



Agenda 21

Chapter 18

c: Application Of Integrated Approaches To The Development, Management And Use Of Water Resources

Introduction

1. Freshwater resources are an essential component of the Earth's hydrosphere and an indispensable part of all terrestrial ecosystems. The freshwater environment is characterized by the hydrological cycle, including floods and droughts, which in some regions have become more extreme and dramatic in their consequences. Global climate change and atmospheric pollution could also have an impact on freshwater resources and their availability and, through sea-level rise, threaten low-lying coastal areas and small island ecosystems.
2. Water is needed in all aspects of life. The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases. Innovative technologies, including the improvement of indigenous technologies, are needed to fully utilize limited water resources and to safeguard those resources against pollution.
3. The widespread scarcity, gradual destruction and aggravated pollution of freshwater resources in many world regions, along with the progressive encroachment of incompatible activities, demand integrated water resources planning and management. Such integration must cover all types of interrelated freshwater bodies, including both surface water and groundwater, and duly consider water quantity and quality aspects. The multisectoral nature of water resources development in the context of socio-economic development must be recognized, as well as the multi-interest utilization of water resources for water supply and sanitation, agriculture, industry, urban development, hydropower generation, inland fisheries, transportation, recreation, low and flat lands management and other activities. Rational water utilization schemes for the development of surface and underground water-supply sources and other potential sources have to be supported by concurrent water conservation and wastage minimization measures. Priority, however, must be accorded to flood prevention and control measures, as well as sedimentation control, where required.
4. Transboundary water resources and their use are of great importance to riparian States. In this connection, cooperation among those States may be desirable in conformity with existing agreements and/or other relevant arrangements, taking into account the interests of all riparian States concerned.
5. The following programme areas are proposed for the freshwater sector:
 - a. Integrated water resources development and management;
 - b. Water resources assessment;

- c. Protection of water resources, water quality and aquatic ecosystems;
- d. Drinking-water supply and sanitation;
- e. Water and sustainable urban development;
- f. Water for sustainable food production and rural development;
- g. Impacts of climate change on water resources.

Programme Areas

A. Integrated water resources development and management

Basis for action

6. The extent to which water resources development contributes to economic productivity and social well-being is not usually appreciated, although all social and economic activities rely heavily on the supply and quality of freshwater. As populations and economic activities grow, many countries are rapidly reaching conditions of water scarcity or facing limits to economic development. Water demands are increasing rapidly, with 70-80 per cent required for irrigation, less than 20 per cent for industry and a mere 6 per cent for domestic consumption. The holistic management of freshwater as a finite and vulnerable resource, and the integration of sectoral water plans and programmes within the framework of national economic and social policy, are of paramount importance for action in the 1990s and beyond. The fragmentation of responsibilities for water resources development among sectoral agencies is proving, however, to be an even greater impediment to promoting integrated water management than had been anticipated. Effective implementation and coordination mechanisms are required.

Objectives

7. The overall objective is to satisfy the freshwater needs of all countries for their sustainable development.
8. Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization. To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perennality of the resource, in order to satisfy and reconcile needs for water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately.
9. Integrated water resources management, including the integration of land- and water-related aspects, should be carried out at the level of the catchment basin or sub-basin. Four principal objectives should be pursued, as follows:
 - a. To promote a dynamic, interactive, iterative and multisectoral approach to water resources management, including the identification and protection of potential sources of freshwater supply, that integrates technological, socio-economic, environmental and human health considerations;
 - b. To plan for the sustainable and rational utilization, protection, conservation and management of water resources based on community needs and priorities within the framework of national economic development policy;
 - c. To design, implement and evaluate projects and programmes that are both economically efficient and socially appropriate within clearly defined strategies, based on an approach of full public participation, including that of women, youth, indigenous people and local communities in water management policy-making and decision-making;
 - d. To identify and strengthen or develop, as required, in particular in developing countries, the appropriate institutional, legal and financial mechanisms to ensure that water policy and its implementation are a catalyst for sustainable social progress and economic growth.

10. In the case of transboundary water resources, there is a need for riparian States to formulate water resources strategies, prepare water resources action programmes and consider, where appropriate, the harmonization of those strategies and action programmes.
11. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could set the following targets:
 - a. By the year 2000:
 - i. To have designed and initiated costed and targeted national action programmes, and to have put in place appropriate institutional structures and legal instruments;
 - ii. To have established efficient water-use programmes to attain sustainable resource utilization patterns;
 - b. By the year 2025:
 - i. To have achieved subsectoral targets of all freshwater programme areas.
 - c. It is understood that the fulfilment of the targets quantified in (i) and (ii) above will depend upon new and additional financial resources that will be made available to developing countries in accordance with the relevant provisions of General Assembly resolution 44/228.

Activities

12. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could implement the following activities to improve integrated water resources management:
 - a. Formulation of costed and targeted national action plans and investment programmes;
 - b. Integration of measures for the protection and conservation of potential sources of freshwater supply, including the inventorying of water resources, with land-use planning, forest resource utilization, protection of mountain slopes and riverbanks and other relevant development and conservation activities;
 - c. Development of interactive databases, forecasting models, economic planning models and methods for water management and planning, including environmental impact assessment methods;
 - d. Optimization of water resources allocation under physical and socio-economic constraints;
 - e. Implementation of allocation decisions through demand management, pricing mechanisms and regulatory measures;
 - f. Flood and drought management, including risk analysis and environmental and social impact assessment;
 - g. Promotion of schemes for rational water use through public awareness-raising, educational programmes and levying of water tariffs and other economic instruments;
 - h. Mobilization of water resources, particularly in arid and semi-arid areas;
 - i. Promotion of international scientific research cooperation on freshwater resources;
 - j. Development of new and alternative sources of water-supply such as sea-water desalination, artificial groundwater recharge, use of marginal-quality water, waste-water reuse and water recycling;
 - k. Integration of water (including surface and underground water resources) quantity and quality management;
 - l. Promotion of water conservation through improved water-use efficiency and wastage minimization schemes for all users, including the development of water-saving devices;
 - m. Support to water-users groups to optimize local water resources management;

- n. Development of public participatory techniques and their implementation in decision-making, particularly the enhancement of the role of women in water resources planning and management;
- o. Development and strengthening, as appropriate, of cooperation, including mechanisms where appropriate, at all levels concerned, namely:
 - i. At the lowest appropriate level, delegation of water resources management, generally, to such a level, in accordance with national legislation, including decentralization of government services to local authorities, private enterprises and communities;
 - ii. At the national level, integrated water resources planning and management in the framework of the national planning process and, where appropriate, establishment of independent regulation and monitoring of freshwater, based on national legislation and economic measures;
 - iii. At the regional level, consideration, where appropriate, of the harmonization of national strategies and action programmes;
 - iv. At the global level, improved delineation of responsibilities, division of labour and coordination of international organizations and programmes, including facilitating discussions and sharing of experiences in areas related to water resources management;
- p. Dissemination of information, including operational guidelines, and promotion of education for water users, including the consideration by the United Nations of a World Water Day.

Means of implementation

(a) Financing and cost evaluation

13. The Conference secretariat has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about \$115 million from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Scientific and technological means

14. The development of interactive databases, forecasting methods and economic planning models appropriate to the task of managing water resources in an efficient and sustainable manner will require the application of new techniques such as geographical information systems and expert systems to gather, assimilate, analyse and display multisectoral information and to optimize decision-making. In addition, the development of new and alternative sources of water-supply and low-cost water technologies will require innovative applied research. This will involve the transfer, adaptation and diffusion of new techniques and technology among developing countries, as well as the development of endogenous capacity, for the purpose of being able to deal with the added dimension of integrating engineering, economic, environmental and social aspects of water resources management and predicting the effects in terms of human impact.

