ICWE/WG.A/Doc.1

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP A

Background Paper

Integrated Water Resources Development and Management

Prepared by

United Nations Department of Technical Cooperation for Development (UN/DTCD)
World Bank (IBRD)
United Nations Development Programme (UNDP)

Introduction

1. Agenda 21, the strategy paper for the United Nations Conference on Environment and Development, identifies integrated water resources development and management as one of the major means of achieving sustainable development of the world's freshwater resources. The term sustainable here implies both economically and environmentally sustainable. Implicit also in its use are the concepts of technical viability and social acceptability.

2. The United Nations Water Conference, held in Mar del Plata, Argentina, in March 1977, was a milestone in providing the most comprehensive documentation up to that time on what had to be done in developing countries to harness water resources for economic benefit and social needs while conserving them for future generations. The recommendations were embodied in the Mar del Plata Action Plan.

3. Hopes were high that this articulation of activities and recommendations would provide a firm basis for accelerated water development and better management of the resource which would allow countries to plan more rationally, identify priorities and free the flow of financial resources to the sector. The emphasis of the Mar del Plata Action Plan was on comprehensive planning over a wide front, to take into account the range of water- related activities which affect economic growth and everyday life. The fragmented nature of the water resources sector was seen as a major constraint to attracting more financial assistance since it lacked focus, a simple and clear message, and many water resources planners and managers failed to communicate the importance of a unified and cross-sectoral approach to their policy makers.

4. The 1980s proved to be a sober reminder of how external factors can completely disrupt even the most comprehensive water resources plans. The failure to achieve targets, and in many cases to maintain even a minimum level of services to monitor the resource in terms of quantity and quality, to implement the projects and programmes, to utilize the resource and to control its pollution and degradation, has forced a reassessment of how the problems are to be tackled and how to determine the order of priority of the tasks to be done, given the continued constraint on financial resources and the many other calls on those limited funds.

5. In 1987, the Administrative Committee on Coordination's Intersecretariat Group for Water Resources was requested by the Committee on Natural Resources to develop a comprehensive strategy for action at the national regional and global levels to bring about a renewed commitment to the objectives of the Mar del Plata Action Plan. A series of in-depth regional assessments and studies were carried out by groups of United Nations agencies working in several cross-sectoral areas, reflecting the need to break from the traditional sectoral approach in tackling the problems of the 1990s. A number of intersectoral programmes of action were presented to the Committee on Natural Resources in March 1991.

6. One such cross-sectoral initiative was undertaken by the United Nations Development Programme and concerned <u>capacity building for water resources management</u>. The elements of capacity building programmes were seen to include improvement of the policy environment and, most importantly, institutional and human resources development at national and local levels. Legal issues, information management, the role of international and national professional associations and the private sector were also seen as important areas to be addressed.

7. A symposium on capacity building was held in Delft, The Netherlands, in June 1991, and a strategy for intensifying capacity building activities in the water sector was outlined in the Delft Declaration. The recommendations contained in the Delft Declaration were used extensively in the work leading up to the preparation of Agenda 21 and each programme area is required to deal specifically with capacity building implications.

Capacity building consists of three basic elements:

- creating an enabling environment with appropriate policy and legal frameworks;
- institutional development, including community participation;
- human resources development and strengthening of managerial systems.

The Delft Declaration, June 1991.

8. Another parallel initiative was undertaken by the Nordic Countries and culminated in the Copenhagen Informal Consultation on Integrated Water Resources Development and Management in November 1991. The Copenhagen Informal Consultation focused on integrated water resources management in rural communities (including small towns) in developing countries and considered that two key principles should be prime components of future strategies for sustainable development. The first is that water and land resources should be managed at the lowest appropriate levels. The second is that water should be considered as an economic good, with a value representing its most valuable potential use.

The Key Principles

1. ....in any given situation, water resources should be managed at the lowest appropriate levels, taking into account the need for integration with land use management.

2. ....efficient allocation of water resources can only come from a full recognition of the costs and benefits associated with various alternative uses taking into account future needs. In other words, water is an economic good.

The Copenhagen Statement, November 1991.

9. The International Conference on Water and the Environment now provides an opportunity to focus on implementing and making operational the recommendations which have already been articulated at Mar del Plata, Delft, Copenhagen and many other fora on what is required to be done to accelerate water resources development for the economic benefit and social well-being of mankind. In particular, it can help to bring about a renewed commitment that water resources development is a catalyst for social and economic development and, by incorporating the specific issues of sustainability, can ensure that lasting progress will be made.

Relationship to the United Nations Water Conference

10. What has changed since Mar del Plata? Not the nature of the problems, although their intensity has increased in response to increasing population pressure, rural-urban migration, stagnation of the economies and the debt burden. Not the fragmentation of the whole water resources sector, which has been a severe constraint not only in developing countries but also among donor nations and throughout the international organizations, fostering competition between different subsectors for limited finance, hampering a coherent or coordinated approach to water resources management and distorting priorities.

11. What has changed is the realization that planning the development of and managing water resources to meet the challenge of rapidly increasing populations, increased expectation of access to reliable water supplies and competing demands only make sense if they are done in an integrated or holistic manner. Secondly, water is a fragile and finite resource for which demand is growing and supply is being limited by wasteful and damaging practices. This is narrowing down the options for reallocating water resources. Thirdly, water has to be regarded as an economic good for which, in most cases, there is an opportunity cost for its alternative use, and in making the most of the resource its economic value must be considered in deciding about utilization, allocation and conservation. This does not imply that users, and particularly the poor, need to be charged the full economic cost. Whenever the full economic cost is not charged for a service or supply, however, a decision is being made to subsidize the beneficiaries and this has implications on managing and financing the whole water development sector.

Integrated water resources development and management

12. There is also now a better understanding of how water resources development must interact with many other sectors of economic and social activity and a realization that it is impossible to think of water resources master planning in isolation. In fact, very few master plans developed in isolation ever reached the stage of programmed implementation because there are always many competing priorities for financial resources. Furthermore, water resources development tends to be regarded as an infrastructural input to a wide range of disparate activities rather than a development arena in its own right. To encompass the whole range of development activities within a framework which is limited by the finite nature of the resource, and the finance available, and seek to optimize the development strategy in terms of supply management, demand management, social equity, economic and environmental sustainability and capacity to undertake the work, requires a new approach to what in the past has been termed integrated water resources development and management.

Integrated water resources development and management

Managing the whole range of development activities within a framework limited by the finite nature of the resource, and the finance available, and optimizing the development strategy in terms of supply management, demand management, social equity, economic and environmental sustainability and national capacities.

13. In this context, "integrated" is defined as satisfying the technical (engineering or scientific), economic, social and environmental requirements when planning the water

resources development programmes and implementing the complex series of interrelated activities in an efficient and comprehensive manner.

14. How does this differ from previous concepts of integrated water resources development and management? It differs primarily in the setting of priorities and targets which must be matched to political and social expectations and the financial resources available. Earlier descriptions of integrated water resources development concentrate on making the planning phase as comprehensive, integrated (in the sense of multiobjective or multipurpose), long-range and systematic as possible. The result was usually a detailed and lengthy master plan, the "executive summaries" of which attempted to condense complex information into something which could be absorbed by busy policy makers. Their very comprehensiveness, however, was often enough to ensure that they would not be implemented because they usually incorporated enormous expenditure, far beyond the resources likely to be available.

15. The new meaning of integrated water resources development and management implies a much more interactive and dynamic process. The essential dialogue with the policy makers takes place during and after a <u>diagnostic phase</u> which is intended to identify the principal problems, potentials and constraints to development. From the dialogue, a <u>strategy</u> evolves to deal with priority issues in keeping with government policy and the resources available. The time frame of the <u>action plan</u> needed to implement the strategy is essentially short term (five years) with longer term implications taken into consideration. Decisions are taken at this stage on whether the achievable targets are consistent with overall government policy objectives and with the electorate's expectations. This provides an opportunity to adjust the budgetary allocations should it be required to increase the scope or pace of implementation. The process is <u>interactive</u>, therefore, in the sense that it works both with policy makers and the recipients of the development. It is <u>dynamic</u> in that it uses much shorter time frames and more limited objectives.

16. There is clearly a chance to adjust the strategy and the subsequent programmed implementation or "action plan" to deal with changing circumstances and changing priorities. By involving decision- or policy-makers at an early stage in the formulation of the strategy and action plans, there is a much greater chance of the promised financial support materializing and, by severely limiting the scope of the development, there is a greater probability of attaining the targets and objectives.

17. The great difficulty inherent in changing from the old style of master planning to the new approach called for by integrated water resources development and management is that dealing with the wide scope of water resources development can be very complex even with the full range of delegation options such as decentralization, privatization and community-based water management. Attempting to simplify the problems and their solution, and being driven by a sense of urgency, can lead to a shallow analysis of options. Conversely, development will take place whether or not all the technical information is available and all the options have been considered. Provided that the environmental and social implications are taken into account and there has been a realistic assessment of priorities, there is a strong case for moving in those priority areas as quickly as possible.

<u>Demand management</u>

18. Out of the consideration of water both as an economic good and a finite and vulnerable resources comes the concept of demand management. At its simplest, this means that water resources development and management is no longer a question of

assessing the resource, matching supply to projected demand and finding the necessary finance to design and implement programmes to utilize it. Because of the limited nature of the resource, decisions have to be made on its "best" use by evaluating the economic, social and environmental costs and benefits of alternatives. Demand management is the application of a range of physical and economic tools to produce greater efficiency in the way in which water is produced and used. It is intended to complement efficient supply management and leads to improved allocation of water among competing users, reduction of wastage, better protection of water quality, improved financial management and, ultimately, to sustainable development.

19. Of all potential measures available to water resources managers, the implementation of rational pricing policies is known to have the largest impact on the pattern of water use. In addition, a whole range of techniques exists to reduce water consumption where there is unnecessary use and wastage or where there is a need to conserve the resource. Two major ways of saving water are to be found, for example, first by reducing the amount of water used in industrial production and the wasteful pollution of watercourses and, secondly, by increasing the efficiency of irrigated agriculture. There are also ways of increasing the resource base. Use of low-quality water, recycling, water harvesting, deliberate mining of groundwater where the long-term effects are known, inter-basin transfers and desalinization all have to be evaluated in terms of their full economic, social and environmental cost and in relation to the similar range of benefits.

Integrated water resources management

20. With regard to the previous perception of what was meant by integrated water resources management, a common term found in the Mar del Plata Action Plan is comprehensive planning. This found practical expression in the popularity of water resources master planning and gave a mistaken emphasis to the view that strong, centralized and comprehensive planning was required and that, equally, the resources were to be managed in the same way. If the analogy with economic planning is used, experience has shown that central planning and management is not the most efficient or effective system, particularly in developing countries where skilled personnel are at a premium and financial resources are severely limited.

21. Clearly, the more complex the activities and their interaction, the greater the demands for managerial skills in the water resources managers. Good management stems from a clear definition of responsibilities and delegation of tasks to allow each individual to do what can most efficiently be done at his or her level with a minimum of delays and unnecessary bureaucratic procedures. It cannot be expected that each manager will have the necessary skills to perform efficiently. What can be done, however, is to examine the institutional framework within which the development will take place and decentralize or delegate task and responsibilities to the most appropriate and efficient level.

22. A variety of institutional arrangements to decentralize planning, development and management exists, including the use of the private sector. Whatever decentralized system is used, the role of government changes to one of providing the enabling environment and the system of checks and balances to safeguard public interest and the environment. The degree of decentralization and use of the private sector will depend to a large extent on conditions within individual countries. Least developed countries without a well-functioning private sector will clearly have to rely on greater government intervention in terms of water resources planning just as a more structural approach to economic development is called for in the absence of a free (i.e. undistorted) market.

23. In some cases, as for community water supplies in rural areas for example, much of the decision making and responsibility can be passed to the village level. In the case of hydropower or navigation, on the other hand, while people affected by the development must have a say in what goes on, the technical, financial and political skills required to make rational decisions are more likely to be found only at the national, provincial or large river basin level.

24. The term integrated applied to management, therefore, implies more the sense of coherence than comprehensiveness. By delegating management authority to the most efficient and appropriate level, the task of management becomes less complex and more coherent. The end result is more effective management because of, on the one hand, the sharing of decision-making responsibility and, on the other, the concentration of central government on the most essential tasks.

Institutional/legal frameworks and public participation

25. Finding the appropriate balance between a top-down (centralized) and a bottom-up (community-based) approach to managing water resources is central to achieving integrated water resources management. Creating the appropriate institutional and legal framework to enable development to take place in a sustainable manner is part of the means of achieving this.

26. The legal and institutional frameworks are the most important implementing mechanisms for integrated water resources development and management which can be readily achieved by governments. In many cases, the existing legislation is not suited to modern conditions or to dealing with questions of environmental sustainability. An overhaul of the water legislation paying particular attention to protection of the resource, water quality and pollution control and providing the enabling framework for demand management is a priority in many countries. Legislation is also required to implement the many aspects of decentralization, delegation and privatization.

27. Developing the most appropriate participatory techniques (both public and private) is another important element of creating the best environment for development to take place and in creating the decentralized management system. It is now a well-known fact that community water supplies will not be sustainable if their development takes place without community participation. What is seldom realized is that costly mistakes in the largest schemes can often be avoided and sustainability can often only be achieved if local knowledge is incorporated into the decision- making process and the public will is behind the development. In the case of demand management applied to water supply, for example, the use of tariffs as an economic tool for inducing efficiency may fail if the beneficiaries of a supply are not consulted or if they misinterpret the reasons behind the measures due to faulty public information.

28. The challenge for the future is to assist all developing countries in finding the most appropriate water management system, tailored to individual countries needs, but nevertheless encompassing the guiding principles which are to be outlined in Dublin. The degree to which external assistance will be required to assist developing countries in creating the enabling environment and the ways in which a technology transfer can take place from more advanced industrialized nations to those countries requiring assistance, is very much part of moving from "what" to do, to "how" to do it.

29. The complex nature of integrated water resources management can be simplified by representing it diagrammatically (Figure 1). The first diagram shows some of the key elements to be integrated and the second, reproduced from the keynote paper on "Water and sustainable development", gives a fuller idea of the interrelationships between the water resources system, the users and the all-important socio-economic and environmental conditions. Management is the process of controlling the activities and their outputs during the implementation phase to achieve the objectives in the given time frame. Integration of the various activities can clearly only be achieved if planning has first been carried out in an integrated manner and the appropriate institutional, legal and participatory mechanisms are in place.

New and more effective technologies

30. Given the task of trying to bring about the more effective "integrated" approach to water resources development and management, what tools do the water resources managers have at their disposal to help them to deal with problems of the 1990s and beyond?

31. The first and foremost management tool, for practical purposes, will normally be developed as an integral part of an water resources planning system, and it concerns information management. Not only is there a need for comprehensive databases for the wide variety of information which will be used in the planning process but also, increasingly, there is a need to communicate technical planning scenarios and the implications of policy decisions in a visual or non-technical way. To assist in the task of handling the data, analyzing them and, most importantly, displaying information vital for decision making in an easily assimilable form, there are microcomputers and software which are much more accessible to water resources planners and managers in developing countries than ever before.

32. As the need for social, economic and environmental information grows to complement the physical data required for planning and design, so the supply of Geographic Information Systems and Expert Systems has increased, making it easier to deal with complex interrelationships and decision making.

33. In developing and using such systems, it must not be forgotten that ultimately the quality of decision making will be, in part, a function of the accuracy of the data being analyzed and processed. The decline of monitoring networks has been a cause for concern for some time and the economic value of the data, although highlighted as an area of priority at Mar del Plata, is rarely translated into government priorities. Faced with this situation, a number of methods of dealing with problems where data are sparse have been developed. These, and the new computer technologies need to be made available, with appropriate training, to help compensate for the lack of data. This should be done, however, without implying that they are a substitute for reliable and continuous data of known accuracy.

34. In the field of new or more effective technology, certainly the dissemination of information about such is not as good as it needs to be and points, perhaps, to a more focused role for the United Nations agencies in continuing and intensifying their training programmes, technical publications and software development. A considerable effort is already being made to disseminate technical information, backed by scientists and engineers from the whole world. Water resources managers from developing countries, however, will be quick to point out that technical publications are not always freely

available in practice and the training courses and seminars are often inaccessible to the senior managers who have to acquire new skills quickly.

35. In terms of research and development, communication of needs between beneficiaries of new technologies and designers must be improved. Encouragement of research and development in developing countries themselves and of technical cooperation among developing countries is a effective way of focusing on the problems facing these countries and need to find appropriate and cost-effective solutions. The provision of venture capital for field trials or pilot projects is also an important element in getting the new technologies commercially available and out to the user.

Activities and related means of implementation

36. The draft document on the freshwater section of Agenda 21 (A/CONF.151/PC/...) lists a number of activities which governments have identified as able to assist the achievement of integrated water resources development and management. These activities are reproduced in this background paper as Appendix 1. The fact sheets prepared for the working group attempt to categorize these and associated activities into six major groupings. These are:

- Integrated water resources planning
- Demand management
- Institutional arrangements
- Legal frameworks
- Public participation, and
- Effective technologies.

37. In the case of activity (o), development and strengthening, as appropriate, of implementation mechanisms at all levels concerned, this is being dealt with more fully by Working Group B - Mechanisms for implementation and coordination at the global, national, regional and local levels.

38. The individual fact sheets give the strategy and programme targets and it must be remembered that, in the case of integrated water resources management, the end product - technically viable, socially desirable, economically efficient and environmentally sustainable water resources development - will also be a function of how effectively the targets of the other thematic programme areas have been reached - that is to say, water resources assessment; protection of water resources water quality and aquatic ecosystems; water and sustainable urban development; and water for sustainable food production and rural development.

39. Managing the other programme areas will be delegated, according to the principle of managing at the most efficient and appropriate level, to the entities which have the diagnostic and decision-making capacities to implement the programmes. Overall management of water resources development within the framework of this thematic programme area, therefore, consists of creating the enabling environment with appropriate policy, legal and institutional frameworks, backed by improved planning, demand management and technologies, all within a framework of participation by the beneficiaries and the private sector.

40. The task of the working group is to examine this premise, the strategy and objectives of the programme issues, the activities and, in particular, the means of

implementation, with a view to achieving a consensus on how to achieve the integrated development and management of water resources.

41. In this context, it must also be borne in mind that it is not necessary to repeat the Mar del Plata Action Plan in an attempt to be comprehensive. Far better would be a concentration on a few key messages which will assist in implementation and in raising the additional finance to achieve some realistic objectives in the given time frame.

Capacity building

42. Part of the action plans can also be devoted to capacity building, including the rationalization and strengthening of institutional and legal structures and the development of the necessary human resource base. To implement demand management requires training, some transfer of technology (such as techniques for leak detection), legal measures and the establishment of whatever institutional mechanisms are necessary to administer the change from supply to demand management. Governments will have to identify how much can be achieved with internal resources and what external resources will be required as part of the action plan.

Technical and financial support

43. Similarly, implementing all the activities identified in Agenda 21 and during the course of the working group discussions will require technical and financial support either from national or local resources or from external sources which will be identified in Agenda 21 as part of the means of implementation. A major task of the working group, therefore, is to consider how the additional finance can be justified and acquired. Again, a simple message which addresses the majority of cases and is preferably tied to practical examples of how it has been done already will have the largest impact on both governments and donors.

44. It is envisaged that the implementation of specific programmes and actions described within Agenda 21 will be subject to the provision of new and additional financial resources and of technology on concessional, preferential and non-commercial terms. The programmes and activities which emerge from the Dublin Conference, however, must be able to be implemented, albeit at a slower pace, should the level of desired finance not be attained. Should the principles of integrated water resources development and management be widely adopted, this will form the best guarantee that financial support will be forthcoming because the logic of the process and the easily communicated strategy will appeal to governments, external support agencies and to an increasingly vociferous general public who, with their future generations, are the intended beneficiaries.

Appendix 1

INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

AGENDA 21 ACTIVITIES

(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 inventorization of water resources, with land-use planning, forest resource utilization and other relevant development activities

(c) development of interactive databases, forecasting methods and economic planning models

(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 using risk analysis and environmental and social impact assessment

(g) promotion of schemes for rational water use through public awareness raising, educational programmes, 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 seawater desalination, artificial groundwater recharge, use of marginal-quality water, wastewater reuse and water recycling

(k) integration of water quantity and quality management, including surface and underground water resources

(l) promotion of water conservation 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 implementation mechanisms at all levels concerned:

- at the global level improved delineation of responsibilities, division of labour and co-ordination of international organizations and programmes;

(- at the regional level watershed-based organizations (river or lake basin authorities) and legal agreements for the joint management of transboundary water bodies;)

- 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;

- at the (local/decentralized) level delegation of water resources management to the lowest appropriate level, including decentralization of government services to local authorities, private enterprises and communities

((p) elaboration, dissemination and application of operational guidelines in support of the implementation of national action plans and local water management schemes)

((q) capacity building, including the rationalization and strengthening of institutional and legal structures and the development of the necessary human resources basis).

INTEGRATED WATER RESOURCES MANAGEMENT

TECHNICAL ⟷ ***ECONOMIC***

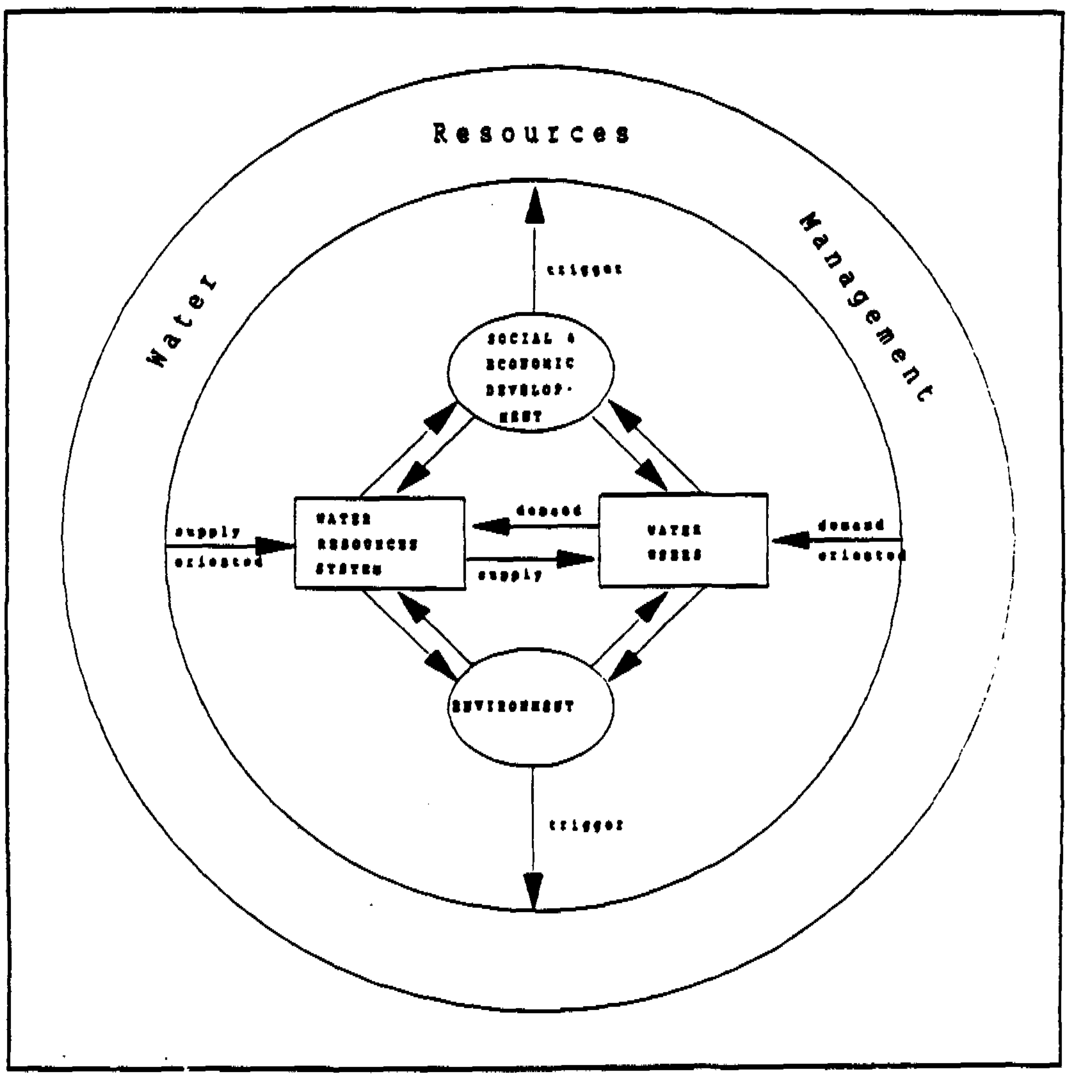
TECHNICAL
- ENGINEERING
- HYDROLOGICAL
- INFRASTRUCTURAL
- AGRICULTURAL
- LEGAL

ECONOMIC
- COSTS & BENEFITS
- FINANCING
- COST RECOVERY
- O & M
- SUSTAINABILITY

SOCIAL ⟷ ***ENVIRONMENT***

SOCIAL
- SOCIAL IMPACT
- QUANTITATIVE AND QUALITATIVE BENEFITS
- PUBLIC PARTICIPATION
- HUMAN DEVELOPMENT PRIORITIES
- POLITICAL ENVIRONMENT

ENVIRONMENT
- ENVIRONMENTAL IMPACT
- LAND USE
- WATER QUALITY
- ECOSYSTEM INTERACTION
- CLIMATIC CHANGE



ICWE/WG.A/Doc.2

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP A

Worksheets

Integrated Water Resources Development and Management

Prepared by

United Nations Department of Technical Cooperation for Development (UN/DTCD)
World Bank (IBRD)
United Nations Development Programme (UNDP)

Working Group Theme: Integrated water resources development and management

Programme Issue: Integrated water resources planning

Basis for Action:	*Strategy and Programme Targets:*
The planning of water resources development is an important activity in all countries. Effective planning is needed to solve the many problems inherent in the control and utilization of water: - conflicting demands; too little or too much water; maximizing economic benefits and social impacts; equity considerations; environmental and economic sustainability. The interdisciplinary nature of water resources planning needs new approaches towards integrating the technical, economic, environmental, social and legal aspects into a coherent framework and the development and dissemination of planning tools or methodologies.	The most effective way to promote the new approach is to apply it to all policy, programme and project formulation exercises to assist governments in selecting appropriate strategies to meet considerations of sustainability, and human development. This will be supported, in developing countries, by training and technical assistance. All countries will be expected to have carried out a diagnostic phase to develop a strategy and a planning phase aimed at costed and targeted national action plans by the year 2000.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Water sector diagnostic assessments - rapid but comprehensive analyses of existing status of water resources development, national goals and strategies, problems and priority areas for action			X	
2. National capacity building - training, transfer of technology, human resources development - institutional strengthening - rationalization of public and private sector intervention - establishment of coordinating mechanisms	X	X	X	
3. Integrated information management - surveys of existing data - needs assessment and technology review - database assembly - data gathering programme formulation - training - use of integrated information in planning exercises		X	X	
4. National Action Plans - community development programmes and activities - district and province programmes and projects - multipurpose projects (including the special problems of man-made lakes) - river basin plans - international watercourses - development of interactive and flexible machinery to update plans - monitoring and evaluation	X	X	X	

Working Group Theme: Integrated water resources development and management

Programme Issue: Demand management

Basis for Action:	*Strategy and Programme Targets:*
Abundance or scarcity of water can mean prosperity or poverty, life or death. It can even be a cause of conflict. Most countries have serious problems concerning the quantity and quality of their freshwater resources. Constraints on the supply of fresh water are increasingly aggravated by droughts, depletion of aquifers and land degradation, while demand for water is rising rapidly for food production, industry and domestic consumption.	Rather than seeking a supply adequate for some set of water "needs", water management is concerned with finding a balance between the benefits of water use and the costs of water supply. "Needs" are no longer measured in consumption per day but in terms of the health and welfare of human populations. Costs are not linked to financial outlays for engineer-ing and construction but include all adverse effects on the economy, or activities which compete for the basis resources and on the environment. Demand management will be introduced into all national action plans and implemented by the year 2000. The necessary training and transfer of technology will have taken place and at least half the developing countries will have carried out evaluations on the effectiveness of demand management.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Water auditing - leak detection and repair - identification of illegal connections - improvement in efficency of supply	X	X	X	
2. Development of water use policy - economic tools for demand management - demand management in domestic supply - demand management in agriculture - demand management in industry			X	
3. Implementation and administration of the policy - legal and institutional aspects - allocating public expenditures - accounting and auditing systems - monitoring and evaluation	X	X	X	

Working Group Theme: Integrated water resources development and management

Programme Issue: Institutional arrangements

Basis for Action:	*Strategy and Programme Targets:*
Sustainable water development is contingent on appropriate institutional arrangements. Such arrangements shall ensure an unbiased and independent approach in policy making, planning, allocation, development, conservation, protection and monitoring of water resources. They should also bring about optimum technical efficiency, and ensure effectiveness in the provision of water-related services.	Centralized and sectoral approaches to water resources development and management have often proved inadequate in addressing local water management problems. Recognizing the need for a central mechanism capable of securing national economic and social interests, the role of government needs to change to enable the delegation of responsibility for water resources development and management to the most appropriate and efficient levels, including the informal and formal private sectors. Governments will have assessed their institutional arrangements and taken steps to establish more appropriate mechanisms as part of national action programmes by 1995.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Implementation of water and land resources management at the lowest appropriate level.	X	X	X	
2. Creation of appropriate water authorities and coordination arrangements.		X	X	
3. Integrating water management at basin level.		X	X	X
4. Inception of efficient and effective organizational alternatives for the provision of water-related public services and for operation and maintenance of projects.	X	X	X	
5. Creation of international arrangements and organizations, when needed for planning, developing, and protecting international waters.			X	X

Working Group Theme: Integrated water resources development and management

Programme Issue: Legal frameworks

Basis for Action:	*Strategy and Programme Targets:*
Policy decisions cannot be implemented successfully unless there is adequate water legislation. Based upon the agreed strategy to develop water resources, water legislation provides part of the enabling environment, ensuring as far as possible the most equitable, economic and sustainable use of available water resources. Such legislation is a complex endeavour since it has to achieve several simultaneous, and sometimes conflicting, objectives: development objectives, including related public and private investments; environmental and conservation goals, requiring effective public control, but also demanding private sector cooperation and involvement; and social objectives, consisting mainly of water-related services and the social impact of development components. At the international level effective treaties or joint or concurrent legislation are essential to deal with increasing instances of transboundary water pollution and conflicting demands on shared watercourse systems.	- Enactment of appropriate, enforceable and applicable legislation, both for water and for activities having an identified impact on water resources. Such legislation shall at the same time encourage and enhance private sector participation and cooperation, and provide tools for expedient public intervention, when and as needed (all countries by the year 2000). - Global acceptance and effective application of rules of cooperation in good faith, environmentally-sustainable management, equitable apportionment and prohibition of causing appreciable harm when developing and using the resources of international watercourse systems (acceptance of rules by 1995, application to large international watercourses by the year 2000).

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Review and analysis of customary and existing water legislation.	X	X	X	
2. Enactment of appropriate water resources legislation including regulations and by-laws.	X	X	X	
3. Enactment of legally compulsory rules for the assessment of water projects and programmes.		X	X	
4. Enactment of legislation for the provision of water-related public services.	X	X	X	
5. Binational, multinational, regional and global agreements on the use, environmentally-sustainable development, protection, and allocation of the resources of international water resources systems.			X	X

Working Group Theme: Integrated water resources development and management

Programme Issue: Public participation

Basis for Action:	*Strategy and Programme Targets:*
No matter how efficiently the water resources planning and implementation process is carried out, its long-term impact and sustainability will depend on the effectiveness of public participation. This applies particularly to the full implementation of demand management, the establishment of a legal framework for water resources management and cost-recovery. In developing countries, the role of women in water resources management must be enhanced since they and their families are the prime users and beneficiaries of water development programmes.	A clear exposition to policy-makers will be made of what is to be accomplished by involving the public in planning and management and how it can be achieved. A major part of the strategy will be using the public information, education and training process to develop an iterative (ie. top-down, bottom-up) open planning process, for example, training professionals in the sector in the use of the participatory techniques and applying the process to individual projects. The specific objectives of the programme will be: - improving the decision-making process - resolving conflicts and enhancing impact - expediting procedures & improving efficiency - reducing costs & improving cost-recovery - enhancing flexibility to external change - ensuring economic and environmental sustainability Since many of these objectives are difficult to quantify or specify as targets, self-evaluations by countries will be performed in the year 2000 to measure qualitatively the extent to which public participation has been enhanced and its impact on programme effectiveness.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Public participatory techniques - development and extension - public relations - public information - conflict resolution - training - social impact assessments	X	X	X	
2. Community participation in planning, implementation, operation and maintenance, evaulation, monitoring.	X	X		
3. Practical implementation of iterative open planning.	X	X	X	
4. Enhancement of the role of women - participation in decision-making process - participation in projects, programmes - development of training materials - training of various target groups - dissemination of results (evaluation, monitoring)	X	X	X	

Working Group Theme: Integrated water resources development and management

Programme Issue: Effective technologies

Basis for Action:	*Strategy and Programme Targets:*
To bring about the more effective integration of water resources development and management activities a wide range of technological options are available. These range from improved methods of data collection and handling which enable the water resources planner to review different ways of developing a resource to so-called "non-conventional" methods of increasing the resource base such as desalination and inter-basin transfer. The dissemination of knowledge of these techniques and options and the technology transfer needed to make them operational in developing countries is a priority area for action.	Developing countries need to strengthen their technological capabilities with the assistance of bilateral and multilateral organizations with regard to transfer of experience and know-how, technical cooperation and training. Such technology transfer should be an integral part of the national action plans implemented, with the goal of reduced dependence on imported technologies and the establishment or strengthening ofindigenous research and development facilities by the year 2000.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Incorporation of the concept of integrated water resources development and management into relevant University graduate and post-graduate courses.		X	X	
2. Priority support to technology transfer and national technical capacity building programmes and projects.			X	X
3. Dissemination and diffusion of new and appropriate technologies to developing countries.				X
4. Promotion of international scientific research cooperation on freshwater resources.			X	X
5. Development of new and alternative sources of water supply.		X	X	
6. Provision of venture capital for field testing of promising new technologies.			X	X

In: isn

ICWE/WG.B/Doc.1

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP B

Background Paper

Mechanisms for Implementation and Co-ordination at Global, National, Regional and Local Level

Prepared by

United Nations Department of International Economic and Social Affairs (UN/DIESA)
United Nations Department of Technical Cooperation and Development (UN/DTCD)
United Nations Development Programme (UNDP)
World Bank (IBRD)
United Nations Conference on Environment and Development (UNCED)

I. INTRODUCTION

The Preparatory Committee of UNCED, at its third session, in its decision 3/22, invited the International Conference on Water and the Environment to:

(a) Consider the material contained in document A/CONF.151/PC/WG.II/L.17/Rev.1, entitled " Protection of the Quality and Supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and Use of Water Resources - Options for Agenda 21", with particular attention to implementation mechanisms, programme targets and costings;

(b) Identify options for appropriate mechanisms for implementing and coordinating the programmes;

(c) Identify options for improved coordination and cooperation on water management at the local, national, regional and global levels;

(d) Submit the report on the results of the meeting to the Secretary-General of the Conference before the fourth session of the Preparatory Committee.

The term mechanism is taken as the set of procedures and functions needed for the setting of objectives and priorities, for planning, for programming and for project implementation and monitoring.

The basic foundation for the integrated development and management of water resources lies in the acceptance of the principle that water is a scarce resource and that the degradation of the freshwater environment decreases its usefulness and availability, contributes to the degradation of associated land and biological resources, and brings about health related consequences. Water and the freshwater environment must be thought of as an ecologically fragile economic good. The main objective of a holistic approach to the development and management of water resources is to maximize the short-and long-term socio-economic benefits derived from the development and utilization of the resource in the context of overall local, regional and national objectives, while minimizing adverse environmental consequences and ensuring the long-term sustainability of its development and use.

The integrated development and management of water resources must take into account the close interrelationship that exists between land and water resources, and that measures taken with regards to one will almost inevitably have an impact on the other. The exercise of integrated water resources management requires the consideration of criteria related to economic efficiency, social equity, health and environmental consequences.

II. MECHANISMS FOR IMPLEMENTATION AND COORDINATION AT THE LOCAL, INTERMEDIATE AND NATIONAL LEVELS

Paragraph 41 of the Mar del Plata Action Plan of the United Nations Water Conference, held in Mar del Plata, Argentina, in 1977, stated that "increased attention should be paid to the integrated planning of water management."

Progress in bringing about integrated approaches to water management have been disappointing. For the most part water resources development and management activities have been carried out by a variety of government entities in a fragmented way. The question of integrated water resources management has usually been looked at from a point of view of the problems arising from a dissipation of responsibilities among government agencies involved. Solutions have often been sought by increasing the degree of centralization of the administrative process, and by establishing central coordination mechanisms which have often lacked the necessary analytical and executive power to be effective. As a general rule, little attention was given to defining the functions that needed to be carried out in the process, or to the attribution of responsibilities at various levels of government, including provisions for intervention by the private sector.

Recent experience has shown that a centralized or top-down approach to water resources development and management does not provide an efficient response to the needs and aspirations of communities and users. There is now a growing realization that central mechanisms must be capable of imparting a sense of direction compatible with national economic and social goals and priorities. At the same time, however, there is also a growing understanding of the need for decentralization and a devolution of responsibilities first and foremost to those operational levels that are best suited to carry out specific tasks, all the way down to local entities closer to communities and user groups. In this regard, for instance, the first principle of the Copenhagen Statement adopted at the Copenhagen Informal consultation, held from 11 to 14 November 1991, states that "In any given situation, <u>water resources should be managed at the lowest appropriate levels</u> taking into account the need for integration with land use management."

However, a decentralized approach to integrated water management would fail if it were to operate in an institutional national vacuum. For it to be successful it requires the administrative, regulatory, financial and technical support from entities at higher levels in complex set of interrelationships of organizations at various geographical and administrative strata.

There is no single organizational prescription that can be offered for the integrated development and management of water resources. Approaches will inevitably vary within different political and administrative national systems. The formulation of mechanisms for the implementation of an integrated approach to water resources development and management however, must be closely related to the set of functions that must be performed from the local to the highest national levels. These functions are essentially related to monitoring and information management, water resources management, the formulation of policies and regulatory frameworks and related enforcement mechanisms, financing, management of technology, human resources development, and public participation. Various aspects of these functions need to be carried out at the local, intermediate (a region within the nation), and national levels.

A. The local level

The term local level is used to encompass the organizations (public or private) and the geographic area in which a specific service is to be provided in the most efficient manner from a socio-economic and environmental point of view. Thus in the case of rural water supply and sanitation, the community for which the service is provided constitutes the appropriate local level. Similarly, in the case of urban centres, the municipality would constitute that level. In the case of irrigation, the specific irrigation district would be considered at the relevant level for water management.

1. Functions

The following functions are relevant at the local level:

(i) Monitoring and information management: Collection of information on the extent and nature of services provided, such as water supply and sanitation service coverage; demographic structure and socio-economic indicators of the target beneficiaries; monitoring water quality in terms of characteristics of the water being supplied, and impact on the resource from solid and liquid waste disposal; monitoring health related variables; monitoring of impacts of water use on land resources; evaluation of the effectiveness of services provided and of socio-economic benefits derived from them.

(ii) Resource management: Full participation in the project planning and implementation process. Ownership of the project operation and maintenance process. Participation in a consultative process with organizations at a higher intermediate and national level in the formulation of priorities, policies, guidelines and regulations required for the integrated development and management of water resources.

(iii) Formulation of policy and regulatory frameworks: Formulation of local guidelines and regulations compatible with those stemming from higher national or provincial laws, designed to create an enabling environment for the provision of services, to define the nature of services to be provided, control water use, and to control pollution.

(iv) Financing: Full participation of users in the recovery of fixed and operating costs involved in the provision of services, bearing in mind equity and social considerations, including environmental costs, and in the generation of local financial resources for investment in project development.

(v) Technology management: Full participation in the process of the selection of technologies and design characteristics best suited to the services to be provided under the prevailing local conditions;

(vi) Human resources development: Full participation in the determination of training needs of the personnel needed for carrying out local monitoring functions, operation and maintenance of services, and for the performance of local regulatory functions.

(vii) Public participation: Full participation of beneficiaries, with special attention to the role of women, in monitoring and evaluation, planning, operation and maintenance of services, formulation and enforcement of local guidelines and ordinances, generation of financial resources, and in the training of local personnel.

2. Institutional implications

The implementation of these functions require the establishment of some entities, public or private, either formal with a political and legal identity, or informal. These are as follows:

(i) A local management entity: Such as a municipal, village or irrigation district authority capable of monitoring local development activities and their environmental impact, defining local requirements, providing a local regulatory and enabling framework, resolving conflicts among users, providing a linkage with the planning, financing and regulatory process at the higher intermediate and national levels, serving as focal point for training programmes, and of providing linkages with the technological management process at higher levels;

(ii) Autonomous organizations responsible for the provision of services: The concept of economic efficiency requires that organizations dealing with service-oriented operation and maintenance, whether public or private, should have administrative and financial autonomy, though subject to controls applicable to public utilities. They should be required to follow guidelines and adhere to standards imposed by national or regional authorities. Financial self sufficiency can be attained only if tariffs are imposed on services in such a manner as to cover all fixed and operating cost, including environmental costs. To the extent that the implementation of price differentials among various classes of users is not able to compensate for subsidies deemed necessary for reasons of social equity, there will be a deficit in revenues relative to those needed for full cost recovery. In such cases, arrangements need to be made with development organizations at the national and provincial levels for them to bear the incidence of the subsidy. If service organizations themselves are left to their own devices to bear the incidence of these deficits, they will face financial hardships leading to improper maintenance and eventual breakdown of services.

Local user associations: Local user associations can play important roles in involving users in the planning and implementation of projects, training of local personnel, monitoring of various land and water related parameters, and enforcing regulations.

The type of local entities to be organized need to remain as simple and cost effective as possible within the context of local conditions. The concept of an entity or authority does not necessarily carry with it the implication that separate organizations have to be established in each case, but rather that there has to be a clear delineation of responsibilities and a clear identification of groups to carry them out with a view to maintaining full accountability. For instance, in cases where water supply services at village or municipal levels are provided by public utilities, the "organization" responsible for these services could be an integral part of the local management authority, as long as responsibilities are clearly delineated. In small villages all three responsibilities might be in the hands of a village council in which distinct groups are responsible for specific functions.

B. The intermediate level

The term intermediate level is used to mean a part of a country defined as a region in terms of physical or hydrological characteristics, political and administrative boundaries, or areas otherwise joined by common economic and social goals and objectives. From a physical point of view the river or lake basin constitute one such unit. Conceptually, groundwater basins could also provide such a unit of management. In reality however, this has not been the case given the difficulties in delineating the extent of such basins, and the usual lack of information to this effect. From a political and socio-economic point of view, political administrative regions, such as counties, departments, provinces or states constitute the most common units.

