a reasonably sustainable level, which could reduce the trauma associated with boom-bust production cycles. However, the economies of many African countries ravaged by recurring droughts, and facing high external debt burdens, are somewhat unlikely to generate enough internal resources to develop their available water resources within near and medium terms. These countries will not only require external assistance for adequate resources to carry out water development but also would need formulation of rational water policies at national levels and the continuing political will and commitment to implement them. Both of these two factors are essential requirements for successful future water development and management.

For better flood and drought management, a better and broader vision is necessary. Water management by itself is unlikely to be enough. We need to look at land and water as an interacting unit if the adverse impacts of floods and droughts are to be alleviated. In many instances the

impacts are worsened due to human activities, which means better planning and control mechanisms need to be used. Watershed management, patterns of land use, a working warning system, and the existence of adequate relief measures are normally essential for management of natural hazards like floods and droughts.

CONCLUDING REMARKS

A review of the past decade clearly indicates that management of limited water resources available has become an increasingly important component to sustain and enhance our development efforts. Any future energy crisis which may re-occur cannot be resolved without water since no large-scale energy development is possible without the use of large quantities of water. Similarly food crises cannot be resolved without better water control. An adequate quantity and quality of water is essential for preserving human health and the health of the environment. With a large and growing human population, water has already become an essential ingredient for any development effort.

United Nations has played an important role in water development and management in recent decades. Through a variety of water-related projects in nearly all developing countries, United Nations and its associated organs have already made substantial contributions in developing and managing national water resources. United Nations Water Conference, by any account, was a milestone in the water resources field, and the International Water Supply and Sanitation Decade, which the Conference had recommended, has already played a seminal role in improving the quality of life of millions of people through provision of clean drinking water and sanitation. Since water is essential resource for food and energy production, health, fisheries and aquatic life, navigation, recreation and wildlife habitat, the interest of the various United Nations agencies in the area of water resources development will undoubtedly continue unabated in the foreseeable future. If anything, this interest is likely to heighten in the future so that the quality of life of a significant percentage of the citizens of this world can be measurably improved.

Since water available to a country is limited, and already water has become a major constraint to development in many arid and semi-arid countries, we have no choice but to make our existing water management practices more and more efficient. This, in a sense, is the main objective of this Symposium. The questions are how do we make our management practices more efficient not only in the five crucial issues discussed earlier but also in related areas, and how can the solutions devised be realistically implemented. This is where the inputs from experts and agencies present at this Symposium can be most helpful in terms of devising appropriate solutions, and then their assistance would be equally essential to implement them. Let us hope that with such inputs and co-operation of all present, we can report a significant improvement in our water management during the coming decade compared to the past decade, even though the progress during the past decade has been both substantial and impressive.

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