15. Pursuant to the recognition of water as a social and economic good, the various available options for charging water users (including domestic, urban, industrial and agricultural water-user groups) have to be further evaluated and field-tested. Further development is required for economic instruments that take into account opportunity costs and environmental externalities. Field studies on the willingness to pay should be conducted in rural and urban situations.

16. Water resources development and management should be planned in an integrated manner, taking into account long-term planning needs as well as those with narrower horizons, that is to say, they should incorporate environmental, economic and social considerations based

on the principle of sustainability; include the requirements of all users as well as those relating to the prevention and mitigation of water-related hazards; and constitute an integral part of the socio-economic development planning process. A prerequisite for the sustainable management of water as a scarce vulnerable resource is the obligation to acknowledge in all planning and development its full costs. Planning considerations should reflect benefits investment, environmental protection and operation costs, as well as the opportunity costs reflecting the most valuable alternative use of water. Actual charging need not necessarily burden all beneficiaries with the consequences of those considerations. Charging mechanisms should, however, reflect as far as possible both the true cost of water when used as an economic good and the ability of the communities to pay.

17. The role of water as a social, economic and life-sustaining good should be reflected in demand management mechanisms and implemented through water conservation and reuse, resource assessment and financial instruments.
18. The setting afresh of priorities for private and public investment strategies should take into account (a) maximum utilization of existing projects, through maintenance, rehabilitation and optimal operation; (b) new or alternative clean technologies; and (c) environmentally and socially benign hydropower.

(c) Human resources development

19. The delegation of water resources management to the lowest appropriate level necessitates educating and training water management staff at all levels and ensuring that women participate equally in the education and training programmes. Particular emphasis has to be placed on the introduction of public participatory techniques, including enhancement of the role of women, youth, indigenous people and local communities. Skills related to various water management functions have to be developed by municipal government and water authorities, as well as in the private sector, local/national non-governmental organizations, cooperatives, corporations and other water-user groups. Education of the public regarding the importance of water and its proper management is also needed.
20. To implement these principles, communities need to have adequate capacities. Those who establish the framework for water development and management at any level, whether international, national or local, need to ensure that the means exist to build those capacities. The means will vary from case to case. They usually include:
 - a. Awareness-creation programmes, including mobilizing commitment and support at all levels and initiating global and local action to promote such programmes;
 - b. Training of water managers at all levels so that they have an appropriate understanding of all the elements necessary for their decision-making;
 - c. Strengthening of training capacities in developing countries;
 - d. Appropriate training of the necessary professionals, including extension workers;
 - e. Improvement of career structures;
 - f. Sharing of appropriate knowledge and technology, both for the collection of data and for the implementation of planned development including non-polluting technologies and the knowledge needed to extract the best performance from the existing investment system.

(d) Capacity-building

21. Institutional capacity for implementing integrated water management should be reviewed and developed when there is a clear demand. Existing administrative structures will often be quite capable of achieving local water resources management, but the need may arise for new institutions based upon the perspective, for example, of river catchment areas, district development councils and local community committees. Although water is managed at various levels in the socio-political system, demand-driven management requires the development of water-related institutions at appropriate levels, taking into account the need for integration with land-use management.

22. In creating the enabling environment for lowest-appropriate-level management, the role of Government includes mobilization of financial and human resources, legislation, standard-setting and other regulatory functions, monitoring and assessment of the use of water and land resources, and creating of opportunities for public participation. International agencies and donors have an important role to play in providing support to developing countries in creating the required enabling environment for integrated water resources management. This should include, as appropriate, donor support to local levels in developing countries, including community-based institutions, non-governmental organizations and women's groups.

B. Water resources assessment

Basis for action

23. Water resources assessment, including the identification of potential sources of freshwater supply, comprises the continuing determination of sources, extent, dependability and quality of water resources and of the human activities that affect those resources. Such assessment constitutes the practical basis for their sustainable management and a prerequisite for evaluation of the possibilities for their development. There is, however, growing concern that at a time when more precise and reliable information is needed about water resources, hydrologic services and related bodies are less able than before to provide this information, especially information on groundwater and water quality. Major impediments are the lack of financial resources for water resources assessment, the fragmented nature of hydrologic services and the insufficient numbers of qualified staff. At the same time, the advancing technology for data capture and management is increasingly difficult to access for developing countries. Establishment of national databases is, however, vital to water resources assessment and to mitigation of the effects of floods, droughts, desertification and pollution.

Objectives

24. Based upon the Mar del Plata Action Plan, this programme area has been extended into the 1990s and beyond with the overall objective of ensuring the assessment and forecasting of the quantity and quality of water resources, in order to estimate the total quantity of water resources available and their future supply potential, to determine their current quality status, to predict possible conflicts between supply and demand and to provide a scientific database for rational water resources utilization.
25. Five specific objectives have been set accordingly, as follows:
- a. To make available to all countries water resources assessment technology that is appropriate to their needs, irrespective of their level of development, including methods for the impact assessment of climate change on freshwaters;
 - b. To have all countries, according to their financial means, allocate to water resources assessment financial resources in line with the economic and social needs for water resources data;
 - c. To ensure that the assessment information is fully utilized in the development of water management policies;
 - d. To have all countries establish the institutional arrangements needed to ensure the efficient collection, processing, storage, retrieval and dissemination to users of information about the quality and quantity of available water resources at the level of catchments and groundwater aquifers in an integrated manner;
 - e. To have sufficient numbers of appropriately qualified and capable staff recruited and retained by water resources assessment agencies and provided with the training and retraining they will need to carry out their responsibilities successfully.
26. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including cooperation with the United Nations and other relevant organizations, as appropriate, could set the following targets:

- a. By the year 2000, to have studied in detail the feasibility of installing water resources assessment services;
- b. As a long-term target, to have fully operational services available based upon high-density hydrometric networks.

Activities

27. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could undertake the following activities:

- a. Institutional framework:
 - i. Establish appropriate policy frameworks and national priorities;
 - ii. Establish and strengthen the institutional capabilities of countries, including legislative and regulatory arrangements, that are required to ensure the adequate assessment of their water resources and the provision of flood and drought forecasting services;
 - iii. Establish and maintain effective cooperation at the national level between the various agencies responsible for the collection, storage and analysis of hydrologic data;
 - iv. Cooperate in the assessment of transboundary water resources, subject to the prior agreement of each riparian State concerned;
- b. Data systems:
 - i. Review existing data-collection networks and assess their adequacy, including those that provide real-time data for flood and drought forecasting;
 - ii. Improve networks to meet accepted guidelines for the provision of data on water quantity and quality for surface and groundwater, as well as relevant land-use data;
 - iii. Apply standards and other means to ensure data compatibility;
 - iv. Upgrade facilities and procedures used to store, process and analyse hydrologic data and make such data and the forecasts derived from them available to potential users;
 - v. Establish databases on the availability of all types of hydrologic data at the national level;
 - vi. Implement "data rescue" operations, for example, establishment of national archives of water resources;
 - vii. Implement appropriate well-tried techniques for the processing of hydrologic data;
 - viii. Derive area-related estimates from point hydrologic data;
 - ix. Assimilate remotely sensed data and the use, where appropriate, of geographical information systems;
- c. Data dissemination:
 - i. Identify the need for water resources data for various planning purposes;
 - ii. Analyse and present data and information on water resources in the forms required for planning and management of countries' socio-economic development and for use in environmental protection strategies and in the design and operation of specific water-related projects;
 - iii. Provide forecasts and warnings of flood and drought to the general public and civil defence;
- d. Research and development:

- i. Establish or strengthen research and development programmes at the national, subregional, regional and international levels in support of water resources assessment activities;
- ii. Monitor research and development activities to ensure that they make full use of local expertise and other local resources and that they are appropriate for the needs of the country or countries concerned.