The integrated development and management of water resources involves a holistic approach based on the physical characteristics of a river or lake basin in order to maximize overall benefits and to control effectively environmental impacts on the land and water resources; and/or at a political administrative level (department, province, state, etc.) in accordance with their jurisdiction over the waters within their territory.

1.Functions

A number of functions are pertinent at this level, to be performed either at the river/lake basin, or at the political/administrative level:

(i) Monitoring and information management: The effective formulation and of implementation of policies and plans is dependent on the availability of a set of data for analytical purposes which is suitable for the decision-making process, and for the monitoring of results. The implementation of this function involves the management of physical data (meteorological; hydrological, both surface and groundwater, quantity and quality, including the monitoring of point and non-point pollution; physiographic and geological, land use and land degradation data, etc.); demographic data (in particular gender segregated data concerning (demographic growth in urban, peri-urban and rural areas); sociological data (information on cultural patterns and attitudes of water users that might have positive or negative impacts on the effective formulation and implementation of policies programmes and projects); economic data (macroeconomic data such as data on income over time, income distribution, regional patterns of economic growth, debt servicing, as well as data concerning economic policies, concerning investment, subsidies, etc); water use data; health and environmental data; technological information (information on alternative technologies that might be applicable to various conditions); comprehensive information on legislation which in one form or another affects water resources development, conservation and use, and on functions and responsibilities of existing institutions; and information concerning the availability of professional and technical personnel in various disciplines, and employment policies in the relevant institutions.

Information is a scarce commodity subject to a number of constraints. Even the most developed among the industrialized countries are unlikely to have all the information that would be ideally required for water management. Consequently, there is a need to generate strategies and approaches to ensure that a certain set of basic data is supplied where and when required. The basic information management function consists of ensuring that the generation of data is demand driven rather than the generated for its own sake. Much of the information required may be collected at lower levels, be it the community or the river basin, or at the national level. Hence, the essential element of this function is to coordinate by supporting activities carried out elsewhere, collecting information where and when necessary, and integrating data into a comprehensive analytical and planning tool.

(ii) Resource management: Participation with authorities at higher and lower levels in a consultative process for the formulation of goals, objectives and standards for the development and conservation of the basin, in keeping with regional and national objectives. Harmonization of specific development projects and apportionment of water resources among competing user groups in order to avoid conflict over the use of scarce resources, and to maximize the socio-economic efficiency of such projects. formulation of a regional framework of priorities, objectives, targets, and policies which determine through time the nature and direction of development, taking into account regional socio-economic conditions and constraints and regional economic plans and policies;

(iii) Formulation of a policy and regulatory framework: Formulation of regulations and guidelines aiming at the optimum development and utilization of the basin's resources, and for the control of pollutants from various sources, and of land degradation due to water uses. Establishment of enforcement procedures via a system of licenses, incentives and penalties. To the extent that departments, provinces or states have jurisdiction over the waters running through their regions, they need to establish a coherent set of regulations or by-laws defining water rights, conditions for the abstraction and use of water, pollution standards, and conditions for the participation of the private sector;

(iv) Financing: This function involves the coherent management of the flow of financial resources from regional sources into projects that meet basin-wide and regional standards, with a view to achieving the objectives and targets set by basin and regional governmental authorities; the establishment of an enabling and regulatory framework for the flow of private funding in a manner compatible with regional objectives; and the establishment of tariffs and subsidy guidelines compatible with socio-economic objectives;

(v) Technology management: Facilitate the transfer of technology and the use of appropriate technologies at the local project level by providing information, including support to research and development and information referral centres by establishing guidelines, standards and incentives designed to influence technological choices. Support to local organizations involved in the participatory consultative process aimed at using appropriate technologies, and participation in that process;

(vi) Human resources development: The availability of technical personnel at all levels of expertise has been a major constraint in the majority of developing countries. Very often, they not only lack the necessary educational and training facilities required to develop the necessary technical skills in sufficient numbers in the various endeavours, but also lack adequate knowledge of the deficiencies in technical personnel. In this regard, the Mar del Plata Action Plan, in paragraph 77(b) recommended that countries "make a comprehensive assessment of the requirements of manpower in the professional, subprofessional, senior, junior and middle-level categories of personnel"; and in paragraph 78(b), that countries should "review the curricula of the existing institutions and training centres...". Regional and national authorities, in consultations with basin and local entities need to carry out these surveys, and establish or support training institutions and programmes with the specific objective of overcoming identified inadequacies. At this intermediate level, this entail the training of personnel dealing with water resources at the basin level, supporting the flow of training programmes to entities at the local level creating an enabling environment within the jurisdiction of the basin or political/administrative region which induce positive employment conditions for technical personnel at all levels.

(vii) Public participation: Establishment of a participatory system of consultations in order to achieve an understanding of the needs and priorities of the communities involved, and the consequent impact on regional planning, and to gain a suitable knowledge of the likely socio-economic impacts of plans and programmes on the communities involved, define objectives at the basin and political/administrative levels, and for the resolution of disputes about allocations. Support to participatory consultative processes at the local level.

2. Institutional implications

a. The river or lake basin as a management unit

The efficient performance of these functions requires the establishment of river or lake basin entities with clear lines of responsibilities. The existence of a number of successful organizations of this type in various parts of the world demonstrates that they can be powerful instruments for harmonizing development within a basin, and catalysts for economic growth where there is a well defined economic incentive to cooperate. The Jordan Valley Commission provides an excellent example of the benefits to be derived from this type of organization. Since its inception in 1973, the value of agricultural production has been reported to have risen form the equivalent of US$ 20 million in 1973, to $180 million in 1987, and the social gains have been outstanding in the fields of education, health and per capita income. In some instances, such entities have been established in order to manage the resources of major tributaries of river basins. For reasons outlined previously, the groundwater basin as a management unit, though desirable in theory, has not proven to be a practical concept

The concept of a river or lake basin entity does not necessarily imply in all cases the establishment of autonomous authorities. While this may be desirable in the case of larger basins in which there is considerable development activity, it may not be feasible in other cases. The concept implies, however, that at the very minimum there be a clear line of responsibility within some governmental authority at the intermediate or national level for the management of activities of such basins. Whatever the case might be, such entities need to establish strong linkages with intermediate regional political/administrative authorities and national authorities. River basin entities may or may not perform themselves the role of developing and managing specific projects. Rather, their role is one of harmonizing such development towards the achievement of basin-wide objectives, either by playing an advisory role, or by having direct jurisdiction for regulating the nature of developments.

b. Political/administrative regions as management units

Political/administrative regions within countries can be called to play an important role in water management depending on the degree of political decentralization and jurisdiction over the water resources within their region. The most extreme case is that of some federal systems where jurisdiction over water resources lies with the state or province. The actual nature of functions to be performed at this level and the assignation of responsibilities at the regional or overall national level to a great extent depends on the extent of political decentralization and the size of the administrative unit.

Whenever jurisdiction over water resources is essentially located at the state/provincial level, there is a need for the establishment of a water authority capable of providing an effective link with national priorities and the socio-economic decision-making process on the one hand, and regional objectives and targets on the other. If jurisdiction over water resources is concentrated at the national level, a state water authority needs to establish strong links at the national level in other to ensure the incorporation of its regional objectives within national plans and programmes. These water authorities must be in charge of establishing the basic guidelines and regulations for the development of water resources in their region, including the regulatory framework for autonomous service organizations, whether public or private.

c. Interprovincial river/lake basins as management units

River or lake basins shared by two or more provinces or states present a special case, particularly within decentralized federal political systems in which jurisdiction over water resources is located at the state level. In such cases, river/lake basin organizations have the particular challenge of harmonizing the interests of the states involved, and in some cases of helping to define those interest, if an integrated development and management of the basin is to take place. Linkages with state authorities are indispensable in order to achieve this objective.

C. The national level

1. Functions

Functions at the national level are closely related to those at the state/provincial level, with the actual distribution of responsibilities depending on the degree of political and administrative decentralization. At the very minimum there is a need at the national level to support and complement activities carried out in the provinces.

(i) Monitoring and information management: This support function is of particular importance with regard to the need for an integrated management of information. Authorities at the national level must be responsible for the establishment of a coherent strategic approach to the collection and analysis of information. They must ensure the availability of the necessary financial, technical and staffing needs to carry out this function at various levels of governments, and complement data gathering, processing storage and analysis activities where necessary.

(ii) Resource management: The most pivotal and complex element of the national water management process lies in the establishment of effective links between the overall socio-economic decision making process and the formulation of water resources policies and programmes. With the possible exception of countries where the scarcity of water resources constitutes a major constraint to development, national development policies are seldom if ever formulated in terms that are readily related to water resources. Policies and programmes involving high levels of investments under stagnant economic conditions, compounded by high levels of inflation and external debt, are unlikely to secure the necessary financial support from the relevant development authorities and international financing organizations, and if they do, may bring about undesirable effects to the economy as a whole. Water resources projects will often fail when they are in conflict with regional and national social or economic policies, as may be the case, for instance, with irrigation programmes that do not take into account import and subsidy policies of the Government. Conversely, the implementation of the best laid down social and economic plans and programmes also will be seriously impaired or come to nought if adequate provisions are not made for the development of the water resources required as inputs to these programmes.

Decisions concerning trade-offs between development and environmental conservation must be related to such issues as poverty and health. Development inevitably alters the environment in one form or another, and in many developing country the most pressing environmental and social problem is poverty. Consequently, the issue is not one of the preservation of a pristine environment within static demographic and economic conditions, but rather one of establishing a balance between the present needs of the population as against needs and opportunities of future generations, and the protection of the ecosystem.

(iii) Formulation of a policy and regulatory framework: Concurrently with the establishment of links with the overall socio-economic process, there is a need for the establishment of a reiterative framework of policies, guidelines standards, objectives, targets and priorities which determine through time the nature and direction of water resources development and utilization programmes. They should constitute the basis for a holistic approach to water resources development and utilization, and for defining a coherent approach to cooperation with external support agencies, including NGOs.

The establishment of the above policy framework requires the existence of a coherent set of regulations and laws defining such questions as land and water rights; abstraction and use of water; and pollution and environmental standards, including the necessary provisions for their enforcement, and the role of the private sector. The scope of the legislative framework at the national level depends on the distribution of jurisdictional attributions between the central and provincial authorities.

(iv) Financing: National authorities also need to manage the flow of financial resources from national and international sources, public and private, with a view to achieving stated objectives and targets. this involves the assignation of national public funds for developmental purposes, the creation of an enabling environment for the flow of private capital, the management of inputs in the form of grants and loans from external support agencies, the establishment of a regulatory framework for the flow of national or international private funding in a manner compatible with national objectives, and the establishment of cost recovery and subsidy guidelines compatible with socio-economic objectives.

(v) Technology management: For the most part developing countries have been captive recipients of technologies from developed countries because of their own weaknesses in their research and development capabilities, and to a great extent also because of the nature of the assistance given by external support agencies. These technologies are in many cases inadequate to the needs of developing countries, and lead to inefficient programmes ill suited to local economic and social conditions. There is a need for governments to provide an enabling environment for research and development activities, and for the transfer of technology from developed and developing countries alike. This involves financial, institutional and legislative support for activities carried out by governmental or private institutions.

(vi) Human resources development: The actual level of involvement at the national level will depend on the distribution of jurisdictions with authorities at lower levels. In any case, however, national governments authorities need to play an effective role in assessing staff requirements, in the development of the technical personnel required for water resources development and management, and in the creation of an enabling environment for suitable employment conditions aimed at avoiding a flow of technical personnel away *from* water related fields. As in the case of information management, it is pertinent for national authorities to formulate and implement overall national human resources development strategies.

2. Institutional implications

The implementation of each of the functions enumerated above is bound to involve a multitude of organizations, whether public or private. Their successful implementation requires the coordination of the relevant activities of each of the actors involved, and effective institutional mechanisms have to be established in order to harmonize approaches.

No matter how politically and administratively decentralized a country might be, there is a need for a national water authority of some sort, preferably capable of prescribing priorities, policy directives, targets and standards (including environmental standards) that are binding on all the actors in the development and utilization process, and for the establishment of guidelines. Such an authority requires a direct link to the legislative process in order to ensure the existence of a comprehensive set of laws and regulations needed for the allocation of water rights, and for the enforcement of targets and standards and to carry out policies. The use of the term "authority" in this context is to reflect its functions of overseeing the implementation of water resources development activities and of providing the essential system of check and balances to safeguard public and national interests. It need not imply a large organization. However, it needs to be equipped with the necessary analytical tools and executive powers to perform its overseeing role. At the very least, a central authority needs to provide a system of linkages between existing organizations dealing with water resources, with a view to harmonizing approaches and policies.

III. MECHANISMS FOR IMPLEMENTATION AND COORDINATION AT THE INTERNATIONAL LEVEL

A. Transboundary basins

Issues related to the integrated development and management of transboundary basins are similar to those arising in the case of basins shared by two or more provinces or states within a country. The situation however, is further complicated by the fact that riparian countries exercise their national sovereignty over different parts of the basin.

Ideally, the integrated development of the transboundary river or lake basins would have the same institutional requirements as in the case of the basin within a single country, i.e., the establishment of a basin authority with suitable linkages to the national water authorities involved. The essential function of the basin organization is one of reconciling and harmonizing the interest of the riparian countries involved into an overall agreed development and conservation strategy. The basin organization needs not be in charge of the development and operation of specific projects, which could be in the hands of national or private concerns, but it must be in position to regulate their nature, to monitor water pollution, and enforce water quality standards. The enforcement of quality standards can be carried out directly, or through the governments of riparian countries. Transboundary groundwater basins present a particular case in view of the difficulties involved in defining the physical characteristics of reservoirs. To date, there are no instances of institutional agreements related to transboundary groundwater basins.

One essential ingredient for a successful basin organization is the availability of suitable physical and socio-economic data which can serve as basis for the harmonization of various national objectives. The task of basin organization is more likely to be one fostering the collection and processing of national data, and ensure its basin-wide compatibility rather than one of collecting the data itself.

The eventual success of shared basin authorities depends on the existence of well defined economic and social objectives, and of a perception on the part of the riparian countries to the effect that benefits derived from a joint integrated development would exceed those that would accrue from individual uncoordinated activities. The Interim Committee for Coordination of Investigations of the Lower Mekong Basin, composed of Laos, Thailand and Vietnam, provides an example of a successful basin organization. The share of basin-wide ongoing projects supported by the committee has increased from 33 to 57 per cent between 1985 and 1991, and the annual expenditures in resource development has accounted for well over half of total expenditures since 1987. As of December 1987, UNDP's total contribution of some US$ 44 million to the Mekong development programme attracted a total of more than $ 800 million in direct investments in the basin area.

B. International regional cooperation

The term region, in the international sense, is used to denote a geographical area comprising two or more countries bound in some form by economic, social, and/or political considerations.

1. Functions

The mature and scope of functions to be performed at that level depend on the objectives that bring countries together. In keeping with a principle of delegation of responsibilities to the lowest appropriate level, mechanisms for the implementation of activities at the regional level need to be related to functions that can only be carried out effectively at that level, or as a means of complementing similar functions at the national and local levels. Basic to any form of cooperation is the availability of relevant information, and the capacity to monitor events pertaining to achieving the targets decided upon by the countries concerned. As a general rule, the collection of information and monitoring functions are carried out at the national level in the first instance, the regional function being more one of ensuring compatibility of result and analysis.

To the extent that there are regional considerations that transcend national boundaries, the formulation of policies to achieve agreed upon objectives may need implementation in a multinational context through the inclusion of considerations at the national level of issues that otherwise would not have been accounted for, and ultimately affect national water resources polices and programmes. Accordingly, there may be a need for the formulation of guidelines, and the formulation of binding multilateral agreements, standards and conventions. This is the case, for instance, within the European Community, with regard to directives concerning water quality standards. The achievement of regional objectives may also require the management of a regional financial flow, via the establishment of regional funds specifically earmarked for these objectives, or by ensuring the availability of funds from existing sources such as regional banks. Regional cooperation concerning the transfer of technology and the promotion of research and development, as well as the establishment of training centres, may be needed either to strengthen activities carried out at the national level or to complement them. This is particularly important in developing regions, where the establishment of research and training centres, with the support of international organizations often have played an important role in achieving regional objectives. The formulation of polices and programmes to foster economic and technical cooperation among the countries in the region is needed as a means of lending the necessary support to national efforts, and to determine additional regional requirements. The convening of the African Ministerial Conference on Environment and Natural Resources (AMCEN) is an example of the implementation of this type of function.

2. Institutional implications

Regional organizations are needed to carry out the objectives and programmes agreed to in a specific regional context. Central to the role of regional organizations is the establishment of an analytical function based on reliable and timely information, with a view to assessing the existing situation, and of predicting those that may require cooperative action in the future, particularly crises situations. Such organizations are also called upon to formulate policies and programmes aimed at facilitating the flow of financial resources available in the region, the transfer of technology, establishing or strengthening research and development, and training activities.

Countries may belong to a variety of regional organizations defined in terms of specific geographic needs as well as in terms of interests. This leads to geographical overlaps and proliferation of organizations dealing with either sectoral or overall aspects of water resources. In terms of efficiency there are benefits to be derived from coordinating functions that have common elements, and harmonizing policies and approaches where common interests are evident. The collection, processing and analysis of data is one area in which cooperation can be most fruitful.

Equally important is the need to harmonize efforts of overlapping subregional and regional organizations in the formulation of policies and programmes to avoid as much as possible the formulation of conflicting policies and programmes. In many cases the existence of informal networks among the various organizations may be sufficient for this purpose. In other cases, however, there might be a need for the establishment or strengthening of a regional organization with a wide regional coverage to deal with equally wide objectives, and to foster coordination and cooperation among the relevant regional and subregional organizations. Such a parent organization may need to have a political identity, and linkage to national processes in order to have an effect on national policies and on other organizations. In addition, some of these organizations can play an important role of providing linkages with global structures for cooperation and coordination. This is the case, for instance, with the regional commissions of the United Nations, the regional banks, and certain regional programmes, such as the regional seas organizations as part of UNEP's Ocean Coastal Areas Programme Activities Centre (OCA/PAC).

C. Global cooperation

Even though water resources development utilization and conservation issues are usually perceived to be of a local or regional nature, many have global dimensions because of their wide environmental, socio-economic and political implications. A global warming trend in the earth's atmosphere, for instance, if it is to take place, could bring about serious disruptions in rainfall distribution and soil moisture with disastrous consequences in agricultural production and economic growth. The unabated discharge of pollutants from rivers into the sea will inevitably lead to major environmental consequences. A continued inability to cope with the water supply and sanitation needs of ever increasing urban populations, particularly among the poor, accompanied by insufficient progress in the provision of such services to rural populations, raises the spectre of an increasing incidence of serious health problems in developing countries, and the need for practical measures to deal with these issues. The spread of cholera in Latin America illustrates the potential seriousness of the situation. Impending water shortages in an increasing number of countries will in time have world-wide socio-economic and political consequences.

1. Functions

With the increasing importance of the global dimension of water resources issues, the ability to monitor current events and to predict emerging issues of global significance is quickly becoming a vitally important function. This requires the availability and accessibility to reliable data collected at the national and regional levels, complemented by additional data generated a the global level on issues that transcend national and regional boundaries, or the capacity to generate it at those levels. The effectiveness of interventions to deal with existing or emerging issues of global concern will often require the formulation of concerted policies and approaches to be carried out by countries individually or jointly, or by international organizations. As in the regional case, in addition to the need for the formulation of policies and approaches that are adhered to on a voluntary basis, there may be the need for the formulation of polices and standards and conventions which are binding on signatory governments and organizations. In time, the adoption of a world water charter committing signatory governments to adhering to certain codes of behaviour and basic standards may become essential.

The efficient allocation of international finances to water resources development, utilization and conservation can benefit from the development of agreed priorities, objectives and criteria to be taken into account by international financing organizations with regards to their financial assistance activities in the forms of grants and loans. It can also benefit from the application at the national level of concerted approaches between governments of developing countries and donor organizations, including bringing about concerted approaches to technical cooperation and its application at the national and regional levels.

Cooperation and coordination is also needed to enhance the transfer of technology and to promote joint research and development for the benefit of developing countries, such as in the case of the research that has taken place for the development of handpumps, or for the international community at large, as is the case with regard to research concerning designs of dams, eutrophication of lakes and reservoirs, and land-based ocean pollution. Equally important, there also is a need to strengthen education and training programmes. Finally, although public awareness of problems associated with water resources development, utilization and conservation is on the rise as a result of certain recent developments, there is a need to sensitize the public at large as to the seriousness and increasing global dimensions of the problems.

2. Institutional implications

There are at the present time a number of international, intergovernmental and non-governmental organizations dealing with specific or overall aspects of water resources development, utilization and conservation. They are endeavouring to carry out some or all of the functions enumerated above. Within the United Nations system of organizations, the General Assembly of the United Nations, and the Economic and Social Council provide the most comprehensive international fora for the consideration of these issues. In addition, each specialized agency of the system has its own governing body dealing with specific issues related to that agency's terms of reference. Other international organizations equally have their own fora for the discussion of issues of concern to them.

The magnitude of the current water resources problems and predicted water shortages leave no doubt as to the need for a global forum to bring about a concerted dialogue on freshwater issues among concerned parties with a view to dealing more effectively with these issues. Such a forum would be called upon to:

1. Monitor on a world-wide basis the situation concerning the development and use of water resources, with particular reference to environmental and socio-economic issues, with a view to assessing the scope and magnitude of existing and emerging problems on a global, regional and national basis.

2. Develop recommendations for action at the global, regional, national and local levels with a view to solving problems, and to promote the adoption of policies and measures at each of these levels. To formulate guidelines, standards, regulations and conventions which may be binding on its member countries.

3. Foster global regional and subregional cooperation and programmes aimed at dealing with problems at these respective levels.

4. Foster the exchange of information on technical, institutional and socio-economic issues related to water resources development and management.

5. Promote the harmonization of policies and programmes among international, regional and bilateral organizations in support of developing countries, and the formulation of joint programmes as and when appropriate.

6. Promote technical and economic cooperation among developing countries.

7. Serve as a clearing house for bilateral and multilateral external support agencies, other international organizations, developing countries, and non-governmental organizations.

For such a forum to be effective in the implementation of these functions, a linkage to the international political process is necessary. At the present time, the General Assembly and the Economic and Social Council have provided these fora. The General Assembly with regard to the International Drinking Water Supply and Sanitation Decade, and work of the International Law Commission concerning the Draft Articles on the Law of the Non-Navigational uses of International Water courses; and the Economic and Social Council directly, or through its Committee on Natural Resources, concerning the implementation of the recommendations of the Mar del Plata Action Plan of the United Nations Water Conference, held in Mar del Plata, Argentina, in 1977. The terms of reference of the Committee on Natural Resources, as established by the Economic and Social Council Resolution 1535(XLIX) of 27 July, 1970, include, inter alia, the following provisions:

"(a) Assistance to the Council in providing guidance in the programming and implementation of activities in the United Nations system for the development of natural resources, particularly with regard to the development of water, energy and mineral resources, keeping in mind requirements for planning for the Second United Nations Development Decade and for the protection of the human environment, and new technological developments in the field of natural resources;

(b) The establishment of guidelines for the provision and for the improvement and strengthening of advisory services to the Governments of Member States, to be made available at their request, for the planning, development and utilization of their natural resources within the framework of their over-all development plans;

(e) The selection and follow-up of priority questions concerning long-term problems and trends of world-wide significance in the field of natural resources;

(g) Appropriate attention to the problem of research promotion and of the exchange and dissemination of experience and information in the fields of the development, utilization and conservation of natural resources;

(h) Recommendations to the Economic and Social Council and, through the Council, to Governments and also to other bodies, such as the Governing Council of the United Nations Development Programme, on appropriate priorities, programmes emphasis and other relevant matters concerning the exploration and exploitation of natural resources."

The role and functions of the Committee, including the need for an intergovernmental forum for freshwater resources, are currently being studied as part of the review of subsidiary bodies of the Economic and Social Council and the General Assembly, being carried by the General Assembly, at its forty-sixth session, in the context of the restructuring and revitalization of the United Nations in the economic, social and related fields. Further examination of this question is also likely to take place in the context of the follow-up to the UNCED Conference.

With regard to the coordination of activities of organizations at the global and regional levels, the Intersecretariat Group for Water Resources of the Administrative Committee on Coordination provides a basis for the coordination of activities of the organizations of the United Nations system. The terms of reference of the Group are as follows: (1) Co-operation in the monitoring of the progress being made in the implementation by Governments of the Action Plan adopted by the United Nations Water Conference; (2) Promotion of co-operation and joint planning of the water-related programmes of the United Nations system and review of their implementation; and (3) Assistance in coordinating the water-related activities of the United Nations system at country and regional levels.

With regard to water supply and sanitation, the Interagency Steering Committee for Water Supply and Sanitation, which is linked closely with the Intersecretariat Group, deals with the coordination of activities of the United Nations system of organizations in the field of drinking water supply and sanitation. The international Action Programme on Water and Sustainable Development (IAP-WASAD), spearheaded by FAO, provides a vehicle for cooperation and coordination in the field of water for agriculture, within the aegis of the ACC Intersecretariat Group. The Global Collaborative Council for Water Supply and Sanitation provides a forum without formal links to an international political process, for a dialogue between the organizations of the United Nations system, other external support agencies at the international, regional and bilateral levels, and developing countries, with a view to promoting concerted approaches and policies dealing with water supply and sanitation. Similar fora exist for water for agriculture through such bodies as the International Commission on Irrigation and Drainage, and The Consultative Group on International Agricultural Research.

ICWE/WG.B/Doc.2

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP B

Worksheets

Mechanisms for Implementation and Co-ordination at Global, National, Regional and Local Level

Prepared by

United Nations Department of International Economic and Social Affairs (UN/DIESA)
United Nations Department of Technical Cooperation and Development (UN/DTCD)
United Nations Development Programme (UNDP)
World Bank (IBRD)
United Nations Conference on Environment and Development (UNCED)

Working Group Theme: Mechanisms for implementation and coordination at global, national, regional and local levels

Programme Issue: Monitoring and information management

Basis for Action:	*Strategy and Programme Targets:*
Information on water resources and related socio-economic issues are essential to integrated water resources management.	Establish a monitoring and data network at national and international levels for the evaluation of the current situation and prediction of future problems.

Activities and Related Means of Implementation	Level of Implementation					
	L	P	N	T	R	G
1. Strengthening of network for the assessment of surface and groundwater resources in terms of quantity and quality.	X	X	X	X		
2. Establishment of coordination mechanism for water data collection and analysis and for integration with socio-economic data.		X	X	X	X	
3. Establishment of an integrated international network for the use of information in the monitoring of issues of an international nature.			X	X	X	X
4. Support from the international community for the strengthening of national capability and for the establishment of an international network.					X	X
5. Establishment of international data clearing system for data management.			X	X	X	X
6. Study the feasibility of establishing a Geographical Information System or interactive systems for the storage, processing and analysis of information.		X	X	X	X	X
7. Assessment of water quantity and quality for policy and programme formulation.	X	X	X	X	X	X

L= Local/scheme; P= Provincial/state; N= National; T= Transboundary; R= Regional; G=Global;

Working Group Theme: Mechanisms for implementation and coordination at global, national, regional and local levels

Programme Issue: Financing of water resources development and conservation

Basis for Action:	*Strategy and Programme Targets:*
There is a need to increase the flow of financial resources for water resources development and conservation.	To develop a system of credits and loan guarantees for direct financing of services, based on the principle of water as an economic good.

Activities and Related Means of Implementation	Level of Implementation					
	L	P	N	T	R	G
1. Ensure the financial and administrative autonomy of local service organizations.	X	X	X	X		
2. Ensure full cost recovery for local services including environmental costs, and provisions for reimbursing direct subsidies to users.	X	X	X			
3. Support the development of financial facilities such as local revolving funds with support from regional, national and international financing institutions.	X	X	X		X	X
4. Establish or strengthen local, regional and national financial institutions to provide loans to service autonomous service organizations or to guarantee such loans from local sources.	X	X	X			
5. Strengthen international support to national efforts to increase the flow of financing.					X	X
6.Review, where necessary rules and regulations of international financial institutions to allow the direct financing of services.					X	X

L= Local/scheme; P= Provincial/state; N= National; T= Transboundary; R= Regional; G=Global;

Working Group Theme: Mechanisms for implementation and coordination at global, national, regional and local levels

Programme Issue: Development of national managerial/administrative infrastructures

Basis for Action:	*Strategy and Programme Targets:*
The efficient integrated management requires the devolution of managerial responsibilities at the lowest appropriate level, and the existence of suitable management/administrative units.	Establish or strengthen organizations at all appropriate levels for the integrated development and management of water resources.

Activities and Related Means of Implementation	Level of Implementation					
	L	P	N	T	R	G
1. Grant managerial and administrative autonomy to service organizations with proper governmental guidelines and controls.	X	X	X			
2. Establish local authorities to monitor local conditions, to ensure the achievement of local objectives, and the participation of the community, in particular of women.	X					
3. Support the establishment of user organizations.	X	X	X			
4. Establish river and lake basin entities as autonomous organizations or as part of a regional management system to have responsibility for the management of the basin.		X	X			
5. Establish regional entities responsible for the integration of regional concerns into the management process.		X	X			
6. Establish a national water authority to oversee the integrated development and conservation of water resources, and to provide guidelines, standards and regulations.			X			
7. Provide concerted support to national efforts to define institutional requirements and to rationalize integrated management procedures.					X	X

L= Local/scheme; P= Provincial/state; N= National; T= Transboundary; R= Regional; G=Global;

Working Group Theme: Mechanisms for implementation and coordination at global, national, regional and local levels

Programme Issue: Cooperation and coordination at the international level

Basis for Action:	*Strategy and Programme Targets:*
The effectiveness of interventions to deal with existing or emerging issues of global concern will often require the formulation of concerted policies and approaches to be carried out by countries individually or jointly, or by international organizations.	Establish or strengthen informal and formal institutional mechanisms for cooperation and coordination at all relevant international levels.

Activities and Related Means of Implementation	Level of Implementation					
	L	P	N	T	R	G
1. Establish transboundary river/lake basin organizations to manage the harmonious planning, development and conservation of transboundary resources, with well defined objectives agreed to by the riparian countries involved.			X	X		
2. Strengthen in coordination mechanisms within the United Nations system of organizations in order to improve its capacity to deal with the integrated development, utilization, conservation and management, and strengthen linkages with sectoral mechanisms.					X	X
3. Strengthen coordination between the United Nations system and other bilateral and multilateral governmental and non-governmental organizations to deal with the integrated development, utilization, conservation and management of water resources, and strengthen linkages with existing sectoral fora.			X	X	X	X
4. Develop concerted approaches to financial and technical cooperation among external support agencies and government of developing countries for the integrated development, utilization, conservation and management of water resources, particularly with regard to the strengthening of national capacity.			X		X	X

L= Local/scheme; P= Provincial/state; N= National; T= Transboundary; R= Regional; G=Global;

Working Group Theme: Mechanisms for implementation and coordination at global, national, regional and local levels

Programme Issue: Development of a framework for the formulation of international policies, strategies and programmes

Basis for Action:	*Strategy and Programme Targets:*
With the increasing importance of the regional and global dimensions of water problems, the ability to monitor events and predict emerging issues is increasing in importance. So is the need for concerted regional and global policies, strategies and programmes.	To strengthen regional and global intergovernmental capacity to formulate and implement policies, strategies and programmes.

Activities and Related Means of Implementation	Level of Implementation					
	L	P	N	T	R	G
1. Review functions of existing intergovernmental bodies dealing with water resources with a view to improve the monitoring of events, develop recommendations, guidelines, standards, and conventions.			X		X	X
2. Develop a charter of rights and duties of national and international organizations in the development, utilization and conservation of water resources through the appropriate intergovernmental body			X		X	X
3. Review the existing capacity of secretariats of intergovernmental bodies to provide support to their respective bodies in a concerted manner.			X		X	X

L= Local/scheme; P= Provincial/state; N= National; T= Transboundary; R= Regional; G=Global;

ICWE/WG.C/Doc.1

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP C

Background Paper

Water Resources Assessment and Impacts of Climate Change on Water Resources

Prepared by

World Meteorological Organization (WMO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)

1. SCOPE OF THE WORK OF THE WORKING GROUP

1.1 The Need for Water Resources Assessment

1.1.1 Water resources assessment (WRA) is the determination of the sources, extent, dependability and quality of water resources, on which is based an evaluation of the possibilities for their sustainable development, management and control.

1.1.2 Reliable information on the condition and trends of a country's water resources - surface water and groundwater, quantity and quality - is required for a number of purposes, such as:

(a) assessing a country's water resources (quantity, quality, distribution in time and space), the potential for water-related development, and the ability of the supply to meet actual or foreseeable demand in a sustainable manner;

(b) monitoring the variations in water resources over time and space caused either by climate variability or by changes in climate;

(c) planning, designing, and operating water projects;

(d) assessing the environmental, economic, and social impacts of water resources management practices, existing and proposed, and planning sound and sustainable management strategies;

(e) assessing the response of water resources to other non-water sector activities, such as urbanization or forest harvesting;

(f) providing security for people and property against water-related hazards, particularly floods and droughts.

1.1.3 The diversity of these uses means that there is a need for a considerable range of types of data, including the statistics of a variety of meteorological and hydrological variables such as:

- precipitation (rainfall, snow, and fog-drip);
- river levels and flows, and lake and reservoir levels;
- groundwater levels;
- soil moisture storage;
- evapotranspiration and the variables from which it can be determined;
- sediment concentrations and loads in rivers;
- water quality (bacteriological, chemical, and physical) of surface water and groundwater.

1.1.4 While not strictly water resources assessment, it is important to mention here the need for effective hydrological forecasting systems. WRA information is essential for planning and designing water resources projects, but their efficient operation and, above all, the protection of lives and property depends on the ability to forecast floods and predict the likely duration of dry periods. Consequently there is a requirement for both historical and real-time data to cater for the range of needs, from projectdesign to flood warning. Flood or drought forecasting requires data to be synthesized for the future, using numeral rainfall-runoff, snowmelt-runoff and flow routing models.

1.1.5 Critical requirements for an effective WRA programme include, not only high quality data, but also the integration of data of many types and a clear idea as to the needs of potential data users. The data situation varies markedly from one region of the World to another, and from country to country. No cases are entirely satisfactory, and in some cases the lack of data is extremely serious.

1.2 Climate Change and Related Issues

Climate change, sea level rise and associated phenomena present a threat, which may alter many facets of society and economy in the coming decades. The threat to water resources is considered to be the most severe amongst the different sectors, particularly when it is coupled to rising demand and decreasing availability of untapped resources, together with an increasing target for floods, droughts and other water induced hazards. The likely timing and intensity of these changes from region to region and how they will affect the hydrological variables are far from clear. However, it seems very necessary for those involved in WRA and their customers such as planners, designers, decision-makers and politicians to take account of likely changes in their areas of responsibility and in the quest for sustainability. Otherwise future generations may suffer the consequences.

2. ANALYSIS OF THE CURRENT SITUATION, ISSUES AND PROBLEMS

2.1 Current Situation in Water Resources Assessment

2.1.1 A variety of challenges face water resources assessment agencies during the 1990s. Some of these are technical, but others arise from the socio-economic environment in which they operate:

(a) Stress on water and the need for more precise information

Globally water resources are under increasing stress. As the balance between demand for and availability of water becomes more finely tuned, the need for more precise and reliable assessments of the status and trends of the resource increases rapidly;

(b) The need for WRA is greatest where economic resources are least and conditions most difficult

The need seems to be greatest in those areas of the world which can least afford to invest in WRA: in the basins which provide sources of water for the growing cities of the developing countries: in irrigated areas where salinization has already damaged productivity and cashflows; in drought-hit areas of the sub-tropics where populations are already impoverished; in rugged and inaccessible headwater catchment areas; during infrequent and extreme events such as floods and droughts; and in circumstances where those attributes of water which are most difficult to measure successfully, such as chemical quality, are of greatest concern.

(c) The long-term nature of WRA

Useful water resources information takes many years to collect, because a key aspect of the water cycle is its variability with the passage of time. Future needs for WRA information are hard to predict, so general data collection programmes need to be established early to provide information tht can be used for a variety of purposes.

(d) The increasing loss of life and property damage resulting from river, estuarine and coastal flooding

Increases in population have resulted in the development of land that is flood prone. Floods are one of the major, if not the major, cause of loss of life from natural disasters, a fact prominent in the International Decade for Natural Disaster Reduction. Analysis of past flood data allows estimates to be made of flood risk as a basis for land use planning. It also provides the information needed for design of flood protection works. The provision of real-time data, including meteorological forecasts, gives agencies the possibility of issuing advanced warnings of floods, to save lives and lessen damage to property.

(e) **The special challenges of international water resources**

Many of the world's major river basins lie within the territory of more than one nation. Assessment and management of water resources are carried out in some international river basins in a fully co-operative fashion, with free exchange of information and use of common standards, but in many others there is little or no co-operation. Indeed, in some, information on water is regarded as a matter of national security, and is withheld for political or economic reason.

(f) **The effect of human activity and climate change on water resources**

The hydrological cycle is being modified in terms of quantity and/or quality in most river basins by land use change, water storage, inter-basin transfers, irrigation, waste water releases and drainage. Any change in global climate will have an impact on water resources throughout the world. Continuous records are necessry in order to identify any trends on a long-term basis.

2.1.2 Following the adoption of the Mar del Plata Action Plan in 1977, an expansion of the world's hydrological networks occurred. An assessment of the trends has been made using data from WMO's INFOHYDRO data base for the years 1977, 1987 and 1989 (Table 1), from information supplied by Member states.

2.1.3 For precipitation there was an increase in stations over the ten-year period to 1987, mainly in the ECLAC Region, with other areas showing only modest increases or no changes. Between 1987 and 1989 a general decrease in the number of stations occurred, especially in the ECA, ECE and ESCAP Regions. The marked increase in discharge stations between 1977 and 1987 levelled off in 1989. The large increase in the ECE Region tends to overshadow the far more modest increases in other regions.

2.1.4 The number of water quality stations increased almost two and a half times from 1977, reflecting the growing concern worldwide over water quality issues. However, the rate of increase has dropped significantly since 1987. Once again, most of the increases occured in the ECE Region. The number of stations in all other regions remains very small, and a decrease has evidently occurred in the ESCAP Region. The number of data banks operated, and especially those using computers, is a good indication of the levels of WRA activities in each Region. These have shown a steady increase since 1977 probably reflecting the implementation of low-cost micro-computer technology. It appears that efforts are being devoted towards establishing new data banks with the data that exists.

2.1.5 Clearly the increase in hydrological networks that occurred after the UN Water Conference must be viewed both as an encouragement and as a source of concern. The growth that did occur took place disproportionately in the developed regions of the world. More modest growth took place in developing regions, and the total number of stations remains very low. In fact, the networks in most countries fall below the minimum density guidelines established by WMO. The fact is that in many of the countries where data are needed the most, the networks are static or declining from already low numbers of stations. Attention must be re-focused on these regions, for without sufficient stations in operation it is impossible to determine whether sustainable development is being achieved so that the concept of sustainable development can be turned into practice. To quote the report on progress in the implementation of the Mar del Plata Action Plan submitted by the Secretary-General of the United Nations to the Twelfth Session of the UN Committee on Natural Resources in March 1991:

"From a global perspective, a serious concern exists regarding the ability of water resources assessment agencies to meet the growing needs for data and information ... A major cause of concern for the future lies in the obvious insufficiency of groundwater and water

TABLE 1 - DEVELOPMENT OF HYDROLOGICAL NETWORKS AND DATA BANKS

		1977	1987	1989
Precipitation Stations	ECA	4 047	4 636	3 596
	ECE	49 240	50 167	48 507
	ECLAC	12 409	19 590	19 531
	ESCAP	20 980	21 027	20 422
	ESCWA	4 018	4 248	4 240
	Total	**90 694**	**99 668**	**96 296**
Discharge Stations	ECA	918	1 694	1 695
	ECE	9 549	24 228	23 946
	ECLAC	3 086	5 730	5 762
	ESCAP	5 923	6 282	7 023
	ESCWA	1 222	1 262	1 383
	Total	**20 698**	**39 196**	**39 809**
Water Quality Stations	ECA	123	361	361
	ECE	15 509	40 030	42 327
	ECLAC	218	1 059	1 439
	ESCAP	3 533	3 314	2 889
	ESCWA	801	801	821
	Total	**20 184**	**45 565**	**47 837**
Hydrological Data Banks Using Computers	ECA	17	23	25
	ECE	23	28	28
	ECLAC	16	18	21
	ESCAP	12	20	23
	ESCWA	(no comparable data)		
	Total	**68**	**89**	**97**

quality data in most regions and even in some parts of the ECE Region. A theme common to many countries is that of problems in training and retaining water resources assessment personnel, and up-dating their abilities to manage more advanced technologies and equipment. The fragmented nature of institutional arrangements is recognized as an impediment to the establishment of national integrated data bases."

2.2 Estimates of Global Warming and Sea Level Rise and their Impact on Water Resources

2.2.1 Global climate models (GCMs) currently forecast a mean temperature increase during the next century of about 0.3oC per decade - greater than that seen during the past 10,000 years. If correct, this would represent an increase of about 1oC by the year 2025 and 3oC before the end of the next century. Using "business-as-usual assumptions" as defined by the Intergovernmental Panel on Climate Change (IPCC) - whereby greenhouse gas emissions are considered to remain at today's levels - simulation models also predict an average rate of global mean sea level rise of about 6 cm per decade over the next century.

2.2.2 The Ministerial Declaration of the Second World Climate Conference (SWCC) 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." The Conference saw that among the most important impacts of climate change will be its effects on the hydrological cycle and 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 national, regional and international levels.

2.2.3 There is still uncertainty in the prediction of climate change at the global level; the uncertainties increase greatly at the regional and national levels and yet it is at the national level that the most important decisions will need to be made. Higher temperatures or decreased precipitation or both will lead to decreased water resources, further downgrading of water quality and increased water demands, 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 will occur at the time of year when it can be used, in addition there is a likelihood of increased flooding. Any rise in sea level will cause intrusion of salt water in estuaries and coastal aquifers and flooding of low-lying coastal areas, putting smaller island countries at great risk.

3. GENERAL RECOMMENDATIONS FOR ACTION AT NATIONAL, REGIONAL AND INTERNATIONAL LEVELS

3.1 Recommended Action for Water Resources Assessment

3.1.1 Water resources assessment is a continuous activity, as it must be to support water resources management that is sustainable into the future. Sufficient information must be continuously collected, particularly as the global environment responds to human activity, and as new issues are recognized. Action in this area is primarily a national responsibility, although there are important regional and international aspects for international river basins and other shared water resources.

Action at national level

3.1.2 Recommendations for action may be listed under a series of topic headings, as follows:

Institutional framework

(a) establishment and strengthening of the institutional capabilities of countries, including the legislative and regulatory arrangements, that are required to ensure the adequate assessment of their water resources;

(b) establishment and maintenance of effective co-operation at the national level between the various agencies responsible for the collection, storage and analysis of hydrological data;

(c) establishment and maintenance of the effective co-operation between countries that is necessary for the assessment of the water resources of shared river basins and aquifers, and of the geographical regions extending over more than one country, and for the installation of flood forecasting systems in international rivers.

Data systems

(d) improvement of networks to meet accepted guidelines for the provision of data on water quantity and quality for both surface and ground water;

(e) application of standards and other means to ensure data compatibility;

(f) upgrading the facilities and procedures used to store hydrological data and to make such data available to potential users, and provision of information as to the availability of the data;

(g) implementation of "data rescue" operations, e.g. establishment of national archives of water resources;

(h) implementation of appropriate well-tried techniques for the processing of hydrological data;

(i) assimilation of remotely sensed data and the use of geographical information systems.

Data dissemination

(j) identification of the need for water resources data for various planning purposes;

(k) analysis and presentation of data and information on water resources in the forms required for planning and management of countries' socio-economic development, for use in environmental protection strategies and in the design and operation of specific water-related projects;

(l) installation of flood and low-flow forecasting systems covering all areas at risk from such phenomena.

Research and development

(m) establishment or strengthening of research and development programmes at national and international levels in support of water resources assessment activities;

(n) monitoring of 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.

Human resource development

(o) establishment of training programmes for observers, technicians and professionals geared to the specific needs of countries and designed to provide newly trained staff and retrain existing staff to a level where they can undertake the tasks called for in the above recommendations

(p) development of sound recruitment, personnel and pay policies which will attract, motivate and keep both professional and technical staff in positions where they can best contribute to WRA activities.

Action at regional and international levels

3.1.3 The work to be undertaken at national level can be greatly enhanced, particularly in developing countries, through regional and international co-operation and support. In this regard, the following recommendations may be offered:

Institutional framework

(a) encourage the evaluation of national WRA capabilities, using the methodology developed by WMO and UNESCO, providing technical assistance and training at the regional and country level where required;

(b) develop and disseminate practical methodologies for estimating benefits of WRA in different circumstances, and assist countries to apply them.

(c) provide funds to enable countries to establish a basic WRA capability, where it is presently lacking, especially for basic requirements such as instruments, text-books and manuals, laboratories, maintenance facilities, and database management systems (electronic and other media);

(d) make provision for long-term sustainability of projects after their initial development and installation phases are completed, paying particular attention to such matters as the availability of spare parts.

Data systems

(e) continue intercomparisons of WRA technology (instruments, procedures, computer software, models, etc.), and widely disseminate the results;

(f) help countries select technology which is appropriate to their socio-economic and physiographic conditions, and which will most effectively meet their needs for information;

(g) continue to facilitate technology transfer, particularly through WMO's Hydrological Operational Multipurpose System (HOMS) and UNESCO's IHP, and develop new approaches to technology transfer;

Data dissemination

(h) promote and assist the development and assembly of global and regional streamflow data bases on new high-volume computer storage devices (e.g. optical disks) and related user-friendly software for basic hydrological analysis and WRA;

(i) promote and facilitate co-operation and information exchange amongst countries, particularly at the scale of the sub-region and the shared river basin or aquifer for purposes of WRA and hydrological forecasting;

(j) closely co-ordinate water-related projects, and freely exchange information both about projects and about the water resources themselves.

Research and development

(k) assist countries to define their information and technology needs, and to develop appropriate plans;

(l) promote the development of WRA technology, especially that using micro-electronics (e.g. telemetry, dataloggers), remote sensing, computers (e.g. geographical information systems, hydrological models).

Human resource development

(m) use water resources projects and consultancies to further the education and training of national staff, make use of national experts and include training of counterpart staff in the terms of reference of foreign consultants;

(n) promote and facilitate specific areas of education and training at a regional or continental level, where individual countries do not have large enough numbers of WRA staff to justify providing a national capacity;

(o) promote the organization of workshops, seminars and conferences in collaboration with international non-governmental organizations.

3.2 Recommended Action on Climate Change Impact Assessment

3.2.1 The very nature of this topic calls for more information about and greater understanding of the threat that is being faced. This may be translated into:

(a) acquire an adequate understanding of the threat of the impact of climate change on freshwater resources so as to permit agencies responsible to plan and implement effective counter-measures

(b) facilitate the implementation of such counter-measures when the threatened impact is seen as sufficiently serious and definite to justify such action.

Both objectives can only be achieved through extended and more comprenehsive monitoring and intensified research into ongoing processes and related characteristics.

3.2.2 Monitoring of climate change and its impact on freshwater bodies must be a closely integrated part of overall national and international programmes for monitoring the environment, in particular those concerned with the atmosphere and with the hydrosphere. Existing networks of stations will need to be strengthened and augmented for this task by the installation of new stations in areas under greatest threat and by measuring variables, such as low flows and salinity, which are not so frequently measured for other purposes. Attention must be given to securing the most error-free and high quality records.

3.2.3 The analyses of data for signs of climate change and as a basis for implementing measures to combat the threat is a specialized task that has yet to be refined to the level required. Extensive developmental work is necessry here and due account will be taken of the work of relevant international programmes (e.g. WCP, OHP, IHP, IGBP).

3.2.4 Research has one primary objective: to improve the understanding of hydrological processes and of their complex inter-relation with climate and environmental factors. Beyond this it is necessary to develop generalized methodologies and the required technical aids (models, software, etc.) for long term predictions of hydrological characteristics under the given and ever-changing climate, land use and vegetation conditions.

3.2.5 Individual countries, especially developing countries, with the assistance of the international community, can undertake the following:

(a) strengthen capabilities to monitor hydrological parameters, including water quality and related climate characteristics, especially where the effects of climate change are most likely to be felt;

(b) contribute to the research activities initiated in current international programmes, in particular to the planned large scale land surface experiments;

(c) develop techniques and methodologies for assessing the potential adverse effects of climate change, in particular through changes in temperature, precipitation and sea-level rise on freshwater resources and flood risk;

(d) delineate areas particularly vulnerable to changes in climate, and identify both natural and anthropogenic causes for the vulnerability;

(e) assess the resulting social, economic and environmental impacts;

(f) develop and implement response strategies to counter the adverse effects that are identified.

3.2.6 The development and implementation of response strategies will call for considerable innovation. Well-tried technological means and engineering solutions are in general available, provided the funding is adequate. These include the installation of flood warning systems and the construction of new water-resource development projects such as dams, aqueducts, well fields, waste water treatment structures, desalination works, levees banks and drainage channels. A search is needed, however, for new approaches and solutions which are efficient in the use of resources and tuned to current demands for sustainable development and environmental protection, in particular the protection of surface and ground water resources against pollution and over exploitation.

3.2.7 In many instances the legislation and institutions are in place to undertake the monitoring and assessment functions required, but they lack the financial and staff resources to carry out the work. Most critical is the requirement for a socio-economic mechanism which can review predictions of the impact of climate change and possible response strategies and make the necessary judgements and decisions. The developmental work and innovation referred to above depend for their success on highly trained and motivated staff. Specialized personnel need to be trained, hired and retained in service where they can serve their countries in this task.

4. ACTION PROGRAMMES

4.1 Action at the International Level

4.1.1 In order to follow up the recommendations given above, it will be necessary to implement phased action programmes at different levels: national, regional and international.

4.1.2 A suitable framework for action at international level is provided by the relevant international programmes of WMO, UNESCO, UNEP, FAO, ICSU and other international organizations, including:

(a) the Operational Hydrology Programme (OHP) of WMO

(b) the International Hydrological Programme (IHP) of UNESCO

(c) the EMINWA (environmentally sound management of inland water resources) programme of UNEP

(d) international activities under the International Decade for Natural Disaster Reducation (IDNDR)

(e) the World Climate Programme (WCP) of WMO, in particular WCP-Water and the World Climate Research Programme (WCRP) and its Global Energy and Water Cycle Experiment (GEWEX)

4.1.3 It is strongly recommended that all action necessary at the international level be incorporated into such international programmes, in an appropriate fashion.

4.2 Phased action programmes

4.2.1 The following seven topics may be identified as the basic issues of concern to Working Group C:

(a) Development of an institutional framework in support of an efficient and continuing water resources assessment programme

(b) Installation and maintenance of an adequate system for the collection and storage of water-related data

(c) Implementation of mechanisms for the dissemination of water information to potential users

(d) Conduct of research and development programmes in the water sciences

(e) Assessment of the impacts of any change in climate on freshwater resources and on river regimes

(f) Assessment of impact of sea-level rise on the water resources of coastal areas and on coastal flooding

(g) Establishment of training programmes and personnel policies designed to ensure adequate staffing for WRA and related activities

4.2.2 On each of these subject areas special worksheets have been prepared for use by Working Group C in its discussions.

4.3 Financial Implications

4.3.1 With such a diverse set of activities and such a differing range of capabilities amongst countries to undertake them, it is difficult to provide estimates of the cost of developing WRA programmes in all countries to an adequate level. Nevertheless, the countries with the most highly developed WRA programmes appear to spend a similar percentage (0.2% per annum) of their gross national product (GNP) on WRA activities. If the objective is set for all countries to attain the same level of investment in WRA by the year 2100, then it is possible to identify in each region the countries currently exhibiting low, medium and high capabilities to assess their water resources and the desirable targets for the number of countries in each category by the years 2000, 2025 and 2100 (Table 2).

4.3.2 Using Table 2 as a basis and accepting the percentage of GNP as an indicator of investment, it is possible to derive regional estimates of the annual expenditures required. These are presented in Table 3 and indicate a total requirement of some US$ 324.9 million.

4.3.3 Efforts to assess the impact of climate change on water resources need activities in monitoring and assessment additional to those for basic WRA. These will cost an extra US$ 40 million per annum.

4.3.4 Action to protect populations and the environment from the impact of climate change on freshwater resources is likely to cost many billions of dollars, in some cases billions of dollars per country. Without a more precise indication as to the extent and regional distribution of the threat and as to the feasible response strategies, there is little to be gained from speculating further on the actual costs likely to be involved. What is clear, however, is that developing countries will be able to bear but a fraction of this cost and there will be a need for very extensive international aid.

4.3.5 If wise decisions are to be taken in allocating national and international funds to mitigate the affects of climate change, then it will be necessary to establish methodologies for making comparative technical and financial analyses of the various options. Such methodologies should be developed on the basis of a series of detailed case studies costing in the order of US$ 6 million per year.

5. MONITORING AND EVALUATION

5.1 WRA activities

5.1.1 In 1988 WMO and UNESCO published a handbook for the national evaluation of WRA activities. It contains detailed descriptions of what such activities should incorporate and a methodology for use in evaluating them, based on

TABLE 2 - WATER RESOURCES ASSESSMENT: ESTIMATE OF PROGRAMME TARGETS FOR THE NUMBER OF COUNTRIES COVERED WITH ADEQUATE SERVICES

YEAR/REGION		LOW CAPABILITY	MEDIUM CAPABILITY	HIGH CAPABILITY
1990	ECA	20	19	-
	ESCWA	5	7	8
	ECLAC	13	12	5
	ECE	3	12	14
	ESCAP	14	13	11
	TOTAL	55	63	38
2000	ECA	14	20	5
	ESCWA	2	6	12
	ECLAC	6	13	11
	ECE	0	8	21
	ESCAP	8	13	17
	TOTAL	30	60	66
2025	ECA	7	22	10
	ESCWA	0	2	18
	ECLAC	0	6	24
	ECE	0	0	29
	ESCAP	0	10	28
	TOTAL	7	40	109
2100		0	0	156

TABLE 3 - ESTIMATE OF ANNUAL FINANCIAL NEEDS (NATIONAL AND EXTERNAL) FOR IMPROVING WRA CAPABILITIES IN US$ MILLIONS/YEAR

REGION	LOW CAPABILITY				MEDIUM CAPABILITY				TOTAL FOR THE REGION			
	NO. OF COUNTRIES	RUNNING COSTS	ESA	TOTAL	NO. OF COUNTRIES	RUNNING COSTS	ESA	TOTAL	NO. OF COUNTRIES	RUNNING COSTS	ESA	TOTAL
ECA	20	18.6	18.6	37.2	20	17.6	13.2	30.8	40	36.2	31.8	68.0
ESCWA	5	3.5	3.5	7.0	7	14.8	11.1	25.9	12	18.3	14.6	32.9
ESCAP	13	6.8	6.8	13.6	13	22.4	16.8	39.2	26	29.2	23.6	52.8
ECLAC	13	16.6	16.6	33.2	12	25.5	19.1	44.6	25	42.1	35.7	77.8
ECE	3	8.3	4.2	12.5	12	70.1	10.8	80.9	15	78.4	15.0	93.4
TOTAL	54	53.8	49.7	103.5	64	150.4	71.0	221.4	118	204.2	120.7	324.9

Total per year/118 countries = 324.9 x 10^6 US$
National funding = 204.2 x 10^6
External Support Agencies (ESA) = 120.7 x 10^6

a series of target levels to be reached with respect to each. This methodology was used as a basis for obtaining much of the information presented above. Its detailed and routine application in a country would permit a clear statement to be made year by year as to the current status of the national WRA programme. This procedure is strongly recommended.

5.1.2 It is not possible to undertake such frequent and detailed analysis at the international level but it is quite feasible to make an evaluation country by country every five or ten years using a more limited set of performance indicators, such as are indicated in Table 4 below. If countries would agree to such an exercise, then the relevant information could be collected in 1992, 1995, 2000, 2010 etc., analyzed and presented within a short space of time to relevant international bodies and UN fora.

5.2 Impact of climate change

The nature of the activities to be undertaken on this subject makes it difficult to monitor and evaluate them. Nevertheless the attempt should be made to do so and the relevant indicators given in Table 4 may be of value in such an exercise.

TABLE 4 - PERFORMANCE INDICATORS OF NATIONAL CAPABILITIES FOR THE ASSESSMENT OF WATER RESOURCES AND THE IMPACT OF CLIMATE CHANGE

Direct indicators for WRA

(a) Availability of a framework for WRA (legislation, organization, financial resources)

(b) Networks of observing stations (hydrological and climatological) established according to WMO minimum density requirements:

e.g. Hydrological stations: from 300 to 20,000 km^2/station
Water quality/sediment: from 5 to 30% of hydrometric stations
Precipitation stations: from 100 to 10,000 km^2/station

(c) Computerized data banks - percentage of water cycle data or station/years stored

(d) Hydrological data and products - amount/frequency of provision to users/annually

(e) Manpower - number of staff (professional, technician) per 100 stations

Indirect indicators for WRA

(a) Percentage of country's area for which WRA has been completed or updated

(b) Availability of National Water Master Plan(s)

Indicators for assessment of climate change impact

(a) Existance of a programme for studying and assessing the potential impact of climate change on freshwater resources and flood risk

(b) Number of long-term monitoring stations being maintained in support of such work

(c) Number of station records being analysed with respect to climate change impacts

(d) Existance of a mechanism for developing and evaluating strategies for response to the threat of climate change on freshwater resources and flood risk

(e) Number of staff working full-time and part-time on the above topics.

ICWE/WG.C/Doc.2

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP C

Worksheets

Water Resources Assessment and Impacts of Climate Change on Water Resources

Prepared by

World Meteorological Organization (WMO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)

Working Group Theme: Water resources assessment and impacts of climate change on water resources

Programme Issue: Institutional framework in support of water resources assessment

Basis for Action:

Different institutional arrangements can support effective water resources assessment (WRA) programmes. In most countries responsibility for WRA is divided between a number of ministries and national or provincial bodies. The growing need for integrated water resource management points to the desirability of close co-ordination of the collection, storage and analysis of the relevant data.

Whether responsibility is centralized or distributed, WRA requires considerable financial resources if it is to provide the support to sustainable socio-economic development that is demanded of it. These resources, however, represent only a small fraction (say 0.2 to 1.0%) of the funds spent on the water sector as a whole and so it should be possible to allocate them once the need is recognized.

Strategy and Programme Targets:

National policy should be that all WRA activities are fully co-ordinated and adequately funded.

The approach taken to achieve this may differ from country to country, but it will usually involve the establishment of regulations and a series of administrative decisions, particularly on the allocation of funds.

The success of these efforts can be measured by the general level of WRA activities and by a review of the degree of duplication of effort.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Ensuring a legislative framework and efficient institutional structure appropriate for WRA.		X	X	
2. Establishment of effective co-operation between the various agencies concerned in WRA.		X	X	X
3. Establishment and maintenance of effective co-operation in WRA and hydrological forecasting activities between countries which share a river basin or aquifer.			X	X
4. Encouraging hydrological services to apply the methodologies developed by WMO and UNESCO for evaluating their WRA activities.			X	X
5. Developing and disseminating information on means of estimating benefits and costs of WRA activities and assisting national services to demonstrate the benefits of WRA.				X
6. Providing sufficient funds to ensure that all countries have at least a basic WRA and forecasting capability.			X	X
7. Making practical and legislative provision for long-term sustainability of WRA and forecasting activities.			X	

Working Group Theme: Water resources assessment and impacts of climate change on water resources

Programme Issue: Collection and storage of hydrological data

Basis for Action:	*Strategy and Programme Targets:*
Reliable information on the condition and trends of a country's water resources - surface - assessing the resource and its potential for supplying the current and foreseeable demand - protecting people and property against water-related hazards - planning, designing and operating water projects - monitoring the response of water bodies to anthropogenic influences, to climate variability and change, and to other environmental factors The capability to collect and store hydrological data varies markedly from country to country. Nowhere is it entirely satisfactory. In some cases the lack of data is extremely serious and poses a major problem for those planning long-term sustainable development.	Data should be collected and stored on all aspects of water resources which are required for a full comprehension of the nature of those resources and for their sustainable development. This involves the installation of networks of stations and other data gathering mechanisms and the development of data storage facilities.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Improving networks of stations to meet accepted standards and guidelines for the provision of hydrological data.		X	X	
2. Upgrading facilities and procedures for storing and safeguarding hydrological data.		X	X	
3. Implementing techniques for processing hydrological data and assimilating related information.		X	X	
4. Comparing, selecting and applying hydrological technology appropriate to each country's needs.			X	X
5. Transfering appropriate technology, particularly between hydrological services.			X	X

Working Group Theme: Water resources assessment and impacts of climate change on water resources *Programme Issue:* Dissemination of water information	
Basis for Action: The collection of hydrological data is not an end in itself. To have any value, data must be used and their use must have an impact on decisions. Too often the potential user of hydrological data is not considered in the planning of data collection systems and is not adequately informed of the availability of data that are collected. To be of real value in practical work, data must be compiled into sets and disseminated in a form appropriate for their use. There is a very real and growing need for large-scale regional and global sets of hydrological data for use in studies of global change, in particular within the context of climate change. One particular application of hydrological data, and one that is to be highlighted in the 1990s during the IDNDR, is in the installation and operation of hydrological forecasting systems which are vital to safeguard lives and property in the face of major natural disasters.	*Strategy and Programme Targets:* Those who plan, design and operate water projects, and those who are concerned with the protection of life, property and the environment from natural or man-made disasters, should have access to the water-related information necessary for their work. They should be informed of the availability of such data and be able to obtain them in forms that are convenient for their use. The approach is to assess the data needs of potential users and to match these with the services provided by information centres and forecasting systems.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Identifying the need for hydrological data for various purposes and the potential users of such data.		X	X	
2. Analyzing and presenting hydrological data in forms appropriate for planning and management of water resource development, and for other uses.		X	X	
3. Installing hydrological forecasting systems for areas at risk.	X	X	X	X
4. Assembling and disseminating basin-wide, regional and global sets of hydrological data and information for use, inter alia, in the management of resources within international river basins and in climate change studies.			X	X

Working Group Theme: Water resources assessment and impacts of climate change on water resources

Programme Issue: Research and development in the water sciences

Basis for Action:	*Strategy and Programme Targets:*
Water resources assessment and hydrological forecasting should be based on a sound understanding of the scientific principals involved and are dependant on technology for their implementation. Both science and technology have made remarkable progress in recent years, but there are still large areas where the water sciences have yet to make a significant breakthrough or where new technological developments are solely needed. In addition to a lack of resources, research and development in the hydrological sciences suffer from insufficient co-ordination and a need to take more account of regional and national variations in the problems to be solved and the expertise available.	Research and development activities should be planned so as to meet the very varied needs of countries and should take account of indigenous expertise. Great benefit can be gained from a co-operative approach at both national and international levels.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Establishing and strengthening research and development programmes appropriate to the needs of countries in support of WRA and hydrological forecasting activities.			X	X
2. Promoting the development of new technology for WRA and hydrological forecasting.				X
3. Ensuring that full use is made of local expertise in research and development programmes in the water field.			X	X
4. Building the capacity for hydrological research in developing countries with regard to integrated water resources management.			X	X
5. Strengthening international hydrology programmes both at national and global levels.			X	X

Working Group Theme: Water resources assessment and impacts of climate change on water resources

Programme Issue: Impact of climate change on freshwater resources and flooding

Basis for Action:	*Strategy and Programme Targets:*
The Second World Climate Conference (November 1991) agreed that "without actions to reduce emissions, global warming is predicted to reach 2 to 5 degrees C over the next century". Changes in the average temperature, precipitation or streamflow are likely to have an important impact on socio-economic systems. However, the limiting factors in water management are the extremes. "Increases in incidence of extremes, such as floods and droughts, would cause increased frequency and severity of disasters". The current draft of the Framework Convention on Climate Change makes reference to the need for: - long-term systematic observations of hydrological elements on global and regional scales - studies of the role of hydrological processes in the cycling of energy, water and nutrients and of the impact of changes in the hydrological cycle on water resources and their utilization - full, open and timely exchange of relevant information - examining options for adapting to a changing climate of water resources.	Policy should be to acquire an adequate understanding of the threat of the impact of climate change on freshwater resources and on the incidence of floods and droughts so as to permit the planning and implementation of effective counter-measures. Efforts should be directed through both national and international programmes involving comprehensive monitoring, research and policy-review.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Strengthening capabilities to monitor hydrological parameters in relation to climate change.			X	X
2. Developing research programmes at national level and contributing to international research projects on the question of climate change and its impact on the hydrological regime.			X	X
3. Developing techniques for assessing the potential adverse effects of climate change, in particular those resulting from changes in temperature and precipitation, on water resources and flood risk.			X	X
4. Assessing the likely socio-economic and environmental impacts of such changes and developing response strategies.			X	X
5. Funding and implementing appropriate response strategies.			X	X

Working Group Theme: Water resources assessment and impacts of climate change on water resources

Programme Issue: Impact of sea-level rise on water resources and flooding

Basis for Action:	*Strategy and Programme Targets:*
The final statement of the Second World Climate Conference (November 1991) notes that global "warming is expected to be accompanied by a sea-level rise of 65 cm ± 35 cm by the end of the next century". It goes on to say that a "sea-level rise would seriously threaten low-lying islands and coastal zones". A rise in sea level would increase the threat of flooding from high tides, storm surges and river discharges in coastal and estuarine zones. In many instances this would make it too dangerous or uneconomic to maintain the current land use. It would also increase salt water intrusion in estuaries and coastal aquifers, the latter posing a major threat to what are often fragile freshwater supplies. The current draft of the Framework Convention on Climate Change makes reference to the need for: - evaluating the impact of sea-level rise on the coastal environmental and coastal settlements - examining options for adapting to a changing climate in coastal areas.	Assessments should be made in all low-lying islands and coastal zones of the potential impact of any rise in sea-level. This impact may be on the quality and quantity of freshwater resources or on the risk of flooding. Both national and international bodies have roles to play in this respect.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Strengthening capabilities to monitor rises in sea-level and related hydrological parameters.			X	X
2. Developing techniques for assessing the potential impact of a sea-level rise on freshwater resources and flood risk.			X	X
3. Assessing the likely socio-economic and environmental impacts of a rise in sea-level and developing response strategies.			X	X
4. Funding and implementing appropriate response strategies.			X	X

Working Group Theme: Water resources assessment and impacts of climate change on water resources *Programme Issue:* Human resources development	
Basis for Action: Salaries and wages commonly account for half or more of the expenditure of an effective programme for water resources assessment and hydrological forecasting. Because people are the most important resource available to the manager of such a programme, personnel matters should but rarely do receive great attention. These matters include the assessment of personnel requirements, the provision of attractive terms of employment and the establishment and use of effective schemes for the education and training of staff.	*Strategy and Programme Targets:* The aim should be to attract and retain personnel to work on WRA 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 national and international level, while adequate terms of employment are a national responsibility.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Establishing of training programmes for observers, technicians and professionals geared to the specific needs of countries.			X	X
2. Developing sound recruitment, personnel and pay policies for staff of national water agencies.			X	
3. Using water projects as a basis for on-the-job training of local staff.			X	X
4. Promoting education and training at regional and international levels.				X
5. Promoting the national capacity for the organization of workshops, seminars and conferences on subjects related to water resources assessment and flood forecasting.			X	X

ICWE/WG.D/Doc.1

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP D

Background Paper

Protection of Water Resources, Water Quality and Aquatic Ecosystems

Prepared by

United Nations Environment Programme (UNEP)
World Health Organization (WHO)

ENVIRONMENTALLY SOUND WATER RESOURCES MANAGEMENT

1. INTRODUCTION

The Mar del Plata Action Plan of the United Nations Conference on Water in 1977 has effectively addressed a wide spectrum of water and water-related issues including assessment of water resources, use efficiency, environmental health, pollution control, natural hazards, policy, planning, public information, education and training and research. Specific resolutions have been adopted with phased actions on water supply and sanitation, water use for agriculture and water resources assessment activities. These were in addition to resolutions related to combating desertification, regional cooperation, shared water resources and institutional and financial arrangements aimed at strengthening international cooperation and coordination for the implementation of the Action Plan.

Since the adoption of the Plan, many achievements in the different issues covered at the Conference can be cited and evaluated. However, the commitment made at the water conference and those achievements have retreated in front of a host of factors that characterized the decade following the adoption of the Mar del Plata Action Plan.

Soaring population growth rates have brought increasing pressures on water and land ecosystems, particularly in water scarce areas hit by persisting drought in the semi-arid zone of the African region. The state of panic associated with those conditions in the form of deforestation, over-grazing and irrational land use practices have further led to complications threatening the environmental stability of the affected areas. The economic crisis, the debt burden and inflation in developing regions, which characterized the past decade, have not only impeded progress in the implementation of the Mar del Plata Action Plan, but have further aggravated the sustainability of the resource base.

In the face of these challenges, the United Nations system of organizations concerned with water issues embarked on the formulation of new strategies for the implementation of the Plan and its objective of attaining the environmentally sustainable management and development of freshwater resources.

The United Nations Environment Programme, in collaboration with concerned United Nations agencies and organizations, launched a new comprehensive programme on environmentally sound management of inland water resources (EMINWA) to assist governments in integrating environmental considerations into the management of water bodies, particularly shared freshwater resources for international river and lake basins as well as aquifers, and in formulating action plans for the environmentally sound management and development of this precious resource.

2. THE CHALLENGES

The fundamental environmental challenges and associated issues that need to be addressed include:

- water scarcity issues resulting from increasing population pressures on the water and land ecosystems and conflicting demands for water leading to the destruction of the resource base and associated land degradation;

- water pollution issues resulting from socio-economic activities that lead to increased human and industrial waste, limiting the use of available resources and augmenting health hazards;

- land degradation issues resulting from improper utilization of water resources resulting in problems such as water logging, salinization, erosion, fertility loss and desertification in arid and semi-arid regions;

- water-related global environmental issues associated with greenhouse emissions and global warming and loss of biodiversity pose as new challenges that can no longer be overlooked for the future well-being of the resource base;

- institutional arrangements, strengthening of technical and scientific capabilities, cooperation and coordination at national, regional and international levels continue to pose as critical challenges;

- funding and financial constraints continue to hamper water resources development and water quality management aimed at sustainable socio-economic development, particularly in poverty-stricken regions.

3. THE CONCEPT OF ENVIRONMENTALLY SOUND MANAGEMENT OF WATER RESOURCES

In the face of these challenges the pivotal role of water in the stability of the environmental and economic and social development need to be strongly emphasized. "In view of various integrated junctions which water plays in a number of sectors (land use, environment, health, employment, industry, forestry, population, food security) water-related issues are intertwined with most sectors in national economics. As a consequence, water cannot be seen as a sector of its own. On the contrary, water strategies have to be truly multi-sectoral in character and integrated with the broader economy: (IWRA, Rabat Statement, May 1991).

The concept of environmentally sound water resources management and development has developed over the years from the simple environmental concerns expressed on development of water projects tot eh environmental impact assessment approach. The concept was given considerable impetus as a result of the 1980 World Conservation Strategy prepared by the International Union for the Conservation of Nature (IUCN), UNEP and the World Wildlife Fund (WWF), which called for a reorientation of all resources management practices in favour of sustainable development.

Environmentally sound and sustainable development of water resources implies the following:

- development is controlled in such a way to ensure that the resource is maintained and enhanced and that adverse effects on other resources are considered and where possible ameliorated;
- efficiency in water use and in the use of capital is a key criterion in strategy selection. River and lake basins, as well as the catchments of aquifer bodies, constitute areas of population concentration and critical human activities; hence, they are the most appropriate areal units for environmentally sound management and development of water resources;

- the development of basin water resources should be beneficial to all water users in the basin, advantageous tot he whole basin and, through mitigation, harmless to others;

- present demands should be met and no harm caused to others in the future nor options for future development foreclosed;

- development should contribute to the economic and social well being of the societies of the basin and cause no harm tot he environmental integrity and equilibrium of the basin ecosystem and resource base.

4. STRATEGY FRAMEWORK

The strategies for environmentally sound management and development of basin water resources:

- need to be based on strong recognition and awareness of the pivotal role of water in economic and social development and well being of the basin societies;

- need to address the fundamental multi-causal environmental challenges emerging from water scarcity, water pollution and water-related land fertility degradation;

- need to acknowledge regional differences in terms of environmental vulnerabilities;

- should aim at maximizing productivity per unit of water available and ensure an integrated approach to land and water use in order to realize sustainable land productivity; and

- should provide the necessary balance between the short term needs and the long term perspective for realizing the protection of the resource base.

5. ELEMENTS OF BASIN ACTION PLANS

Action plans for entire watersheds or catchment basins generally provide the most comprehensive approach to the environmentally sound integrated management of freshwater resources. The major components of comprehensive basin action plans should consist of:

(a) environmental assessment,
(b) environmental management,
(c) environmental legislation,
(d) support measures.

a. Environmental assessment

There is a need for continuing systematic assessment of the main factors influencing water quality management and water-related ecosystem quality. The tasks that should be performed include:

- assessment of national and sub-regional capabilities to investigate and manage environmental processes, including scientific and administrative institutions, manpower, research facilities and equipment, together with the identification of institutions with the potential to serve as regional activity centres in particular disciplines;

- the gradual development and operation of a basin-wide unified monitoring system for water and the water-related environment, covering water quantity and quality, pollution, siltation, water consumption, water supply and sanitation, hydroelectric power plants, major irrigation schemes, human health, forestry, soil conservation, desertification and wildlife conservation;

- assessment of the effects of the major water projects on the environment;

- provision of equipment needed for the assessment of environmental quality;

- compilation of inventory of the sources and amount of pollutants reaching the river and coastal waters from land-based sources;

- analysis of data on competing demands for resource utilization, including development of proper data storage, retrieval and management systems;

- survey and assessment of present and planned socio-economic activities, including development projects, that have an impact on the quality of the environment of the river basin and its coastal and marine environment;

- encouragement of collaboration among institutions, scientists and technicians front the region;

- strengthening capabilities in water quality management and monitoring for assessing the state of the river, coastal and marine environment, the condition of living resources, including training of scientists and technicians in methods and techniques for the assessment and evaluation of river and related marine pollution;

- development of integrated information programmes taking into account existing information systems, the target audience and the promotion of community participation;

- assessment of water-borne and other water-related disease vectors and their effects on human health.

b. <u>Environmental management</u>

The key to sustainable and environmentally sound development is proper management of the resource base. Such management should take into account the assimilative capacity of the environment, the development goals as defined by national authorities, and the economic feasibility of their implementation. The following activities may be undertaken to strengthen the ability of governments to adopt appropriate environmental management practices for water and related resources:

- strengthening or expansion of ongoing development activities that demonstrate sound environmental management practices;

- improvement of drinking water supply, sanitation and human health through strengthening of sectoral institutions, drinking water supply and sanitation programmes;

- development of water quality control programmes based on a uniform water monitoring system such as GEMS/WATER;

- encouraging "end users" of water, women in particular, who are actually in charge of making use of water in daily life, to participate in the planning, construction and maintenance of water distribution, purification and sanitation systems;

- cooperation in preparedness for pollution emergencies and water-related natural hazards, including measures to prevent them and/or mitigate their consequences;

- environmentally sound development of water resources to meet the demands of industries, mines, irrigation, hydropower, navigation, drinking water supply, etc;

- cooperation in the application of existing international measures to reduce and control the degradation of the natural resource base, to combat the vast problem of desertification, and to coordinate efforts concerning the problems of land use practices in relation to flood and drought management and pollution control;

- formulation of regionally and locally applicable programmes, including development principles governing the treatment and discharge of wastes;

- harmonization of policies on the management of wildlife genetic resources, natural habitats and landscape;

- cooperation in the establishment and management of protected rivers, lakes (natural and artificial), coastal areas and related marine habitats, wetlands, nurseries, breeding grounds and mangroves, including training of technical personnel and managers in the conservation of wildlife and habitats;

- cooperation in devising land use, watershed management, soil conservation and development practices appropriate for the specific conditions of the river basin and its related marine regions, including improvement of national capabilities to assess environmental impact of development;

- cooperation in the preparation of measures to conserve timber resources, and to increase their supply on a sustainable basis which may reduce deforestation rates. In this context, improvement of biomass fuel processing and combustion techniques should be investigated;

- cooperation in the assessment and utilization of fisheries to achieve the highest rational utilization of this resource on a sustainable basis;

- development of a river basin planning process base, *inter alia*, on sound environmental management practices;

- studies of the environmental, social and cultural effects of tourism and the elaboration of environmentally sound strategies for tourism development;

- implementation of intensive human resources development programmes to support the above measures as well as provision of environmental education and training in order to develop the knowledge of human resources in all basin countries.

Within the component of environmental management, particular attention has to be given to the protection of freshwater living resources, not only as an essential ingredient of aquatic ecosystems but also as a source of nutrition for human consumption. Actions that are required to ensure the sustainability of living freshwater resources include:

- the setting aside of areas as suitable reserves to retain reservoirs of the natural diversity of stocks of fish in their wild state;

- the involvement of fishery and aquaculture managers in the planning of water and land use at the initial stages;

- legislative controls and enforcement regulation for minimum agricultural use of fertilizers, heat load of discharged waters, use of potentially dangerous biocides, etc;

- an integrated approach deploying satellite remote sensing and G.I.S. techniques for inland fishery development and aquaculture;

- development of approaches to the management of rivers and lakes where basins lie within more than one country, and of agreements for harmonizing fishing regulations and management policies in the various riparian states;

- management of stream flows by creation of flood-prone areas and implanting instream structures to create artificial breeding environments;

- accord high priority to the monitoring and prevention of environmental degradation in the context of fisheries, including aquaculture, and to promote international collaboration to protect the aquatic environment;

- improve national capacities to monitor and analyze environmental data and to react to early warning through adequate systems of regulations and enforcement;

- at the national level, inter-ministerial coordination to deal with conflicts in the utilization of resources and to implement policies and mechanisms for integrating fisheries and aquacultures protection into the pattern of resource use at the river basin and coastal areas levels, encouraging an integrated management and development approach;

- at the international level, collaboration between international specialized organizations on matters relating to data collection, research and training programmes for integrated development and management of freshwater living resources;

- consideration of water management strategies in detail to establish the most suitable types of fish production systems for a variety of water regimes;

- establishment and strengthening of international basin commissions with the authority and technical knowledge to take effective measures of pollution control;

- consideration of the protection of fisheries and aquacultures in the location of industries, mining centres, new urban areas, etc;

- consideration of fisheries' interests in establishing water quality standards for various uses and working out minimum flow to be released downstream.

c. Environmental legislation

National laws and regulations pertaining to the protection and development of a water basin, including its coastal and marine environment, should be developed, reviewed, and when necessary expanded, updated or strengthened. The enforcement of national laws and regulations pertaining to the basin, including its coastal and marine resources, should be improved. This concerns, for example, laws related to deforestation, soil and water conservation, rural and urban health, development planning, mining and industrial activities, prevention of pollution of the freshwater and marine environments and protection of the species living there.

National laws and regulations on the protection and development of basin resources should as far as possible be harmonized whenever regional uniformity is required to meet the objectives of such legislation.

An up-to-date compilation of national legislation of the basin states related to the protection of the river, coastal and marine environment should be maintained.

National legislation should be developed, adopted and implemented to integrate environmental considerations into planning, development, construction, operation and rehabilitation of water projects. This legislation should also include environmental impact assessment procedures. Implementation of the legislation adopted should be supported by the appropriate machinery. Such legislation and machinery should also be adopted with regard to water supply and sanitation.

Regional conventions for the protection, management and development of international basin resources, including the related coastal and marine environment, should be developed and adopted. These should be supplemented by protocols prescribing agreed measures, procedures and standards to prevent, reduce and control pollution from all sources, and to promote states environmental objectives.

d. Support measures

- Intensive training programmes need to be formulated on the concept of environmentally sound management of water resources and the promotion of the implementation of sustainable development and carried out through national, regional and international institutions. Particular attention should be given to the promotion of public awareness of the objectives and aims of the environmentally sound management of freshwater resources.

- Education on the principles of protection and development of the natural and human resources of water basins should be provided as part of the ordinary educational curricula at the primary, secondary and university levels and should include the training of educators and supportive professional staff.

- Existing water institutions need to be reoriented from purely engineering functions and biases to multi-disciplinary functions. Their capabilities must be enhanced to undertake environmental assessment and management activities. In doing so, they should involve the scientific community and research active in issues such as environmentally sound water management, thus reducing the gap between scientists, development experts and politicians in this area.

6. INITIATION OF BASIN ACTION PLANS

The development of environmentally sound action plans for national and international basins is envisaged in three phases.

First, the country or countries involved should establish a group of government-designated experts to review and approve the terms of reference and cooperation for the preparation and implementation of an action plan. During this phase, a diagnostic study of the existing status of environmental problems and water management in the basin would be developed by the experts to assess the condition of the basin. The objectives of the diagnostic study will be to:

a) define specific environmental problems and their impacts at the time and in the foreseeable future;

b) assist the basin governments in identifying key programmes for inclusion in the action plan;

c) strengthen the awareness of the various governmental institutions involved in socio-economic development activities of the potential impacts within the basin;

d) identify areas in the preparation and implementation of the action plan where donor support will be needed.

Second, an action plan will be prepared based on the findings of the diagnostic study. The objectives of the action plan will be to (a) overcome the problems identified in the diagnostic study and (b) to promote environmentally sound management of the whole basin. In the case of an international watershed, it will contribute to the incorporation by the basin states of environmental consideration into water resources management while increasing long-term sustainable development of the resource in the basin.

For the implementation of the action plan, legal and institutional arrangements should be made. For an international basin, these will generally include a convention or an agreement expressing the willingness of the governments to cooperate in implementing the action plan and outlining the modalities of its implementation.

Finally, the action plan will be put into effect through a series of projects financed by either the basin countries, United Nations organizations and/or donor countries.

The above process was followed in promoting the preparation and implementation of action plans for two important international watersheds in Africa: the Zambezi River System (1987) and the Lake Chad Basin (1991-92). Action plans are in preparation for the Orinoco River Basin, Lake Titicaca and lake Xolotlan in Latin America; the Nile and Okavango River Basins in Africa; and the Aral Sea in Asia.

The Lake Chad Basin serves as a positive example on the process of preparing an action plan for an international watershed. The Lake Chad Basin is the largest inland drainage basin in Africa with an area of 2,335,000 sq km covering parts of Cameroon, the Central African Republic, Chad, Niger and Nigeria. The waters of the basin have been increasingly exploited during recent years, as all the riparian states have mounted development projects in agriculture and industry that utilize the basin's water resources. However, as the surface and water volume of Lake Chad have decreased tremendously since the early 1970s, the activities planned for the development of the area have met with difficulties. The Action Plan consequently aims at (a) the sustainable development of the basin and (b) protecting the environment of Lake Chad by providing a comprehensive plan for the environmentally sound management of the entire area of the Lake.

The following measures form part of the water master plan and action programme envisaged for the Lake Chad renovation:

(a) Lake inflow and water balance control;

(b) Reinforcing the recharge of underground waters;

(c) Development of sound water use;

(d) Water and soil conservation projects;

(e) Improvement of rain-fed irrigated agriculture;

(f) A food security preparedness scheme, including the development of fisheries; and

(g) Restoration of vegetation.

Following the adoption of the diagnostic study of the Lake Chad Basin by the Ministers of Environment, the Action Plan was elaborated and cost estimates are being prepared for its implementation. The preparation of the Action Plan was carried out by the Lake Chad Basin Commission, comprised of the countries of Chad, Cameroon, Niger and Nigeria, which will also have the responsibility for its implementation.

7. COSTS OF BASIN ACTION PLANS

Determining the costs of protecting water resources, water quality and aquatic ecosystems is not an easy task since this requires an integrated multi-sectorial approach. Cost estimates can best be established within a spatial context in which the functions of freshwater resources, including groundwater, in the overall ecosystem can be plotted; their inter-relationships with other natural resources, established; their utilization for socio-economic development activities, quantified and costed; and the combined impacts of their exploitation within the ecosystem as a whole, assessed. The most effective spatial context for determining the costs of the environmental management of freshwater resources is the basin, since freshwater functions as a major dynamic integrating force that contributes intrinsically to the formation and operation of the system itself.

Any estimates of the costs of the environmentally sound management of freshwater resources in a basin, or any other spatial context, is inextricably tied to other factors such as the size of the basin, population density, the provision of basic social services such as drinking water supply and sanitation, the kinds and degrees of economic development activities and the status of human intervention on the environment. Costs will vary greatly for a basin that has been subject to major intervention and one that has suffered minor impacts.

The application of an environmentally sound integrated multi-sectoral approach to freshwater resources requires costs in three major areas. First, traditional environmental management activities must be strengthened in fields such as monitoring and assessment, environmental legislation, training, institutional capabilities particularly as regards planning and regulation, pollution control, conservation and protection of aquatic ecosystems and their living resources. Second, major investments may be required in basin or other regional infrastructures, particularly as relates to the provision of drinking water supply and sanitation, the development of hydroelectric sources of energy, the construction of irrigation canals, the installation of treatment plants for urban and industrial waste waters and flood control projects, among others. Finally, the greatest costs will be incurred in reorienting the economy of a basin or region away from unsustainable exploitation of freshwater resources, and other natural resources impacting on freshwater resources, towards an economic development model based on the environmentally sound utilization of freshwater.

The costs of preparing and implementing environmentally sound integrated management action plans for national and international basins vary greatly as a result of many of the points raised above.