Means of implementation

(a) Financing and cost evaluation

28. The Conference secretariat has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about \$355 million, including about \$145 million from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Scientific and technological means

29. Important research needs include (a) development of global hydrologic models in support of analysis of climate change impact and of macroscale water resources assessment; (b) closing of the gap between terrestrial hydrology and ecology at different scales, including the critical water-related processes behind loss of vegetation and land degradation and its restoration; and (c) study of the key processes in water-quality genesis, closing the gap between hydrologic flows and biogeochemical processes. The research models should build upon hydrologic balance studies and also include the consumptive use of water. This approach should also, when appropriate, be applied at the catchment level.

30. Water resources assessment necessitates the strengthening of existing systems for technology transfer, adaptation and diffusion, and the development of new technology for use under field conditions, as well as the development of endogenous capacity. Prior to inaugurating the above activities, it is necessary to prepare catalogues of the water resources information held by government services, the private sector, educational institutes, consultants, local water-use organizations and others.

(c) Human resource development

31. Water resources assessment requires the establishment and maintenance of a body of well-trained and motivated staff sufficient in number to undertake the above activities. Education and training programmes designed to ensure an adequate supply of these trained personnel should be established or strengthened at the local, national, subregional or regional level. In addition, the provision of attractive terms of employment and career paths for professional and technical staff should be encouraged. Human resource needs should be monitored periodically, including all levels of employment. Plans have to be established to meet those needs through education and training opportunities and international programmes of courses and conferences.

32. Because well-trained people are particularly important to water resources assessment and hydrologic forecasting, personnel matters should receive special attention in this area. The aim should be to attract and retain personnel to work on water resources assessment who are sufficient in number and adequate in their level of education to ensure the effective implementation of the activities that are planned. Education may be called for at both the national and the international level, with adequate terms of employment being a national responsibility.

33. Recommended actions include:

- a. Identifying education and training needs geared to the specific requirements of countries;

- b. Establishing and strengthening education and training programmes on water-related topics, within an environmental and developmental context, for all categories of staff involved in water resources assessment activities, using advanced educational technology, where appropriate, and involving both men and women;
- c. Developing sound recruitment, personnel and pay policies for staff of national and local water agencies.

(d) Capacity-building

34. The conduct of water resources assessment on the basis of operational national hydrometric networks requires an enabling environment at all levels. The following national support action is necessary for enhanced national capacities:

- a. Review of the legislative and regulatory basis of water resources assessment;
- b. Facilitation of close collaboration among water sector agencies, particularly between information producers and users;
- c. Implementation of water management policies based upon realistic appraisals of water resources conditions and trends;
- d. Strengthening of the managerial capabilities of water-user groups, including women, youth, indigenous people and local communities, to improve water-use efficiency at the local level.

C. Protection of water resources, water quality and aquatic ecosystems

Basis for action

35. Freshwater is a unitary resource. Long-term development of global freshwater requires holistic management of resources and a recognition of the interconnectedness of the elements related to freshwater and freshwater quality. There are few regions of the world that are still exempt from problems of loss of potential sources of freshwater supply, degraded water quality and pollution of surface and groundwater sources. Major problems affecting the water quality of rivers and lakes arise, in variable order of importance according to different situations, from inadequately treated domestic sewage, inadequate controls on the discharges of industrial waste waters, loss and destruction of catchment areas, ill-considered siting of industrial plants, deforestation, uncontrolled shifting cultivation and poor agricultural practices. This gives rise to the leaching of nutrients and pesticides. Aquatic ecosystems are disturbed and living freshwater resources are threatened. Under certain circumstances, aquatic ecosystems are also affected by agricultural water resource development projects such as dams, river diversions, water installations and irrigation schemes. Erosion, sedimentation, deforestation and desertification have led to increased land degradation, and the creation of reservoirs has, in some cases, resulted in adverse effects on ecosystems. Many of these problems have arisen from a development model that is environmentally destructive and from a lack of public awareness and education about surface and groundwater resource protection. Ecological and human health effects are the measurable consequences, although the means to monitor them are inadequate or non-existent in many countries. There is a widespread lack of perception of the linkages between the development, management, use and treatment of water resources and aquatic ecosystems. A preventive approach, where appropriate, is crucial to the avoiding of costly subsequent measures to rehabilitate, treat and develop new water supplies.

Objectives

36. The complex interconnectedness of freshwater systems demands that freshwater management be holistic (taking a catchment management approach) and based on a balanced consideration of the needs of people and the environment. The Mar del Plata Action Plan has already recognized the intrinsic linkage between water resource development projects and their significant physical, chemical, biological, health and socio-economic repercussions. The overall environmental health objective was set as follows: "to

evaluate the consequences which the various users of water have on the environment, to support measures aimed at controlling water-related diseases, and to protect ecosystems"./1/

37. The extent and severity of contamination of unsaturated zones and aquifers have long been underestimated owing to the relative inaccessibility of aquifers and the lack of reliable information on aquifer systems. The protection of groundwater is therefore an essential element of water resource management.
38. Three objectives will have to be pursued concurrently to integrate water-quality elements into water resource management:
 - a. Maintenance of ecosystem integrity, according to a management principle of preserving aquatic ecosystems, including living resources, and of effectively protecting them from any form of degradation on a drainage basin basis;
 - b. Public health protection, a task requiring not only the provision of safe drinking-water but also the control of disease vectors in the aquatic environment;
 - c. Human resources development, a key to capacity-building and a prerequisite for implementing water-quality management.
39. All States, according to their capacity and available resources, through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could set the following targets:
 - a. To identify the surface and groundwater resources that could be developed for use on a sustainable basis and other major developable water-dependent resources and, simultaneously, to initiate programmes for the protection, conservation and rational use of these resources on a sustainable basis;
 - b. To identify all potential sources of water-supply and prepared outlines for their protection, conservation and rational use;
 - c. To initiate effective water pollution prevention and control programmes, based on an appropriate mixture of pollution reduction-at-source strategies, environmental impact assessments and enforceable standards for major point-source discharges and high-risk non-point sources, commensurate with their socio-economic development;
 - d. To participate, as far as appropriate, in international water-quality monitoring and management programmes such as the Global Water Quality Monitoring Programme (GEMS/WATER), the UNEP Environmentally Sound Management of Inland Waters (EMINWA), the FAO regional inland fishery bodies, and the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention);
 - e. To reduce the prevalence of water-associated diseases, starting with the eradication of dracunculiasis (guinea worm disease) and onchocerciasis (river blindness) by the year 2000;
 - f. To establish, according to capacities and needs, biological, health, physical and chemical quality criteria for all water bodies (surface and groundwater), with a view to an ongoing improvement of water quality;
 - g. To adopt an integrated approach to environmentally sustainable management of water resources, including the protection of aquatic ecosystems and freshwater living resources;
 - h. To put in place strategies for the environmentally sound management of freshwaters and related coastal ecosystems, including consideration of fisheries, aquaculture, animal grazing, agricultural activities and biodiversity.