For a highly impacted medium-sized national basin of major economic importance, the preparation of an action plan, including a diagnostic study, can cost between US$ 300,000 and US$ 500,000. For an international basin such as the Nile or the Orinoco, the preparation of an action plan can run from US$ 500,000 to US$ 1,000,000. The first phase in the preparation and implementation of environmentally sound integrated management action plans for national and international basins can be supported largely through various organizations of the United Nations system as well as national counterpart contributions.

The implementation phase of an environmentally sound action plan for a national or international basin is much costlier since this requires large investments for financing traditional environmental management activities, essential infrastructural projects and the restructuring of the economy to include new technologies and environmentally sound systems of production.

This second phase in the preparation and implementation of environmentally sound integrated management action plans for national and international basins will depend largely on support from multi-lateral and bi-lateral development agencies, as well as from the United Nations system as a whole. Such multi-sectoral basin-wide action plans for the protection of freshwater resources are indispensable for achieving regional and economic development on a sustainable basis.

ICWE/WG.D/Doc.2

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP D

Worksheets

Protection of Water Resources, Water Quality and Aquatic Ecosystems

Prepared by

United Nations Environment Programme (UNEP)
World Health Organization (WHO)

Working Group Theme: Protection of water resources, water quality and aquatic ecosystems *Programme Issue:* Water resources protection and conservation	
Basis for Action: The relative scarcity of water resources in the face of continuously growing demands requires rational and sustainable management of this limited resource. The development of water resources implies their protection from over-exploitation, pollution and degradation. Limited resources demand conservation with regard to parsimonious use as well as conservation in terms of quantity, quality and ecosystem integrity. Widespread lack of perception of these inter-dependencies requires action programmes at all levels.	*Strategy and Programme Targets:* Protection and conservation measures should be derived from the under-standing of the aquatic environment as a coherent ecosystem which is integrated with other terrestrial ecosystems. Land-use activities, agri-cultural practices and industrial developments must be planned taking water resource requirements into account with regard to water supply demands and pollution impacts. A preventive approach is crucial to avoid costly subsequent containment and rehabilitation measures. By the year 2000 all countries, appropriate to their capacities and resources available, should have identified potential sources of water supply and prepared programmes for their protection, conservation and rational use.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Establishment of intersectoral programmes and coordination mechanisms which integrate land use planning with water use and conservation requirements.		X	X	
2. Development and application of water quality criteria for ecosystems, health protection and water user groups.			X	X
3. Design and application of simplified and readily applicable methods to assess environmental impacts of major development projects upon aquatic ecosystems and intended water users.			X	X
4. Establishment of a permanent, multi-sectoral planning and evaluation mechanism for water resources development, covering hydrological, ecological, social and health aspects.			X	
5. Establishment of appropriate legislation and enforcement mechanisms for water resources protection and conservation			X	
6. Initiation of contingency plans to control accidental spills which might damage aquatic ecosystems and make vital sources of water supply unfit for human use.		X	X	X
7. Provision of tax incentives and other economic benefits to industry for water conservation, recycling of water and minimization of waste discharges.			X	
8. Subsidizing environmentally sound agricultural practices and compensating for restrictions needed to reduce water pollution from diffuse agricultural sources.			X	

Working Group Theme: Protection of water resources, water quality and aquatic ecosystems

Programme Issue: Monitoring and surveillance of water resources

Basis for Action:	*Strategy and Programme Targets:*
Scientifically sound monitoring data are a prerequisite for the reliable assessment of water quality problems. Water quality management requires such an information basis without which rational policy formulation and decision-making is not possible in an economically oriented framework for integrated water resources management. Compliance monitoring is needed to enforce water quality standards and effluent permits.	The prime objective is to strengthen national and international capabilities for the establishment and operation of adequate water quality monitoring networks, including improved staff skills and institutional mechanisms. Assessment of regionally or globally significant issues, including land-based pollutant fluxes to the oceans, long-range atmospheric transport of pollutants and land degradation, erosion, etc. By the year 2000 all countries should participate, as far as appropriate, in regional and international water quality monitoring programmes such as the Global Water Quality Monitoring Programme GEMS/WATER.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Establishment of purpose-oriented water quality monitoring systems for policy option development, water-use planning, environmental impact assessment, early warning for emergency situation, and verification of water pollution control measures	X	X	X	
2. Harmonization of sampling programmes, analytical procedures, data processing and reporting over entire river or lake basins leading to the establishment of basin-wide water quality data systems.		X	X	X
3. Training of laboratory managers, analysts and technicians for good laboratory practice, analytical quality control and maintenance of laboratory instruments.	X	X	X	
4. Integrated monitoring of water quality together with land use practices, pollution sources, socio-economic developments and other environmental compartments.	X	X	X	
5. Development and application of appropriate field methods, remote sensing techniques, GIS and other innovative monitoring and assessment methodology.			X	X
6. Improve monitoring data reliability through upgrading and maintenance of laboratory services, rigorous analytical quality control, inter-laboratory comparison studies, establishment of regional reference laboratories or national/regional equipment service centres.		X	X	X

Working Group Theme: Protection of water resources, water quality and aquatic ecosystems

Programme Issue: Water pollution prevention and control

Basis for Action:	*Strategy and Programme Targets:*
In spite of great efforts to contain water pollution and its impacts on aquatic ecosystems, the past decade has witnessed a general deterioration in the quality of most of the vital water resources on all continents. Water availability and its suitability for different uses in industry, agriculture and for domestic supply is co-determined by its quantity and quality thus making water quality protection a mandatory component of integrated water resources management.	Three objectives have to be pursued con-currently in water quality management: Maintenance of ecosystem integrity and the protection of aquatic resources from pollution and their impacts due to socio-economic development. Public health protection through the control of disease vectors and pathogens in water resources. Sustainable water use by providing adequate amounts of water of a suitable quality on a long-term basis. By the year 2000 all countries should have put in place national water pollution control programmes based upon enforceable standards for major point-source discharges and high-risk non-point sources, commensurate with their socio-economic development.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Identification, inventorization and quantification of pollution sources through rapid assessment procedures, effluent monitoring, industrial sector reviews and agrochemical use verification.	X	X	X	
2. Enactment of water-specific or comprehensive environmental laws which cover preventive measures and pollution source control, including regulations and water quality standards.			X	
3. Cosing the enforcement gap between regulations and actual pollution control measures through capacity building in the regulatory agencies.		X	X	
4. Charging point sources of pollution directly for the quantity and environmental hazard potential of wastes discharged, in accordance with the polluter pays principle.	X	X	X	
5. Levying of surcharges on water supply and abstractions to cover costs of wastewater treatment and protection of waters receiving wastes.	X	X	X	
6. Development and application of low-waste industrial production technology, recycling of wastewater or by-product recovery, biotechnology for organic wastes and indigenous methods for water pollution control.			X	X
7. Operation and maintenance of water pollution control installations, including regular treatment efficiency verification, procurement of spare parts and the coordination of manufacturing and servicing and equipment.	X	X	X	

Working Group Theme: Protection of water resources, water quality and aquatic ecosystems

Programme Issue: Protection of groundwater from pollution

Basis for Action:
The extent and severity of groundwater contamination has long been underestimated due to the relative inaccessibility of aquifers. Pollutants are leaching into groundwater bodies from on-site excreta disposal, landfill sites and mines. Fertilizers and pesticides are infiltrating into the groundwaters underlying agricultural areas. Preventative measures have become a matter of urgency since groundwater bodies, once contaminated, take a long time to recover from pollution and will thus be unavailable for vital supply needs, often for many years.

Strategy and Programme Targets:
The strategy on groundwaters must be preventive and protective, aimed towards containment and ultimately elimination of all high-risk sources of potential pollution releases into the ground. Regulatory and technological measures must cover all major categories of point and non-point sources: domestic sewage, municipal and industrial landfills, mining operations, agricultural practices. Overexploitation of aquifers leading to quality degradation must be prevented. By the year 2000, national assessments of existing groundwater resources and their vulnerability should be completed by all countries concerned. Potential groundwater pollution sources should be identified and plans for their control elaborated.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Establishment of national inventories of existing ground-water resources and the hydrogeological features determining their vulnerability to future development activities.		X	X	
2. Assessment of the extent of on-site sanitation and domestic sewage discharges with regard to their potential threat to shallow aquifers and related drinking water supplies.	X	X		
3. Identification of existing and formerly used landfills for solid waste dumping and their possible need for rehabilitation and development of appropriate technology for rehabilitation.	X	X	X	X
4. Programmes for waste minimization and the pretreatment or recycling of hazardous wastes.		X	X	
5. Ceaning-up of mining operations with regard to the drainage of wastewaters, the safe storage of mine tailings and the protection of underlying groundwaters.	X	X		
6. Introduction of agricultural practices and regulations for the economic and environmentally safe application of fertilizers, pesticides and herbicides.	X	X	X	
7. Protection of groundwater abstraction and recharge areas through the establishment of protective zones where polluting activities are prohibited.	X	X		
8. Prevention of saline intrusion into aquifers of small islands and coastal areas through regulations avoiding overpumping of aquifers.		X	X	

Working Group Theme: Protection of water resources, water quality and aquatic ecosystems

Programme Issue: Protection of aquatic ecosystems and freshwater living resources

Basis for Action:	*Strategy and Programme Targets:*
Aquatic living resources are threatened by a variety of human activities, particularly their over-utilization with the objective of obtaining valuable products. Other human activities which produce threats to living freshwater resources include: accidental or incidental killing in the process of fishing for other species or in other ways; disturbance or harassment which may interfere with reproductive activities; and production of adverse environmental changes such as despoilment of breeding areas, reduction of food supplies and noxious chemical pollution.	The living resources within the aquatic ecosystem should be managed in such a way as to maximize the benefits for human needs derived from the ecosystem as a whole. Individual populations of commercially important species should be brought to highly productive levels on a sustainable basis. Improved conservation measures are required, based upon expanded research, for the depleted or threatened state of many living freshwater resources. By the year 2000, all countries with significant freshwater fisheries or aquaculture developments should have put in place national strategies for the protection and management of freshwater living resources.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Integration of water resources development with the conservation of aquatic and terrestrial ecosystems, including catchment forests, wetlands, floodplains and river flow control.		X	X	X
2. Environmental impact assessment mandatory for all large water management projects, especially dams, including ecological requirements and cost-benefit evaluations.	X	X		
3. Conservation or restoration of wetland ecosystems to preserve their ecological and habitat importance for many species and their socio-economic value.	X	X		
4. Rehabilitation of polluted and degraded surface water bodies to restore aquatic habitats and improve the quality of the water for various human uses.	X	X		
5. Initiation of ecotoxicological studies of the long-term effects of particularly harmful chemicals on aquatic biota and related ecosystems			X	X
6. Planning and implementation of pollution control programmes with particular attention to the protection of aquatic habitats and inland fisheries		X	X	

ICWE/WG.E/Doc.1

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP E

Background Paper

Water and Sustainable Urban Development and Drinking Water Supply and Sanitation in the Urban Context

Prepared by

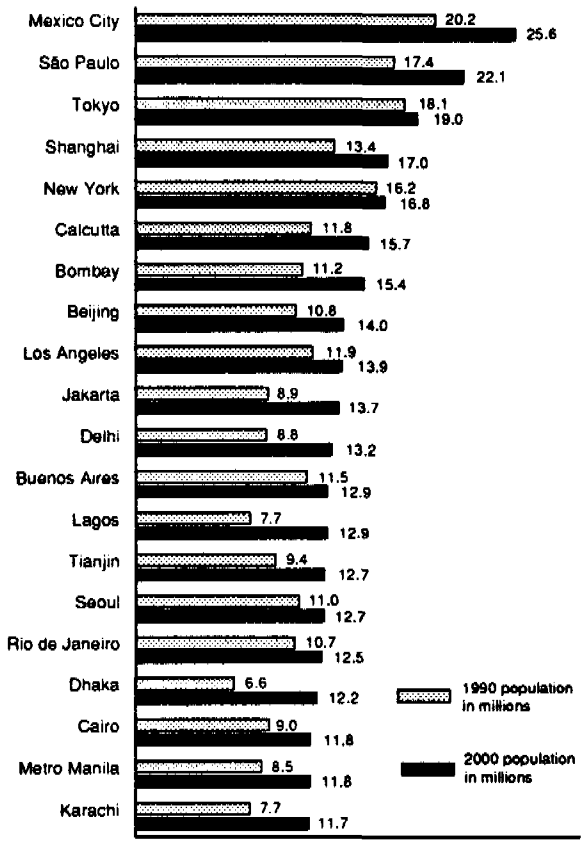
United Nations Centre for Human Settlements (UNCHS/HABITAT)
World Health Organization (WHO)
World Bank (IBRD)
United Nations Development Programme (UNDP)
United Nations Children's Fund (UNICEF)

1. INTRODUCTION

The urban centres of developing countries are environmental battlegrounds. Domestic and industrial consumers demand a progressively greater share of finite water resources, while at the same time degrading those same resources with their wastes. Expanding city populations need more and more food, increasing the demand for irrigation water and leading to more pollution from agricultural runoff.

The Top 20 in AD 2000

How the world's largest cities will look at the end of the century



Management challenge

Balancing the needs of food production, industrial output, domestic water supplies and environmental protection is a formidable challenge, which few countries have so far met successfully. Yet meeting that challenge, by managing water and wastes in a sustainable way, is the only way to avoid social and economic crises in many of the world's major cities.

An increasing number of developing countries are finding that the industrial progress necessary to fuel economic growth brings with it new threats and challenges. Their problems are exacerbated by a relentless rise in urban populations. Natural growth, rather than migration from rural areas, is now the prime cause of rising numbers in the majority of urban centres. That growth will continue, bringing with it intensifying demands for food and water, and corresponding increases in threats to health and the environment from the resulting liquid and solid wastes.

Population projections into the 21st Century are becoming so familiar that they no longer shock. They are no less ominous for that. In the year 2000, when Istanbul is likely to become the 22nd city to reach a population of 10 million or more, 18 of those giant metropolises will be in developing countries. By 2025, it is estimated that 60% of the world's population, more than 5 billion people, will be living in cities.

To meet their domestic needs for drinking, cooking and hygiene, city water utilities will need to provide some 350 million cubic metres of clean, safe water every day. That is about twice the average flow in America's "mighty Mississippi" – but it has to be a good deal cleaner than that. At the same time, the cities will have to find safe and environmentally acceptable ways of disposing of more than 300 million cubic metres a day returned as wastewater, along with 2 million tonnes a day of human excreta.

For many cities, the waste disposal problem, including the mountains of household and municipal solid wastes they have to deal with every day, is the single greatest threat to sustainable development. It is in fact a multiple threat. As well as fostering the spread of water- and vector-related disease, and creating squalid living conditions in crowded urban settlements, untreated wastewater and unmanaged solid wastes contaminate the rivers and groundwater which are the city's precious water resources.

Industrialization and economic growth

Industrial growth is powering economic development in all countries, rich and poor. Until quite recently, water supply and waste disposal were not seen as serious constraints to the establishment of new industries. Cities with apparently abundant supplies (most major cities in the developing world are located on or near large rivers) were happy to provide cheap and plentiful water and to rely on natural dilution and biological action to look after the polluting discharges. Some residual contamination of land and water was a reasonable trade-off for the jobs and prosperity brought by industrial growth.

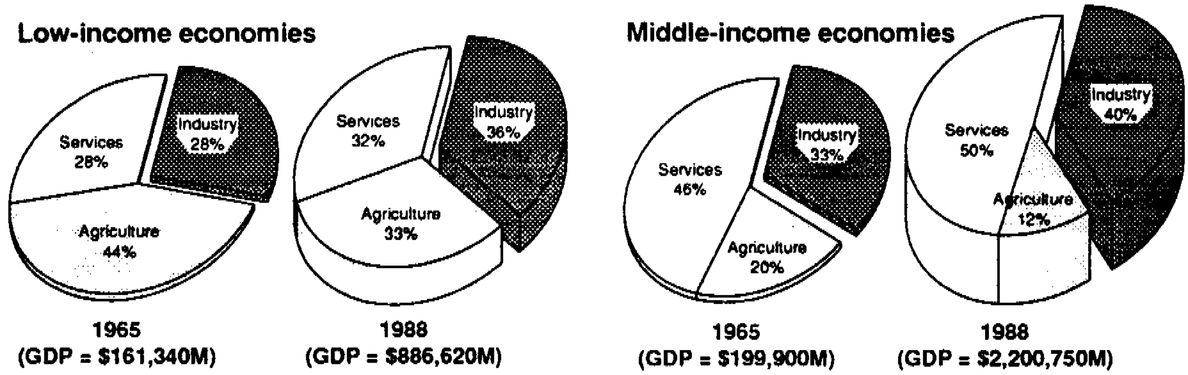
The explosive growth of urban centres over the last 25 years has demonstrated that, while the objective was valid, the policy was flawed. As water scarcity and pollution

The wheels of industry

Urban growth and industrialization are dominant features of national economic development. Figures from *World Development Report 1990* (World Bank, 1990) demonstrate the progressively rising proportion of gross domestic product (GDP) provided by industrial output in just about every country.

Aggregated figures for the low-income economies (1988 GNP per capita < $545) show how the relative economic importance of agriculture and industry has altered substantially between the Bank's indicator years 1965 and 1988. Over those 23 years, GDP on average rose by a factor of 5.5 in the low-income countries. While the contribution of agriculture fell from 44% of GDP in 1965 to 33% in 1988, that of industry rose from 28% to 36%.

It is a similar story in the middle-income countries (1988 GNP per capita between $545 and $6,000), though the overall rise in GDP is markedly greater (aggregated GDP up by a factor of 11.0). Agriculture in 1988 represented just 12% of GDP in the middle-income countries, compared with 20% in 1965. Industry's contribution rose over the period from 33% to 40%.



Source: World Development Report 1990, Table 3 (page 182)

Note: GDP figures for low-income and middle-income countries are totals for the respective groups of countries. Contributions of industry, agriculture and services are weighted averages

force exploitation of ever more distant sources, marginal costs of meeting fresh demands are growing exponentially. The polluting load from industry and domestic consumers long ago passed the threshold of nature's recovery processes, with alarming consequences for the natural environment and for the health of urban residents.

Agricultural, industrial and domestic consumers have been receiving water at highly subsidised rates, which provide little or no incentive for water conservation, improved efficiency, or recycling/reuse of wastewater. Unless water charges and pollution penalties begin to reflect real costs of the provision of water and the treatment/ disposal of wastewater, the converging curves of increasing demand and diminishing resources will become the overriding controls on further economic development in more and more cities.

Solutions are not easy to find, especially where past policies have created widespread expectation of copious cheap water. The city of Bulawayo has a problem which many will find familiar. With all local dam sites fully exploited, the most economic option for new supplies is a long pipeline from the Zambezi. The projected cost of untreated water from such a scheme is 200 cents/m^3. That compares with current charges for potable water in Bulawayo of 58 cents/m^3. Even more significantly, the irrigation supplies needed to justify the Zambezi investment are presently provided at a cost of 1.8 cents/m^3. Who pays the rest? Or should a way be found to improve the efficiency of use of available supplies, including through the adoption of more realistic tariffs? Even more controversially, if transporting food is cheaper than transporting water, can food security be achieved more economically than through heavily subsidised irrigated agriculture?

The health dimension

If better management of urban water and wastes is vital for *economic* reasons, the *humanitarian* case is equally powerful. A tragic paradox of urbanization is that so many of the migrants and their dependants live in more abject poverty and greater squalor in the urban squatter settlements than they left behind in their rural homes. Yet the magnet, real or illusory, of access to work opportunities and basic services continues to draw in more people, even while natural growth is straining city infrastructure beyond its limits.

In the low-income areas of developing country cities, the disease threat is ever present. Inadequate water supplies, lack of sanitation facilities, and rudimentary health knowledge compound the problems of an already marginal existence. As well as the obvious threat of water-related diseases, poor sanitation and solid waste disposal practices encourage vermin, flies, etc, while inadequate surface water drainage leaves pools of stagnant water as breeding grounds for mosquitos and other disease-carrying vectors.

With a choice between grossly contaminated water from surface sources or expensive clean water from vendors, the poor cut their consumption of clean water to the minimum and pay for it with sickness and disease. As well as jeopardizing their own health, the wastes generated by periurban communities contaminate land, air and water and destroy the potential for future development. Casting aside the economic cost through lost productivity, the suffering and indignity endured by the urban poor are shameful blights on the whole world community.

The 1991 cholera outbreak in Peru is a tragic reminder that the faecal-oral disease transmission route is well-nigh impossible to intercept when there are so many points of contact. Yet the $460 million now estimated to have been lost through the drop in exports and tourism would have more than paid for the water and sanitation systems needed to prevent such an outbreak occurring. Will that lesson now be learned?

It is not hard to see that improving water supplies is a sound economic investment. Innumerable cost-benefit analyses have shown that the returns in improved productivity and the stimulation of income-generating activities far outweigh the costs of installing and maintaining new water supplies. That is without accounting for the undoubted, but more difficult to quantify, health benefits. Reductions of up to 50% in diarrhoeal morbidity have been estimated by Esrey and Feachem (WHO, 1985) where new water supplies are accompanied by improved sanitation and hygiene education.

Environmental Impacts

Profligate water use and neglect of pollution control have already had damaging environmental and economic effects around the world's major cities. Rivers have become open sewers, devoid of fish and transformed from amenity to nuisance. Over-abstraction of groundwater has led to serious land subsidence – parts of eastern Bangkok are now below sea level, and unlicensed industrial abstractions from deep wells are mainly to blame for continuing subsidence at rates of up to 10cm a year. Groundwater depletion is aggravated by the rapid spatial growth of cities, which increases the impermeable area and prevents natural recharge of local aquifers.

Import of water from other river basins, and minimum use of wastewater recycling can have major environmental impacts. In São Paulo, effluent flows from sewers and industrial discharges are close to exceeding the natural flow in the Tiete river, which flows through the city.

Saline intrusion, resulting from excessive drawdown of the freshwater table, can make aquifers unsuitable for further water supplies. In Lima, future water supplies will cost more than double those from the last major water project, because groundwater can no longer be used to satisfy future demand.

Matching supply and demand

Globally, agriculture accounts for about 73% of all water use; industry uses 21% and domestic consumers about 6%. In developing countries, the proportions are thought to be: agriculture 85%; industry 10%; and domestic use 5%.

Though the overall total amounts of water used by industry and domestic consumers are less than for agriculture, the rate of growth is very much higher. Industrial growth is expected to continue at a rate of 7-8% per year through to the year 2000. If present consumption trends continue, that will mean an average of about 25km^3 more water having to be found each year.

On the basis that urban water supply coverage may be expected to rise from 82% in 1990 to 92% in 2000, an extra 33km^3 of water would have to be found over the ten years, or 3.3km^3 more each year. The figures assume that per capita consumption figures remain the same. In fact, these are likely to rise, both because of improving living standards and because the anticipated parallel increase in waterborne sewerage will require extra flushing water.

All the consumption figures used in these calculations include water which is lost or wasted (unaccounted-for water). In urban water utilities in developing countries, it is not unusual for the amount of unaccounted-for water to exceed 50% of withdrawals, and World Bank research puts the average figure at 36%. This compares with figures ranging from 10 to 25% in the industrialized nations.

As demand begins to approach the limit of economically available supplies, governments face difficult decisions about water allocation. Most would argue that top priority should be given to providing the comparatively small amount of water needed to meet basic needs of presently unserved populations. But it is difficult and costly to provide and maintain services for informal settlements on the fringe of cities, many of them on marginal land. Arguably too, the very provision of services may be seen as legitimising what are usually illegal settlements. The counter argument is equally strong. Failure to provide hygienic living conditions in squatter settlements aggravates already perilous health conditions, exacerbates the problem of urban poverty, and is a major cause of the degradation and depletion of groundwater and surface-water resources.

In economic terms, there can be no question that the return on each cubic metre of water provided for industry is hugely more than that from the same amount used for irrigation. Politically, though, the choice is not that simple. The devastating effects of drought over large parts of Africa in the 1980s have lifted food security to the top of many political agendas. Even where, as is increasingly the case, the cost of irrigation water cannot be recovered through crop prices, government may see subsidy as a key part of a self-sufficiency strategy.

Urban water scarcity is by no means limited to countries with low annual rainfall. The world's largest city, Mexico City, is in a country with more than 4,000m^3 of replenishable water available per inhabitant per year. Yet keeping pace with the growing demands of industry, agriculture and the steadily rising population of the federal capital is a continual challenge, with mounting economic and environmental costs.

Over exploitation of the Mexico Valley aquifer has led to lowering of the water table, serious land subsidence, and the risk of irreversible damage to the resource itself. Abstraction from the aquifer is now restricted, forcing Mexico City to pump water through a 180km pipeline with a rise of 1000m from the Cutzamala river. Bringing water from this source costs about US\$0.82/m^3, more than half as much again as the well water. Even this source will soon be fully used, and the next, with a longer transmission line and a 2,000m pumping lift, will be even more expensive.

The recycling option

One vitally important aspect of water resources management is recycling or reuse of wastewater. The *effective* proportion of irrigation water is taken up by plants and returned to the atmosphere by transpiration. The remainder (63%) either passes through the soil into aquifers, or is discharged through drainage systems into rivers and streams. A small part of industry's process water becomes incorporated in end products; the rest is discharged as effluent. Virtually all other uses of water result in a large proportion being returned in one form or another to the local water environment.

Often such returns are seen as an environmental nuisance. Agricultural drainage pollutes ground and surface water with nitrates and pesticides; industrial effluent adds toxic chemicals; while human wastes pollute the water and land environment and pose health threats. The result is a progressive deterioration in the quality of available water resources, and often actual depletion of resources as contamination makes them unsuitable for any worthwhile use.

For countries facing impending water scarcity, however, wastewater is a valuable resource. Treated municipal wastewater has been used extensively for many years in Middle Eastern countries for irrigation of landscaped areas and of fodder crops. The double benefits of environmental improvement and cost-effectiveness have prompted a dramatic increase in recycling and effluent reuse among industrialists in the developed countries during the last decade. In water-short developing countries, water-conservation and recycling may be the only way forward.

Prospective savings in the domestic use of water are apparent from the high wastage and unaccounted-for water in urban water systems. Equally important, severe urban pollution, caused by inadequate sanitation and wastewater treatment, inhibits reuse of river water by downstream users. So, whereas the same water may be abstracted and returned nine times in the course of its journey down the river Thames, before reaching London, Bangkok's Metropolitan Waterworks Authority can currently count on each litre of water being used only once before it becomes unsuitable to be treated for further human consumption. Protection of surface water from gross industrial pollution and severely polluting urban runoff could contribute enormously to the conservation and reuse of water resources.

The way forward

Sustainable progress has become the development target of the 1990s. The Brundtland concept (World Commission on Environment and Development, 1987) of satisfying today's needs without compromising the ability of future generations to meet their needs has won widespread support.

In today's urban areas, sustainable development requires more than conservation of the present environment. Preserving the rivers and the living environment of the poor urban settlements in their present state will not be enough to safeguard future water resources. Pollution has to be reduced; waste disposal has to be improved; and groundwater depletion has to be reversed, before *sustainability* becomes an acceptable goal.

This introduction has focused a great deal on the real and potential damage caused by neglectful or inadequate management of urban water resources – deliberately so in the light of the perilous situations prevailing in so many of the world's major cities.

The fact remains that effective water management has a crucial part to play in the continuing industrial expansion which is the key to future economic progress. The resources, the techniques and the knowledge do exist to ensure that progress is both sustainable and socially equitable.

It is the aim of this paper to highlight the political, technical and financial issues which must be addressed by governments and city administrations, if present damaging trends are to be reversed. Problems are featured, not so as to criticize or assign blame, but to ensure that lessons are learned. Above all, the objective is to be forward looking. The five priority issues elaborated next should be the focus of collaborative efforts in the coming years.

National action programmes and international support can then ensure the continuing and reliable supply of **water for sustainable urban development.**

2. PRIORITY ISSUES

The challenges facing developing country governments in the management of water resources to achieve continuing and sustainable urban development can be presented as five key issues. By developing and implementing nationally relevant policies to address these five issues, governments can help to ensure that water resources play an optimum part in social and economic development.

In this section, the five issues and their listed subthemes are presented in terms of the problems which need to be solved, along with some questions which need to be addressed by governments and city administrations in trying to solve them. Failure to do so will accelerate the trend towards social and environmental crisis in many of the world's fast growing cities.

ISSUE No. 1: Access to water, sanitation and waste disposal services

- Inadequate water and sanitation services, particularly for the poor
- Affordability gap between increasing costs and users' ability/willingness to pay
- Lack of sustainability of services and unreliability of supplies

ISSUE No. 2: Depletion and degradation of water resources

- Contamination of surface water and groundwater, with resulting health threats
- Environmental impacts

ISSUE No. 3: Allocation and effective use of water resources

- Competitive uses
- Lack of demand management
- Inadequate pricing of services

ISSUE No. 4: Institutional/legal/management inadequacies

- Lack of integrated management
- Ineffective monitoring, surveillance and enforcement of standards
- Legal/administrative/social constraints on water use
- Lack of appropriately qualified management/human resources
- Insufficient involvement of users and the private sector

ISSUE No. 5: Resource mobilzation

- Low sector investments
- Inadequate tariffs and pollution penalties
- Untapped potential for self-help

ISSUE No. 1: Access to water, sanitation and waste disposal services

It is a much-repeated truism that water is essential for life. Individual needs vary, depending on climate and type of activity, but no-one can survive for long without a daily intake of about two litres of potable water. When cooking and hygiene needs are taken into account, the basic requirements of a healthy life include at least 30 litres of clean water a day for every man, woman and child.

In terms of global water resources, such needs are small. Why then are water- and hygiene-related diseases killing more than 500 children every hour of every day? Images of sick and dying children and their overburdened mothers are a grim reminder of what should be the overriding priorities in sustainable development strategies.

A Decade of progress

In the course of the International Drinking Water Supply and Sanitation Decade (IDWSSD), the number of people with access to safe water supplies almost doubled, with an extra 1.3 billion people benefiting from improved supplies. That means that every day during the 1980s an average of 360,000 more people were provided with clean water – a rate of progress more than double that achieved in the previous decade. Fastest progress was in the rural areas, where coverage in 1980 had been very poor. In the cities, though overall coverage rose from 77% to 82%, these figures mask the fact that provision of new services still could not keep up with the rapid growth in population.

While an extra 360 million urban residents were provided with improved water supplies, the urban population grew by 400 million. At the end of 1990, some 240 million people in the low-income areas of Third World cities had no access to clean water. With the urban population set to rise by another 600 million by the end of the century, the task facing city water utilities is enormous.

The sanitation picture is even more bleak. Adding the 600 million population growth to the 377 million still without basic sanitation services at the end of 1990, means that approaching a billion people would have to gain access to new facilities in ten years, in the urban areas alone, if full coverage was to be achieved by the year 2000.

Human excrement is the single most serious pollutant of the urban environment. Piped sewerage carries away the wastes of only 40% of the developing world's urban population and only a very small proportion of that is treated. The rest pollutes rivers and groundwater and pervades every aspect of life in the home environment of the urban poor.

Garbage is another serious health threat. The amount of solid waste left uncollected in developing country cities varies from about 30% to as much as 70%, with the poorest areas again the hardest hit. Sanitary landfills are the exception rather than the rule, and the open dumps, often on poorly drained marginal land, are breeding grounds for vector-borne diseases such as filariasis.

Statistics are a helpful way of judging progress, but they do not tell the whole story. They cannot, for instance, convey the reality of filth and squalor which is visibly apparent in the crowded low-income settlements on the fringe of so many cities.

What kind of service?

IDWSSD statistics can be misleading for another reason. In general, they show a steady increase in the number of people served. There is an implicit assumption that once "served", people remain served. The city of Bombay provides one of many examples of the fallacy of this assumption. A population growing at about 300 people per day is placing unmanageable demands on available supplies, to the extent that two-thirds of the city's population receive water for four hours a day or less. Are these people served? In fact, only 4% of Bombay residents have a water supply available for more than eight hours a day.

Scarcity leading to intermittent supplies can rapidly become a vicious circle. People receiving intermittent supplies adopt their own solutions, leaving taps open and storing water between supply periods. Surplus water is then dumped when fresh supplies arrive. A survey of eight Bombay buildings found that 15% of the water was wasted in this way.

The reliability of water supplies depends too on the quality of operation and maintenance carried out by water utilities. Broken down and malfunctioning water and sanitation systems are evident throughout the developing world. The health benefits of an improved water supply can be destroyed overnight if people are forced to revert to contaminated sources when the public supply fails. Rehabilitation of failed or neglected systems is being seen as an economic way of deferring investment in new facilities. It will only be so if it is accompanied by correction of previous operation and maintenance shortcomings.

Affordability gap

Poor people place a high value on the convenience and the improvements in health and living conditions brought by access to a reliable water supply. Studies have demonstrated a willingness to devote a high proportion of their meagre incomes to obtaining water (up to 15% of family income paid to water vendors by some Philippine families on the outskirts of Metro Manila). However, both the capacity and the willingness to pay are eroded by rising charges. Willingness to pay also diminishes when the service provided is inefficient and unreliable.

ISSUE No. 1: FIVE KEY QUESTIONS

In seeking to develop policies for addressing the issue of access to water, sanitation and waste disposal services, governments and city administrations will need to answer five key questions:

Q1 If current trends continue, what will be the social, environmental and economic costs in 10 years and 25 years time? Are these costs acceptable?

(a) Social costs:
Numbers of urban poor living in squalid, health-threatening conditions, without access to safe water supplies and hygienic means of personal sanitation.

(b) Environmental costs:
Degree of contamination of soil and water resources serving the city and downstream water users.

(c) Economic costs:
Collection, transmission and treatment of water from progressively more expensive sources. Consequences for industry's costs and affordability of agricultural and domestic water supplies. Costs to the national budget of ever-increasing subsidies.

Q2 What will be the impact on these costs of a programme to accelerate the provision of water and sanitation services to those who currently lack them?

(a) Social impact:
Improved health and quality of life for all urban residents, particularly the poor.

(b) Environmental impact
Much reduced pollution load on soil and water, and more amenable living environment.

(c) Economic impact
Capital and recurrent costs incurred in providing and maintaining new services. Compensating direct savings through longer viability of existing water resources; indirect savings in health care; productivity gains and greater competitiveness of industry.

Q3 Taking account of future population growth and current coverage levels, what achievable targets can be set for improved access to water supply and sanitation services? E.g.

- Halve the number of urban residents unserved in the period 1991-2000?
- Achieve full coverage for all urban residents by 2015?

Q4 Which of the following policy options need to be adopted/reviewed, to improve WSS services?

- Give priority to programmes providing basic services to those who currently lack them
- Promote more efficient use of existing services, including loss reduction, recycling and reuse.
- Base choice of technology and service levels on user preferences and willingness to pay.
- Make low-cost water supply and sanitation technologies available.
- Optimize the involvement of users, NGOs and the private sector in the provision and upkeep of water and sanitation facilities.
- Enhance hygiene education programmes, with a focus on women and children.
- Employ cost recovery policies or other financial procedures which assure adequate operation and maintenance.
- Apply design norms (e.g. for per capita consumption) which can be achieved with available water resources, to prevent intermittent supplies.

Q5 Where will the money come from to invest in WSS improvements?

- Government allocations to the sector commensurate with its economic, social and environmental returns (see Q1 and Q2).
- Realistic pricing of water for different uses.
- More efficient operation of city water utilities
- Support from donors.

ISSUE No. 2: Depletion and degradation of water resources

Rivers of waste

So many of the rivers which flow through the developing world's major cities are little more than open sewers. Untreated municipal and industrial wastes add polluting loads way above the rivers' self-cleansing capacities, turning precious water resources into unpleasant, health-threatening nuisances.

Of 24 major Latin American rivers monitored, only one has a faecal coliform count below 100 per 100ml; two are in the 10,000 to 100,000 range, and two have counts of more than 100,000 coliforms per 100ml.

Urban water pollution is so bad that, in most cases, the river is ruined as a potential water resource. This is an overwhelming constraint on urban water management, preventing the countries concerned from adopting the type of strategy, based on multiple water use, which has enabled industrialized nations to cope with rising domestic and industrial water demands.

The major Chinese industrial city, Tianjin, is a classic example. Tianjin shares the water resources of the Haihe basin with Beijing. It also receives, via those resources, most of the untreated sewage discharges of the Chinese capital. Particularly in dry years, Beijing's pollution makes the Haihe water quality so poor that it seriously reduces the amount which can be used to meet Tianjin's growing water demands. With virtually all accessible water resources fully exploited, both cities now face a water crisis. Belatedly, they are being forced to adopt demand management strategies along with measures to combat pollution and so make increased water reuse a viable option.

Groundwater threats

Grossly polluted rivers are a highly visible sign of urban water quality degradation. Less visible, but equally threatening to future water supplies, is the depletion and degradation of groundwater.

When convenient groundwater is available, it will usually be the most economic type of water supply, requiring only minimal storage and treatment. Major cities such as Lima, Bangkok, Cairo, Manila, Jakarta, and Mexico City have depended heavily in the past on groundwater as a major component of their water supplies. Cheap and relatively secure supplies have fueled rapid industrial growth and formed the basis for water tariffs which are now proving far too low to meet the costs of providing future supplies.

The attraction of groundwater as a supply source has led to widespread overexploitation. Abstraction exceeding the rate of replenishment has led to falling water tables and resulted in serious land subsidence in Mexico City and Bangkok among others. Excessive withdrawal causes quality problems too. As the natural water table falls, so saline water is drawn in to replace the freshwater withdrawn. High salinity has meant the curtailment of supplies from aquifers in numerous coastal cities, including Jakarta, Buenos Aires, and a number of states in the Persian Gulf.

It is not only salinity which can cause quality problems with aquifers. In congested urban settlements with hopelessly inadequate sanitation and waste disposal facilities, seepage through the soil brings with it pathogens, organic pollutants, heavy metals, and a wide variety of potentially toxic compounds dumped in solid or liquid form by industry.

Often too, aquifer replenishment comes from the contaminated river, with pollutant concentrations beyond the natural absorption capacity of the soils inbetween. That is the case in Shenyang, China, for instance, where upstream pollution of the Hun river has made the aquifer underlying the city unusable for public supplies. Shenyang's water will have to come instead from 51km away, at a cost almost three times as much as the groundwater supplies would have been. This and other examples of the real cost of groundwater degradation are shown in the graphic.

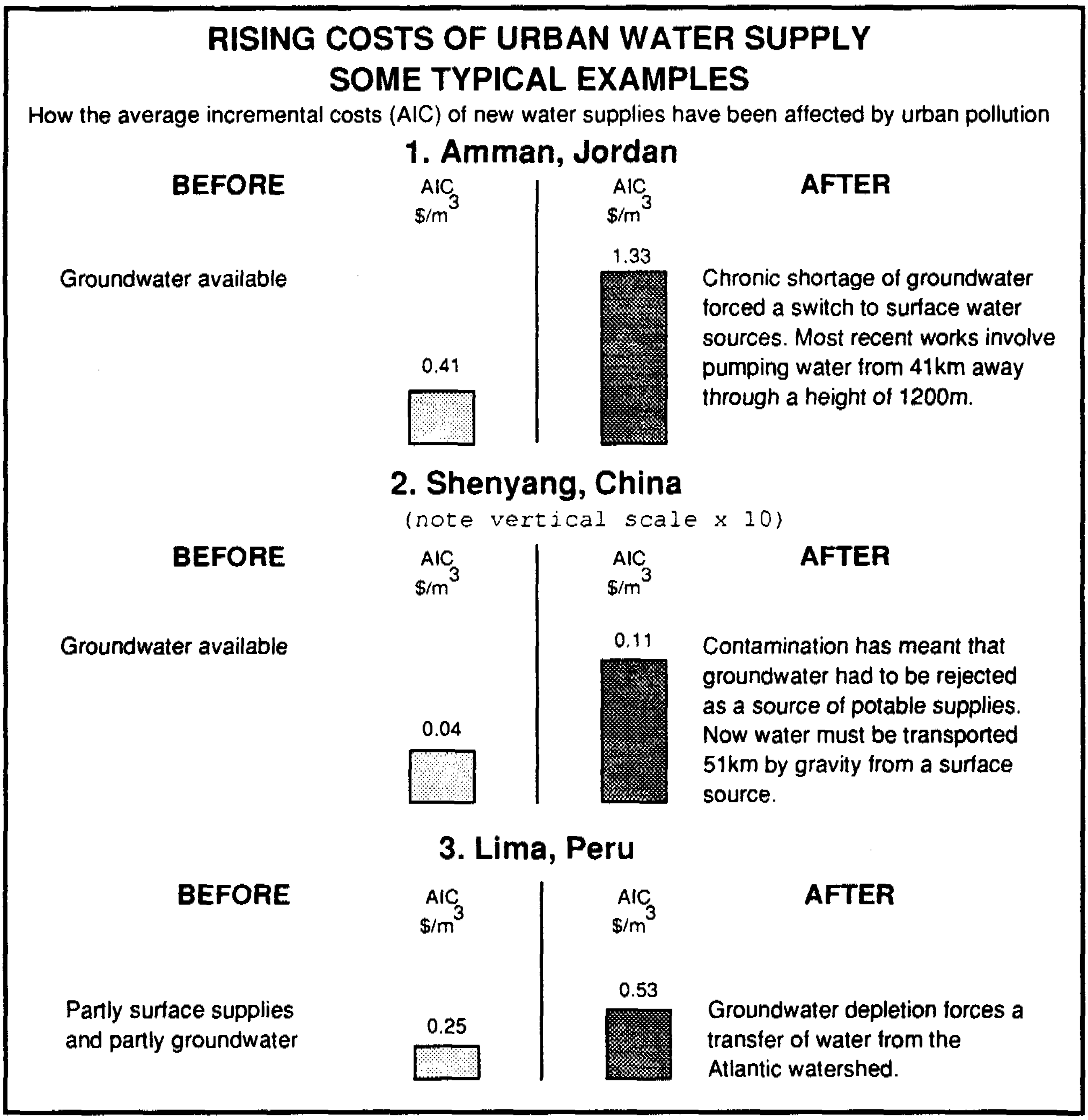
Sources of pollution

Domestic sewage

Human waste accounts for a substantial part of the biological polluting load on both surface water and groundwater resources. In Rio de Janeiro, for example, it has been estimated that 70% of the pollutants in the receiving waters are of human origin.

Water usage in the urban areas of developing countries ranges from a minimum of about 30 litres per head per day up to about 200 litres a day, with isolated examples considerably higher. Only about 25% of the water *used* is actually *consumed*. The rest is returned, in one polluted form or another to the local environment. With it comes about 350 grams of solids and 1.8 litres of liquid per person per day of human excreta. In a city of 10 million people, that means about a million cubic metres (a million tonnes) of highly polluted wastewater to be disposed of every single day.

Human waste is biodegradable, but the quantities discharged in and around crowded cities are beyond the natural assimilation capacity of the soils and watercourses. Sewerage alone is not enough. That simply converts the problem from a series of scattered pollution sources to one single concentrated source. In São Paulo, it was estimated in 1982 that, without a massive programme of sewage treatment, untreated sewage flows into the river Tiete and



other watercourses would rise from $21m^3/s$ in 1975 to $96m^3/s$ in the year 2000, and that this would cause the biochemical oxygen demand (BOD) in the river to rise from an already unacceptable 80mg/l in 1975 to 250mg/l (the strength of an average municipal raw sewage) in 2000.

As well as causing foul, stinking rivers, human sewage contains dangerous pathogenic organisms, responsible for the spread of waterborne diseases. That constitutes a deplorable health threat to all those without reliable public water supplies, who, even if they buy clean water from vendors for drinking, may be forced to use the polluted river for bathing and clothes washing, and even for 'cleaning' cooking utensils. High diarrhoeal morbidity and mortality rates in low-income communities can be directly associated with unhygienic living conditions, including the use of unsafe water for personal hygiene.

Industrial effluent

In the industrialised nations, a combination of realistic water pricing, pollution penalties and environmental responsibility has led to a considerable reduction in recent years in polluting discharges from manufacturing industries. Water-conserving techniques, recycling, and on-site treatment of problem effluents dramatically reduce the polluting load on rivers and municipal treatment works.

Few developing countries yet have the same preconditions. Industries have commonly been attracted by low water rates, faced few controls over discharges, and seen pollution prevention as the enemy of cost competitiveness. The biggest water users are usually also the greatest polluters. They may also be the country's largest export earners.

A recent study of water pollution hazards in Latin America and the Caribbean (ECLAC, 1990) showed that, while industrial water supplies account for only a small proportion of total water use, chemical and biological contamination from industrial effluents can in some instances rival domestic wastes as the main source of pollution. In metal-ore mining, for example, the polluting load of the waste generated per employee has a population equivalent of 40, while in sugar refining it can be as high as 1000. In El Salvador, where coffee processing is the major industry, and sugar is also an important export earner, the manufacturing labour force in 1980 was less than quarter of a million people. The population equivalent of the industrial effluent, on the other hand, was equal to the the population of the whole country – nearly 5 million.

Agricultural runoff

Irrigation drainage flows carry a variety of pollutants into rivers, while the excess water draining through the soil is often described as a pollution time bomb, threatening the purity of underlying aquifers. The 63% of irrigation water not taken up by plants, adds to the polluting load from natural rainfall washing the soil, salts and agricultural chemicals into the rivers.

Agricultural pollution is a prime source of nutrients (nitrates and phosphates) in river waters, aggravating eutrophication problems.

Pollution prevention

There are few reliable data on the amount of domestic and industrial wastewater in developing countries which receives any form of treatment before being discharged to the surrounding land or water. Probably the best estimate is that no more than 2% of the total flow is treated.

More and more cities appear to be in a downward spiral. Polluting loads are far above the absorptive capacity of receiving waters; yet the costs of collecting and treating the offending wastes require massively more investment than could be recovered from water and/or sewage charges. If depletion and degradation of water resources is allowed to continue, there will be no way to meet the long term needs of domestic and industrial consumers.

As it becomes increasingly clear that the current situation is not sustainable, governments and industrialists together are seeking ways of coping with rising demands and diminishing resources. Their task is formidable. Projections for Mexico show how the amount of effluent generated by major industries is set to double between 1985 and the end of the century, unless ways are found to reduce it. Efforts have begun. In the municipal field, recycled wastewater currently (1990) accounts for 4% of total water use. The effluent, rich in nutrients, is mainly used for irrigation of public parks and in recreation lakes. By the year 2000, the Federal District aims to recycle about 17% of its municipal wastewater, to provide 12% of projected water demand.

The Mexico scheme is thought to be the largest scale use of *raw* sewage for irrigation in the world, and will be closely monitored to assess its technical success and any health risks.

More widespread use of wastewater for such uses as crop irrigation is dependent on appropriate treatment systems. Waste stabilization ponds have been gaining in popularity in different parts of the world as a relatively economic form of municipal wastewater treatment, capable of producing good quality effluent. Extensive research in Europe and Brazil has led to improved knowledge of the performance of different types of ponds, and their use is now becoming much more widespread. The clear disadvantage for crowded urban areas is the large amount of land taken up by the ponds, but their capacity to produce effluent suitable for crop irrigation is an added attraction where land is available on the edge of a city. There are also encouraging results from the use of covered, anaerobic ponds, which require very much less land for the same degree of treatment.

In the low-income areas, on-site sanitation facilities and improved surface water drainage can have a major impact both on the living environment and on the polluting load on rivers and groundwater. Also, the costs of sewerage, particularly shallow sewerage, decrease sharply as population density increases. It is in the most crowded low-income settlements, rather than in the low-density high-income areas, that sewerage is most cost-effective.

Conventional wastewater treatment technologies, such as activated sludge plants or biological filtration are costly. It has been estimated that the overall cost of sewerage and sewage treatment for an urban settlement is about five times the cost of providing the water in the first place. The city of São Paulo has been forced by economic circumstances to trim its massive sanitation master plan SANEGRAN, but still aims to provide secondary treatment for 53.2m^3/s of the 90m^3/s total effluent flow by the year 2005, removing 90% of the organic load.

The amount of human waste generated in a city cannot be controlled; it has to be managed. The situation with industry is somewhat different. Variations in the manufacturing processes used can often result in considerable savings both in the amount of water used and the amount of waste produced.

Recycling rates (the number of times each cubic metre of water is used within a plant) in manufacturing plants in the US have grown substantially in the last 25 years, and are expected to increase exponentially by the end of the century (see table). Similar trends in manufacturing plants in developing countries would transform the pollution picture, and have a huge impact on future water demand.

In the US, recycling is a sound economic option, because of savings in water charges and pollution penalties. It is also encouraged by tight environmental legislation and enforcement. A number of developing countries (e.g. China, Brazil, Turkey, Mexico), have introduced legislation capable of controlling industrial discharges, with varying degrees of success. Others will need to follow quickly.

Year	*Paper and allied products*	*Chemicals and allied products*	*Petroleum and coal products*	*Primary metal industries*	*All manufacturing*
1954	2.4	1.6	3.3	1.3	1.8
1959	3.1	1.6	4.4	1.5	2.2
1964	2.7	2.0	4.4	1.5	2.1
1968	2.9	2.1	5.1	1.6	2.3
1973	3.4	2.7	6.4	1.8	2.9
1978	5.3	2.9	7.0	1.9	3.4
Projections					
1985	6.6	13.2	18.3	6.0	8.6
2000	11.8	28.0	32.7	12.3	17.1

Water Recycling Rates in Major Manufacturing Industries in the US
Source: Worldwatch Institute, State of the World 1986

ISSUE No. 2: FOUR KEY QUESTIONS

In seeking to develop policies for addressing the issue of depletion and degradation of water resources, governments and city administrations will need to answer four key questions:

Q1 If current pollution trends continue, what will be the impact on available water resources in 10 years and 25 years time?

Can projected water demand be met at affordable cost?

Will the environmental damage to rivers and coastal waters be acceptable to future generations?

How many people will die as a direct result of their contaminated environment?

Q2 What economic benefits would there be if present contaminated resources were restored to acceptable quality?

- Deferred investment in more expensive development of distant sources
- More sustainable industrial growth

Q3 What measures can be taken, both quickly and in the longer term, to recover polluted rivers and/or groundwater as future water resources? E.g.

- Accompany investments in water supply with appropriate investment in removal and disposal of wastes
- Implement national programmes to introduce sanitary waste disposal facilities, based on low-cost upgradable technologies
- Adopt safeguards and legislative controls on the disposal of hazardous and toxic wastes
- Recognize the severe polluting effects of urban stormwater runoff and implement commensurate drainage programmes
- Take advantage of recycling opportunities as part of city-wide plans for collection and disposal of garbage, to remove breeding grounds for vermin and other disease vectors, and to prevent pollution of groundwater and surface water by leachates
- Promote widespread reuse of treated wastewater by industry and agriculture, through education, water pricing, effluent charges, and adoption and enforcement of appropriate water quality objectives/criteria

Q4 What realistic targets can be set for the control/prevention of water pollution on an achievable time scale? E.g.

- Within 10 years, initiate programmes to provide sanitary containment or treatment for 50% of the polluting load from domestic wastes, and to achieve a minimum industrial water recycling rate of 2.0
- Within 25 years, achieve river water quality standards which safeguard downstream users.

ISSUE No. 3: Allocation and effective use of water resources

Competing uses

As demands grow and resources diminish, the competition for available water resources is intensifying. Governments face stark choices, with serious social, economic and environmental implications. Oversimplifying, to illustrate the point:

In one year, 1000m³ of water may be used EITHER

- *to provide 70 litres a day for 40 people; OR*
- *to irrigate land for 2 tonnes of maize grain; OR*
- *to help in the production of 10 tonnes of steel.*

Until recently, there has been enough affordable water to do all those things, and choices have been comparatively easy to avoid. Current patterns of water use in developing countries (Agriculture 85%, Industry 10%, Domestic 5%) indicate that:

In one year each 1000m³ of water is actually used:

- *to provide 70 litres a day for 2 people; AND*
- *to irrigate land for 1.7t of maize grain; AND*
- *to help in the production of 1 tonne of steel.*

In strictly economic terms, this distribution of water resources is absurd, especially in countries where such resources are scarce. A small amount of extra steel production would pay for the import of all the grain needed, and liberate most of the agricultural water for alternative uses.

This exaggerated example highlights the dilemma facing politicians seeking to balance desires for food security, health improvement, social development, environmental protection, and – as a prerequisite for all those things – economic growth. Past profligacy with apparently plentiful water supplies has only intensified the problems.

An agricultural sector accustomed to copious supplies of cheap water cannot be transformed overnight into a water-efficient, cost-effective producer of cash crops. Yet, it is inescapable that the sector which accounts for 85% of water consumption, and requires massive subsidies to do so, should be a target for potential water savings. Without those savings, water resource limitations will have an increasing impact, slowing the pace of economic growth and social development.

In a number of countries, both developed and developing, historic riparian water rights constrain efforts to reallocate water resources, and so aggravate the inefficient distribution of available resources. It is quite apparent that, in an open auction for the 1000m³ of water featured in the earlier example, industrial needs would be satisfied first and domestic needs second, with agriculture left with what the others did not need. Less extreme examples of market forces, operating within individual sectors, can be introduced through the sale of water rights and the encouragement of private water markets. Or governments may intervene by assigning specific water resources for particular uses.

Demand management

Reallocation of water resources can help significantly in assuring the sustainability of future supplies, but it is by no means the only mechanism for doing so. Continuously increasing the amount of water available, to meet demand projections based on current water use inefficiencies, is neither sensible nor sustainable. Instead, consumers need to be encouraged to use water more efficiently, to protect existing resources from further degradation, and to opt for agricultural or industrial practices which economise on water use.

City planners have an important role to play. The availability and sustainability of water resources should feature in development planning criteria. Industries known to have high water demands and/or highly polluting effluents are not appropriate in cities facing water or environmental problems. Those able to demonstrate economic use of water and minimal discharge of residual wastes will generally be favoured. Incentives for relocation can help to transfer problem industries to less damaging locations.

Water pricing is a very important instrument for stimulating efficient use of water. Users who do not pay the real cost have little incentive to conserve water, whereas progressive tariffs penalising excessive use both dampen demand and reduce waste.

User charges also act as a spur to increased efficiency of water utilities. Consumers paying realistic charges demand reliable services. The excessive levels of wasted water in urban networks will not be tolerated by informed consumers. At the same time, financially viable institutions are better equipped to operate and maintain efficient supplies. Rehabilitation and better management of existing supplies is more economic in terms of both water and financial resources than is investment in new supplies.

The present situation in developing countries is aggravating rather than improving water resources problems. On average, water charges cover only about half of the economic cost of producing the water and, because of wastage, actual cost recovery represents only about one third of total production costs. Water supply institutions therefore depend heavily on government subsidies, are frequently starved of funds, suffer low staff morale, and are unable to operate their systems in a reliable way. A vital element in correcting this deteriorating situation is improved water pricing.

Conservation and recycling

Without the discipline of realistic water pricing, major water consumers have found it more economic to increase consumption than to introduce conservation or recycling techniques. Impending water scarcity is forcing a review of such attitudes, and industrialists in particular are actively seeking ways to conserve water, cut waste, and increase the degree of water reuse, through treatment and recycling of wastewater.

The economics of wastewater treatment and reuse are closely linked to water pricing and pollution charges, as discussed in the previous section. They also depend on the establishment of appropriate standards on the quality of water for different types of use. Health protection is a top priority in the setting of such standards, but often pollutant limits are unnecessarily restrictive for historic reasons. Recent World Health Organization guidelines on the quality requirements of water for agricultural reuse enable countries to set realistic standards with confidence that health will be protected. Reuse of municipal wastewater for irrigation will usually be more economic than enhanced treatment to allow safe discharge to watercourses. It must however be accompanied by appropriate health safeguards; there is suspicion that food crop irrigation with untreated effluent may have contributed to the rapid spread of the 1991 cholera epidemic in Chile.

Municipal wastewater is also valuable for groundwater recharge, though it is important to ensure that pretreatment ensures that potential pollutants are removed first.

Public awareness

The greatest sufferers from urban degradation and water scarcity are those in low-income settlements. Properly informed and supported, people are willing to contribute to water conservation and environmental protection, and often take pride in doing so.

Improvements at household and neighbourhood level can have a big impact on water resource protection, by reducing one of the major pollution causes – the flushing of excreta and garbage directly into watercourses by unchannelled stormwater. Raised public awareness is also an important instrument for ensuring that public and private organizations act in an environmentally responsible way.

By encouraging community members to participate as partners in decisions on policies and programmes, urban water agencies can stimulate interest in the conservation and protection of water resources and the recycling of solid and liquid wastes. It is however important that any public awareness campaigns include the right balance of hygiene and health education messages.

ISSUE No. 3: THREE KEY QUESTIONS

In seeking to develop policies for addressing the issue of the allocation and effective use of water resources, governments and city administrations will need to answer three key questions:

Q1 Does the current distribution of water resources among the three main sectors (agriculture, industry, domestic water supply) represent the right balance of economic, social and environmental priorities for the foreseeable future ?

Compare the *competing* needs of food security, industrialisation, and human health and productivity, in terms of their developmental priorities.

Would changing the balance to favour industrial supplies over agriculture bring sufficient economic benefits to compensate for diminished food production?

Could historic water rights be exchanged/sold with mutual benefit to agricultural vendors and industrial purchasers?

Q2 Can the level of subsidy of each main sector be sustained in relation to forecasts for the next 10 years, or the next 25 years?

Would more realistic pricing of water supplies stimulate greater water use efficiency, defer the need for further investments, and improve the sector's financial viability?

What are the pros and cons of charging full marginal costs (including opportunity costs) for all water supplies, with subsidies restricted to meeting basic needs of the very poor?

Q3 How can water conservation and recycling be encouraged?

- Progressive water tariffs and pollution penalties
- Imposition of effluent discharge controls and monitoring/surveillance
- Development and promotion of recycling techniques and technologies
- Example by municipal authorities (garbage recycling, wastewater reuse)

ISSUE No. 4: Institutional/legal/management inadequacies

Effective management of urban water resources requires skilled people, working in an enabling environment of supportive policies, legislation and incentives, in institutions which have power, responsibility and financial viability. The reality is very different. Urban water utilities in developing countries are typically badly staffed, under-financed and highly dependent on government subventions for their day-to-day operations. Responsibility for water supply is often separate from that for pollution control. Utilities have little control over the level of charges they levy or the use of the revenue they collect.

The need for national and local integration of water management with related activities in land use, housing and environmental protection poses complex administrative problems. In this Issues Paper, we are primarily concerned with water management at the city level. The closely linked issue of integrated water resources management at national level is addressed through other fora. It is, nevertheless helpful to review ways in which national water resources and environmental protection policies can beneficially influence sustainable urban development.

National needs

Water allocations, environmental protection standards, and general development objectives are all set by national government, based on political, economic and social considerations. If investments in urban water management are to reflect the major contribution of cities to national economic growth, national planners need to be aware of the threats posed by present trends, and the options available for dealing with them. Institutional arrangements should provide for this linkage at the highest levels of government.

Legislation commonly establishes water quality and effluent discharge standards, including sanctions for non-compliance. In some countries, abstraction and discharge permits provide mechanisms for controlling agricultural and industrial users. They may be linked to ambient water quality standards, with "zoning" of watercourses for designated uses, as in Brazil, for example. River basin authorities may sometimes be given powers to establish and enforce standards. Legislative controls need to be backed by regular monitoring and enforcement of penalties.

Even in the big cities, central government finance will generally be needed for the implementation of new water development or wastewater treatment programmes. Financial involvement frequently brings with it technical and managerial interference. Where this goes beyond the application of design standards and the organized training of local staff, it can be damaging. Autonomous and financially viable urban utilities are much more effective than those which have to rely on central government support.

Municipal authorities

Integration of water and waste management with other development activities is just as important at the city level as it is at national level. Planning and implementation has to be coordinated with programmes for land use and housing. Water and sewerage agencies therefore need to seek collaboration with policy makers in these other sectors.

National environmental protection standards may need to be supplemented with local discharge consents and enforcement strategies, including charging mechanisms. Local planning boards need to be fully involved in the establishment of environmental objectives, and should be encouraged and empowered to link land use and water management into the development planning process.

At city level, there is a considerable role for the private sector, including NGOs, in the provision of services, but this requires clear lines of responsibility and empowerment. Private sector operations also need to be subject to the control of municipal agencies, backed by appropriate regulations and means of enforcement.

Inefficiencies in water and sewerage agencies contribute to the high level of unaccounted-for water in most major cities. Illegal connections, incomplete records and billing errors add to the losses from undetected or neglected leakage. Institutional inadequacies are seen as a major constraint hampering improvement in the management of urban water and wastes.

There is no universal model for effective management of urban water resources. Wherever possible, capacity building should seek to strengthen existing institutions and develop integration mechanisms within the existing framework. It is, however, crucial that environmental concerns should be reflected in the decision-making processes, and, in the major cities, one option may well be the creation of a municipal environmental protection agency, with power, authority and resources to establish and enforce standards.

Consumer involvement

The capacity for self help among local communities is particularly strong in the field of community water supply, which is a high priority felt need. By involving benefiting communities in the formulation of water supply and pollution prevention alternatives, city agencies are able to promote a sense of ownership which is then reflected in greater willingness to pay and to participate in the upkeep of installed facilities.

Non-governmental organizations, with their experience in community-based development, can provide a helpful bridge between the water utility and the community. Local water associations have proved effective in some countries, providing a basis for the upkeep and extension of services in informal settlements which the urban utility may find it difficult to service economically.

Community interest in water supply is generally easier to stimulate than concern for sanitation improvements and other environmental issues. Health and hygiene education programmes, focusing particularly on vulnerable groups (women, children and the elderly), are an important way of raising awareness. Such programmes have had some success in mobilizing support for latrine construction alongside new handpump-based water supply systems in Bangladesh, and, with seed money to initiate interest, in Zimbabwe. These mainly rural experiences may provide pointers to awareness raising in problem low-income settlements around major cities too. Governments and donors can usefully collaborate in a series of demonstration projects, from which shared information may assist the development of operational models for conveying key health messages.

Human resources development

The most common shortcoming of urban water agencies is a chronic shortage of properly trained and motivated staff. Pleas for improved education and training of sector professionals and semi-professionals are not new. Nor are they confined to urban water management. While governments and donor agencies regularly identify human resources development as a priority need, follow-up action is hard to find. To be successful, a national HRD strategy has to be clearly linked to national development aims. Similarly, municipal agencies need to initiate recruitment, training and career development programmes focused on the established needs of the sector.

Multidisciplinary training is complicated and expensive. The success rate is limited, and the retention rate of newly trained professionals is low. As well as receiving the right training, staff need to be motivated and properly rewarded. Salary levels in public services rarely compete with those available in the private sector; and trained staff may also be attracted by opportunities offered in other countries with more generous salary levels.

Responsibility, recognition, promotion prospects and pleasant working conditions all contribute to job satisfaction. On the negative side, regular interference from central authorities is a strong disincentive.

The Delft Declaration

In the Delft Declaration (June 1991), participants in a UNDP-sponsored symposium developed a new initiative for capacity building in the field of water resources management. The strategy includes improved policy and legal frameworks, institutional development, and a commitment to development of human resources and managerial systems for the sector. The Declaration sets out what should be the main elements of national sector strategies, for support by external support agencies (ESAs), including:

- Improved policy and legal frameworks, institutional development and a commitment to development of human resources and managerial systems
- ESAs to adopt capacity building as an essential element of assistance efforts, including support for community and water user associations; and recognize the pivotal role of women in water-related activities
- Involvment of the private sector where appropriate in managing or providing water-related services
- Encouraging local and foreign universities, institutes, consulting firms, professional associations and others to participate in capacity building
- Water sector assessments which include the need for capacity building

ISSUE No. 4: TWO KEY QUESTIONS

In seeking to develop policies for addressing the issue of institutional, legal and management inadequacies, governments and city administrations will need to answer two key questions:

Q1 Does the present legal framework for water use and pollution protection provide an adequate basis for managing water resources into the next century? If not, what rationalization/changes are needed?

Is there a need to review existing water rights legislation to permit greater flexibility in the use of scarce resources?

Does the framework of standards, permits, discharge consents, etc, provide enough legal basis for protecting surface and ground water from contamination?

Q2 Is the institutional framework adequate for a fully integrated approach to urban water resources management?

Can sector agencies coordinate their activities nationally and on a city-wide basis with other sectors?

Are responsibility and authority correctly divided among national and local bodies, with appropriate financial autonomy available to municipal agencies?

What capacity building programmes are necessary to ensure that sector agencies are adequately staffed to manage water supply and pollution control operations?

5. Resource mobilization

Reversal of present trends in urban degradation is going to require much higher levels of investment by central governments, city administrations, donor agencies, and local communities, and quickly.

The economic case for greater investment is powerful: unless the twin problems of water scarcity and pollution are tackled urgently and effectively, shortage of water will become an overriding constraint on national economic growth in a growing number of countries. This message must be made apparent to political leaders and development support agencies as quickly and as frequently as possible. It will need to be supported by costed proposals for remedying the present trends, and that requires prompt analysis by sector professionals of the available options and achievable targets, some of which have been suggested in this Issues Paper.

Data need to be collated on technological options for sanitary waste disposal and wastewater treatment in crowded periurban areas, to enable recommendations to be backed by reliable costings, but enough information exists already for governments to assess the investment levels needed. Globally, it is possible that investment in urban water resources management and pollution prevention may have to rise by a factor of three or more, at least in the short term, to make up for past neglect. In the longer term, anticipated benefits from water conservation, improved efficiency and much enhanced recycling and reuse of wastewaters should bring savings by deferring investment in expensive new water resource development.

More realistic water pricing, coupled with provision of services more responsive to consumer demand and willingness to pay, could substantially boost cost recovery on urban water supplies. Similarly, widespread application of the "polluter pays" principle, backed by legislation, surveillance and enforcement, will make a significant contribution to environmental protection measures.

At the community level, people presently unserved by public water systems are already paying dearly for poor quality water from vendors. This untapped resource is available to fund the provision of safe, reliable supplies, once municipal agencies are equipped to implement and sustain such services.

The contribution of water resources to poverty alleviation and national economic growth has been stressed repeatedly in this paper. It makes a strong economic case for allocation of extra financial resources for water resources management and pollution control. While it can readily be argued that such investments will produce good returns in terms of sustainable development, it is also helpful to indicate some sources of extra revenue to finance the investments.

Water as an economic good

It is rare in developing countries for users to pay charges which represent the true value of the water they consume. The World Health Organization reports that, at the end of the International Drinking Water Supply and Sanitation Decade, less than half of the reporting countries have average domestic water tariffs higher than costs. Of those that do, many collect only a part of the revenues due to them. Cost recovery for sanitation services is even worse.

Industry is generally heavily subsidised, with water charges well below costs and derisory (if any) penalties for polluting discharges. The notional *value* of irrigation water, linked to crop prices, is way below the actual cost of providing the water, and charges are lower still.

In total, this disparity between the costs of providing water services and the charges to users of those services represents a huge subsidy, going mainly to the biggest users. The irony is that the only people directly paying the real cost (and more) of the water they receive are those unserved by public systems. People cannot live without water, so the unserved, invariably also the poorest members of society, have to obtain what water they can afford from water vendors. The price is inevitably high.

Though not highly priced, public water supplies are highly valued. There is considerable evidence that people are prepared to pay realistic prices for dependable supplies, rather than low prices for a poor quality service.

Higher prices, with progressive tariffs to control wasteful use, have other benefits as well as greater cost recovery. By encouraging water conservation, they help to mitigate rising demand; recognition of water as a *commodity*, with a value which rises with inflation, raises awareness of the need to protect resources from contamination; and consumers paying realistic prices legitimately seek efficiency in those providing water services.

Who pays?

Any strategy for improving the access of the poor to water and sanitation services needs to include clear indication of how capital and recurrent costs will be met. There is an arguable case for subsidy: improved health and productivity translate into economic benefits; better sanitation cuts down pollution and safeguards valuable water resources. But where should the subsidy come from?

Present water tariffs on average represent only half the economic costs of the water produced. When unaccounted-for water is taken into account, actual revenues cover only about one third of the costs of water production. The rest, plus a corresponding shortfall in cost recovery for sewerage and sanitation, has to come from government tax revenues or from external grants and loans.

As water development and pollution prevention costs rise, the level of subsidy is getting progressively higher. The question of whether water and sanitation services should be paid for through water charges or general taxation is for governments to decide. Taxpayers and water users are, after all, essentially the same people. Whichever option is chosen, the key criteria are that water consumers and polluters should be aware of the true costs, and that water utilities should have enough secure funding for operation and maintenance. That is rarely the case now.

In the longer term (because adjustment will necessarily take some time), realistic water pricing, with revenues clearly assigned to the responsible water agencies, must be seen as the logical way to bring supply and demand into balance, encourage conservation, and promote efficient utility operations. It is also arguably the most effective way of providing affordable services for the poor. Progressive tariffs, with an element of penalty for excessive use, can be used to provide a degreee of subsidy for those unable to afford even basic levels of service.

Paying for pollution

Regrettably, consumer willingness to pay for water supplies is not matched by an equal willingness to pay the much higher costs of sewerage and wastewater treatment. As pollution control and water protection are going to be vital aspects of urban water resources management in the coming years, willingness to pay for these services will have to be promoted through education and public awareness campaigns.

Technology choice is also important. Low-cost water and sanitation technologies developed appreciably during the IDWSSD. More research is needed into sanitation and waste disposal technologies appropriate for high-density low-income settlements, but in general, a range of technologies is now available to match the financial capacity and development level of most urban communities.

There are two possible ways of regulating industrial pollution. The most common is the *command and control* approach, involving the setting of discharge standards related to water quality objectives in the receiving waters, with charges recovered through water tariffs. The alternative is the economic approach, through which companies are charged according to the polluting load (volume and quality) of their discharges.

Both require effective monitoring and surveillance. The attraction of the pricing approach is that it gives companies the option of improving their effluents and paying less, or paying the authority to clean up the wastewater after discharge to a public sewer. If the pricing is realistic, this "market forces" approach can be highly effective in encouraging pretreatment, recycling and conservation. Critics of the system dislike the notion of authorities selling the right to pollute the environment (though the issuing of discharge consents is essentially the same concept). Nevertheless, the "polluter pays principle" has a wide measure of political and public support.

Community resources

An important resource in low-income settlements is the community's capacity for self help. If people are involved in choice of technology, siting of latrines and water points, digging of trenches and laying of pipes, and the subsequent upkeep of new facilities, the resulting sense of ownership lowers investment needs and induces greater willingness to pay operation and maintenance costs, and to extend services when needed. If the self-help programme is accompanied by security of tenure for the inhabitants of informal settlements, the motivation for further improvements is increased considerably.

Water Associations have proved effective in both developed and developing countries. They can ensure that water and sanitation programmes respond to the wishes of local people, and they are generally better able than city water utilities to collect payments and manage facilities in low-income urban settlements.

ISSUE No. 5: THE KEY QUESTION

In seeking to finance sustainable urban water resources management, governments and city administrations will need to answer just one key question:

Q1 How can greater budgetary allowances for the sector be mobilized?

- From national government and donors, through convincing awareness campaigns promoting health, environmental and demonstrable economic benefits.
- From domestic and industrial users through improved tariff structures and collection efficiency
- From enhanced consumer willingness to pay and more efficient management of resources.

ICWE/WG.E/Doc.2

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP E

Worksheets

Water and Sustainable Urban Development and Drinking Water Supply and Sanitation in the Urban Context

Prepared by

United Nations Centre for Human Settlements (UNCHS/HABITAT)
World Health Organization (WHO)
World Bank (IBRD)
United Nations Development Programme (UNDP)
United Nations Children's Fund (UNICEF)

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Efficient and equitable allocation of water resources

Basis for Action:	*Strategy and Programme Targets:*
At present in developing countries, about 85% of available water resources are used for agriculture, 10% for industry, and 5% for domestic supplies. In strictly economic terms, this distribution of water resources is highly inefficient, especially where such resources are scarce. Industrialization powers national economic growth, while agricultural production is almost invariably heavily subsidized. As demand grows and resources diminish, the allocation of scarce resources is becoming a major political issue. Priorities have to be established which balance desires for food security, health improvement, social development, environmental protection, and - as a prerequisite for all those things - economic growth.	- Establish economic, social and environmental priorities which take account of the availability and long term sustainability of water resources, and allocate water resources accordingly, ensuring as a top priority the availability of sufficient affordable domestic supplies. - Introduce charging structures which reflect the full marginal costs (including opportunity costs) for all water supplies, with subsidies restricted to meeting basic needs of the very poor. - By the year 2000, have in place a water resources master plan which matches development objectives with water resource sustainability, and which enables cities to plan on the basis of assured water allocations.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Technical and financial support for assessment of the availability and quality of surface and groundwater resources, and their present and future allocation among agricultural, industrial and domestic users.			X	X
1A. Hydrological studies, establishment of monitoring stations, and analysis of data, to establish national water resources profiles.		X	X	
1B. Compilation of data on water use and polluting load by sector, with projections for future water use and polluting load based on alternative conservation/reuse strategies.		X	X	
1C. Political judgment on development priorities and corresponding allocation of water resources to each sector to achieve long term sustainability.			X	
1D. River basin management plans to safeguard future supplies.		X	X	

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Efficient and equitable allocation of water resources

Basis for Action:	*Strategy and Programme Targets:*
See worksheet E1	See worksheet E1

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
2. Institutional strengthening and technical support for the introduction and application of water charges and pollution penalties which reflect the marginal and opportunity cost of water. Capacity building should aim to equip developing countries to:			X	X
2A. Develop and implement pricing mechanisms which encourage conservation and protection of water resources.	X		X	
2B. Make available affordable supplies for meeting the basic needs of the unserved poor.	X		X	
2C. Provide incentives for industries with high water demands or damaging polluting loads to relocate to more favourable sites.	X	X	X	
2D. Monitor compliance with abstraction licences and discharge consents, and ensure effective collection of charges and imposition of penalties.	X	X	X	

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Protection against depletion and degradation of water resources

Basis for Action:	*Strategy and Programme Targets:*
Pollution from untreated municipal and industrial wastes is causing health-threatening conditions in surface water resources. At the same time, over-abstraction and contamination are depleting groundwater resources. The costs of providing new water supplies are rising exponentially, when protection, conservation and reuse could enable demands to be met much more economically. Experiences in developed countries demonstrate great scope for successive use and reuse of water for both industry and agriculture. To achieve the economic gains, resources need to be protected, and water charges and pollution penalties have to reflect the true value of water.	- As part of an overall strategy to protect health and the environment and to make the most economic use of all available water resources, seek to reverse present pollution trends and progressively improve river water quality. - Within 10 years, initiate programmes to provide sanitary containment or treatment for at least 50% of the polluting load (BOD) from domestic wastes, and halve the direct water consumption (double the water recycling rate) of specified industries. - Within 25 years, achieve river quality standards (varying from location to location) which safeguard supplies for downstream users.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Development of guidelines and protocols for the protection of surface water and groundwater resources. Using the guidelines, developing countries should be able to:			X	X
1A. Set quality objectives for all river systems and groundwater resources, based on optimum successive use by downstream riparians, and translate the objectives into discharge quality standards for municipal and industrial effluents.		X	X	
1B. Implement monitoring programmes, backed by legislation and pricing mechanisms, to monitor ambient water quality and control polluting discharges.	X	X	X	
1C. Include water consumption and effluent polluting load among the criteria conditioning the choice/approval of new industries or expansion of existing industries.	X	X		
1D. Establish standards for the recycling rate and effluent quality to be achieved by existing and new industries, based on those achieved in similar industries in other countries.	X	X	X	
1E. Demonstrate the need for improved agricultural and forestry practices to prevent the degradation and depletion of water resources for downstream users.			X	X

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Protection against depletion and degradation of water resources

Basis for Action:	*Strategy and Programme Targets:*
See worksheet E2	See worksheet E2

Activities and Related Means of Implementation	Level of Implementation L	P	N	I
2. Technical and financial support to enable developing countries to:			X	X
2A. Implement national programmes to introduce sanitary waste disposal facilities, based on low-cost upgradeable technologies.	X	X	X	X
2B. Accompany investments in public water supply with appropriate investment in the removal and disposal of municipal wastes.	X	X	X	X
2C. Implement surface water drainage programmes to reduce the pollution caused by uncontrolled urban runoff.	X	X	X	X
3. Promotion and public information campaigns to:				
3A. Increase environmental awareness among politicians, industrialists, farmers, and the public, and stimulate behavioural change to conserve water and combat gross pollution of water resources.	X	X	X	X
4. Applied research and information exchange programmes to:			X	X
4A. Develop and document improved recycling techniques for a range of industries.			X	X
4B. Disseminate data on groundwater protection methods, and on treatment techniques for contaminated aquifers.		X	X	X
4C. Demonstrate the serious pollution caused by urban runoff and the benefits from investment in surface water drainage.			X	X

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Enhanced access to water and sanitation services

Basis for Action:	*Strategy and Programme Targets:*
Despite many commendable efforts, the International drinking Water Supply and Sanitation Decade left 244 million urban residents without access to safe water supplies and 380 million lacking adequate sanitation. These unserved millions are poor, politically powerless, and living in slum conditions on the periphery of towns and cities The dismal situation is aggravated still further by large numbers of broken down and malfunctioning water and sanitation systems. Accelerated provision of basic water and sanitation services is a prerequisite for improved health and for sustainable social and economic progress. The poor put a high priority on the dignity and convenience of clean water and hygienic sanitation, and this is reflected in a proven willingness to pay for reliable services.	Make provision of reliable water and sanitation services to the urban poor a priority component of national environmental management strategies. Assign budgets and institute cost recovery policies reflecting the popular demand and willingness to pay for such services. Set achievable national targets for accelerated and sustainable coverage, e.g. by the year 2000: - Halve the number of people lacking basic WSS services in 1990 and have in place measures to achieve full coverage by 2015. - Ensure that a minimum of 85% of installed facilities function at any given time, breakdowns are repaired within 3 days, and water is available for at least 12 hours a day.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Technical and financial support for the design and implementation of programmes in which developing countries:			X	X
1A. Develop costed proposals (including operation and maintenance costs) for providing services to the urban poor, and allocate commensurate budgets at national and local level to implement the programmes.	X	X	X	X
1B. Review water tariffs, to ensure that they reflect the true cost of providing new supplies, including recovery of capital and recurrent costs, use progressive tariffs to encourage conservation and minimize waste, and employ charging policies which enable the very poor to receive basic services at affordable cost. Secure the financial viability of urban water utilities, with adequate allowance for the upkeep, and replacement as needed, of installed facilities.		X	X	
1C. Evaluate scope of rehabilitation of existing malfunctioning systems before investing in new projects. Evaluation should include analysis of the reason for past failure and formulation of measures to correct operation and maintenance inadequacies.	X	X	X	X

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Enhanced access to water and sanitation services

Basis for Action:	*Strategy and Programme Targets:*
See worksheet E3	See worksheet E3

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
2. Strengthening of the capability of WSS agencies at all levels to design and implement sustainable projects. The aim should be to develop institutions which will:	X	X	X	X
2A. Ensure the technical, institutional and budgetary requirements for future operation and maintenance are provided for in the planning, design and implementation phases of new WSS projects. Match capital investment with corresponding training and career development programmes for operations and maintenance professional staff, technicians, mechanics and caretakers. Base choice of technology and service levels on user preferences and willingness to pay ("effective demand").	X	X	X	X
2B. Encourage and equip local water associations and water committees to manage community water supply systems and communal latrines, with technical backup available when required. Mobilize and facilitate the active participation of women in water management teams. Enable private sector agencies, including NGOs, to offer support services, where these can be provided more efficiently than through public utilities. Make maximum use of existing retail outlets and distribution channels, strengthened where necessary, to assure the accessibility of spare parts, tools and materials for operation and repair of WSS facilities.	X	X	X	
2C. Establish preventive maintenance schedules, leak detection programmes, and regular quality surveillance, with formal monitoring, reporting and follow-up procedures.	X	X	X	
3. Applied research and information exchange projects to:				
3A. Develop improved low-cost sanitation systems for high-density settlements, and make low-cost water supply and sanitation technology choices available in all countries.		X	X	X
3B. Develop guidelines on the achievement of sustainable water and sanitation services.		X	X	X

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Health impacts from urban water resources management

Basis for Action:	*Strategy and Programme Targets:*
Contamination of drinking water sources and distribution systems creates high risks of diarrhoea and other enteric infection. Unreliable water supplies forces people to store drinking water, which can create breeding places for mosquito vectors of malaria and dengue fever. Inadequate sanitation leads to organic pollution of water bodies, which then serve as breeding places for vectors of bancroftian filariasis. Rigorous care in drinking and in eating habits and in personal hygiene, is the most effective way of reducing cholera risk. Inadequate water and sanitation is responsible for 90 per cent of cholera cases. Poor populations on the fringe of large cities are highly exposed to contamination in a cholera outbreak.	- Establish medium and long-term plans for environmental sanitation to ensure permanent protection of vulnerable groups against disease risks. - Establish and implement immediate interventions for the prevention and control of cholera.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Technical and financial support for the design and implementation of programmes in which developing countries:			X	X
1A. Make an inventory of urban communities at risk, collect environmental and epidemiological data, select priority areas, and implement appropriate interventions.	X	X	X	X
1B. Educate populations at risk, particularly with regard to their individual responsibilities in the prevention and transmission of cholera and other water-related diseases.	X	X	X	
1C. Intensify water quality control and the operation of water treatment plants and other supplies (wells, springs, etc.). Promote the use of in-house disinfecting techniques where public supplies cannot be adequately safeguarded.	X	X	X	
1D. Assist urban communities to upgrade water storage facilities and identify appropriate technologies for the disinfection of water and wastes.	X	X	X	
2. Institutional strengthening and capacity building programmes, to equip developing countries to:			X	X
2A. Strengthen the monitoring and reconnaissance capabilities of water authorities in relation to the identification of health risks and potential beneficial health impacts of improved water and sanitation programmes.		X	X	

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Health impacts from urban water resources management

Basis for Action:	*Strategy and Programme Targets:*
See worksheet E4	See worksheet E4

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
2B. Develop and implement multisectoral rapid response interventions for dealing with cholera outbreaks.		X	X	X
3. Promotion and public education campaigns to:				
3A. Urge the general population as well as public and private institutions to intensify sanitary controls and to improve the cleaning and disinfecting of wells, tanks and drinking water installations.		X	X	
4. Applied research and information exchange projects to:				
4A. Develop improved domestic disinfection systems suitable for use with low-cost water supply and sanitation technologies.			X	X

there hasn't been [illegible] ed campaign

CCount [illegible] lately – prevalence

in spite of [illegible] 's WCAP'77

really not much

both country + global

hampered by pol [illegible] as well as

[illegible] [illegible]

active ~~[illegible]~~ happening / action in ~~[illegible]~~

pol + cap

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Institutional/legal/management reforms

Basis for Action:	*Strategy and Programme Targets:*
A prerequisite for effective water and waste management is an institutional and legislative framework able to resolve conflicting demands and enforce standards. Water and sanitation agencies need sufficient autonomy to control their own finances, to respond to local needs, and to attract and retain the right staff. In contrast, urban water utilities are often underfunded, understaffed and working in an institutional vacuum. Water and sanitation services in cities need to be integrated with land use, housing and environmental protection. As scarcity gets worse, water resources have an increasingly important impact on development planning, and this needs to be recognized through appropriate institutional and sector management channels.	• Ensure city-wide and national-level integration of water resources management with all aspects of the planning process. • Encourage autonomy and financial viability of city water and sewerage agencies, with power to generate and manage increased revenue. • By the year 2000, initiate and enforce water and effluent quality standards, based on a realistic appraisal of health risks and development objectives, and use financial instruments, including the 'polluter pays' principle to protect water resources.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Capacity building programmes to establish the institutional and legislative framework for implementation of water management and pollution protection strategies. Programmes should equip developing countries to:			X	X
1A. Adopt a city-wide approach to water resources management, integrated with land use planning, housing and environmental health programmes.	X	X	X	
1B. Incorporate the sustainability of water resources in national development plans.			X	
1C. Adopt regulatory and economic instruments to combat pollution from all sources, and ensure that the monitoring and surveillance capability is available to enforce standards.		X	X	
1D. Combine the skills of NGOs, the private sector, and the users themselves in the planning, implementation and maintenance of water and sanitation systems.	X	X	X	X

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context *Programme Issue:* Institutional/legal/management reforms				
Basis for Action: See worksheet E5	*Strategy and Programme Targets:* See worksheet E5			
Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1E. Establish an institutional framework which ensures that the real needs and potential contributions of presently unserved populations are reflected in urban development planning. This may include:	X	X	X	
a. Local dialogues involving WSS agencies, community groups, NGOs and private sector organizations;	X	X		
b. Intersectoral planning groups involving housing, land management and environmental protection agencies at city and regional level, and health, finance and environment ministries at national level.		X	X	
1F. Train and retain staff at all levels with skills in community involvement, low-cost technologies, and financial management.	X	X	X	
1G. Enhance hygiene education programmes, with a focus on women and children, to stimulate demand for and use of improved sanitation and waste disposal facilities.	X	X		
2. International collaboration and information exchange to evaluate legislative and institutional frameworks and develop guidelines which will enable developing country governments and city administrations to adopt the most suitable combination of regulatory and economic measures for effective water resources management.				X

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Resource mobilization

Basis for Action:

Reversal of present trends in urban degradation is going to require much higher levels of investment by municipal authorities, governments and external support agencies. The economic case for greater investment is powerful: unless the twin problems of water scarcity and pollution are tackled urgently and effectively, shortage of water will become an overriding constraint on national economic growth in a number of countries.

This message must be made apparent to political leaders and development support agencies, as quickly and as frequently as possible. It will need to be supported by costed proposals for remedying present trends and that requires prompt analysis by sector professionals of available options and achievable targets.