Activities

40. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including United Nations and other relevant organizations as appropriate, could implement the following activities:
 - a. Water resources protection and conservation:

- i. Establishment and strengthening of technical and institutional capacities to identify and protect potential sources of water-supply within all sectors of society;
 - ii. Identification of potential sources of water-supply and preparation of national profiles;
 - iii. Preparation of national plans for water resources protection and conservation;
 - iv. Rehabilitation of important, but degraded, catchment areas, particularly on small islands;
 - v. Strengthening of administrative and legislative measures to prevent encroachment on existing and potentially usable catchment areas;
- b. Water pollution prevention and control:
- i. Application of the "polluter pays" principle, where appropriate, to all kinds of sources, including on-site and off-site sanitation;
 - ii. Promotion of the construction of treatment facilities for domestic sewage and industrial effluents and the development of appropriate technologies, taking into account sound traditional and indigenous practices;
 - iii. Establishment of standards for the discharge of effluents and for the receiving waters;
 - iv. Introduction of the precautionary approach in water-quality management, where appropriate, with a focus on pollution minimization and prevention through use of new technologies, product and process change, pollution reduction at source and effluent reuse, recycling and recovery, treatment and environmentally safe disposal;
 - v. Mandatory environmental impact assessment of all major water resource development projects potentially impairing water quality and aquatic ecosystems, combined with the delineation of appropriate remedial measures and a strengthened control of new industrial installations, solid waste landfills and infrastructure development projects;
 - vi. Use of risk assessment and risk management in reaching decisions in this area and ensuring compliance with those decisions;
 - vii. Identification and application of best environmental practices at reasonable cost to avoid diffuse pollution, namely, through a limited, rational and planned use of nitrogenous fertilizers and other agrochemicals (pesticides, herbicides) in agricultural practices;
 - viii. Encouragement and promotion of the use of adequately treated and purified waste waters in agriculture, aquaculture, industry and other sectors;
- c. Development and application of clean technology:
- i. Control of industrial waste discharges, including low-waste production technologies and water recirculation, in an integrated manner and through application of precautionary measures derived from a broad-based life-cycle analysis;
 - ii. Treatment of municipal waste water for safe reuse in agriculture and aquaculture;
 - iii. Development of biotechnology, inter alia, for waste treatment, production of biofertilizers and other activities;
 - iv. Development of appropriate methods for water pollution control, taking into account sound traditional and indigenous practices;
- d. Groundwater protection:
- i. Development of agricultural practices that do not degrade groundwaters;

- ii. Application of the necessary measures to mitigate saline intrusion into aquifers of small islands and coastal plains as a consequence of sealevel rise or overexploitation of coastal aquifers;
- iii. Prevention of aquifer pollution through the regulation of toxic substances that permeate the ground and the establishment of protection zones in groundwater recharge and abstraction areas;
- iv. Design and management of landfills based upon sound hydrogeologic information and impact assessment, using the best practicable and best available technology;
- v. Promotion of measures to improve the safety and integrity of wells and well-head areas to reduce intrusion of biological pathogens and hazardous chemicals into aquifers at well sites;
- vi. Water-quality monitoring, as needed, of surface and groundwaters potentially affected by sites storing toxic and hazardous materials;
- e. Protection of aquatic ecosystems:
 - i. Rehabilitation of polluted and degraded water bodies to restore aquatic habitats and ecosystems;
 - ii. Rehabilitation programmes for agricultural lands and for other users, taking into account equivalent action for the protection and use of groundwater resources important for agricultural productivity and for the biodiversity of the tropics;
 - iii. Conservation and protection of wetlands (owing to their ecological and habitat importance for many species), taking into account social and economic factors;
 - iv. Control of noxious aquatic species that may destroy some other water species;
- f. Protection of freshwater living resources:
 - i. Control and monitoring of water quality to allow for the sustainable development of inland fisheries;
 - ii. Protection of ecosystems from pollution and degradation for the development of freshwater aquaculture projects;
- g. Monitoring and surveillance of water resources and waters receiving wastes:
 - i. Establishment of networks for the monitoring and continuous surveillance of waters receiving wastes and of point and diffuse sources of pollution;
 - ii. Promotion and extension of the application of environmental impact assessments of geographical information systems;
 - iii. Surveillance of pollution sources to improve compliance with standards and regulations and to regulate the issue of discharge permits;
 - iv. Monitoring of the utilization of chemicals in agriculture that may have an adverse environmental effect;
 - v. Rational land use to prevent land degradation, erosion and siltation of lakes and other water bodies;
- h. Development of national and international legal instruments that may be required to protect the quality of water resources, as appropriate, particularly for:
 - i. Monitoring and control of pollution and its effects in national and transboundary waters;
 - ii. Control of long-range atmospheric transport of pollutants;
 - iii. Control of accidental and/or deliberate spills in national and/or transboundary water bodies;
 - iv. Environmental impact assessment.

Means of implementation

(a) Financing and cost evaluation

41. The Conference secretariat has estimated the average total cost (1993-2000) of implementing the activities of this programme to be about \$1 billion, including about \$340 million from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Scientific and technological means

42. States should undertake cooperative research projects to develop solutions to technical problems that are appropriate for the conditions in each watershed or country. States should consider strengthening and developing national research centres linked through networks and supported by regional water research institutes. The North-South twinning of research centres and field studies by international water research institutions should be actively promoted. It is important that a minimum percentage of funds for water resource development projects is allocated to research and development, particularly in externally funded projects.

43. Monitoring and assessment of complex aquatic systems often require multidisciplinary studies involving several institutions and scientists in a joint programme. International water-quality programmes, such as GEMS/WATER, should be oriented towards the water-quality of developing countries. User-friendly software and Geographical Information Systems (GIS) and Global Resource Information Database (GRID) methods should be developed for the handling, analysis and interpretation of monitoring data and for the preparation of management strategies.

(c) Human resource development

44. Innovative approaches should be adopted for professional and managerial staff training in order to cope with changing needs and challenges. Flexibility and adaptability regarding emerging water pollution issues should be developed. Training activities should be undertaken periodically at all levels within the organizations responsible for water-quality management and innovative teaching techniques adopted for specific aspects of water-quality monitoring and control, including development of training skills, in-service training, problem-solving workshops and refresher training courses.

45. Suitable approaches include the strengthening and improvement of the human resource capabilities of local Governments in managing water protection, treatment and use, particularly in urban areas, and the establishment of national and regional technical and engineering courses on the subjects of water-quality protection and control at existing schools and education/training courses on water resources protection and conservation for laboratory and field technicians, women and other water-user groups.

(d) Capacity-building

46. The effective protection of water resources and ecosystems from pollution requires considerable upgrading of most countries' present capacities. Water-quality management programmes require a certain minimum infrastructure and staff to identify and implement technical solutions and to enforce regulatory action. One of the key problems today and for the future is the sustained operation and maintenance of these facilities. In order not to allow resources gained from previous investments to deteriorate further, immediate action is required in a number of areas.

D. Drinking-water supply and sanitation

Basis for action

47. Safe water-supplies and environmental sanitation are vital for protecting the environment, improving health and alleviating poverty. Safe water is also crucial to many traditional and cultural activities. An estimated 80 per cent of all diseases and over one third of deaths in developing countries are caused by the consumption of contaminated water, and on average

as much as one tenth of each person's productive time is sacrificed to water-related diseases. Concerted efforts during the 1980s brought water and sanitation services to hundreds of millions of the world's poorest people. The most outstanding of these efforts was the launching in 1981 of the International Drinking Water Supply and Sanitation Decade, which resulted from the Mar del Plata Action Plan adopted by the United Nations Water Conference in 1977. The commonly agreed premise was that "all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs".² The target of the Decade was to provide safe drinking-water and sanitation to underserved urban and rural areas by 1990, but even the unprecedented progress achieved during the Decade was not enough. One in three people in the developing world still lacks these two most basic requirements for health and dignity. It is also recognized that human excreta and sewage are important causes of the deterioration of water-quality in developing countries, and the introduction of available technologies, including appropriate technologies, and the construction of sewage treatment facilities could bring significant improvement.