Strategy and Programme Targets:

- Make investments in urban water and waste management commensurate with the major contribution of cities to national economic growth.
- Convert the cash paid to water vendors by currently unserved populations into investment in reliable public supplies.
- Employ tariffs and collection systems which assure adequate cost recovery for the upkeep and extension of services.
- Develop fully costed estimates and identify funding sources for achieving coverage targets and pollution protection objectives by the year 2000.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Promotion and public information campaigns at national and international level. The aim should be to:			X	X
1A. Emphasize the economic importance of sustainable urban development, and the extent to which this is threatened by current trends.			X	X
1B. Overcome conceptions that water is a free good, and establish that it is a valuable commodity, bringing benefits which outweigh costs.	X	X	X	X
1C. Raise political and public awareness of the urgent need to invest in water resource protection and pollution prevention, and so increase budgetary contributions to the sector from governments and external support agencies.		X	X	X
1D. Mobilize community self-help activities and willingness to pay for reliable public services.	X			

[illegible] public info. [illegible] — target — [illegible]

[illegible] effectiveness efficiency [illegible] + support | [illegible] | target target [illegible] —

Working Group Theme: Water and sustainable urban development and drinking water supply and sanitation in the urban context

Programme Issue: Resources mobilization

Basis for Action:	*Strategy and Programme Targets:*
See worksheet E6	See worksheet E6

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
2. Technical support and capacity building to assist developing countries to:			X	X
2A. Build up the financial viability of municipal water and sewerage agencies through improved tariff structures and collection systems, leading to full recovery of capital and recurrent costs in an achievable timescale.	X	X	X	X
2B. Ensure that water, sanitation and waste disposal programmes respond to consumer demands, through community involvement in decision making and studies of willingness to pay.	X	X	X	
2C. Increase the efficiency of service delivery, by reducing the excessive amounts of unaccounted-for water, combating the problems of intermittent supplies, and taking full advantage of recycling opportunities in municipal wastewater and solid waste disposal.	X			
2D. Compare and cost different options for achieving identified targets of water and sanitation coverage, waste disposal and pollution protection.	X	X	X	

ICWE/WG.F/Doc.1

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP F

Background Paper

Water for Sustainable Food Production and Rural Development and Drinking Water Supply and Sanitation in the Rural Context

Prepared by

Food and Agriculture Organization of the United Nations (FAO)
World Health Organization (WHO)
United Nations Development Programme (UNDP)
United Nations Children's Fund (UNICEF)

1. INTRODUCTION

A brief critical overview of the present state of water use in food and agricultural production has been presented to this Conference in the Second Plenary Session under the title "Water for Sustainable Food and Agricultural Production: Issues and Options". Its intention is to create awareness of the problems involved amongst non-specialists and to serve as a starting point for discussions of this Working Group on an achievable programme of action. This working Group will discuss strategies and actions at local, regional, national and international levels on a broader context, covering water quantity and quality requirements and conservation needs for food production including crops, livestock, inland fisheries and aquaculture and overall rural development.

WS

1.1 What is Sustainable development ?

Sustainable development is development that meets the needs of the present without compromising the ability of the future to meet their own needs (WCED, 1987). It embodies two key principles:

* the needs, in particular the essential needs of the world's poor, to which overriding priority should be given;

* the limitation which need to be imposed on technology and economic development, when required, to protect environment's ability to meet present and future needs.

"Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such sustainable development (in the agriculture, forestry and fisheeries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable."

The satisfaction of human needs and aspirations is the major objective of development. The essential needs of vast numbers of people in developing countries are not being met, and beyond their basic needs, these people have legitimate aspirations for improved quality of life. In many parts of the world, agriculture is not fulfilling its vital function of feeding people, providing other basic agricultural commodities and generating stable income. More than 500 million people are undernourished and the vast majority of the 1.2 billion of poor people live in or come from rural areas. A world in which hunger and poverty are endemic will always be prone to ecological and other crises. For this reason, top priority should be given to sustainable agricultural development within the overall sustainable development effort. FAO's definition of sustainable agricultural development is presented in Box 1 (FAO, 1989).

1.2 Implications of Sustainable Agricultural Development

In developing countries, sustainable agricultural development implies the following (FAO, 1991):

* meeting the basic nutritional requirements of present and future generations;

* providing durable employment, sufficient incomes and decent working and living conditions of rural people;

* maintaining productive capacity of the natural resource base, while protecting the environment; and

* reducing the vulnerability of the agricultural sector to adverse natural and socio-economic factors and other risks and strengthening self reliance.

This conference is concerned with the maintaining and where possible, enhancing the productive capacity of the natural resource base, particularly, water and land, without disrupting the ecological balance and destroying the socio-cultural attributes of rural communities. The availability of adequate amounts of good quality water will, if anything, be one of the major crucial factors in sustaining food production and rural development.

The overall message is clear: concerted and coordinated effort will have to be made to increase food production on a sustainable basis in developing countries. Available natural resources, on the whole, do not favour much lateral expansion, so that intensification of agriculture , to a large extent, has to has to rely on efficient management of natural resources, particularly, water resources at river basin and field levels.

2. POPULATION AND DEMAND FOR FOOD

2.1 Population Growth

The world population today is estimated at approximately 5.3 billion, compared to 3 billion in 1960. Of this total, 23 percent is in the more advanced regions, and 77 percent in the less-developed regions. By the year 2000, the total is expected to reach 6.26 billion, with 5 billion or 80 percent in less developed regions. Figure 1 illustrates population estimates in late 20th and early 21 centuries (UN 1991). Already, the population expansion has placed huge pressure on natural resources. Certainly, further development, which is inevitable to meet the future increases, will press more heavily on natural resources under strain.

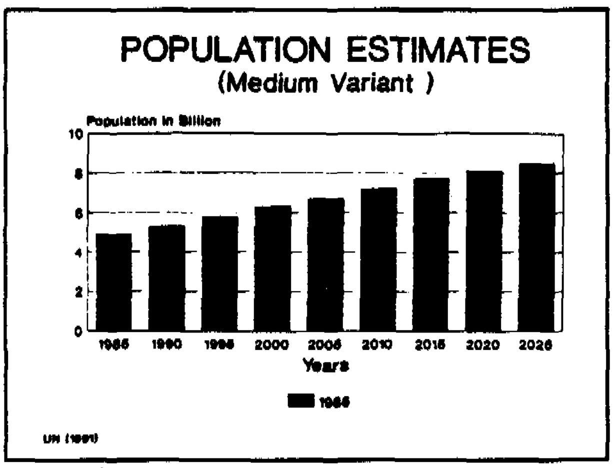


Figure 1

2.2 Food Demand

Several scenarios have been presented and discussed in many fora. The optimistic scenarios start from the observation that current yield and productivity gaps are large enough to allow sufficient food and livestock products to be produced from limited land and water resources. Assuming that high yields realized in developed nations can be achieved in developing nations as well, the capacity of existing resource base is largely sufficient for the next twenty to thirty years. the relevant concerns are how to identify and adapt technological options for sustainable use of water and soil resources, rapidly transfer best management and proven technologies and provide incentives to farmers to accept these technological innovations.

The FAO/UNFPA/IIAS study (1984) on agro-ecological zoning and population carrying capacities arrives at similar results. The study concludes that agricultural production from existing technologies is largely sufficient to feed growing populations; the real problem is one of transferring the technology through the right mix of institutions and incentives.

3. WATER AND SUSTAINABLE AGRICULTURE

Water is an indispensable resource for all life systems and is a critical component of sustainable agricultural and rural development. In arid and semi-arid countries, irrigation is often the only alternative for producing food and fibre. In sub-humid and many semi-arid areas, the value of increasing the amount of rainfall captured for crop production on rainfed lands must be weighed against the cost of irrigation. Expansion of livestock to meet part of the food requirements, and dietary protein; energy needs in farming and local transport, wool, hides and others; will require additional water resources of acceptable quality. Inland fisheries and aquaculture is another agricultural sub-sector that will exert its demand on the limited freshwater resources of the world. But by far, irrigation, is the major activity in terms of volume of water consumed.

3.1 Water for Crop Production

During the past four decades, development of irrigated agriculture provided a major part of the increase in production necessary to meet population demands. By the mid-1980s, 36 percent of the total crop production came from less than 15 percent of the arable land which was irrigated. Figure 2 illustrates a 1990 estimate of regional distribution of irrigated lands (FAO 1990). On a global basis, the average rate of expansion was about 1 percent per year in the early 1960s and reached a maximum of 2.3 percent per year from 1972 to 1975. The rate of expansion began to decrease in the mid 1970s and is now less than 1 percent per year.

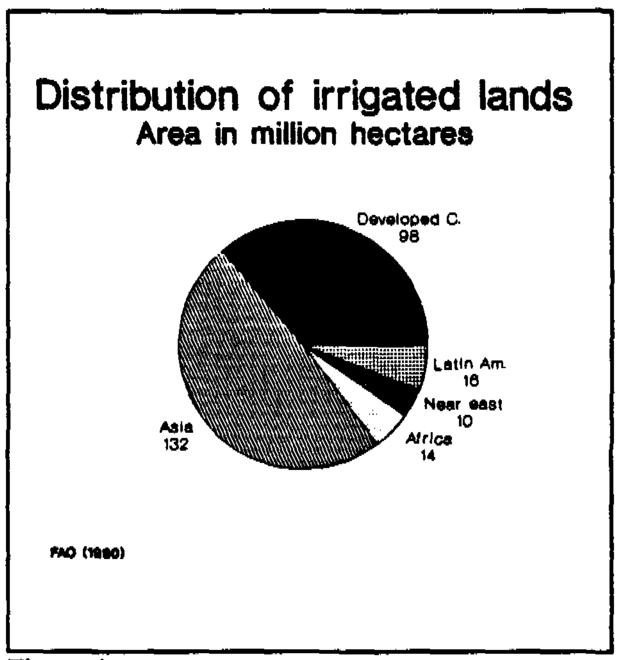


Figure 2

The reasons for the decrease in expansion in irrigated land are many and have been elaborated in various reports. Of major concern is the continuing decrease in the rate of expansion of irrigated land in developing countries while population growth rates are about 2 percent per year. The FAO projections of expansion of irrigated land to the year 2 000, based on previous trends modified by land, capital and inputs, required to meet future needs was 2.25 percent per year from 1982/4 to 2 000 (FAO 1988). Recent data show that these projections are not likely to be met. Clearly, needed increases in production cannot be achieved from continuing increases in irrigated land. Rather, production increases must be achieved from both rainfed and irrigated agricultural lands. Investment costs in conservation measures to increase available water on rainfed lands must be evaluated relative to capital investments and operating costs of irrigated agriculture. In some regions such as sub-Saharan Africa, rainfed agriculture is the primary source of agricultural production and this production can be increased significantly by implementing effective soil and water conservation practices.

3.2 Water Supply for Livestock

Three ways of increasing livestock production are recognized; namely, expansion in livestock numbers, increased intensity of range and extensively managed systems, and higher out put through improved management and breeding. All these three means will required increased water supply for drinking, cleaning, and other purposes. Greatest limitation of water supply in livestock production is in the extensively managed system, namely, rangeland livestock system, particularly in the arid and semi-arid regions. The most serious problem is related to the quality of water available to animals under grazing conditions. Table 1 presents the maximum dissolved salt levels that can be tolerated by different classes of livestock (FAO, 1986).

Table 1 SALT TOLERANCE LEVELS IN DRINKING WATER FOR LIVESTOCK

Livestock	Dissolved solids (in g/l)
Poultry	2.8
Pigs	4.3
Horses	6.4
Cattle (dairy)	7.1
Cattle (beef)	10.0
Adult dry sheep	12.8

However palatable and plentiful the forage may be, the livestock using it must have all the water they may need, or they will not thrive. Deprivation of water results in loss of appetite and if prolonged results in death (3 - 5 days in zebus cattle, 6 to 10 days in sheep, and 15 or more for camels). Inadequate stock water development in range areas not only contributes to unstable livestock industry, but prevents profitable utilization of pastures and encourages overgrazing in the vicinity of existing water supplies. The prime objective of developing rangeland water supply is to provide adequate amounts of clean water to enable an even utilization of the available forage without endangering the ecology of the rangelands.

3.3 Inland Fisheries and Aquaculture

Production of food fish from freshwater can be achieved by various means. These all, however, fall into two broad categories, namely, inland fisheries (or capture fisheries) and aquaculture. Inland fisheries constitute the exploitation of natural fish stocks, ideally at a level which will allow sustainable annual production from the resource. The potential yield of any fishery is a reflection of the physical conditions (area, volume, flow, temperature, etc.) of the water and the climate and soils of its watershed which influences its chemical makeup.

In aquaculture systems, the farmer has certain degree of control over the environment in which the fish are grown. Depending on the type of the system employed, the farmer can vary the flow rate of water through the farm to accommodate changes in stock biomass or water quality; control stocking rates; provide additional food; and adjust the time of harvest and size at harvesting. Production from aquaculture vary with the intensity of the system as illustrated in Table 2 (Redding and Midlen 1990).

With increasing pressure on world water resources, especially in arid areas, there is a movement towards integration of water uses. This is especially true in the case of agriculture and fish production, which are in many ways complimentary. There are, however, significant areas of conflict, particularly, where pesticides and other agrochemicals are used or where substantial modifications to the physical structure of the aquatic environment is needed for increasing agricultural yields. Nevertheless, yield from inland fisheries can be improved by intensification of management through stocking and other practices.

Table 2 INTENSITY AND YIELD LEVELS IN AQUACULTURE

Culture method	Species	Yield kg/ha/yr
Extensive	Mullet	150-300
	Shrimp	1250
Semi-intensive	Milkfish	1000
	Carp	125-700
	Tilapia	400-1200
Intensive	Rainbow trout	2 million
	Carp	1-4 million
	Shrimp	6000

3.4 Rural Development

Sustainable development is closely linked to rural development. In many rural areas, root cause of environmental degradation is the lack of access by poor households to sufficient productive resources for meeting basic needs. Whereas several generations ago ample land, water and forest existed to meet the needs of most rural communities, population growth is now leading to diminishing farm sizes and increasing fragmentation of holdings.

The need to reduce rural poverty and to bring about greater equity is one the most pressing economic and social issues of sustainable development. Agricultural growth generally, but not always, lessens rural poverty. Experience in a number of countries and local situations indicates that a better agricultural performance generally results in a lower price of food, higher agricultural wage rates and employment and consequently lower incidence of rural poverty.

The role of women in relation to rural development deserves great attention. In many societies, women contribute labour for cash crop production and grow food for daily consumption or earn money for its purchase. It is rare, however, for women to be recognized as farmers in their own right or to have the same access to resources as are available to men (FAO, 1988).

4. SOME MAJOR ISSUES

4.1 Performance of Irrigation Projects

Currently, the overall performance of many irrigation projects is much less than was expected. Inadequate operations and maintenance and inefficient management of an increasingly scarce water resource contributes to many socio-economic and environmental problems. Of major concern is the rapid rise in groundwater leading to waterlogging, depressed crop yields and soil salinity. It is not unusual to find that 60 percent of the water diverted or pumped for irrigation is not made available for crop use. This excess input to project areas from canal and water course seepage and deep percolation on farm fields is the major source of water causing waterlogging.

4.2 Waterlogging and Salinity

The estimated gross area of irrigated land globally is 270 million hectares. The gross irrigated area includes the land commandable and equipped to be irrigated and cropped and fallow. Of this, about 20/30 million hectares are severely affected by salinity and an additional 60-80 million hectares are affected to some extent. These lands were at one time good arable lands and have been subjected to secondary salinization. Priority should be given to reclaim these lands and put them back into production.

4.3 Water Quality Deterioration

The quality of water available to agriculture is as important as the quantity, and the quantity and quality are interlinked. Depending on the sensitivity of the crop, when the nature and composition of dissolved salts and pollutants or ions in the water exceed threshold levels, crop production decreases with increasing concentrations. In addition, there may be phytotoxic and consumer health implications. Agricultural practices also impact surface and groundwater quality. Excess plant nutrients in surface runoff and deep percolation from both irrigated and rainfed areas can contribute to pollution of surface and ground water sources. A major pollution hazard is the contamination of groundwater used for potable use by nitrates and pesticides. Effluents from agro-industries and aquaculture also contribute to serious water quality problems.

4.4 Small-Scale Water Programmes

During recent decades, large irrigation projects have been given high priority while small-scale water programmes for agriculture have received inadequate attention. Small-scale irrigation, including supplementary water for rainfed agriculture, and a variety of water harvesting and water spreading techniques, have considerable potential to support agricultural and domestic water needs and to enhance land and water conservation. It has been estimated that in the semi-arid and dry sub-humid regions of Africa, water harvesting can increase agricultural production on 10 million ha in the short term and 50 million ha in the long term. Lack of political will, policy and support to local groups are some of the major problems.

4.5 Scarce Water Resources

The climatic anomalies of the seventies and eighties, especially in Africa, and the associated problem of how to ensure sustainable agricultural development under such uncertain water regimes, have highlighted the importance of rational water management in water-scarce and drought-prone areas. Increased rates of land and water degradation, induced by low and uncertain rainfall, is often the principal long-term effect of drought. Accelerated erosion by water and/or wind erosion is a main hazard. In drought-prone areas, a few very short duration and high intensity rains may occur each year. The accelerated runoff from these rains cause soil erosion and permanent soil damage. Policies and programmes to combat drought and manage limited water resources to support sustainable agricultural development are urgently needed.

4.6 Use of Wastewater

In many arid and semi-arid countries, agricultural development is affected by limited availability of freshwater. In these countries, freshwater is allocated, as a matter of priority, for drinking and domestic use and agriculture is encouraged to use alternate sources of water. In many cases, this has resulted in the use of marginal quality for crop production. Marginal quality water includes treated wastewater as well as drainage water. China, Egypt, Jordan, Kuwait, United Kingdom, USA and many other countries are now using such marginal quality water for irrigation and groundwater recharge. Use of marginal quality water requires special attention in terms of salinity control, health considerations and other environmental protection measures.

4.7 Farming Systems

Sustained production on both irrigated and rainfed lands requires optimal use of the physical environment in each soil-crop-climate ecosystem. In rainfed areas, of primary importance are water conservation measures such as fallow management including crop residue management, control of runoff and water harvesting. Integrated with these practices are selection or development of high-yielding, drought-tolerant varieties, optimal use of herbicides and fertilizers, crop rotation and optimal planting dates to maximize the probability of rainfall during critical periods of crop growth. These practices, when integrated through management with household systems, are called farm house systems or farming systems. The synergistic effects of farming systems are even more pronounced under irrigation. Under irrigated agriculture, farming systems may also include crop rotations to control plant diseases and pests.

4.8 Livestock Water Supply

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. In particular, lack of sufficient drinking water drinking points and their even distribution for extensively grazed animals, have resulted in overgrazing and local pollution around water supplies and significantly affected livestock performance, the local environment and water quality.

4.9 Aquaculture

Aquaculture is becoming an increasingly important consideration in terms of land and water use. Fish production can be considered to be a crop imposing specific requirements for water quality and quantity. It thus competes with other agricultural uses for land and water but provides farmers the option of diversifying their production. Harmonious interactions have been developed between fish and other crops in many parts of the world like the rice-fish culture in south and south-east Asia. There is also increasing use of small on-farm water storage bodies for agriculture and aquaculture. Alternatives need to be explored by which all these activities can be considered within an integrated programme of water and sustainable agricultural development.

4.10 Land Degradation

Land degradation is accelerated by increasing human and livestock populations resulting in soil erosion, overgrazing, bush fires, expansion of croplands and deforestation due to demands for firewood. Such degradation in semi-arid and arid areas is referred to as desertification. It was estimated in 1983 that desertification affected nearly 75 percent of all productive rainfed lands (3 475 million ha out of a total of 4 500 million ha) and 60 percent of the rural population (280 million people) living in these areas. Thus, water and land management under water scarce conditions need special attention.

4.11 Water-borne Diseases

In recent years, there have been a number of notable cases of adverse changes in patterns of water-borne diseases resulting from development of water-related projects. One reason is because many irrigation projects provide an ideal environment for the multiplication of water-borne disease organisms and their increased contact with people. Of notable importance is the increased population of mosquitoes that cause malaria and aquatic snails that infect people with schistosomiasis. The water-borne vector related diseases seriously threaten the health and productive life of rural families and hence the sustainability of irrigation development itself. Thus it is imperative that sustainable water development should take into consideration these health hazards and should build into the process of irrigation project planning, design and operation means to overcome these hazards. Many interventions are now available to minimize the health hazards, such as chemotherapy, improved water supply and sanitation for farm families and control of multiplication of disease vectors and decreasing opportunities of disease infection. In the case of the latter, many environmental management measures have been found to be cost effective. Measures such as drainage, filling depressions, land levelling, vegetation clearance, improved irrigation systems and water management broadly classified as "Environmental Management" measures can lead to significant reduction in the occurrence of water-borne diseases in water development projects.

4.12 Socio-economic Analysis

A development path that is sustainable cannot be secured unless development policies consider economic aspects, such as costs and benefits to the society and individuals. This means that sustainable development and use of natural resources should be compatible with the principles of sustainable economic activity.

The recent decrease in the rate of irrigation expansion reflects the reduced investment on irrigation and by itself is an economic impact. Construction costs have risen steadily and the world price for major cereals has fallen sharply, for example, the price for rice fell by about 40 percent in real terms between 1965 and 1985. Further, as much of the suitable lands for irrigation development and available water supplies are already developed, progressively more expensive and socio-economically unfavourable areas are left for further expansion.

Nevertheless, new lands need to be brought under irrigation. Their economic viability will have to be evaluated in the context of trade-offs between increased yields and environmental protection.

Economists and financial analysts always argue for a strict application of economic criteria in evaluating feasibility of new agricultural development. A common criteria used is the Economic Internal Rate of Return (EIRR). As a rule of thumb, a project is recognized to be in the danger zone if the EIRR is less than 10 to 12 percent.

The strict application of EIRR to evaluate feasibility of projects is now seriously questioned. EIRR is only one of the indicators of the projects merits, as it is only concerned with those effects of the project which can be measured in monetary terms. There are inevitably other effects to be taken into account in making a responsible judgement on whether a project is feasible or not. The effect of development both favourable and adverse, on natural resources, human welfare, and the ecosystem as a whole, should be evaluated. Perhaps, the application of 'cost-effectiveness' as an economic principle to evaluate new investments may offer a new realistic approach.

5. OVERALL STRATEGY

The amount of fresh water that is available for all practical purposes is finite. Thus there is a natural constraint that needs to be reckoned with. Resolution of conflicts and competition to this limited and finite resource in an optimum manner between the various demand sectors such as the drinking water supply and sanitation, agriculture, industry,etc., is an essential first step to any water use strategy. By an large, the agricultural sector is the major water user, accounting for about 70 percent of the global freshwater withdrawal.

Countries need to develop or reexamine their national water use policies in terms of quantity, quality and time and space distribution of their freshwater supplies to meet both short and long term demands within the framework of their national economic development plans. This calls for a holistic and integrated approach in water resources planning at macro level. No sectoral water development plan will be sustainable unless this essential first step is fulfilled. National water resources plans should be developed taking into full consideration the physical, economic, social, cultural and political aspects.

Within this integrated macro-level policy and planning, sectoral (micro-level) plans, programmes and projects will have to be implemented. Sectoral programming and programme implementation require specific expertise and integration within sectors, as for example, within the agricultural sector, where integrated development of crops, livestock, fisheries and forestry elements is essential. At the same time, collaboration between sectors is important and in many cases there is need to formalize intersectoral collaboration by means of institutional arrangements and legislation. In Box 2 are given some steps in planning and implementing water resources development and management programmes for sustainable agricultural development.

POLICIES AND PROGRAMMES FOR SUSTAINABLE WATER USE IN AGRICULTURE

* **Develop and/or update national water use policy within the framework of overall economic and agricultural development plan.**

* **Draw strategies for implementing agricultural water use and conservation within the policy framework.**

* **Develop and implement programmes to translate the policies into action.**

* **Strengthen national capacity to implement and monitor development programmes**

6. INTERNATIONAL ACTION PROGRAMME - WATER AND SUSTAINABLE AGRICULTURAL DEVELOPMENT

6.1 Programme Objectives and Goals

An International Action Programme on Water and Sustainable Agricultural Development (IAP-WASAD) has been initiated by FAO in cooperation with other international organizations (FAO, 1990). The main objective of the IAP-WASAD is to assist developing countries in planning, developing and managing water resources on an integrated and environmentally sound basis to meet the present and future needs for agricultural production.

The IAP-WASAD, has developed a framework for sustainable water use in the agricultural sector and identified priority areas for action at national, regional and global levels.

6.2 Priority Areas for Action

The IAP-WASAD focused on five priority areas for action as follows:

i. *Water use efficiency*: Efficient use of water in the agricultural sector is absolutely critical to improve overall water use efficiency. Positive actions are required to transfer existing technologies and to support their implementation. Urgent action is required to educate and train extension staff; strengthen water and soil management research under irrigated and rainfed conditions; monitor and evaluate irrigation project performance; and establish effective demand management procedures and water pricing policies.

ii. *Waterlogging, salinity control and drainage*: In rainfed agriculture, surface drainage is required to prevent any temporary waterlogging and flooding of lowlands. In irrigated agriculture, artificial drainage is essential under most conditions. It is essential to minimize drainage requirements and costs by reducing the sources of excess water through improved system design and on-farm water management practices. Design of appropriate drainage systems, securing funds for their construction and maintenance, farmers' involvement in the management of drainage systems and safe disposal of drainage effluents are important. Groundwater monitoring, water balance studies and conjunctive use of surface and groundwater should be encouraged. Pilot projects in waterlogged and salinized areas need to be established to verify available technologies and train personnel.

iii. *Water quality management*: Concerted and planned actions are necessary to establish and operate functional and cost-effective monitoring systems and to ensure that water available for agricultural uses is of an acceptable quality. Simultaneously, appropriate steps must be taken to ensure that agricultural activities do not adversely affect water quality so that subsequent uses of water for different purposes are impaired.

Suitability of water in terms of quality should be properly evaluated in order to optimize crop yields and minimize environmental damage. Crop, water and soil management practices will need to be adopted to minimize agricultural pollution, particularly, nitrate pollution of groundwater sources. Treated wastewater, when used in crop production, should follow recommended health and environmental criteria.

iv. *Small-scale water programmes*: Small-scale water programmes can fulfil many local water needs and have considerable global potential for the achievement of sustainable agricultural development. Such programmes should include development of small-scale irrigation, water supply for humans and livestock, improved infiltration to groundwater, soil conservation, water harvesting and flood control. These initiatives should be designed to integrate development and conservation and enhance local involvement in environmental management. The programmes, when properly implemented, would generate employment, promote equity, improve health standards and can help to slow down or prevent migration to urban areas. It is important that small-scale water programmes should be founded on adequate technical advice and support, improved institutional collaboration and greater involvement of local communities.

v. *Scarce water resources management*: Water scarcity conditions require long-term strategies and practical implementation programmes for the development of agricultural water use in ways consistent with limited water resources and competing demands for water. National planning capacities should be developed to formulate policies and strategies to cope with scarce water conditions; appropriate legal frameworks on water rights should be formulated to enable efficient and equitable water use; under certain conditions specialized programmes focused on "drought preparedness" should be formulated and implemented with special emphasis on food scarcity, environmental protection and improving community resilience.

6.3. Additional Priority Areas for Action

A further expansion of the IAP-WASAD included the following two additional priority areas for action:

i. **Inland fisheries and aquaculture**: Freshwater fisheries in lakes and streams are an important source of food and protein. Fisheries of inland waters should be managed to maximize the yield of aquatic food organisms on an environmentally sound manner. This requires the conservation of water quality and quantity as well as the functional morphology of the aquatic environment. On the other hand, fishing and aquaculture themselves may damage the aquatic ecosystem and hence their development can only be pursued subject to guidelines for impact limitation.

ii. **Livestock water supply**: The drinking water requirements of livestock vary according to species and environment in which they are kept. Different species have different tolerances to dissolved minerals and in particular, to salinity. It is also important that pigs and to a lesser extent dairy cattle also have an extra need for water for washing which generally can be of lower quality. Apart from salinity, drinking water should be free of pathogenic organisms and be palatable. It is estimated that the current global livestock drinking water requirement is around 60 billion litres a 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.

6.4 Common Actions

In order to implement effectively these programme activities, certain common and complementary actions needs to be taken, such as: development of adequate data bases; adaptive research, institutional strengthening; human resources development; better socio-economic analysis; environmental protection and conservation; and technology transfer and infrastructure.

6.5 Mobilizing Resources

The importance of financial and human resources to the successful implementation of the programme is well recognized. This has direct implications for national governments, NGOs and the private sector, UN organizations and bilateral and multilateral organizations. The indispensable condition for success is strong commitment and sustained support at all levels. At the country level, this should involve not only the Ministries of Agriculture and Water but also the Ministries of Planning, Environment and others concerned. While it is recognized that many developing countries are faced with extremely difficult economic situations, national governments may wish to consider the possibility of reallocating committed funds or allocating extra-budgetary sources of funds in order to support this programme, which responds to basic national concerns such as food security, poverty eradication, economic development and sustainable use of natural resources.

The commitment of bilateral and multilateral donors to support the programme is necessary if the international programme is to make a tangible and lasting contribution to the developing nations. Commitment to the programme may take various forms. In many cases, there are ongoing programmes of the bilateral and multilateral organizations in water and agricultural development which should be strengthened or re-oriented as needed. The UN agencies' role will be to facilitate member nations to develop policies and strategies and implement programmes aimed at increased production on an environmentally sound basis through effective technical cooperation, capacity building and promoting exchange of information and technology.

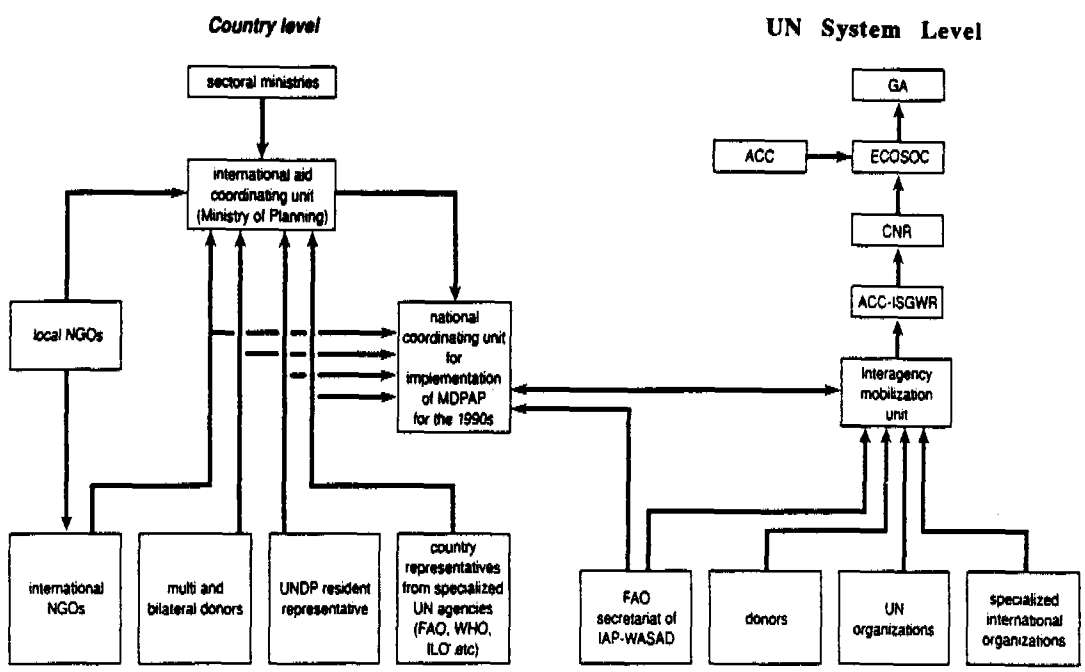
6.6 Institutional Elements

In its present form, IAP-WASAD is designed to be implemented within the framework of inter-agency arrangements with full participation of bilateral and multilateral development agencies in every phase of the programme.

A national coordinating unit (NCU) for implementing all component action programmes including IAP-WASAD under the umbrella of the Mar del Plata Action Plan Strategy for the 1990s is a possible modality for implementation at country level. The major role of such a unit would be to serve as a national focal point to coordinate the various Action Programmes with relevant national and international organizations at the country level.

At the UN System level, the establishment of interagency mobilization unit may be desirable. The role of this unit would be to assist UN agencies, national governments and donors in the planning and implementation of multidisciplinary water sector programming missions, identification of projects, developing project documents, seeking donor support, and monitoring. Box 3 presents a schematic representation of the proposed institutional arrangement.

Mechanism of coordination for implementing the Action Programme



7. EXTERNAL FUNDING NEEDS

In addition to mobilization of national funds and human resources, substantial external funds will be required to implement the actions recommended in developing countries. A broad and tentative estimate of funding needs is provided below:

Investments and low interest loans are required to accelerate development. This is particularly needed to bring new areas under irrigation, improvement and modernization of existing projects, provision of drainage to waterlogged and salinized irrigated lands, water and soil conservation to rainfed areas and water resources development programmes for livestock and aquaculture. It is estimated that international capital investment will be required on a low interest loan basis to the value of US dollars 8.7 billion per year during the period 1991 - 2000.

Grants are required to strengthen capacities for managing new developments and improved and modernized systems, monitor programme performance including environmental parameters, and to develop policy frameworks and legislation, covering water management programmes for irrigated and rainfed agriculture, livestock and aquaculture. The estimated grant needs amount to about US Dollars 1.1 billion per year during the period 1990 - 2000.

Strengthening the capacity of international institutions is indispensable for providing support to national programme on a regional and global scale. Funds to these institutions will be needed to the value of US$ 10 million per year.

Thus, the total external support to implement the proposed action programmes, is estimated to be around US Dollars 9.8 billion per year during the period 1993 - 2000.

Details of estimates will be provided to the Working Group participants separately.

8. CASE STUDIES

The aim throughout is to assist member countries to formulate programmes to meet country needs within the framework of the International Action Plan on Water and Sustainable Agricultural Development.

To facilitate this, five missions were sent to the field to develop methodologies and to produce specific action plans, which could serve as models for others. Their reports on Egypt, Indonesia, Mexico, Tanzania and the Lake Chad Basin are distributed separately.

9. REFERENCES

FAO/UNFPA/IIASA (1984) Land, Food and People, FAO Economic and Social Development Series 30, Rome

FAO (1986) Water for Animals, AGL/MISC/4/85, Rome

FAO (1988) World Agriculture: Toward 2000 , Ed: N. Alexandratos, FAO and Belhaven Press, London

FAO (1989) Sustainable Development and Natural Resources Management, Twenty-fifth Session of FAO Conference, C 89/2, Rome

FAO (1990) An International Action Programme on Water and Sustainable Agricultural Development, Rome

FAO (1991) Issues and Perspectives in Sustainable Agriculture and Rural Development, Main Document No.1, FAO/Netherlands Conference on Agriculture and the Environment, Rome

Redding T. A. and Midlen A. B., (1990) Fish Production in Irrigation Canals, A Review. FAO Fisheries Technical Paper No. 317, Rome

United Nations (1991) World Population Prospects 1990, Population Studies No. 120, Department of International Economic and Social Affairs, New York

WCED (1987) Our Common Future, Report of the World Commission on Environment and Development, Oxford University Press, Oxford

ICWE/WG.F/Doc.2

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

WORKING GROUP F

Worksheets

Water for Sustainable Food Production and Rural Development and Drinking Water Supply and Sanitation in the Rural Context

Prepared by

Food and Agriculture Organization of the United Nations (FAO)
World Health Organization (WHO)
United Nations Development Programme (UNDP)
United Nations Children's Fund (UNICEF)

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Efficient and rational allocation of water

Basis for Action:	*Strategy and Programme Targets:*
At present in many developing countries, about 85% of available water resources are used for agriculture, 10% for industry, and 5% for domestic supplies. This distribution of water resources will need to be reevaluated, especially where water resources are scarce. As demand grows and resources diminish, the allocation of scarce resources is becoming a major political issue. Priorities have to be established which balance desires for food security, health improvement, social development, environmental protection, and - as a prerequisite for all those things - economic growth.	- Establish economic, social and environmental priorities which take account of the availability and long term sustainability of water resources, and allocate water resources accordingly. - Introduce charging structures which reflect the full marginal costs (including opportunity costs) for all water supplies. - Develop a water resources master plan which matches development objectives with water resource sustainability, and which enables rural communities and villages to plan on the basis of assured water allocations.

Activities and Related Means of Implementation	Level of Implementation L	P	N	I
1. Technical and financial support for assessment of the water resources, and their allocation among users.				
1A.Hydrological studies, establishment of monitoring stations, and analysis of data, to establish water resources profiles.			X	X
1B.Compilation of data on water use by sector, with projections for future water use.	X	X	X	
1C.Political judgment on development priorities and corresponding allocation of water resources.			X	X
1D.River basin and transboundary management plans to safeguard future supplies.		X	X	X
2. Policies and programmes to manage scarce water resources for agriculture should be adopted to:				
2A.Develop long-term programmes for agricultural water use under water scarcity conditions.and formulation of drought preparedness programmes.	X	X	X	X
3. Institutional strengthening and technical support for the introduction and application of water charges and pollution penalties which reflect the marginal and opportunity cost of water. Capacity building should aim to equip developing countries to:				
3A. Develop and implement pricing mechanisms which encourage conservation and protection of water resources.			X	X
3B. Make available affordable supplies for meeting the basic needs of the unserved poor.			X	X
3C. Monitor compliance with abstraction licences and discharge consents, and ensure effective collection of charges and imposition of penalties.			X	

Attulae

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Protection against depletion and degradation of water resources

Basis for Action:	*Strategy and Programme Targets:*
Under many irrigated conditions, crop yields and quality are severely affected by high salinity or specific ion toxicity of water. Equally, improper agricultural activities and discharges of waste water from rural settlements have led to pollution of surface and groundwaters and render these sources unsuitable for potable use.	Quality of water assessed for irrigation and drinking purposes; water use and agronomic practices in the farm adapted to minimize water pollution; and implementing proper treatment and use of wastewater in agriculture; and identifying and monitoring sources of drinking water in rural areas.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Set quality objectives for all river systems and groundwater resources and translate the objectives into discharge quality standards.		X	X	
2. Implement monitoring programmes, backed by legislation and pricing mechanisms, to monitor ambient water quality and control polluting discharges.	X	X	X	
3. Evaluation and monitoring of quality of water for agricultural use and adopting appropriate management practices.	X	X	X	X
4. Demonstrate the need for improved agricultural and forestry practices to prevent the degradation and depletion of water resources for downstream users.			X	X
5. Adoption of appropriate water management and agronomic practices to prevent agricultural water pollution.	X	X	X	X
6. Proper treatment and use of municipal and farm effluents in agriculture and their eventual safe disposal.	X	X	X	X
7. Minimizing use of agrochemicals by practicing integrated nutrient and pest management practices.	X	X	X	X
8. Improve water quality criteria for agricultural, livestock, fisheries and aquatic ecosystems.			X	X
9. Increase environmental awareness and stimulate behavioural change to conserve water and combat gross pollution of water resources.	X	X	X	

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Efficient use of water at the (scheme and) farm level

Basis for Action:	*Strategy and Programme Targets:*
In most parts of the world water is not used efficiently at scheme and on-farm level. This causes low dry matter yield per unit of water diverted, inequity of water distribution, salinization and adverse environmental impacts including water-borne diseases.	The strategy consists of improving and modernizing 12 million ha of existing irrigated lands by year 2000. Existing irrigation schemes should be improved, monitoring of performance, strengthening institutions including water users associations.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Improving irrigation infrastructure and introducing improved irrigation and agronomic practice.	X		X	X
2. Strengthening of extension services and water and soil management adaptive research under irrigation and rainfed condition.	X	X	X	X
3. Monitoring and evaluation of irrigation project performance and improving operation and maintenance.	X			
4. Supporting water users groups.	X		X	
5. Encouraging water pricing and cost recovery mechanisms.	X	X	X	X
6. Supporting the appropriate use of brackish water for irrigation.	X			X

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Small-scale water programmes

Basis for Action:	*Strategy and Programme Targets:*
Small-scale water programmes can fulfill many local water needs and promote community participation. These programmes can be cost-effective,and provide a basis for multiple use of water.	Assisting local communities and institutions to develop and manage water resources to meet multi-purpose community needs, providing technical assistance and institutional support; About 10 million ha of rainfed arable lands will be improved through small-scale water programmes.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Providing technical and investment support for small-scale irrigation, water supply, sanitation and conservation projects.	X	X	X	X
2. Introduction of water harvesting techniques in rainfed arable lands.	X			X
3. Enhancement of community participation and ensuring the role of women in community based water projects	X		X	X
4. Promotion of integrated farming approaches in accordance with educational levels, and local capacities.	X			X
5. Educating and encouraging local groups to adopt environmentally sound small-scale water programmes.	X		X	X
6. Promote environmental protection through use of appropriate technologies, i.e. low cost technologies, low waste generation.	X		X	
7. Develop methods to assess environmental impacts of all small-scale water programmes.			X	X
8. Target interventions to optimize investments and increase productivity.			X	X
9. Promote safe disposal/use of human excreta/waste through appropriate sanitation and hygiene education.	X		X	X

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Waterlogging, salinity control and drainage

Basis for Action:	*Strategy and Programme Targets:*
Lack of adequate drainage and poor operation and maintenance has led to severe waterlogging and salinization of about 30 million ha of irrigated lands, resulting not only in loss of agricultural production, but also degradation of the environment.	The overall strategy consists of providing artificial drainage, and reducing sources of excess ground water input. Artificial drainage will be provided to about 7 million ha of irrigated lands, during the period 1993-2000

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Promoting surface drainage of low-lying rainfed areas to prevent flooding by rainfall and improper management practices.	X	X	X	
2. Introducing artificial drainage to control groundwater build-up and salinization of farm lands.	X	X		X
3. Promotion of conjunctive use of groundwater and surface water and monitoring water balance at basin/and project levels.	X	X		X
4. Ensuring proper installation,operation and maintenance of drainage systems in irrigated areas in arid and semi-arid regions including reuse/or safe disposal of the drainage water.	X	X	X	X

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Water for livestock

Basis for Action:	*Strategy and Programme Targets:*
The non availability of adequate amount of good quality water limits livestock production under grazing and rangeland conditions in many countries. Improper use and disposal of animal wastes have contributed to water pollution. Overgrazing has contributed to degradation of grasslands and desertification.	Adequate amount of good quality water should be made available for livestock particularly under extensively grazing conditions. Animal water requirement is likely to increase from 60 billion liters/day to 65 billion liters per day by year 2000.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Ensuring availability of good quality water with particular reference to salinity and toxic elements.	X	X	X	
2. Improving water availability and spatial distribution of watering points grazing conditions.	X	X	X	X
3. Prevention of water pollution by contamination with animal wastes and spread of human diseases from livestock.	X	X	X	X
4. Encouraging water spreading in naturally grazing lands.	X	X	X	X
5. Promotion of multiple use of water supplies through agro-livestock-fisheries systems.	X	X	X	X

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Inland fisheries and aquaculture