Objectives

48. The New Delhi Statement (adopted at the Global Consultation on Safe Water and Sanitation for the 1990s, which was held in New Delhi from 10 to 14 September 1990) formalized the need to provide, on a sustainable basis, access to safe water in sufficient quantities and proper sanitation for all, emphasizing the "some for all rather than more for some" approach. Four guiding principles provide for the programme objectives:
- a. Protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid wastes;
 - b. Institutional reforms promoting an integrated approach and including changes in procedures, attitudes and behaviour, and the full participation of women at all levels in sector institutions;
 - c. Community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programmes;
 - d. Sound financial practices, achieved through better management of existing assets, and widespread use of appropriate technologies.
49. Past experience has shown that specific targets should be set by each individual country. At the World Summit for Children, in September 1990, heads of State or Government called for both universal access to water-supply and sanitation and the eradication of guinea worm disease by 1995. Even for the more realistic target of achieving full coverage in water-supply by 2025, it is estimated that annual investments must reach double the current levels. One realistic strategy to meet present and future needs, therefore, is to develop lower-cost but adequate services that can be implemented and sustained at the community level.

Activities

50. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could implement the following activities:
- a. Environment and health:
 - i. Establishment of protected areas for sources of drinking-water supply;
 - ii. Sanitary disposal of excreta and sewage, using appropriate systems to treat waste waters in urban and rural areas;
 - iii. Expansion of urban and rural water-supply and development and expansion of rainwater catchment systems, particularly on small islands, in addition to the reticulated water-supply system;
 - iv. Building and expansion, where appropriate, of sewage treatment facilities and drainage systems;

- v. Treatment and safe reuse of domestic and industrial waste waters in urban and rural areas;
 - vi. Control of water-associated diseases;
- b. People and institutions:
- i. Strengthening of the functioning of Governments in water resources management and, at the same time, giving of full recognition to the role of local authorities;
 - ii. Encouragement of water development and management based on a participatory approach, involving users, planners and policy makers at all levels;
 - iii. Application of the principle that decisions are to be taken at the lowest appropriate level, with public consultation and involvement of users in the planning and implementation of water projects;
 - iv. Human resource development at all levels, including special programmes for women;
 - v. Broad-based education programmes, with particular emphasis on hygiene, local management and risk reduction;
 - vi. International support mechanisms for programme funding, implementation and follow-up;
- c. National and community management:
- i. Support and assistance to communities in managing their own systems on a sustainable basis;
 - ii. Encouragement of the local population, especially women, youth, indigenous people and local communities, in water management;
 - iii. Linkages between national water plans and community management of local waters;
 - iv. Integration of community management of water within the context of overall planning;
 - v. Promotion of primary health and environmental care at the local level, including training for local communities in appropriate water management techniques and primary health care;
 - vi. Assistance to service agencies in becoming more cost-effective and responsive to consumer needs;
 - vii. Providing of more attention to underserved rural and low-income periurban areas;
 - viii. Rehabilitation of defective systems, reduction of wastage and safe reuse of water and waste water;
 - ix. Programmes for rational water use and ensured operation and maintenance;
 - x. Research and development of appropriate technical solutions;
 - xi. Substantially increase urban treatment capacity commensurate with increasing loads;
- d. Awareness creation and public information/participation:
- i. Strengthening of sector monitoring and information management at subnational and national levels;
 - ii. Annual processing, analysis and publication of monitoring results at national and local levels as a sector management and advocacy/awareness creation tool;
 - iii. Use of limited sector indicators at regional and global levels to promote the sector and raise funds;
 - iv. Improvement of sector coordination, planning and implementation, with the assistance of improved monitoring and information management, to increase the sector's absorptive capacity, particularly in community-based self-help projects.

Means of implementation

(a) Financing and cost evaluation

51. The Conference secretariat has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about \$20 billion, including about \$7.4 billion from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Scientific and technological means

52. To ensure the feasibility, acceptability and sustainability of planned water-supply services, adopted technologies should be responsive to the needs and constraints imposed by the conditions of the community concerned. Thus, design criteria will involve technical, health, social, economic, provincial, institutional and environmental factors that determine the characteristics, magnitude and cost of the planned system. Relevant international support programmes should address the developing countries concerning, inter alia:

- a. Pursuit of low-cost scientific and technological means, as far as practicable;
- b. Utilization of traditional and indigenous practices, as far as practicable, to maximize and sustain local involvement;
- c. Assistance to country-level technical/scientific institutes to facilitate curricula development to support fields critical to the water and sanitation sector.

(c) Human resource development

53. To effectively plan and manage water-supply and sanitation at the national, provincial, district and community level, and to utilize funds most effectively, trained professional and technical staff must be developed within each country in sufficient numbers. To do this, countries must establish manpower development plans, taking into consideration present requirements and planned developments. Subsequently, the development and performance of country-level training institutions should be enhanced so that they can play a pivotal role in capacity-building. It is also important that countries provide adequate training for women in the sustainable maintenance of equipment, water resources management and environmental sanitation.

(d) Capacity-building

54. The implementation of water-supply and sanitation programmes is a national responsibility. To varying degrees, responsibility for the implementation of projects and the operating of systems should be delegated to all administrative levels down to the community and individual served. This also means that national authorities, together with the agencies and bodies of the United Nations system and other external support agencies providing support to national programmes, should develop mechanisms and procedures to collaborate at all levels. This is particularly important if full advantage is to be taken of community-based approaches and self-reliance as tools for sustainability. This will entail a high degree of community participation, involving women, in the conception, planning, decision-making, implementation and evaluation connected with projects for domestic water-supply and sanitation.

55. Overall national capacity-building at all administrative levels, involving institutional development, coordination, human resources, community participation, health and hygiene education and literacy, has to be developed according to its fundamental connection both with any efforts to improve health and socio-economic development through water-supply and sanitation and with their impact on the human environment. Capacity-building should therefore be one of the underlying keys in implementation strategies. Institutional capacity-building should be considered to have an importance equal to that of the sector supplies and equipment component so that funds can be directed to both. This can be undertaken at the

planning or programme/project formulation stage, accompanied by a clear definition of objectives and targets. In this regard, technical cooperation among developing countries owing to their available wealth of information and experience and the need to avoid "reinventing the wheel", is crucial. Such a course has proved cost-effective in many country projects already.

E. Water and sustainable urban development

Basis for action

56. Early in the next century, more than half of the world's population will be living in urban areas. By the year 2025, that proportion will have risen to 60 per cent, comprising some 5 billion people. Rapid urban population growth and industrialization are putting severe strains on the water resources and environmental protection capabilities of many cities. Special attention needs to be given to the growing effects of urbanization on water demands and usage and to the critical role played by local and municipal authorities in managing the supply, use and overall treatment of water, particularly in developing countries for which special support is needed. Scarcity of freshwater resources and the escalating costs of developing new resources have a considerable impact on national industrial, agricultural and human settlement development and economic growth. Better management of urban water resources, including the elimination of unsustainable consumption patterns, can make a substantial contribution to the alleviation of poverty and improvement of the health and quality of life of the urban and rural poor. A high proportion of large urban agglomerations are located around estuaries and in coastal zones. Such an arrangement leads to pollution from municipal and industrial discharges combined with overexploitation of available water resources and threatens the marine environment and the supply of freshwater resources.

Objectives

57. The development objective of this programme is to support local and central Governments' efforts and capacities to sustain national development and productivity through environmentally sound management of water resources for urban use. Supporting this objective is the identification and implementation of strategies and actions to ensure the continued supply of affordable water for present and future needs and to reverse current trends of resource degradation and depletion.
58. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could set the following targets:
- a. By the year 2000, to have ensured that all urban residents have access to at least 40 litres per capita per day of safe water and that 75 per cent of the urban population are provided with on-site or community facilities for sanitation;
 - b. By the year 2000, to have established and applied quantitative and qualitative discharge standards for municipal and industrial effluents;
 - c. By the year 2000, to have ensured that 75 per cent of solid waste generated in urban areas are collected and recycled or disposed of in an environmentally safe way.

Activities

59. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could implement the following activities:
- a. Protection of water resources from depletion, pollution and degradation:
 - i. Introduction of sanitary waste disposal facilities based on environmentally sound low-cost and upgradable technologies;
 - ii. Implementation of urban storm-water run-off and drainage programmes;
 - iii. Promotion of recycling and reuse of waste water and solid wastes;
 - iv. Control of industrial pollution sources to protect water resources;

- v. Protection of watersheds with respect to depletion and degradation of their forest cover and from harmful upstream activities;
 - vi. Promotion of research into the contribution of forests to sustainable water resources development;
 - vii. Encouragement of the best management practices for the use of agrochemicals with a view to minimizing their impact on water resources;
- b. Efficient and equitable allocation of water resources:
- i. Reconciliation of city development planning with the availability and sustainability of water resources;
 - ii. Satisfaction of the basic water needs of the urban population;
 - iii. Introduction of water tariffs, taking into account the circumstances in each country and where affordable, that reflect the marginal and opportunity cost of water, especially for productive activities;
- c. Institutional/legal/management reforms:
- i. Adoption of a city-wide approach to the management of water resources;
 - ii. Promotion at the national and local level of the elaboration of land-use plans that give due consideration to water resources development;
 - iii. Utilization of the skills and potential of non-governmental organizations, the private sector and local people, taking into account the public's and strategic interests in water resources;
- d. Promotion of public participation:
- i. Initiation of public-awareness campaigns to encourage the public's move towards rational water utilization;
 - ii. Sensitization of the public to the issue of protecting water quality within the urban environment;
 - iii. Promotion of public participation in the collection, recycling and elimination of wastes;
- e. Support to local capacity-building:
- i. Development of legislation and policies to promote investments in urban water and waste management, reflecting the major contribution of cities to national economic development;
 - ii. Provision of seed money and technical support to the local handling of materials supply and services;
 - iii. Encouragement, to the extent possible, of autonomy and financial viability of city water, solid waste and sewerage utilities;
 - iv. Creation and maintenance of a cadre of professionals and semi-professionals, for water, waste-water and solid waste management;
- f. Provision of enhanced access to sanitary services:
- i. Implementation of water, sanitation and waste management programmes focused on the urban poor;
 - ii. Making available of low-cost water-supply and sanitation technology choices;
 - iii. Basing of choice of technology and service levels on user preferences and willingness to pay;
 - iv. Mobilization and facilitation of the active involvement of women in water management teams;
 - v. Encouragement and equipment of local water associations and water committees to manage community water-supply systems and communal latrines, with technical back-up available when required;

- vi. Consideration of the merits and practicality of rehabilitating existing malfunctioning systems and of correcting operation and maintenance inadequacies.

Means of implementation

(a) Financing and cost evaluation

60. The Conference secretariat has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about \$20 billion, including about \$4.5 billion from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Scientific and technological means

61. The 1980s saw considerable progress in the development and application of low-cost water-supply and sanitation technologies. The programme envisages continuation of this work, with particular emphasis on development of appropriate sanitation and waste disposal technologies for low-income high-density urban settlements. There should also be international information exchange, to ensure a widespread recognition among sector professionals of the availability and benefits of appropriate low-cost technologies. The public-awareness campaigns will also include components to overcome user resistance to second-class services by emphasizing the benefits of reliability and sustainability.

(c) Human resource development

62. Implicit in virtually all elements of this programme is the need for progressive enhancement of the training and career development of personnel at all levels in sector institutions. Specific programme activities will involve the training and retention of staff with skills in community involvement, low-cost technology, financial management, and integrated planning of urban water resources management. Special provision should be made for mobilizing and facilitating the active participation of women, youth, indigenous people and local communities in water management teams and for supporting the development of water associations and water committees, with appropriate training of such personnel as treasurers, secretaries and caretakers. Special education and training programmes for women should be launched with regard to the protection of water resources and water-quality within urban areas.

(d) Capacity-building

63. In combination with human resource development, strengthening of institutional, legislative and management structures are key elements of the programme. A prerequisite for progress in enhancing access to water and sanitation services is the establishment of an institutional framework that ensures that the real needs and potential contributions of currently unserved populations are reflected in urban development planning. The multisectoral approach, which is a vital part of urban water resources management, requires institutional linkages at the national and city levels, and the programme includes proposals for establishing intersectoral planning groups. Proposals for greater pollution control and prevention depend for their success on the right combination of economic and regulatory mechanisms, backed by adequate monitoring and surveillance and supported by enhanced capacity to address environmental issues on the part of local Governments.

64. Establishment of appropriate design standards, water-quality objectives and discharge consents is therefore among the proposed activities. The programme also includes support for strengthening the capability of water and sewerage agencies and for developing their autonomy and financial viability. Operation and maintenance of existing water and sanitation facilities have been recognized as entailing a serious shortcoming in many countries. Technical and financial support are needed to help countries correct present

inadequacies and build up the capacity to operate and maintain rehabilitated and new systems.

F. Water for sustainable food production and rural development

Basis for action

65. Sustainability of food production increasingly depends on sound and efficient water use and conservation practices consisting primarily of irrigation development and management, including water management with respect to rain-fed areas, livestock water-supply, inland fisheries and agro-forestry. 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 rain-fed 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. While significant expansion of the area under rain-fed agriculture has been achieved during the past decade, the productivity response and sustainability of irrigation systems have been constrained by problems of waterlogging and salinization. Financial and market constraints are also a common problem. Soil erosion, mismanagement and overexploitation of natural resources and acute competition for water have all influenced the extent of poverty, hunger and famine in the developing countries. Soil erosion caused by overgrazing of livestock is also often responsible for the siltation of lakes. Most often, the development of irrigation schemes is supported neither by environmental impact assessments identifying hydrologic consequences within watersheds of interbasin transfers, nor by the assessment of social impacts on peoples in river valleys.
66. The non-availability of water-supplies of suitable quality is a significant limiting factor to livestock production in many countries, and improper disposal of animal wastes can in certain circumstances result in pollution of water-supplies for both humans and animals. The drinking-water requirements of livestock vary according to species and the environment in which they are kept. It is estimated that the current global livestock drinking-water requirement is about 60 billion litres per day and based on livestock population growth estimates, this daily requirement is predicted to increase by 0.4 billion litres per annum in the foreseeable future.
67. Freshwater fisheries in lakes and streams are an important source of food and protein. Fisheries of inland waters should be so managed as to maximize the yield of aquatic food organisms in an environmentally sound manner. This requires the conservation of water-quality and quantity, as well as of the functional morphology of the aquatic environment. On the other hand, fishing and aquaculture may themselves damage the aquatic ecosystem; hence their development should conform to guidelines for impact limitation. Present levels of production from inland fisheries, from both fresh and brackish water, are about 7 million tons per year and could increase to 16 million tons per year by the year 2000; however, any increase in environmental stress could jeopardize this rise.