Basis for Action:	*Strategy and Programme Targets:*
The fisheries of inland waters should be managed to maximize the yield of aquatic food organisms. This requires the conservation of water quality and quantity as well as functional morphology of the aquatic system. There is need to promote aquaculture as a component of integrated farming system. This will enable to increase farm income, balanced nutrition, and greater community participation. There is also a need to guide aquaculture development to safeguard aquatic ecosystems and environment.	The strategy consists of promoting inland fishery and aquaculture programmes within the framework of national and international water resources planning and monitoring. The target is: - to increase capture fisheries from the current 7 million tons/year to 10 million tons/year by 2000. - to double inland aquaculture production by year 2000 from the current 7 million to 14 million tons.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Developing sustainable inland fishery management programmes compatible with multipurpose water resources planning and development.		X	X	X
2. Studying specific aspects of the hydro-biology of key inland fish species in relation to water regimes and environmental conditions.	X			X
3. Conservation, mitigation and rehabilitation of aquatic environments to conserve biological diversity of living aquatic resources.	X	X	X	X
4. Establishing data bases on water quality, quantity and channel morphology as they relate to inland fisheries.			X	X
5. Developing environmentally sound inland fisheries and aquaculture technologies that are compatible with local, regional and national water management plans.	X	X	X	X
6. Introducing aquacultural techniques to countries that lack experience in aquaculture.			X	X
7. Assess environmental impacts of aquaculture.	X	X		X
8. Evaluate economic feasibility of aquaculture in relation to alternative use of water.	X	X	X	X

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Providing WSS coverage for the unserved rural poor

Basis for Action:	*Strategy and Programme Targets:*
During the now-completed Water Decade an additional 1141 million rural residents obtained access to safe water supplies, but an estimated 842 million remain unserved at present. Only 427 million rural residents obtains access to appropriate means of excreta disposal, leaving a total of around 1385 million still unserved. There is a need to find the means of improving resource flows to these rural communities and encourage rural inhabitants to undertake local development initiatives with resources available to them.	- Establish national policies which ensure an equitable allocation of development resources to the unserved rural poor. - Promote appropriate technologies, cost recovery policies, and implementation procedures which are suitable for the expansion of WSS coverage in rural areas. - Promote community empowerment and management of rural WSS facilities. - Establish monitoring systems to measure the progress in serving the rural poor. - Establish the target of providing adequate access to WSS services to all rural inhabitants by the year 2000.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Develop policies, strategies and legislation to ensure an equitable allocation of resources to the rural poor;				
1A. Establishment of explicit national policies and development plans for the WSS sector.			X	
1B. Formulation of legislation necessary to support viable water and sanitation systems.			X	
1C. Require external support agencies (ESAs) to channel WSS assistance in conformance with national policies.				X
2. Adoption of appropriate procedures for project implementation and the improvement of WSS services;				
2A. Design rural projects on the basis of effective demand, and what people want and are willing to pay for.	X			
2B. Utilize technologies appropriate to the capabilities of the rural communities.	X			
2C. Adopt cost recovery policies which are compatible with the users´ willingness to pay for WSS services.	X	X	X	
3. Promotion of community empowerment and management of WSS systems through:				
3A. Acceptance of rural WSS as a comprehensive development activity rather than an engineering project.	X	X	X	X
3B. Emphasis on community involvement and participation in the management of WSS services.	X	X		
4. Establishment of monitoring systems to measure progress:				
4A. Identification of a core set of WSS indicators.and establishment of a national monitoring office.			X	X
4B. Implementation of annual monitoring of WSS indicators.	X	X	X	X

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Ensuring sustainability of WSS services in rural areas

Basis for Action:	*Strategy and Programme Targets:*
Problems encountered in implementing programmes to achieve the IDWSSD goals expressed in term of constraints identified by governments include the lack of sufficient funding, inadequate cost-recovery to ensure sector sustainability, insufficient trained manpower, poor operation and maintenance of systems, and lack of community involvement. In addition, improper utilization of systems resulting fro lack of awareness of the health consequences of unhygienic services has often led to less than satisfactory level of health benefits achieved after commissioning of a system.	Ensure the sustainability of WSS services in rural areas through sector strengthening with emphasis on the implementation of institutional development programmes based on efficient management and an appropriate framework for financing of the services. - award high priority to sector plans for drinking water and sanitation; - formulate and implement institutional development programmes with emphasis of the development of human resources, adequate operation and maintenance, sound financial practices, involvement of the women, community participation and hygiene education.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Evaluate water and sanitation facilities, including institutional arrangements for operation, maintenance, planning and financing of these services.	X			
2. Prepare projects for the formulation of the organizational structure of the WSS agencies in terms of their objectives and targets and allocate responsibilities.	X	X	X	
3. Implement institutional development programmes.	X	X	X	
4. Implement public education campaigns directed towards the efficient use of water.	X	X	X	
5. Prepare WSS sector plans and national programmes with particular emphasis on the optimization and sustainability of existing systems, the adoption of appropriate technology in new schemes, institutional development, sound financial practices, and the extension of coverage to marginal areas.		X	X	
6. Establish a forum to encourage national governments and external support agencies to develop common policies.			X	X
7. Promote the exchange of information between water agencies from different countries.			X	X
8. Coordinate and expand international efforts regarding technical and financial cooperation to developing countries, particularly related to sector sustainability.				X
9. Develop guidelines for the sustainability of WSS services to be used by external support agencies and developing countries in the formulation of development plans.			X	

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Health impacts of rural water supply and sanitation

Basis for Action:	*Strategy and Programme Targets:*
The risk factors involved in the lack of adequate water supply and sanitation in rural areas cover a broad range, from contact with contaminated water (schistosomiasis), protozoal, bacterial and viral contamination of water (amoebic dysentery, various enteric infection, hepatitis), and the propagation of guinea worm infection. Water storage in and around houses may create breeding sites for Aedes vectors of dengue hemorrhagic fever. Village ponds and collections of seepage water around hand pumps may contribute to malaria problems. Rigorous care in drinking and eating habits and in personal hygiene, is the most effective way of reducing cholera risk. Inadequate water and sanitation is responsible for 90% of cholera cases.	- A combined strategy of provision of drinking water and sanitation, health education and the elimination of transmission foci should reduce the environmental risks contributing to the schistosomiasis problem. - In guinea worm endemic countries, governments should establish and enforce policies to extend the coverage of water supply services as a priority to the areas most affected by the infection. - Simple and appropriate technology for water purification should be promoted in rural areas, - Community-based action for peridomestic environmental management should be promoted in a concentrated effort of health education, agricultural extension and school education - Establish and implement immediate interventions for the prevention and control of cholera.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. In irrigation project a water supply and sanitation component should be built in.	X	X	X	
2. Monitoring of relevant health indicators should accompany any water supply and sanitation project.	X	X	X	
3. Implement community education methods to promote environmental management in the peridomestic areas.	X	X		
4. Strengthen local health services in relation to the needs.	X	X	X	
5. Educate people at risk with regard to their individual responsibilities in the prevention of cholera and other water-related diseases.	X	X		
6. Promote the use of larvivorous fish for malaria vector control in village ponds.	X			
7. In areas with high levels of diarrhoeas and other enteric infection, focus the WSS activities on sanitation improvement and water quality monitoring.	X	X		
8. Develop and implement multisectoral rapid response interventions for dealing with cholera outbreaks.		X	X	X
9. Develop improved disinfection systems suitable for use with low-cost water supply and sanitation technologies.			X	X

Working Group Theme: Water for sustainable food production and rural development and drinking water supply and sanitation in the rural context

Programme Issue: Capacity building

Basis for Action:	*Strategy and Programme Targets:*
Lack of efficient institutions and trained human resources has been a major cause of inefficient water management for agricultural and rural development. There is an urgent need to assist developing countries to build their capacity to manage water resources.	The major strategy is to create policy and legal frameworks, develop and or strengthen institutions, promote community participation and train human resources. A realistic national level goal for 2000 may include establishing national capacity building policies and programmes and their phased implementation.

Activities and Related Means of Implementation	Level of Implementation			
	L	P	N	I
1. Developing or updating agricultural and rural development related water management policy and legal frameworks.	X	X	X	X
2. Strengthening of institutions based upon human resources development and managerial systems.			X	X
3. Training staff at all levels including farmers and local community members with a special emphasis on upgrading of females´skills.	X	X		X
4. Enhancing involvement of private sector in human resources development and infrastructure.	X	X	X	
5. Promoting transfer of technologies and technical cooperation among local groups and national and international institutions.	X	X	X	X

INTEGRATED WATER RESOURCES DEVELOPMENT

AND

MANAGEMENT

NEPAL COUNTRY PAPER

DR. CHANDRA KANT SHARMA

To be presented at the International Conference on Water and Environment; Development issues for the 21st Century.

26-31 January 1992, Dublin Ireland.

INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

Abstract

Compared to her size Nepal has huge hydropower and water resources potential but due to extremely uneven distribution of these resources in time and space-wise capital intensive storage dams need to be built to meet energy and water resources demand of the people. Due to lack of financial resources very little has been developed. A lot can be done through regional and international cooperation in this field.

Lack of poverty and over dependence on forest are causing environmental problem. Furthermore unharnessed energy of the river is also causing land slide and soil erosion in mountains and sedimentation of unfertile sand on the fertile land in the plain.

For this a long term Integrated Water Resources and Energy Development Programme has to be formulated in such a fashion that it is technically sound and environmentally sustainable and socially acceptable and affordable and economically viable. The proposed eight five year plan tries to accommodate this concept to some extent. Developed countries should help with funds to harness vast water and energy resources of Nepal for the benefit of mankind and also to reduce air pollution by plantation of trees for energy and environment for all and jobs to poorer people. Instead of going to liberal arts which produces clerical types of work force, develop countries should help to proliferate agriculture science education in developing countries so that education is utilized in increasing food production of the countries along with environmentally sound management of the water at local and district levels.

Background Information

The Kingdom of Nepal is located in the mid-sector of Himalayan belt and it occupies an area of 147181 sq. km. Three-fourth of the terrain is mountainous part whereas, the one-fourth consists of plain located in the south. Northern part of the country is occupied by snow covered mountains while in the middle part low lying midland valleys are found. The southern plain is the bread basket of Nepal.

Nepal has about 18 million people. About 92% of the population is engaged in the agriculture. The population is growing at a rate of 2.6% per annum. Most of the population live in scattered villages across the country while about 8% of population is settled in the urban area. Nepal is in the beginning of industrialization and has a few cement, sugar and jute factories. Most of industries run with commercial energy such as hydropower (indigenous) and hydrocarbons (imported). A large sector of the population is still dependent on fire wood for fuel needs. Forest and Agriculture residue provide 96% of total energy need of Nepal.

Water Resources

The annual/average rain fall in the country is about 1500 mm. The average annual rainfall is about 1500 mm which occurs mostly between July and September by the monsoon. Rest of the year except January-February it is mostly dry. Some westerly showers fall between January to February. Out of total precipitation about 72% (174 billion cubic meter) of rainfall goes as run off immediately during the rainy season. About 10 percent is retained as snow cover and 18 percent as ground water. Thus rainfall is not even between time and space-wise.

Use of Water

Consumptive Use

Maximum water is used in the irrigation sector. At present Nepal has 2.64 million hectares (M.H.) of cultivated area (1.36 M.H. in Terai 1.1 M.H. in hills and 0.23 M.H. in mountains). Whereas net irrigated area is 9.33 M.H. (0.7 M.H. in Terai 1.8 M.H. in hill and 0.29 M.H. in mountains). The average consumption is 1 litre per second per hectare. Evapotranspiration is on the average of 1000 mm per annum.

For drinking water about 9% of urban and about 30% of rural population is supplied by piped drinking water. Some places water is treated before it is supplied whereas, in other areas it is supplied directly from source i.e. tube well or gravity system.

For Industrial purpose water is used in processing industries such as tannery paper and carpet which released chemically polluted water. In other industries such as sugar, brick and bread it is used as consumptive. Draining of untreated industrial and municipal wastes to the river system cause water pollution.

Non Consumptive Uses

Water is also used for the generation of hydropower. Out of 83,000 MW potential of hydropower only 232 MW has been developed. Nepal faces shortage of power hence people have shifted either on forest, cow dung, agriculture residue or in the importation of hydrocarbon (Petrol, kerosene and diesel). With the increase of import about 40% of the foreign exchange earning is going to be used in the near future. Those who can not afford to purchase commercial fuel such as kerosene will use fuelwood from the forest which will be depleted very sharply in coming years. Existing forest which is about 38% is being attacked by people to meet their fuelwood, timber, fodder and agriculture land demand. Thus, Nepal faces multi facet environmental problems such as loss of soil cover and frequent landslides, river damming by slide in the hills and dam outburst floods and river aggradation in plains. To develop hydropower very fast it requires a lot of capital, and time, likewise afforestation programme will show result only after ten years of investment. To meet above challenges Nepal is embarking an integrated water and energy resources management plan which will deal water and energy sectors together Integrated Water Resources Development and Management will be one of sub-sector.

The following are the extract from the "approach paper for eight five years plan" to be initiated from 1992 July.

Energy Development

The national energy strategy will have two major elements. One relates to commercial energy (mostly hydropower and fossil fuels) which provides a basis for new economic growth; the other relation to traditional energy (fuel bio-mass) which needs proper management for sustainable economic development and environmental balance.

The management of traditional energy demand and supply involves management of forest and bio-mass resources at the community level and the promotion of efficient and-use technologies, such as improved cook stoves at the family level. This, to a large extent, involves forest management by the local communities. As already indicated, this would have to be carried out by means of the forest user groups. In the commercial fossil energy sector, policy emphasis will be to create an environment for gradual movement towards energy self reliance and energy conservation. Priority will be on the replacement of imported fuels with local forms of energy, so as to mitigate balance of payments problems. In the hydropower sector, the emphasis will be on integration with irrigation, transportation, and energy intensive industries, where low cost energy can provide the needed competitive edge.

A long term Perspective Energy Plan (Master Plan) will be formulated. This will help identify priority areas within the demand and the supply sides of the energy sector in terms of needed long term policies, suitable technologies and appropriate institutional forms.

The energy policies are specified as follows:

a. The Perspective Energy Plan will be used to identify and develop an adequate number of power projects of various scales, particularly in the hydropower sector, so that an adequate number of prepared projects of different scales are readily available for financing and development.

b. For large hydropower projects, an export-oriented development strategy will be adopted. This can earn much needed foreign currency; efforts will be made to encourage bilateral and multilateral initiatives for these developments.

c. For the development of medium hydropower projects, energy intensive industries with high comparative advantage, will be promoted for integration with the hydropower sector, so that, the bankability of the composite can be enhanced.

d. External and domestic private sector initiatives will be promoted in the development and financing of medium and small hydropower projects; adequate legal and institutional arrangements will be made to facilitate exchange and pricing of electrical energy.

e. The hydropower sector will be integrated with the irrigation sector and time of day demand industries. This can improve the load factor of the electricity system and reduce electricity costs.

f. Traditional energy sources such as fuelwood or bio-gas will be produced on a sustainable basis under improved forest management practices by the user communities. The commercialization of traditional fuelwood and biomass energy sources will be promoted thorough institutional and user group pricing mechanisms.

g. Energy demand management will regulate the energy needs of the urban sector. Pricing of various energy sources will reflect their true social costs so as to induce households to adopt more energy efficient devices and equipment. Complimentary import policies will be formulated with respect to transport equipment and machinery.

h. Fossil fuel energy needs of the industrial, commercial and transport sectors will be replaced by indigenous electricity production where practical. Gradual replacement of imported fuels by electricity will be promoted.

i. Development of renewable and alternative energy technologies will be encouraged in order to reduce the present dependence on traditional and imported fuels. Private participation will be encouraged in technology transfer, adaptive research and development, and indigenization of the hydropower, bio-mass, and other renewable energy technologies. Rural energy demands can be met in a decentralized manner through locally produced technology and equipment (e.g., cross-flow turbines, induction generators and gasifiers).

j. Some venture capital and technology promotion institutions will be set up for the purpose of facilitating the manufacture of energy equipment, along with the setting up of the needed mechanisms and policies for judicial and legal services, royalties and patents.

k. Electricity supply to the district headquarters will be provided on a priority basis.

Irrigation

Experience with large irrigation projects indicates the ineffectiveness of these projects in delivering water in a timely manner to all the farmers in the command area. The high costs and low returns associated with these schemes demands a strong set of remedial policies. These policies are broadly specified below:

a. Agriculture and irrigation programmes will be integrated for the maximization of crop yield and gainful utilization of available resources.

b. The management of large schemes is possible only if users are involved in the design of these schemes from the inception and planning stages. Therefore, it should be the norm for these projects to have user group participation early on.

c. The cost per hectare of the present irrigation schemes will be lowered through more efficient designs. The possibility of delivery of water through alternative schemes to the large gravity canal systems will be examined and implemented if found to be cost effective.

d. Locally available technologies and methods will be promoted in community irrigation schemes which will be constructed and managed by the users.

e. Rural electrification and irrigation development programmes will be integrated wherever the potential for ground water irrigation can be exploited.

f. The use of alternative forms of energy such as water power, electricity, bio-gas, photo-voltaic, producer gas and wind power which replace fossil fuels will be promoted for lift irrigation in the terai, the tars and valleys in the hills.

g. Large irrigation schemes will be divided into smaller units for management of water and will be managed through a group of smaller, community units and organizations from within the command area for the collection of the water cess and for the repair and maintenance of secondary and tertiary canals.

h. Private sector participation in irrigation will be enhanced through the promotion of small farmer user groups. For this, subsidies will be provided for capital equipment through rural credit institutions particularly the Agriculture Development Bank. Credit opportunities will be enhanced and access to credit will be widened through collective collateral.

Drinking Water and Sanitation

Safe and adequate drinking water supply and minimum sanitation facilities are basic human requirements without which improvement in the health status of the population at large will not be possible. A majority of the country's population do not yet have access to safe drinking water; and minimum sanitation facilities. Water borne diseases are still endemic in the country.

In view of this situation, the Government is committed to providing safe drinking water throughout the country within the next 10 years. The Government will also implement a complimentary programme of health education and sanitation. The Government is also committed to extending knowledge of low cost on-site sanitation systems. These are herculean tasks. To accomplish them the Government will mobilize cooperation from all quarters, domestic as well as external. Specific policies to achieve these goals are as follows:

a. Local communities will be given the responsibility of planning, implementing, and managing the drinking water and sanitation systems in their areas. The responsibility of managing existing drinking water and sewerage systems in urban areas will be gradually transferred to the municipalities. Increased attention will be given on preparation and implementation of dynamic, district based sector development plans that are based on an inventory of all potential project and priority projects according to sound and objective criteria on an annual basis.

b. Beneficiaries will mobilized to the maximum extent possible in the construction of small-scale, rural drinking water schemes to bring down the construction cost. Drinking water and sanitation charges will be adjusted in a phased manner and based on the principle of cost recovery. The responsibility of managing existing municipal drinking water and sewerage systems will be gradually transferred to the respective user's committees and municipalities.

c. Research on the development of appropriate technologies in drinking water and sanitation systems will be encouraged. Cost effective technologies will be widely disseminated. The role of the private sector and NGOs will be recognized in the implementation of co-ordinated, district-based sector development plans.

d. Existing drinking water source, e.g., traditional stone spouts, natural springs, wells, etc., will be protected, improved and utilized to the maximum.

e. In collaboration with the local communities, the Government will assist educational institutions of all levels to establish and maintain appropriate drinking water and sanitation systems. Priority will be given for the implementation of a linked programme of water supply and sanitation with environmental sanitation and functional linkage will be established between water supply, sanitation and primary health care programmes.

f. Spring protection programmes will be launched in small communities to provide safe water supplies from local traditional sources.

g. Necessary laws will be framed, enacted and enforced to control and protect the drinking water, water sources and maintain the appropriate environmental sanitation standards. Norms of water quality standards will be established.

h. Women's involvement will be encouraged in all phases of water supply and sanitation programmes.

Nepal Experience

Nepal has enough experiences both "top down" and "bottom up" approach in the irrigation, drinking water sectors.

Irrigation Sector

Before country gained independence from autocratic Rana rule, most of farmers managed to form the group and constructed their own head works and canal. This system is continuing in Terai plains in east as well as west Nepal. Local people's demand for water for their land was met by then ruler by employing British engineer as early as 1928. This was managed by Government. Later on in 1950 Department of Irrigation was created and it started, survey design and construction works without peoples participation. Till to date billions of rupees were invested by donor agencies in mega irrigation projects run by Department. Now it is found that farmers in command area of irrigation are not better off than the people outside of the command area. Money has been not properly utilized by engineers and contractors. Peoples participation was not there. Now in stead of organizing by themselves all are pressing the Government to provide irrigation. This has resulted heavy financial load to the Government and mobilization of internal resources is not possible. This has complicated the issue of cost recovery in form of watercess and enactment and enforcement of law. To meet all above objectives the bureaucracy has to be expanded on the cost of farmers.

After Realizing this problem Water and Energy Commission along with Ford Foundation carried out rehabilitation of farmers canal on peoples participation approach. Now, it is found to be successful and this principal is being utilized by some donor agency in some pockets of Nepal.

Now, Agriculture Development Bank gives credit to farmers group for the construction of canal and in this credit Government gives subsidies.

<u>In Drinking Water</u>

In rural drinking water from very beginning the approach was "bottom up" type, with the result most of drinking water projects in hills were built by farmer themselves with Government participation of supply of polythene pipes and cement etc. It is functioning well.

Whereas, in small towns, Government provided "top down approach" to distribute the drinking water. This has created problem to expand the bureaucracy to collect water charges and on the other hand people are paying less than what costs to supply them. In organized system as town it is difficult to raise water charges. On the other hand Government gave some water works to local municipalities which later on could not be run due to lack of technical knowledge as well as financial problem.

How to Meet above Objectives

To meet above objectives both economically and environmentally sustainable manner it has to be done on integrated approach, technical (engineering or scientific), social economic and environmental consideration basis.

Water resources of development and management needs to carried out in a decentralized fashion i.e., "bottom up" approach rather than "top down" by utilizing beneficiaries from the concept to the management of projects. However initially to assess the entire water and energy resources of the country. Water and Energy Commission Secretariat should continue basin study and should prepare master plan in the fields of irrigation and hydropower sectors.

In physical development of Irrigation and Drinking Water projects Department of Irrigation and the Drinking Water Supply should continue to meet the demand of the local people in already identified projects in the Master Plan prepared by Water and Energy Commission by utilizing beneficiaries in the construction and management of projects on cost sharing basis. The local cost of project may be in the form of labour. The water users group which are being organized and registered as N.G.O. in irrigation sector should continue in each project. Peoples participation in Mega project will be difficult in the beginning but it can be applied in secondary and tertiary canals and tube well irrigation system. Tube wells and drinking water supply should be constructed in areas where demand is there and also projects benefit to maximum number of people. To achieve this it requires information management of the existing data base on resource and demand of each district, basin and region.

Environment and Energy

In Nepal Environment is closely linked with the energy supply. For centuries Nepalese people were dependent on fuelwood for their energy need and will continue to do so in coming future unless some substitution is arranged. Hydropower which has enormous potential in Nepal is also a clean energy. At present, only 232 MW out of 83,000 MW is developed. The energy demand inform electricity is increasing and total installed capacity and energy has become insufficient to meet 1991 demand and next project in pipe line is to come after year 2000. How to meet present electricity demand is one challenge and how to save forest from further degradation is another. Even if power plant and afforestation programs are started to day they will bear fruits only after 10 years. To meet the energy gap in coming decade Nepal has to import hydrocarbon from its foreign exchange earning. By year 2000 Nepal's entire foreign exchange will be used in the importation of energy.

On the other hand rural people would not be able to afford to use the imported energy and would continue to rely on fuelwood. This will cause severe environmental problem by way of soil erosion, landslide and pollution of air. Urban area which were partly using electricity, kerosene and wood will switch to kerosene and this will cause more air pollution of urban areas.

To meet the above challenges there are two options:

- Cut down the demand by way of tariff
- Increase the supply

Suppression Demand

Putting heavy tariff in electricity, kerosene and fuelwood will definitely suppress the demand and will help to utilize the resources more efficiently but it will cause be a big problem for decision maker in a democratic set up. Recent tariff increase in electricity upto 60 percent has created widespread dissatisfaction among the people.

Increase the Supply

- By proper use of water resources, food production will be increased and agricultural waste available will also increase. This will help in the development of bio-gas plants to meet the energy need of 1 million people (200,000 plants are feasible in a span of ten years).

- By developing mini micro small, medium hydroplants in all parts of the country one can meet to some extent energy need of the people. For this it also requires gestation period of at least 5 to 8 years. In micro hydro people participation is possible and New Water Resources Law (which is in process) allows private party to participate in the development of small and medium hydro (<50 MW).

- By carrying out heavy afforestation in the barren hill as conceived in the Forestry Master Plan it will provide new jobs to village people in the mountain and also help to restor soil erosion and environmental degradation besides the supply of fuel wood in coming decades. For this privatization of forest sector will induce private sector and peoples participation.

- By enacting new water law it will help investor and users to use resources on one hand and environmentally sound management on the other.

- By watershed management it will help reduce soil erosion and sediment load in the river and mitigating siltation of the irrigated land as well as aggradation of the river bed. For this also people participation is thought essential from the conception to management of project.

- HMG has committed to supply drinking water to all the people by the turn of century. To meet this herculean task, it is only possible through people participation.

Hence it can be said that Nepal is entering in a age of integrated water resources development and management coupled will water and energy sectors integrated management. It has to meet the rising expectation with limited financial resources. For this, people participant is equally import to reduce the resource gap. Water and energy should not be subsidized unless there is enough justification. For this water charges and electricity tariff should be same as cost of generating the goods. If peoples participation is utilized in the form of labour the water charges for maintenance and cost recovery will not be required.

Institutions involved in Water and Energy

Water and Energy

Water and Energy Commission Secretariat is a multidisciplinary institution engaged in the development of water and energy in coordinated way.

Energy

For traditional Energy Ministry of Forest and Environment and Department of Forest and Department of Soil and Water Conservation deal in the matter of forest and environment. Emphasis is given towards community forest and private owned forest.

In commercial energy, Nepal Electricity Authority is responsible for Hydropower development through small medium and large projects. Now Ministry of Water Resources is planning to attract private sector in the development of medium size project on BOT basis or providing buy back rate. Agriculture Development Bank is providing loan to Nepalese entrepreneurs in hydropower development of less than 100 kW. In this, HMG/Nepal provides subsidies in the capital cost.

To meet the energy deficiency Agriculture Bank also provides credit for the development of bio-gas. In this HMG/Nepal also provides subsidy.

For imported commercial energy, Nepal Oil Corporation and Nepal Coal Ltd. are providing coal and oil through their depots spread all over the country.

<u>**Water Resources**</u>

Integrated water resources development multipurpose project for the irrigation hydropower generation and flood control are being developed by Ministry of Water Resources along with Water and Energy Commission Secretariat.

Department of Irrigation, through its 75 district offices covering entire country mobilizes people participation in irrigation schemes. It has also mega irrigation projects which it handles through its individual "Boards" Ground Water is being developed through Ground Water Board and Nepal Drilling Company.

In drinking water Drinking Water Supply Corporation Supply the major cities whereas Department of Drinking Water is engaged for the supply of drinking water in towns. Ministry of Local Development is looking after the rural water supply programme on peoples participation basis.

Ministry of Forest and Environment, Water and Energy Commission, National Planning Commission and King Mahendra Trust for Nature and Conservation are engaged in the environmental impact assessment of the development projects in the country.

Regional Cooperation

Nepal posses enough sites inside the mountain to hold about 100 billion cubic meters of water (out of 200 billion cubic meters of total annual flow) for the generation of inexpensive hydropower, dry season augmentation of irrigational need and also to mitigate the damage created by floods in rainy season, not only for herself but also for the region. Unless countries in the region cooperate to share benefit and cost, Nepal alone cannot be able to harness these resources. By utilizing storing capacity of Nepal the entire region can save coal and oil used in electricity generation and also reduce air pollution caused by thermal and atomic plants.

International Cooperation

As South Asian region is inhabitated by one-fifth of the population of world and the poorest of the poor live there, to alleviate the sufferings caused by pervasive poverty, annual draught and floods integrated water resources development and management is essential. For this international financial help to carry out mega project development is needed.

To keep water resources environmentally sustainable heavy afforestation programmes needs to be carried out in each country. For this developed country should provide help to give jobs to villagers and also to plant trees for carbon sink for the pollution of industrialization.

Furthermore, developing countries such as Nepal need help to expand agricultural and environmental education from school to the college level. At present most of students are graduating in liberal arts for clerical type works. This is creating two problems i) educated unemployment ii) education is not suitable to need of the countries.

Developed countries should also develop cheap and clean technologies for solar energy harnessing and using hydrogen gas as a fuel in industries and transport to make use of water not only for irrigation and drinking water but also for fuel.

Conclusions

Nepal has all required institutions in place for decentralized planning but it lacks the required dedication. Meanwhile, new democratic Government is pushing forward the integrated planning approach in the development and management of water resources in "top down and bottom up" approach.

CONFERENCE INTERNATIONALE SUR L'EAU

ET L'ENVIRONNEMENT DU 26 AU 31 JANVIER 1992

DUBLIN

CONTRIBUTION DE LA REPUBLIQUE DU TCHAD,

PREPARE PAR ALAINAYE DJOGROMEL JEREMIE,

LE COORDONNATEUR NATIONAL DES QUESTIONS

HYDROLOGIQUES

SOMMAIRE

.../...

INTRODUCTION :

L'eau est une précieuse ressource minérale par la multiplicité de ses fonctions. Elle est capitale pour différents aspects de développement : production d'énergie, agriculture, alimentation domestique et industrielle... Compte tenu de l'essor économique et démographique ces besoins sont en augmentation permanente.

La dépendance de l'homme, des plantes et des animaux vis-à-vis de cette ressource est telle que tout changement dans le chimisme ou le physique de systèmes hydrologiques se traduit par de changements dans d'autres caractéristiques écologiques. De ce fait, des projets de développement, d'aménagements des ressources en eau ont eu des effets adverses sur l'environnement naturel et sur d'autres valeurs socio-économiques ou culturelles. Il convient d'évaluer les potentialités exactes des bassins, connaître les relations reciproques qui existent entre les éléments du milieu, définir une politique d'ensemble pour assurer un aménagement fiable et intégré.

Au TCHAD où les aménagements sont à leur début, sans grande ampleur, il est néanmoins souhaitable de partir sur de bonnes bases. Notre écosystème étant de nature très fragile, toute dégradation mettrait notre pays en danger insurmontable.

1. LES RESSOURCES EN EAU DU TCHAD

Les Ressources en Eau du TCHAD sont inégalement reparties dans le temps et dans l'espace.

1.1. LA PLUVIOMETRIE :

La pluviomètrie décroit régulièrement du Sud vers le Nord avec quelques influences orographiques très localisées : Massif de Djebel Marra à l'Est, le Massif Central du Guéra, etc...

En année normale de pluviomètrie, elle varie ainsi de plus de 1.200 mm à moins de 50 mm. Son irrégularité interannuelle, saisonnière dans l'espace et dans le temps la rend très précaire pour les activités socio-économiques, pour le remplissage des réservoirs superficiels et souterrains. Cela est particulièrement ressenti ces 25 dernières années caractérisées par le phénomène de séchèresse généralisée. L'irrégularité est telle qu'en année de séchèresse, il peut se produire des inondations car la plus grande partie de la pluviomètrie annuelle peut survenir en un temps très bref pour présenter une abondance destructrice.

.../...

1.2. LES EAUX DE SURFACE

Elles sont étroitement soumises au régime des précipitations annuelles et présentent :

- une période de hautes eaux durant la saison pluvieuse et les premières semaines qui en suivent (Juillet à Décembre), puis

- une période de basses eaux pour certains cours d'eau et lacs permanents. La plupart s'assèche après les dernières pluies.

Ainsi les principales ressources en eau de surface sont constituées par les eaux du Chari, du Logone, du Mayo-Kebbi, du Batha et des lacs: Tchad, Fitri, Iro, Léré, Fianga, Tikem. De nombreux cours d'eau et mares temporaires se forment suivant l'improtance des précipitations de l'année, puis disparaissent par infiltration et par évaporation.

Chari-Logone : 34,4 milliards de m3 en moyenne.

Lac-Tchad : un peu moins de 49 à 105 milliards de m3.

1.3. LES EAUX SOUTERRAINES

Trois grandes formations géologiques déterminent les conditions de gisément des principales nappes aquifères du Tchad.

1°) - Le socle cristallin au Centre-Est du pays renferme de faibles potentialités localisées dans des unités hydrogéologiques discontinues.

2°) - Les plateaux gréseux au Nord du pays (BET) contiennent d'importants aquifères encore mal connus.

3°) - Les réserves aquifères de la cuvette tchadienne.

Les formations sédimentaires du tertiaire et du quaternaire couvrent presque la moitié Sud du pays. Elles constituent les principales couches aquifères généralisées reparties à 3 niveaux :

- niveau statique entre 20 à 60 m pour l'aquifère de formations quaternaires pluvio-lacustres et de sable éoliens ;

- 250 à 350 m pour la nappe des séries argileuses pliocènes en charge et artésien au tour du Lac-Tchad.

- l'aquifère de grés et sables argileux du continental terminal avec un niveau situé de 80 à 400 m de profondeur.

Les réserves renouvelables annuellement en eau souterraine sont de l'ordre de 20 000 millions de m3.

.../...

2. ETUDES REALISEES & INSUFFISANCES ACTUELLES

Les études entreprises depuis le début du siècle par les Organismes français, puis par l'Agence pour la Sécurité et la Navigation en Afrique (ASECNA), la Direction des Ressources en Eau & de la Météorologie (DREM) et le Bureau de l'Eau ont permis de disposer de séries appréciables des données sur cette ressource.

A l'heure actuelle, on dénombre :

- 51 stations climatologiques (ou stations similaires) ;
- 137 postes pluviomètriques ;
- 54 stations hydrologiques ;
- quelques piézomètres.

Pour un pays de 1 284 000 km2, cela s'avère nettement inférieur aux normes adéquates. Des lacunes subsistent donc dans différents domaines. Il est nécessaire aujourd'hui de les parfaire afin de fournir de base fiable aux besoins d'aménagements socio-économiques.

1. Le réseau pluviomètrique actuel est peu dense pour permettre d'apprécier la variable précipitation qui se caractérise par son irrégularité spatiale. Il en est ainsi des autres paramètres climatiques intervenant dans le bilan hydrologique.

2. Le réseau hydrologique couvre uniquement les principaux cours d'eau et lacs. Il est nécessaire de l'étendre aux cours d'eau temporaires et grandes mares. Les réseaux urbains de drainage constituent un autre volet important auquel, les mesures sont indispensables.

3. Les suivis des transports solides, de la nature physico-chimique, biologique et de la qualité de l'eau, restent un défit pour le pays. Les aménagements hydro-agricoles, la pollution industrielle et la pression démographique introduisent chaque jour des variations dans les milieux aquatiques qu'il convient de suivre pour préserver l'homme et l'environnement immédiat.

4. Le suivi piezomètrique des nappes phréatiques dans les zones du socle et l'évaluation des nappes plus profondes restent tout entier à faire.

5. Une surveillance régulière des différents paramètres du système hydrologique permettra de détecter les changements climatiques qui sont en cours et qui ne sont pas toujours propices à l'homme et son milieu physique.

.../...

3. LES AMENAGEMENTS, UTILISATION & DANGERS POTENTIELS

La stratégie du développement du secteur rural, document de travail établi en 1988 par des Comités ministériels de planification a retenu les principaux axes d'exploitation de l'eau en tenant compte des besoins généraux, de l'Agriculture, de la Pêche, de l'Elévage et de la consommation domestique.

3.1. AGRICULTURE

Les aménagements en cours de réalisation ou projetés pour l'immédiat totalisent environ 11 650 ha pour l'irrigation et 21 500 ha de plaines soumises à l'épandage naturel de crues. Ce sont notamment :

- les polders et ouaddis de la SODELAC : 4 200 ha
- le Casier A : 1 400 ha
- le Caiser B : 800 ha
- le Casier C : 48 ha
- les Zones de l'ex-OMVSD : 3 570 ha
- Eré Nord : 633 ha
- les Périmètres CARE : 300 ha
- les Petits Périmètres proches de N'DJAMENA : 360 ha
- les Petits Périmètres du BET : 100 ha
- les Périmètres Irrigués du Chari de GUELENDENG : 105 ha
- les Ouaddis du Kaneru : 75 ha
- ASSO : 34 ha
- MISKIEV MAILAO : 22 ha
- les Plaines du BATHA : 15 000 ha
- les Plaines d'AM-TIMAN :6 500 ha

La liste n'est pas exhaustive. Le prélèvement s'élèvera à 5C millions de m3 sur la base de 1 500 m3/ha.

3.2. PECHE :

Il est recommandé d'assurer une production continuede la pêche dans toutes les zones où celle-ci est possible. Ce qui suppose le maintien de l'environnement sain du système Chari-Logone, Lac-Tchad, Lac Fitri, Lac Léré...

3.3. ELEVAGE & CONSOMMATION DOMESTIQUE :

Le programme d'hydraulique fixe des objectifs nécessaires pour les différents besoins que les moyens permettront de mettre progressivement en place :

- 5 900 forages pour la consommation domestique (1 forage pour 500 habitants Pour l'an 2 000 on estime à 95.9 millions de m3 la consommation annuelle.

- 3 000 puits pastoraux. Consommation estimée à 60 millions de m3 pour l'an 2 000.

.../...

3.4. INDUSTRIE :

La consommation industrielle n'est pas estimée. Elle est certainement minime, mais il faut tenir compte de son effet sur la qualité de l'eau à la longue. La projection du bilan diagnostic de l'hydraulique rurale du Tchad, la chiffre à 15 millions de m3 pour l'an 2 000.

A première vue, tout cela s'avère insignifiant au regard de la disponibilité actuelle de l'eau. Mais cela n'est pas statique. La démographie, la sécheresse, les transformations à l'échelle locale, régionale font peser une situation imprévisible. L'évaluation et la surveillance continue tant du point de vue quantitative que qualitative s'imposent pour l'harmonisation d'une politique de développement intégré et durable. Il convient en effet de signaler que toute perturbation anthropogène de la composition de l'hydrophère et du régime des eaux naturelles donne lieu à de modifications écologiques profondes.

3.5. EFFETS DE L'AGRICULTURE :

Sans eau, impossible de développer l'agriculture surtout dans nos régions arides aussi fallait-il y mettre en place des systèmes d'irrigation. Cette expansion de l'irrigation changera progressivement la qualité des écosystèmes, des nouvelles concentrations végétales apparaîtront sur les sols irrigués, tandis que la construction de barrages et canaux ainsi que le travail du sol modifieront l'aspect de la surface terrestre.

Pour augmenter la production, la consommation d'engrais, d'insecticides va croître. On estime que 60 % des engrais fournis sont consommés par les plantes, le reste disparaît dans l'eau superficielle ou sous-jacente par la voie de l'irrigation. L'excès d'azote résultant de ce processus entraine au contact des matières organiques en décomposition la formation de nitrites qui détruit la faune aquatique. Salinisation et alcalinisation sont parmi les grands dangers car toute parcelle de terre irriguée étant ménacée en permanence par ces fléaux.

On fait également une consommation importante d'insecticides. Utilisés en concertrations nombreuses et variables, ces produits ont des effets sur l'homme, la faune et la flore.

Hormis tout cela, les systèmes d'irrigation peuvent causer de dommages considérables aux poissons, par exemple, les barrages peuvent empêcher la migration des poissons, la reduction des débits en aval des dérivations peuvent porter tort à la vie des poissons.

.../...

3.6. EFFETS DES AGGLOMERATIONS & DE LA POLLUTION INDUSTRIELLE :

On peut altérer directement les eaux superficielles et souterraines en deversant des déchets et des effluents dans les cours d'eau ou autres lieux où la contamination de ces lieux peut facilement se produire. Nos villes ne sont pas équipées de systèmes d'égouts. Ces défaillances risquent de se solder par une contamination de l'eau souterraine. La contamination s'opère généralement à partir des :

- résidus des ensembles communautaires ;
- substances chimiques.

Les déchets de tous genres, et notamment ceux des animaux domestiques, sont devenus une source de pollution des eaux. Le nettoyage des écuries, des étables, des porcheries et des poulaillers produit d'énormes quantités d'eau usées. On peut citer également les tas de fumier d'où les engrais liquides s'écoulent dans les eaux souterraines puis dans les cours d'eau voisins, les déchets solides pour le recyclage ou l'élimination desquels il reste encore à trouver un moyen sûr.

Les eaux domestiques usées sont une grande source de microbes dans les agglomérations. Les déchets les plus difficiles à éliminer sont les matières fécales.

La conséquence de tout cela est l'épuisement de l'oxygène dissous qui peut entraîner une serieuse mortalité chez les poissons, la contamination de l'eau potable par les maladies infectueuses dans les nappes souterraines et les conduites, ainsi que dans les puits.

Cela soulève des problèmes auxquels beaucoup de pays sont déjà confrontés. Il est souhaitable d'en tirer des leçons pour ne pas en arriver là. L'aménagement des eaux doit reposer sur l'examen de chaque bassin en tant qu'une unité hydrologique limitée. Ainsi, il est nécessaire de préparer des plans d'aménagements et de formuler des projets visant à l'exploitation des ressources en eau du Tchad. Toute mesure perturbant le cycle hydrologique peut alors être appliquée de manière compatible avec les besoins futurs de la société et l'écart entre le rendement actuel des ressources hydriques et les besoins de l'homme reduit au minimum.

4. NECESSITE D'UNE POLITIQUE, DE LEGISLATION & DE GESTION ADEQUATE DES RESSOURCES EN EAU :

Pour parvenir à une utilisation rationnelle de l'eau, il est nécessaire de coordonner ou de centraliser la gestion des ressources et de concilier les demandes contradictoires et complémentaires dans les programmes intégrés de mise en valeur et de conservation. Il faut donc se préoccuper de la réorientation et de la modernisation des organisations et institutions compétentes ; et ce, sous 3 aspects principaux :

- la politique de l'eau ;
- la législation ;
- les institutions.

4.1. POLITIQUE DE L'EAU :

Cette politique a pour objet de garantir l'utilisation la plus avantageuse et la conservation optimale des eaux disponibles, en se basant sur le cycle hydrologique, la demande actuelle et les besoins futurs estimés. Elle doit se fonder sur les principes suivants :

- définition comprenant tous les types de l'eau ;
- en tant que ressources naturelle, l'eau doit être declarée bien public ou soumis au contrôle de l'Etat ;
- droit de personnes physiques et morales à utiliser l'eau ;
- priorités d'utilisation souple de manière à répondre au contexte présent et futur sous réserve que la première priorité aille à la consommation domestique ;
- protection juridique des usagers présents et futurs et droits d'usage compatibles avec tous les facteurs en jeu, notamment la protection de l'environnemnt ;
- droit de l'Etat à contrôler les utilisations, dans les zones ménacées par la dégradation, les déchets, une mauvaise utilisation et une surexploitation.
- ...

4.2. LA LEGISLATION DES EAUX :

La législation des eaux est un instrument qui permet de mettre en oeuvre et de faire respecter une politique. Elle doit tenir compte des caractèristiques sociales, réligieuses et philosophiques du pays. Elle doit comporter les dispositions portant sur les points suivants :

- propriété de l'eau, elle est à définir clairement tant pour l'eau que pour les lits des cours d'eau,les berges et toutes autres dépendances nécessaires.