Objectives

68. The key strategic principles for holistic and integrated environmentally sound management of water resources in the rural context may be set forth as follows:
- a. Water should be regarded as a finite resource having an economic value with significant social and economic implications reflecting the importance of meeting basic needs;
 - b. Local communities must participate in all phases of water management, ensuring the full involvement of women in view of their crucial role in the practical day-to-day supply, management and use of water;

- c. Water resource management must be developed within a comprehensive set of policies for (i) human health; (ii) food production, preservation and distribution; (iii) disaster mitigation plans; (iv) environmental protection and conservation of the natural resource base;
 - d. It is necessary to recognize and actively support the role of rural populations, with particular emphasis on women.
69. An International Action Programme on Water and Sustainable Agricultural Development (IAP-WASAD) has been initiated by FAO in cooperation with other international organizations. The main objective of the Action Programme is to assist developing countries in planning, developing and managing water resources on an integrated basis to meet present and future needs for agricultural production, taking into account environmental considerations.
 70. The Action Programme has developed a framework for sustainable water use in the agricultural sector and identified priority areas for action at national, regional and global levels. Quantitative targets for new irrigation development, improvement of existing irrigation schemes and reclamation of waterlogged and salinized lands through drainage for 130 developing countries are estimated on the basis of food requirements, agro-climatic zones and availability of water and land.
 71. FAO global projections for irrigation, drainage and small-scale water programmes by the year 2000 for 130 developing countries are as follows: (a) 15.2 million hectares of new irrigation development; (b) 12 million hectares of improvement/modernization of existing schemes; (c) 7 million hectares installed with drainage and water control facilities; and (d) 10 million hectares of small-scale water programmes and conservation.
 72. The development of new irrigation areas at the above-mentioned level may give rise to environmental concerns in so far as it implies the destruction of wetlands, water pollution, increased sedimentation and a reduction in biodiversity. Therefore, new irrigation schemes should be accompanied by an environmental impact assessment, depending upon the scale of the scheme, in case significant negative environmental impacts are expected. When considering proposals for new irrigation schemes, consideration should also be given to a more rational exploitation, and an increase in the efficiency or productivity, of any existing schemes capable of serving the same localities. Technologies for new irrigation schemes should be thoroughly evaluated, including their potential conflicts with other land uses. The active involvement of water-users groups is a supporting objective.
 73. It should be ensured that rural communities of all countries, according to their capacities and available resources and taking advantage of international cooperation as appropriate, will have access to safe water in sufficient quantities and adequate sanitation to meet their health needs and maintain the essential qualities of their local environments.
 74. The objectives with regard to water management for inland fisheries and aquaculture include conservation of water-quality and water-quantity requirements for optimum production and prevention of water pollution by aquacultural activities. The Action Programme seeks to assist member countries in managing the fisheries of inland waters through the promotion of sustainable management of capture fisheries as well as the development of environmentally sound approaches to intensification of aquaculture.
 75. The objectives with regard to water management for livestock supply are twofold: provision of adequate amounts of drinking-water and safeguarding of drinking-water quality in accordance with the specific needs of different animal species. This entails maximum salinity tolerance levels and the absence of pathogenic organisms. No global targets can be set owing to large regional and intra-country variations.

Activities

76. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could implement the following activities:

- a. Water-supply and sanitation for the unserved rural poor:
 - i. Establish national policies and budget priorities with regard to increasing service coverage;
 - ii. Promote appropriate technologies;
 - iii. Introduce suitable cost-recovery mechanisms, taking into account efficiency and equity through demand management mechanisms;
 - iv. Promote community ownership and rights to water-supply and sanitation facilities;
 - v. Establish monitoring and evaluation systems;
 - vi. Strengthen the rural water-supply and sanitation sector with emphasis on institutional development, efficient management and an appropriate framework for financing of services;
 - vii. Increase hygiene education and eliminate disease transmission foci;
 - viii. Adopt appropriate technologies for water treatment;
 - ix. Adopt wide-scale environmental management measures to control disease vectors;
- b. Water-use efficiency:
 - i. Increase of efficiency and productivity in agricultural water use for better utilization of limited water resources;
 - ii. Strengthen water and soil management research under irrigation and rain-fed conditions;
 - iii. Monitor and evaluate irrigation project performance to ensure, inter alia, the optimal utilization and proper maintenance of the project;
 - iv. Support water-users groups with a view to improving management performance at the local level;
 - v. Support the appropriate use of relatively brackish water for irrigation;
- c. Waterlogging, salinity control and drainage:
 - i. Introduce surface drainage in rain-fed agriculture to prevent temporary waterlogging and flooding of lowlands;
 - ii. Introduce artificial drainage in irrigated and rain-fed agriculture;
 - iii. Encourage conjunctive use of surface and groundwaters, including monitoring and water-balance studies;
 - iv. Practise drainage in irrigated areas of arid and semi-arid regions;
- d. Water-quality management:
 - i. Establish and operate cost-effective water-quality monitoring systems for agricultural water uses;
 - ii. Prevent adverse effects of agricultural activities on water-quality for other social and economic activities and on wetlands, inter alia, through optimal use of on-farm input and the minimization of the use of external input in agricultural activities;
 - iii. Establish biological, physical and chemical water-quality criteria for agricultural water-users and for marine and riverine ecosystems;
 - iv. Minimize soil run-off and sedimentation;
 - v. Dispose properly of sewage from human settlements and of manure produced by intensive livestock breeding;

- vi. Minimize adverse effects from agricultural chemicals by use of integrated pest management;
- vii. Educate communities about the pollution-related impacts of the use of fertilizers and chemicals on water-quality, food safety and human health;
- e. Water resources development programmes:
 - i. Develop small-scale irrigation and water-supply for humans and livestock and for water and soil conservation;
 - ii. Formulate large-scale and long-term irrigation development programmes, taking into account their effects on the local level, the economy and the environment;
 - iii. Promote local initiatives for the integrated development and management of water resources;
 - iv. Provide adequate technical advice and support and enhancement of institutional collaboration at the local community level;
 - v. Promote a farming approach for land and water management that takes account of the level of education, the capacity to mobilize local communities and the ecosystem requirements of arid and semi-arid regions;
 - vi. Plan and develop multi-purpose hydroelectric power schemes, making sure that environmental concerns are duly taken into account;
- f. Scarce water resources management:
 - i. Develop long-term strategies and practical implementation programmes for agricultural water use under scarcity conditions with competing demands for water;
 - ii. Recognize water as a social, economic and strategic good in irrigation planning and management;
 - iii. Formulate specialized programmes focused on drought preparedness, with emphasis on food scarcity and environmental safeguards;
 - iv. Promote and enhance waste-water reuse in agriculture;
- g. Water-supply for livestock:
 - i. Improve quality of water available to livestock, taking into account their tolerance limits;
 - ii. Increase the quantity of water sources available to livestock, in particular those in extensive grazing systems, in order to both reduce the distance needed to travel for water and to prevent overgrazing around water sources;
 - iii. Prevent contamination of water sources with animal excrement in order to prevent the spread of diseases, in particular zoonosis;
 - iv. Encourage multiple use of water-supplies through promotion of integrated agro-livestock-fishery systems;
 - v. Encourage water spreading schemes for increasing water retention of extensive grasslands to stimulate forage production and prevent run-off;
- h. Inland fisheries:
 - i. Develop the sustainable management of fisheries as part of national water resources planning;
 - ii. Study specific aspects of the hydrobiology and environmental requirements of key inland fish species in relation to varying water regimes;
 - iii. Prevent or mitigate modification of aquatic environments by other users or rehabilitate environments subjected to such modification on behalf of the sustainable use and conservation of biological diversity of living aquatic resources;

- iv. Develop and disseminate environmentally sound water resources development and management methodologies for the intensification of fish yield from inland waters;
- v. Establish and maintain adequate systems for the collection and interpretation of data on water quality and quantity and channel morphology related to the state and management of living aquatic resources, including fisheries;
- i. Aquaculture development:
 - i. Develop environmentally sound aquaculture technologies that are compatible with local, regional and national water resources management plans and take into consideration social factors;
 - ii. Introduce appropriate aquaculture techniques and related water development and management practices in countries not yet experienced in aquaculture;
 - iii. Assess environmental impacts of aquaculture with specific reference to commercialized culture units and potential water pollution from processing centres;
 - iv. Evaluate economic feasibility of aquaculture in relation to alternative use of water, taking into consideration the use of marginal-quality water and investment and operational requirements.

Means of implementation

(a) Financing and cost evaluation

77. The Conference secretariat has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about \$13.2 billion, including about \$4.5 billion from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Scientific and technological means

78. There is an urgent need for countries to monitor water resources and water-quality, water and land use and crop production; compile inventories of type and extent of agricultural water development and of present and future contributions to sustainable agricultural development; evaluate the potential for fisheries and aquaculture development; and improve the availability and dissemination of data to planners, technicians, farmers and fishermen. Priority requirements for research are as follows:

- a. Identification of critical areas for water-related adaptive research;
- b. Strengthening of the adaptive research capacities of institutions in developing countries;
- c. Enhancement of translation of water-related farming and fishing systems research results into practical and accessible technologies and provision of the support needed for their rapid adoption at the field level.

79. Transfer of technology, both horizontal and vertical, needs to be strengthened. Mechanisms to provide credit, input supplies, markets, appropriate pricing and transportation must be developed jointly by countries and external support agencies. Integrated rural water-supply infrastructure, including facilities for water-related education and training and support services for agriculture, should be expanded for multiple uses and should assist in developing the rural economy.

(c) Human resource development

80. Education and training of human resources should be actively pursued at the national level through: (a) assessment of current and long-term human resources management and training needs; (b) establishment of a national policy for human resources development; and (c)

initiation and implementation of training programmes for staff at all levels as well as for farmers. The necessary actions are as follows:

- a. Assess training needs for agricultural water management;
- b. Increase formal and informal training activities;
- c. Develop practical training courses for improving the ability of extension services to disseminate technologies and strengthen farmers' capabilities, with special reference to small-scale producers;
- d. Train staff at all levels, including farmers, fishermen and members of local communities, with particular reference to women;
- e. Increase the opportunities for career development to enhance the capabilities of administrators and officers at all levels involved in land- and water-management programmes.

(d) Capacity-building

81. The importance of a functional and coherent institutional framework at the national level to promote water and sustainable agricultural development has generally been fully recognized at present. In addition, an adequate legal framework of rules and regulations should be in place to facilitate actions on agricultural water-use, drainage, water-quality management, small-scale water programmes and the functioning of water-users' and fishermen's associations. Legislation specific to the needs of the agricultural water sector should be consistent with, and stem from, general legislation for the management of water resources. Actions should be pursued in the following areas:

- a. Improvement of water-use policies related to agriculture, fisheries and rural development and of legal frameworks for implementing such policies;
- b. Review, strengthening and restructuring, if required, of existing institutions in order to enhance their capacities in water-related activities, while recognizing the need to manage water resources at the lowest appropriate level;
- c. Review and strengthening, where necessary, of organizational structure, functional relationships and linkages among ministries and departments within a given ministry;
- d. Provision of specific measures that require support for institutional strengthening, inter alia, through long-term programme budgeting, staff training, incentives, mobility, equipment and coordination mechanisms;
- e. Enhancement of involvement of the private sector, where appropriate, in human resource development and provision of infrastructure;
- f. Transfer of existing and new water-use technologies by creating mechanisms for cooperation and information exchange among national and regional institutions.

G. Impacts of climate change on water resources

Basis for action

82. There is uncertainty with respect to the prediction of climate change at the global level.

Although the uncertainties increase greatly at the regional, national and local levels, it is at the national level that the most important decisions would need to be made. Higher temperatures and decreased precipitation would lead to decreased water-supplies and increased water demands; they might cause deterioration in the quality of freshwater bodies, putting strains on the already fragile balance between supply and demand in many countries. Even where precipitation might increase, there is no guarantee that it would occur at the time of year when it could be used; in addition, there might be a likelihood of increased flooding. Any rise in sealevel will often cause the intrusion of salt water into estuaries, small islands and coastal aquifers and the flooding of low-lying coastal areas; this puts low-lying countries at great risk.

83. The Ministerial Declaration of the Second World Climate Conference states that "the potential impact of such climate change could pose an environmental threat of an up to now

unknown magnitude ... and could even threaten survival in some small island States and in low-lying coastal, arid and semi-arid areas".³ The Conference recognized that among the most important impacts of climate change were its effects on the hydrologic cycle and on water management systems and, through these, on socio-economic systems. Increase in incidence of extremes, such as floods and droughts, would cause increased frequency and severity of disasters. The Conference therefore called for a strengthening of the necessary research and monitoring programmes and the exchange of relevant data and information, these actions to be undertaken at the national, regional and international levels.

Objectives

84. The very nature of this topic calls first and foremost for more information about and greater understanding of the threat being faced. This topic may be translated into the following objectives, consistent with the United Nations Framework Convention on Climate Change:
- a. To understand and quantify the threat of the impact of climate change on freshwater resources;
 - b. To facilitate the implementation of effective national countermeasures, as and when the threatening impact is seen as sufficiently confirmed to justify such action;
 - c. To study the potential impacts of climate change on areas prone to droughts and floods.

Activities

85. All States, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could implement the following activities:
- a. Monitor the hydrologic regime, including soil moisture, groundwater balance, penetration and transpiration of water-quality, and related climate factors, especially in the regions and countries most likely to suffer from the adverse effects of climate change and where the localities vulnerable to these effects should therefore be defined;
 - b. Develop and apply techniques and methodologies for assessing the potential adverse effects of climate change, through changes in temperature, precipitation and sealevel rise, on freshwater resources and the flood risk;
 - c. Initiate case-studies to establish whether there are linkages between climate changes and the current occurrences of droughts and floods in certain regions;
 - d. Assess the resulting social, economic and environmental impacts;
 - e. Develop and initiate response strategies to counter the adverse effects that are identified, including changing groundwater levels and to mitigate saline intrusion into aquifers;
 - f. Develop agricultural activities based on brackish-water use;
 - g. Contribute to the research activities under way within the framework of current international programmes.

Means of implementation

(a) Financing and cost evaluation

86. The Conference secretariat has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about \$100 million, including about \$40 million from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Scientific and technological means

87. Monitoring of climate change and its impact on freshwater bodies must be closely integrated with national and international programmes for monitoring the environment, in particular those concerned with the atmosphere, as discussed under other sections of

Agenda 21, and the hydrosphere, as discussed under programme area B above. The analysis of data for indication of climate change as a basis for developing remedial measures is a complex task. Extensive research is necessary in this area and due account has to be taken of the work of the Intergovernmental Panel on Climate Change (IPCC), the World Climate Programme, the International Geosphere-Biosphere Programme (IGBP) and other relevant international programmes.

88. The development and implementation of response strategies requires innovative use of technological means and engineering solutions, including the installation of flood and drought warning systems and the construction of new water resource development projects such as dams, aqueducts, well fields, waste-water treatment plants, desalination works, levees, banks and drainage channels. There is also a need for coordinated research networks such as the International Geosphere-Biosphere Programme/Global Change System for Analysis, Research and Training (IGBP/START) network.

(c) Human resource development

89. The developmental work and innovation depend for their success on good academic training and staff motivation. International projects can help by enumerating alternatives, but each country needs to establish and implement the necessary policies and to develop its own expertise in the scientific and engineering challenges to be faced, as well as a body of dedicated individuals who are able to interpret the complex issues concerned for those required to make policy decisions. Such specialized personnel need to be trained, hired and retained in service, so that they may serve their countries in these tasks.

(d) Capacity-building

90. There is a need, however, to build a capacity at the national level to develop, review and implement response strategies. Construction of major engineering works and installation of forecasting systems will require significant strengthening of the agencies responsible, whether in the public or the private sector. Most critical is the requirement for a socio-economic mechanism that can review predictions of the impact of climate change and possible response strategies and make the necessary judgements and decisions.

Notes

- 1 Report of the United Nations Water Conference, Mar del Plata, 14-25 March 1977 (United Nations publication, Sales No. E.77.II.A.12), part one, chap. I, sect. C, para. 35. [\[return\]](#)
- 2 Ibid., part one, chap. I, resolution II. [\[return\]](#)
- 3 A/45/696/Add.1, annex III, preamble, para. 2. [\[return\]](#)

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