- droit d'usage de l'eau, il doit être distinct du droit de propriété ;

- conservation de l'eau, dispositions portant sur les aspects de la santé publique, l'amélioration des approvisionnements, le drainage, la saturation, la salinisation, la prévention de la pollution et la lutte contre celle-ci, la protection de l'environnement ;

.../...

- Administration des droits et organismes officiels, l'allocation des ressources en eau quant à la quantité, la destination et la fréquence, doit être centralisée par une administration agissant selon le cas au niveau de l'Etat, du bassin ou au minimum du sous-bassin dans le cas de grands bassins. Il est indispensable d'instaurer une coopération institutionnalisée coordonnée entre tous les organes ayant un contrôle sur les ressources en eau.

- Critères d'évaluation des priorités et d'approbation des projets : ils doivent se fonder sur les facteurs financiers, économiques, sociaux, techniques et notamment sur les nécessités de la protection de l'environnement.

- Utilisations profitables de l'eau : elles doivent englober les usages ménagers, agricoles, industriels, l'énergie hydro-électrique, la pêche, les transports, les loisirs, la protection des sites etc...

- Lutte contre les actions nocives de l'eau : inondations, salinisation, érosion du sol, débordement, drainage défectueux, protection des berges etc...

- Qualité de l'eau, lutte contre la pollution, protection sanitaire.

- Promotion des associations d'usagers de l'eau regroupant un grand nombre d'usagers en une seule personne juridique apte à participer localement à la gestion de l'eau.

- Pouvoir de décréter certaines zones protégées en cas d'urgence : sécheresses, inondations, tarissement des nappes aquifères, conflits en matière de l'eau, pollution,propagation des maladies transmises par l'eau, dégradation de l'environnement etc...

- Coordination et harmonisation de diverses règlementations ayant des incidences sur l'eau : forêts, pêches, logement, utilisation des terres, urbanisme, etc...

- Compétence pour élaborer des règlemtnations touchant tous les aspects de la loi fondamentale ou du code.

4.3. INSTITUTIONS & ADMINISTRATION DES EAUX

Il est nécessaire de créer des institutions au plan national, régional local, international ou l'échelle du bassin selon les besoins.

Au plan national : la coordination politique et technique ainsi que le contrôle administratif des ressources peuvent être assurés par un Conseil National de l'Eau qui réunierait les ministres exerçant des responsabilités sectorielles en matière d'eau. Un tel organe pourrait définir la politique globale de la nation pour l'eau ;

- décider de l'attribution de l'eau aux divers objectifs ;

.../...

- étudier les problèmes relatifs à l'environnement.

On pourrait créer une Commission de l'Eau, de caractère technique et économique composé des techniciens, économistes et juristes compétents des divers ministères. Les associations d'usagers seraient représentées.

Il pourrait avoir un rôle d'exécution ou de consultation. Il est nécessaire de le doté d'un secrétariat permanent.

Au plan de la région, du bassin ou sous-bassin : prévoir des institutions régionales fonctionnant soit comme divisions ou départements d'une administration des eaux unifiée soit comme organe plus ou moins autonome.

Au plan international, lorsque se posent des problèmes de caractères international relatifs à l'environnement à des bassins ou à des nappes aquifères, il est nécessaire de créer des institutions de cours d'eau ou de bassins afin :

a) - d'échanger des données hydrologiques et autres ;

b) - de soumettre les propositions de projets touchant un autre Etat d'un même bassin ;

c) - d'instaurer une coopération technique en vue d'une mise en valeur intégrée ;

d) - de prévenir ou règler tous les litiges se rapportant à la repartition équitable et à la conservation des ressources hydriques ;

e) - de réunir et conjuguer les efforts pour trouver plus facilement un financement.

En matière d'institutions, il faut dire qu'il existe au Tchad :

- Un Comité de Coordination de l'Hydraulique ;

- Un Comité National de l'Eau et de l'Assainissement avec un Bureau Technique National.

Ces Comités ne sont pas aussi opérationnel qu'on aurait souhaité pour assurer la bonne marche des tâches qui leur incomberont.

Une redynamisation pour leurs rôles à l'avenir permettrait de pallier à ces vides qui planent actuellement. Sur ce même élan, l'élaboration d'une politique en la matière et les textes administratifs afférents pourrait surgir pour compléter la machine administrative.

.../...

CONCLUSION :

Les ressources en eau constituent un bien public qu'il convient de gérer comme les autres ressources naturelles pour assurer un développement socio-économique de la société. Il faut dire qu'elles sont limitées. On doit se préoccuper d'assurer en quantité et qualité suffisantes, un approvisionnement en eau qui pourvoie à la consommation de chaque individu, aux nécessités de la production alimentaire, de l'industrie ainsi que des loisirs et autres activités économiques et sociales. On doit aussi protéger ces ressources pour les générations futures.

Les services nationaux doivent établir des critères scientifiques pour la recherche, la documentation et l'échange d'information sur la planification, la gestion et l'utilisation de l'eau. Utiliser immédiatement ces données pour la prise des décisions. Il faut donc définir, prendre des mesures et instaurer une coopération intergouvernementale pour planifier, aménager et mettre en valeur les ressources en eau d'une région donneée. Nous avons encore du chemin à faire mais cela est parfaitement réalisable avec une certaine volonté politique soucieuse de l'avenir.

**GUINEA-BISSAU WATER AND SANITATION
MASTER PLAN**

SUMMARY AND CONCLUSIONS

I. BACKGROUND AND OBJECTIVES

It is a paradox that, with exceptionally favourable natural conditions and substantial potential resources, Guinea-Bissau can only offer its inhabitants one of the lowest incomes in Africa and the shortest life expectancy.

One of the major problems is water, sometimes available in quantity, but rarely in quality. Many serious health problems facing the population are related to water and sanitation.

For that reason, the Master Plan ~~proposed here~~ elaborated is a genuine priority of the country and an essential step for its development.

Its prime objective is improvement in the coverage of water and sanitation requirements, both to make up for delays in this sector and to keep pace with the demographic evolution of the country.

Efficiency dictates the definition of a programme of actions capable of bringing about that improvement in the shortest time possible and to the greatest number of people. In that sense, priority is given to the satisfaction of needs of the productive and most populous areas, particularly in the most heavily populated rural villages, the semi-urban centres and the suburban neighbourhoods of Bissau. - the Capital

~~This~~ The Master Plan defines a short and medium-term programme, divided into three sub-programmes:

1992-1995
1996-1998
1999-2001

It necessitated, as a result of insufficient basic statistics, the formulation of a certain number of hypotheses to be verified and actualized over the coming decade. This Plan should thus be considered flexible in function of new data as they are gathered, particularly with respect to demographics and water consumption.

The Plan concerns primarily drinking water supply and sanitation, as well as management of water resources; agricultural projects, which are the object of another programme, have only been taken into account in estimating resources and needs.

II. THE CONTEXT

From the 767,739 inhabitants enumerated in the 1979 census, the population has increased to 1,053,000 (estimated) in 1991 and will reach 1,364,000 in 2001. The average growth rate is estimated at 2.25% until 1991 and 2.5% thereafter. The population of Bissau will increase more rapidly, from 110,000 inhabitants in 1979 to 180,000 in 1991 and 252,000 in 2001. In 1979, four towns had more than 5000 inhabitants.

The country's <u>per capita</u> GNP is $ 160 per year, one of the lowest in Africa, although it is improving thanks to the 1987 Structural Adjustment Program, which is yielding encouraging results. The economy is based on rainwater agriculture with one yield per season, which benefits from plentiful rainfall and large fertile arable areas, but food self-sufficiency, which is an altogether attainable objective, has not yet been reached.

Despite all efforts to date, water supply is satisfactory for only one portion of the population (34%). The sanitation network is often old or absent. Equipment is insufficient and its management cannot be assured for lack of funds and trained personnel.

The Water Code, approvadet recently by the government ~~in the process of Government approval~~, ~~will~~ set the main direction and functions of each of the organs concerned, as well as establish the basis for organizing water resources management and the administration of water rights.

The main constraints encountered were insufficient community participation and the weakness of water supply exploitation infrastructures.

A series of projects has already been executed with external financing, both international and national, but the needs are great in relation to external assistance which has decreased regularly since 1986.

III. WATER RESOURCES

Surface water resources are abundant, but unevenly distributed, since 90% runs off over six months and only over the eastern half of the country; they total 14,260 Mm^3 in an average year, but only 6,800 Mm^3 in a decennial dry year. These resources are hardly developed or tapped at all.

Superficial groundwater aquifers are productive everywhere: at several hundred Mm^3/a (10-250 mm/year depending on the area), but pumping rates are low and there are salinity problems near the seashore.

Deep aquifers, still poorly known in the southern province, would have much more limited renewable and exploitable resources, roughly 10 to 30 Mm^3/a.

Guinea-Bissau has 2270 modern waterpoints (boreholes and wells) of which 14% exploit the deep aquifers. Actual exploitation of groundwater aquifers is estimated at 15 Mm^3/year.

IV. WATER DEMAND

Actual and future water demand for the year 2001 has been evaluated as follows:

Rural water supply:	6.5 Mm^3 in 1991 and	8.3 Mm^3 in 2001
Semi-urban centres:	2.9 Mm^3 in 1991 and	3.7 Mm^3 in 2001
Bissau:	10 Mm^3 in 1991 and	14 Mm^3 in 2001.

These needs are theoretical, in the hypothesis a total domestic water supply coverage;

Cattle water supply:	3.2 Mm^3 in 1991 and	3.9 Mm^3 in 2001
Irrigation:	137 Mm^3 in 1991 and	210 Mm^3 in 2001.

If rural water supply requires mostly superficial aquifers where resources are generally sufficient, the supply network of the urban areas, particularly Bissau, taps groundwater aquifers, and there, the problems are as large as the resources.

In irrigation for rice cultivation, primarily surface water is used; fruit trees and vegetable gardens sometimes use water from superficial aquifers which is plentiful but with small yields per well, or from deep aquifers.

Pastoral water supply uses essentially surface water and sometimes superficial aquifers; resources are abundant and the pumping rates are low; local supply problems arise in the dry season.

V. PLAN OF ACTION

Sectoral policy addresses drinking water supply and sanitation services, support to water-related sectors, and the management and utilization of water resources.

Its objective is water-user satisfaction, through equitable and sufficient distribution, and the installation of supply systems to meet any increase in demand.

External funding for the installation of water supply and sanitation systems is necessary now more than ever. The "user pays" principle for financing exploitation costs has been accepted, transitional measures having been taken to set a price compatible with local revenue.

At the management level, the DGRH (General Directorate for Water Resources) determines policy direction and actions to be taken. The Water Code application decrees should permit it to be put rapidly into practice.

The investment programme is concerned with project proposals in the following areas:

- the construction of 2500 new boreholes and wells and 780 rehabilitations for rural water supply

- construction and rehabilitation of water points and the distribution network for secondary urban centres

- completion of the extension of Bissau's present water network, in extension of the AFDB programme

- urgent action to supply Bissau's periurban areas

- rural and urban sanitation actions including construction of latrines in villages and semi-urban centres, upgrading of the rainwater network in semi-urban centres, and support to Bissau for cleaning septic tanks and for garbage collection.

Substantial aid is foreseen for establishing efficient management systems, both at the level of central services and regional centres and villages, with user sensitization and community participation at all stages of exploitation.

A series of studies is programmed, for example to evaluate pastoral hydraulics needs, for a Bissau sanitation plan, for water resources management of the Geba and Corubal basins, or else in the geological and hydrogeological fields, to increase knowledge and control catchment conditions and water resource exploitation with a view to conservation and protection.

VI. INVESTMENT PROGRAMM[illegible]

investment programme as a whole for the
been budgeted at $ 75 M.

that amount, $ 38.2 M will be devoted to the
: following breakdown:

inking water supply:	US $	30.
storal water supply:		0.[illegible]
.nitation:		7.3

or the urban areas the following has been foreseen:

ırban water supply:	US $	15.3 M
semi-urban water supply:		5.9 M
sanitation:		8.5 M

For the studies on mobilization of water
ources and institutional support: US $ 6.7 M

Among other things, this investment programme will permit
country as a whole to increase its average rate of water
ıply from the present 34% to 86% in 2001.

VII. CONCLUSION

The proposed Master Plan programme has been intentionally restricted to remain within reasonable financial limits. The proposed actions are homogeneous since they comprise one portion of investment for infrastructures judged absolutely indispensable, a reinforcement of the institutions for proper administration of funds and human resources, substantial assistance to management, and sensitization activities towards increased participation of the local communities.

This programme must be considered as a minimum one in view of the magnitude of the needs and the extended duration of the population's aspirations to a better life.

R E P U B L I C A   D E L   E C U A D O R

INSTITUTO NACIONAL DE METEOROLOGIA E HIDROLOGIA

AGUA Y MEDIO AMBIENTE
EN EL ECUADOR

Quito, enero 1992

I N D I C E

INTRODUCCION.-

La humanidad, ha basado todas sus actividades en la irraracional y constante utilización del agua, confiada en la abundancia y pureza del recurso en el planeta. Si tomamos en cuenta que en las últimas décadas, uno de los grandes problemas que afectan a la humanidad, tiene su raiz en el desequilibrio provocado por el hombre en el medio ambiente.

En efecto, la contaminación como resultado de la acción directa del hombre, constituye y sobresale entre muchas de las calamidades que afligen a la humanidad contemporánea, presentando signos de graves alteraciones, con frecuencia irreversibles, que permitan valorar el problema en sus verdaderas proporciones.

El estilo de desarrollo del país, inspirado básicamente en el crecimiento económico, orientado al mejoramiento de la calidad de vida de una parte de la población, en la mayoria de los casos ha permitido el uso irracional de los recursos naturales renovables en especial del recurso hídrico, lo que ha ocasionado su constante deterioro, afectando la calidad de vida de toda la población.

La situación conflictiva de los usos inapropiados de los recursos renovables y las graves consecuencias que está experimentando el medio ambiente, ha inducido al gobierno, entidades nacionales, seccionales o regionales a tomar acciones concretas, identificar áreas degradadas que requieren mayor atención en su manejo ambiental.

El INAMHI, como ente rector de las actividades hidrológicas y meteorológicas del país, ha considerado de singular importancia desarrollar las actividades concernientes a determinar la calidad del recurso agua tanto superficial como subterránea, por lo que a través del Departamento de Aguas Subterráneas y Sedimentología ha constituído dos tipos de redes: superficial y subterránea, en las que periódicamente se viene realizando el muestreo para el análisis físico-químico del agua, de acuerdo a las necesidades específicas planteadas tanto por el INAMHI como por Organismos Gubernamentales, que requieren de esta información.

GENERALIDADES

El presente informe es un aporte del Ecuador a la Conferencia Internacional sobre el Agua y Medio Ambiente, a desarrollarse en Dublín - Irlanda del 26 al 31 de enero de 1992.

Los temas desarrollados son los que se han considerado como objetivos principales de la mencionada Conferencia, los mismos que se detallan a continuación:

EVALUACION DEL RECURSO HIDRICO

Para la evaluación y gestión de los recursos hídricos el Instituto Nacional de Meteorología e Hidrología cuenta con una red hidrometeorológica distribuída en todo el país, compuesta por 125 estaciones hidrométricas y 176 estaciones meteorológicas, con una serie homogénea de parámetros hidrológicos y meteorológicos de 25 años de registros de información básica que se utiliza en la ejecución de proyectos de aprovechamiento de los recursos hidráulicos. En el cuadro No. 1 se presenta el potencial hídrico existente en el país, obtenido del informe Balance Hídrico del Ecuador realizado por el INAMHI.

AGUA Y DESARROLLO AGRICOLA

El Instituto Ecuatoriano de Recursos Hidráulicos (INERHI) es la entidad en el país que administra el recurso hidráulico para el riego a través de sus respectivos districtos especificados en el Cuadro No.2 del Anexo, del indicado cuadro se define que un 78% de la área de riego administrada por el INERHI se encuentra utilizada.

El regadío en el país administrado por el INERHI comprende de 90.405 Ha.con un caudal de 65 m3/s. El regadío particular (Cuadro No.3) es del orden de 476.597 Ha. que utilizan 225 m3/s dado un total en el país de 567.002 Ha. que consumen un caudal de 290 m3/s., correspondiendo el regadío particular a un 84% y el estatal un 16%.

En lo referente a electrificación en el Ecuador se utiliza un caudal de 40 m3/s., para generar el 95% de energía hidroeléctrica que requiere la actual demanda.

ABASTECIMIENTO DE AGUA Y SANEAMIENTO

El Instituto de Obras Sanitarias IEOS y las Empresas de Agua Potable del país son los organismos rectores, ejecutores de los proyectos de agua potable y de saneamiento ambiental.

Con la finalidad de presentar una visión de la situación actual del país, referente a la dotación de agua potable y al tipo de abastecimiento que la población realiza de este recurso se ha elaborado los cuadros No.4 y 5. Ver Anexos.

Del Cuadro No.4, se puede definir que el 48% de la población utiliza el agua para usos domésticos provenientes de fuentes como: pozos o vertientes, río o acequía y distribución por carros repartidores, es decir agua no potabililizada, con los consecuentes peligros para la salud debido a la contaminación que se presenta producida por varias causas.

Los requerimientos de dotación de agua potable en la zona urbana y rural son el 20% y 76% respectivamente.

A continuación se presenta la demandad de agua para los años 2000 y 2020 de la Capital de la República.

QUITO

Año	Población Total	Población Servida	%	Demanda l/h/día	Caudal l/seg.
1990	1'095.000	885.179	80.8	300	3.073
2000	1'676.000	1'508.400	90.0	300	5.238
2020	3'535.000	3'535.000	100.0	300	12.274

CALIDAD Y CONTAMINACION DEL AGUA

Para el presente informe se seleccionó 6 cuencas hidrográficas del Ecuador, consideradas como prioritarias que requieren mayor atención en su manejo ambiental, debido al actual deterioro y contaminación de sus aguas en la que se encuentran.

Las cuencas seleccionadas se presentan en el siguiente cuadro:

No.	CUENCA	AREA drenaje Km	CAUDAL MULTI anual m^3 /S	OBSERVACIONES
1	Río Mira	6490	210	Cuenca ubicada al norte del pais (límites con Colombia)
2	Río Pastaza	8010	115	Ubicada en el centro del país.
3	Río Guayllabamba	3270	47	Ubicada en el norte del país.
4	Río Puyango	3690	21	Ubicado al sur del país (límites con el Perú).
5	Río Arenillas	2725	72	Ubicado al sur del país
6	Río Portoviejo	2230	12	Ubicado en el litoral ecuatoriano.

Las cuencas indicadas anteriormente presentan problemas del uso inadecuado de los recursos tierra y agua, caracterizados por la deforestación, erosión acelerada, alta tasa de sedimentación, alta densidad demográfica, expansión descontrolada de los centros urbanos y contaminación del agua por vertidos de desechos humanos e industriales. A continuación se presenta un resumen de la situación actual referente a la contaminación del recurso hídrico.

CUENCA DEL RIO MIRA

Esta cuenca se encuentra ubicada en la parte norte del país (límites con Colombia) tiene un área de drenaje de 6490 Km2, una precipitación media multianual de 1790 m.m. y una escorrentía de 210 m3/S; presenta un alto grado de deforestación. De acuerdo a los resultados de los análisis realizados en la Cuenca, se define que un 70% de las fuentes superficiales tienen una degradación respecto a su calidad para los diferentes usos ya que se encuentran contaminadas, en alto grado con materiales orgánicos e inorgánicos, esta contaminación se presenta especialmente a la salida de las ciudades principales (Tulcán, Ibarra, Otavalo, San Gabriel). Los contaminantes detectados son los siguientes : nitrito un 0.1 mg/h.,fosfato un 1.3 mg/l sobrepasando los límites permitidos por la O.M.S. que son de 0.02 mg/l y 0.5 mg/l respectivamente.

La indicada contaminación es producida por los aportes de aguas servidas, desechos industriales y excesos de fertilizantes.

Del análisis realizado en muestras de agua de los lagos de la cuenca del Mira, a excepción del Lago Mojanda, los demás están contaminados, y en franco proceso de deterioro. El Lago San Pablo es el que mayor grado de contaminación orgánica e inorgánica presenta, (nitrito alrededor de 0.8 mg/l; fosfato alrededor de 1 mg/l.), lo que ha insidido en la paulatina desaparición de las especies bioacuáticas.

Con respecto a las fuentes subterráneas, del análisis realizado de 120 muestras de pozos y vertientes de la cuenca del Mira, se desprende que en particular la parte central y sur de la cuenca presenta cierto grado de contaminación orgánica e inorgánica, debido a la presencia de iones contaminantes como son: fosfato, nitrito, amoníaco, en concentraciones fuera del rango permitido.

Se debe indicar que los pozos son someros y satisfacen las necesidades de grupos familiares.

CUENCA DEL RIO PASTAZA

Se ubica en la parte central del país, tiene un área de drenaje de 8010 (parte alta de la cuenca), una precipitación media multianual de 600 m.m. y una escorrentía de 115 m3/s. existen un

40% de áreas deforestadas. En esta zona del país existe un gran deterioro de la calidad física del agua, debido a la gran magnitud del proceso erosivo. Entre los iones indicadores de la contaminación está el fosfato el cual se encuentra significativamente en casi todos los ríos de la Cuenca, y con un alto valor a la altura de la ciudad de Baños 1.7 mg/l y a la salida de la ciudad de Ambato con un promedio
de 1.26 mg/l, los ríos de la cuenca presentan un alto grado de contaminación inorgánica ya que en ellos vierten aguas servidas y desechos industriales.

El valor mas alto de nitritos detectados en la cuenca es de 0.5 mg/l.El ion amonio se encuentra en una concentración promedio de 0.56 mh/l.

CUENCA DEL RIO GUAYLLABAMBA

Ubicada al norte del país, tiene un área de drenaje de 3970 una precipitación media multianual de 1500 m.m. y una escorrentia de 47m3/s.. Los parámetros físicos como turbidez y color se encuentran en concentraciones elevadas, igualmente la materia en suspensión y de arrastre. Los ríos de esta cuenca presentan promedios altos de fosfatos, nitritos y amonio con la existencia de contaminación orgánica e inorgánica. La mayor contaminación del recursos hídrico se produce a la altura de la ciudad de Quito, Capital de la República, detectándose la presencia de iones contaminantes como: fosfatos, nitritos, nitrato, amoníaco, sulfuro de hidrógeno, hierro, cromo en altas concentraciones fuera del rango permitido (nitrito alrededor de 0.1 mg/l., fosfatos 6 mg/l, sulfuros de hidrógeno 3 mg/l), éstos productos contaminantes son resultados de desechos urbanos e industriales.

CUENCAS DE LOS RIOS PUYANGO Y ARENILLAS.

Los materiales contaminantes en éstas dos cuencas son similares, en las partes altas, los niveles de acidez tienen un PH alrededor de 4, los iones presentes como sulfato 300 mg/l , hierro 3 mg/l; cromo 0.05 mg/l, valores considerados muy elevados y que son resultados de la actividad minera de la zona lo cual hace que el recurso hídrico sea inadecuado para los diferentes usos. En la parte baja de las cuencas las
aguas superficiales presentan menos peligrosidad y se puede aprovechar en el riego. El 70% de aguas subterráneas por su alto contenido salino es inapropiado para los cultivos.

CUENCA DEL RIO PORTOVIEJO

Esta cuenca se encuentra ubicada en el litoral ecuatoriano, tiene un área de drenaje de 2230 Km2, una precipitación media de 740 m.m. y una escorrentia de 12 m3/S (valores multianuales)

Los cursos de agua tanto subterránea como superficial en la parte noroeste de la cuenca presentan un cierto grado de contaminación inorgánica, causado posiblemente por el uso de pesticidas, hervicidas, en las labores agrícolas.

Del análisis del agua subterránea de la zona, se establece que el agua del 40% de los pozos está dentro del rango de buena a mediocre para uso doméstico, el 60% no es apta para consumo humano.

Con referencia al uso agrícola el 30% del agua subterránea es aceptable para cultivos con mediana tolerancia a las sales.

EVALUACION DE LOS RESULTADOS

Del análisis de los resultados obtenidos en el estudio de estas cuencas representativas podemos afirmar que la calidad integral del recurso tanto superficial como subterráneo en el país se está deteriorando cada vez más.

La calidad física en las Cuencas: del Mira, Alta del Pastaza va en decadencia, quizá son las que mayor degradación poseen, su influencia sobre las estructuras hidráulicas de riego y electrificación, especialmente en la Cuenca Alta del Pastaza, ocasionará problemas de operación y mantenimiento. La intensa erosión existente en esa zonas, contribuye a la salinización , alcalinización impermeabilidad gradual en el suelo.

Por el contenido de las sales y de sodio, evaluados de acuerdo a la clasificación de Flannery - Lohn, mediante la conductividad eléctrica y la relación de absorción de sodio, el 80% de las fuentes en el país, son aptas para cultivos con mediana tolerancia a las sales.
La calidad físico - química en el curso subterráneo de la Cuenca del Portoviejo es objetable, pues la concentración salina es alta razón por la que el agua es realmente mala para aprovecharla en los diferentes usos, de acuerdo a las Normas Internacionales de Salud.

La contaminación tanto orgánica como inorgánica causada por el hombre, se hace notoria en el 80% del recurso superficial en las cuencas, especialmente a la salida de las áreas pobladas. El 70% del recurso subterráneo aún conserva su estado natural.

La degradación y erosión del suelo, la contaminación del agua, la desforestación, como efecto de las actividades humanas, son la causa de los impactos ambientales negativos de los ecosistemas nacionales. Produciendo consecuencias conexas de carácter social, demográfico y económico.

PLANIFICACION DE LOS RECURSOS HIDRAULICOS

La planificación y gestión de los recursos hidráulicos en el país es realizado por varias instituciones entre ellas tenemos: El Instituto Nacional de Meteorología e Hidrología INAMHI, encargado de la planificación , dirección y supervisión de las actividades hidrometeorológicas del país; el Instituto Ecuatoriano de Recursos Hidráulicos INERHI que se encarga de administración de los proyectos de riego; el Instituto Ecuatoriano de Electrificación INECEL, encargado de los Sistemas de Electrificación del país y otras instituciones de carácter regional que realizan una gestión multiple relacionada al aprovechamiento de los recursos hidráulicos.
Un resumen de las actividades relacionadas a la gestión del recurso hidráulico realizadas por las instituciones indicadas se detallaron anteriormente.

CAPACITACION

Es necesario reforzar la capacitación de la instituciones del país, dirigido al recurso humano que realiza actividades de vigilancia, evaluación y gestión de los recursos hídricos, para el efecto el Instituto Nacional de Meteorología e Hidrología ha elaborado un Plan de Capacitación, el mismo que contempla una serie de cursos (cuadro No.6) referentes al tema pero en la mayoría de los cuales no se cuenta con el respectivo financiamiento, requiriéndose que organismos internacionales como la OMM a través de sus respectivos programas (PNUD, PCV, etc.) faciliten que técnicos de mi país se capaciten en este campo muy fundamental en el desarrollo y superación de nuestros países.

CONCLUSIONES Y RECOMENDACIONES

- De acuerdo a los datos presentados en los anexos tenemos que el recurso hídrico en el país es de 90.000 m3/s (de acuerdo al Balance Hídrico del país).

- Los caudales utilizados en dotación de agua potable, riego y electrificación son de: 22; 290 y 40 m3/s., dando un total de 352 m3/s de lo que se deduce que el caudal utilizado del recurso existente es mínimo.

- Los recursos hidráulicos tanto superficiales como subterráneos están contaminados en porcentajes muy elevados especialmente por los vertidos de los sitios poblados.

- Se requiere de manera urgente establecer proyectos de rehabilitación de cuencas.

- Es urgente implementar normas y ordenanzas para la utilización de los recursos hídricos con la finalidad de disminuir el grado de contaminación de los mismos.

- Es necesario establecer normas que regulen la descarga de aguas servidas en ríos fronterizos.

BIBLIOGRAFIA

- Calidad y Contaminación del Agua en el Ecuador. Informe elaborado por el Instituto Nacional de Meteorología e Hidrología año 1992.

- Recursos Hidrológicos Superficiales del Ecuador. Primera Evaluación Tomo 12 elaborado por el Instituto Ecuatoriano de Recursos Hidráulicos año 1981.

- Informes actualizados del INERHI sobre Sistemas de Riego Estatales y Particulares.

- Informes actualizados del Instituto de Obras Sanitarias y de la Empresa de Agua Potable Quito.

A N E X O S

A N E X O S

PAIS: ECUADOR — BALANCE HIDRICO DE LAS CUENCAS: DEL PACIFICO NORTE

CUENCA O SUBCUENCA	AREA DE DRENAJE	PRECIPITACION (P)	ESCORRENTIA (R)			EVAPOTRANSPIRACION REAL (ETR)		COEFICIENTE ESCURRIMIENTO
	km2	mm	l/s/km2	mm	m3/s	mm	km3	(R)/(P)
PACIFICO NORTE								
RIO MATAJE	684	3052	51.139	1616	34.98	1434	1.0	0.529
RIO MIRA	6495	1788	32.310	1021	209.85	765	5.0	0.571
RIO CARCHI	348	1215	17.722	560	6.17	650	0.2	0.461
RIO VERDE	2169	2038	19.810	626	42.97	1412	3.1	0.307
RIO CAYAPAS-ONZOLE	6024	3326	66.930	2115	403.19	1202	7.2	0.636
RIO MUISNE	1285	2639	40.981	1295	52.66	1339	1.7	0.491
RIO COJIMIES	1617	1425	11.171	353	18.06	1072	1.7	0.248
RIO ESMERALDAS	20401	1980	33.323	1053	679.82	913	18.6	0.532
RIO JAMA	2095	821	2.595	82	5.44	737	1.5	0.100
RIO CHONE	2483	1070	10.443	330	25.93	740	1.8	0.308
RIO PORTOVIEJO	2231	737	5.253	166	11.72	568	1.3	0.225
RIO JIPIJAPA	2638	371	1.867	59	4.93	305	0.8	0.159
RIO GUAYAS	32112	1662	26.013	822	835.32	857	27.5	0.495
RIO ZAPOTAL	5561	465	3.766	119	20.94	346	1.9	0.256
RIO TAURA	2348	1196	12.943	409	30.39	774	1.8	0.342
RIO CAÑAR	2384	1327	22.278	704	53.11	619	1.5	0.531
RIO BALAO	3417	1335	18.576	587	63.47	746	2.5	0.440
RIO JUBONES	4054	898	14.620	462	59.27	519	2.1	0.514
RIO ARENILLAS	2725	861	7.816	247	21.30	606	1.7	0.287
RIO PUYANGO	3694	1222	19.399	613	71.66	636	2.3	0.502
RIO CATAMAYO	6717	999	13.861	438	93.10	586	3.9	0.438

PAIS: ECUADOR — BALANCE HIDRICO DE LAS CUENCAS: DEL AMAZONAS

CUENCA O SUBCUENCA	AREA DE DRENAJE	PRECIPITACION (P)	ESCORRENTIA (R)			EVAPOTRANSPIRACION REAL (ETR)		COEFICIENTE ESCURRIMIENTO
	km2	mm	l/s/km2	mm	m3/s	mm	km3	(R)/(P)
AMAZONAS								
SAN MIGUEL-PUTUMAYO	6539	3388	64.905	2051	424.4	1337	8.7	0.605
RIO AGUARICO	11065	3127	59.715	1887	660.7	1240	13.7	0.603
RIO NAPO	30948	3255	66.266	2094	2050.8	1161	35.9	0.643
RIO CURARAY	17159	2883	46.709	1476	801.5	1407	24.1	0.512
RIO PASTAZA	24296	2175	37.025	1170	899.6	1005	24.4	0.538
RIO TIGRE	6492	2742	40.854	1291	265.2	1451	9.4	0.471
RIO SANTIAGO	26176	1603	24.146	763	632.0	840	22.0	0.476
RIO MORONA	6481	3354	69.905	2209	453.1	1142	7.4	0.659
RIO MAYO-CHINCHIPE	2844	1796	27.468	868	78.1	948	2.7	0.483

SISTEMAS DE RIEGO CUADRO No.2

ADMINISTRADOS POR EL INERHI

DISTRITO	SISTEMA DE RIEGO	AREA DOMINADA Ha.	AREA REGABLE	AREA MAXIMA REGADA Ha.	ANIO INICIO OPERAC.	DE USUARIOS
CARCHI	MONTUFAR	4.000	2.800	2.353	1.976	1.665
	S.V.PUSIR	600	400	360	1.983	156
IMBABURA	SALINAS	2.400	2.115	2.115	1.968	72
	AMBUQUI	1.500	1.325	1.102	1.981	452
	SANTIAGUILLO-CUAMBO	200	170	150	1.989	56
PICHINCHA	TABACUNDO	2.000	387	387	1.983	133
	PISQUE	14.880	6.793	6.793	1.966	3.065
	TUMBACO	3.060	1.926	1.694	1.966	2.309
COTOPAXI	LATAC.SALCE.AMBATO	9.270	8.400	6.557	1.983	17.000
	CANAL DEL NORTE	1.350	1.000	946	1.987	319
	JIMENEZ - CEVALLOS	700	700	689	1.986	685
	POZOS PUJILI	223	201	196	1.987	189
TUGURAHUA	PACHANLICA	1.000	600	481	1.982	1.043
	PATATE	1.200	700	400	1.983	500
	GARCIA MORENO	1.600	1.000	770	1.982	1.300
	AMBATO-HUACHI-PELILEO	8.400	6.400	3.600	1.989	3.500
BOLIVAR	VINCHOA	400	280	250	1.988	395
	SANTA FE	820	600	200	1.991	300
CHIMBORAZO	CHAMBO	9.600	6.300	5.213	1.966	9.000
	CEBADAS	750	600	513	1.981	436
	QUIMIAG	2.300	1.900	513	1.990	900
AZUAY	MACHANGARA	1.357	847	847	1.981	4.366
	SANTA ISABEL	2.960	2.000	300	1.991	800
CANIAR	PATACOCHA	1.200	900	300	1.990	1.266
LOJA	TABLON DE ONIA	1.351	1.000	775	1.984	150
	LA PAPAYA	800	700	250	1.984	150
	PAQUISHAPA	510	400	95	1.984	600
	GUAPALAS	500	500	261	1.984	150
	LA ERA	500	400	205	1.984	200
	VILCABAMBA	300	300	140	1.987	250
	QUINARA	510	400	200	1.984	125
	MACARA	2.500	1.800	1.254	1.975	396
	EL INGENIO	510	400	318	1.987	350
	CHUCCHUHIR	350	280	35	1.990	150
GUAYAS	CHILINTOMO	2.500	1.100	707	1.980	118
LOS RIOS	MILAGRO	20.000	11.420	10.102	1.966	340
	BANCO DE ARENA	600	269	30	1.982	4
	EL AZUCAR	300	242	83	1.985	100
	MANUEL J. CALLE	50.000	22.000	18.862	1.966	326
EL ORO	CHACRAS-HUAQUILLAS	3.000	250	117	1.981	120
	TABLON DE PORTOVELO	1.200	600	360	1.980	60
TOTAL		154.501	90.405	70.522		53.496

CUADRO No. 3

INSTITUTO ECUATORIANO DE RECURSOS HIDRAULICOS

DIRECCION DE ADMINISTRACION DEL AGUA

SUPERFICIE DE RIEGO PARTICULAR

POR AGENCIAS (A mayo de 1990)

CODIGO	AGENCIAS	(Has)	%
1	Portoviejo	41216.00	8.65%
2	Guayaquil	168084.00	35.27%
3	Riobamba	31704.78	6.65%
4	Ibarra	34065.00	7.15%
6	Loja	34544.84	7.25%
7	Cuenca	11685.00	2.45%
9	Ambato	43475.29	9.12%
10	Latacunga	25853.89	5.42%
15	Machala	18791.49	3.94%
17	Quito	63229.98	13.27%
20	Guaranda	3037.95	0.64%
21	Esmeraldas	909.50	0.19%
	TOTAL :	476597.72	100.00%

VIVIENDAS PARTICULARES OCUPADAS, POR TIPO DE ABASTECIMIENTO DE AGUA, SEGUN PROVINCIAS Y AREA

DATOS ACTUALIZADOS HASTA EL ANIO 1990

REPUBLICA DEL ECUADOR	TOTAL VIVIENDAS	TIPO DE ABASTECIMIENTO DE AGUA								
		DE RED PUBLICA				DE OTRAS FUENTES				
		TOTAL	DENTRO DE LA VIVIENDA	FUERA DE LA VIVIENDA PERO EN EL EDIFICI	FUERA DEL EDIFICIO	TOTAL	POZO O VERTIENTE	RIO O ACEQUIA	CARRO REPARTIDOR.	OTROS
T O T A L	1'576.441	816.943	503.178	205.178	108.319	759.498	323.668	226.035	165.068	44.727
PORCENTAJE	49.94	51.82	61.59	25.15	13.26	48.18	42.62	29.76	21.73	5.89
URBANA	787.214	629.435	440.995	145.520	42.920	157.779	20.229	7.685	113.012	16.853
PORCENTAJE	50.06	79.96	70.06	23.12	6.82	20.04	12.82	4.87	71.63	10.68
RURAL	789.227	187.508	62.183	59.926	65.399	601.719	303.439	218.350	52.056	27.874
PORCENTAJE		23.76	33.16	31.96	34.88	76.24	50.43	36.29	8.65	4.63

CUADRO No. 5

VIVIENDAS PARTICULARES OCUPADAS, POR TIPO DE ABASTECIMIENTO DE AGUA, SEGUN PROVINCIAS Y AREA

PROVINCIAS Y AREA	TOTAL VIVIENDAS	TIPO DE ABASTECIMIENTO DE AGUA							
		DE RED PUBLICA				DE OTRAS FUENTES			
		TOTAL	DENTRO DE LA VIVIEN-DA.	FUERA DE LA VIVIEN-DA PERO EN EL EDIFICIO	FUERA DEL EDIFICIO	TOTAL	POZO O VERTIENTE	RIO O ACEQUIA	CARRO REPAR-TIDOR
REPUBLICA DEL ECUADOR									
TOTAL CARCHI	25.229	16.165	8.963	5.787	1.415	9.064	3.598	5.087	6
URBANA	9.842	9.563	7.019	2.257	287	279	104	35	1
RURAL	15.387	6.602	1.944	3.530	1.128	8.785	3.494	5.052	5
TOTAL IMBABURA	51.315	32.794	17.166	7.322	8.306	18.521	6.859	9.808	507
URBANA	19.047	17.900	13.287	3.605	1.008	1.147	328	303	214
RURAL	32.268	14.894	3.879	3.717	7.298	17.374	6.531	9.505	293
TOTAL PICHINCHA	289.191	217.487	141.535	57.655	18.297	71.704	26.140	23.175	16.152
URBANA	210.224	187.385	129.897	47.928	9.560	22.839	7.405	1.510	10.767
RURAL	78.967	30.102	11.638	9.727	8.737	48.865	18.735	21.665	5.665
TOTAL COTOPAXI	58.079	18.728	7.864	5.960	4.904	39.351	18.359	18.077	297
URBANA	8.705	8.192	5.053	1.887	352	513	274	47	6
RURAL	49.374	10.536	1.911	4.073	4.552	38.838	18.085	18.030	291
TOTAL TUNGURAHUA	70.303	37.516	19.870	12.923	4.723	32.787	7.293	21.691	1.200
URBANA	25.712	24.686	17.200	6.663	823	1.026	103	410	77
RURAL	44.591	12.830	2.670	6.260	3.900	31.761	7.190	21.281	1.123
TOTAL BOLIVAR	30.420	9.967	6.041	2.632	1.294	20.453	13.936	5.929	2
URBANA	4.885	4.498	3.250	1.079	161	387	277	6	1
RURAL	25.535	5.469	2.783	1.553	1.133	20.066	13.659	5.923	1
TOTAL CHIMBORAZO	71.313	35.419	16.928	8.124	10.367	35.894	25.931	7.047	831
URBANA	18.393	17.518	13.606	3.276	638	875	165	27	506
RURAL	52.920	17.901	3.332	4.850	9.729	35.019	25.766	7.020	325
TOTAL CANIAR	37.144	11.450	6.276	2.673	2.501	25.694	18.836	5.123	648
URBANA	5.620	4.771	3.614	705	362	849	621	50	40
RURAL	31.524	6.679	2.662	1.878	2.139	24.845	18.215	5.073	608

POBLACION DEL ECUADOR POR AREAS, SEGUN REGIONES Y PROVINCIAS

DATOS CENSOS 1990

PROVINCIAS	TOTAL	%	URBANA	%	RURAL	%
TOTAL REPUBLICA	9'622.608	100.0	5'305.911	55.1	4'316.697	44.9
REGION SIERRA	4'416.427	100.0	2'261612	51.2	2'154.815	48.8
AZUAY	506.546	100.0	219.407	43.3	287.139	56.7
BOLIVAR	170.593	100.0	32.852	19.3	137.741	80.7
CAÑAR	189.102	100.0	55.541	29.4	133.561	70.6
CARCHI	141.992	100.0	57.322	40.4	84.670	59.6
CHIMBORAZO	360.600	100.0	117.823	32.7	242.777	67.3
COTOPAXI	283.236	100.0	66.274	23.4	216.962	76.6
IMBABURA	273.261	100.0	129.770	47.5	143.491	52.5
LOJA	389.632	100.0	156.340	40.1	233.292	59.9
PICHINCHA	173.4942	100.0	127.4352	73.5	460.590	26.5
TUNGURAHUA	366.523	100.0	151.931	41.5	214.592	58.5
REGION COSTA	474.2596	100.0	293.7640	61.9	180.4956	38.1
EL ORO	415.073	100.0	290.902	70.1	124.171	29.9
ESMERALDAS	307.190	100.0	134.379	43.7	172.811	56.3
GUAYAS	246.3423	100.0	187.8750	76.3	584.673	23.7
LOS RIOS	530.844	100.0	20.1999	38.1	328.845	61.9
MANABI	102.6066	100.0	43.1610	42.1	594.456	57.9
REGION AMAZONICA	383.201	100.0	98.750	25.8	284.451	74.2
MORONA SANTIAGO	95.785	100.0	23.557	24.6	72.128	75.4
NAPO	102.623	100.0	23.712	23.1	78.911	76.9
PASTAZA	40.714	100.0	14.802	36.4	25.912	63.9
SUCUMBIOS	77.450	100.0	20.328	26.2	57.122	73.8
ZAMORA CHINCHIPE	66.729	100.0	16.351	24.5	50.378	75.5
REGION INSULAR	97.49	100.0	79.09	81.1	18.40	18.9
GALAPAGOS	97.49	100.0	79.09	81.1	18.40	18.9

INSTITUTO NACIONAL DE METEOROLOGIA E HIDROLOGIA

CAPACITACION A TRAVES DE LA COOPERACION DE ORGANISMOS INTERNACIONALES

ANEXO # 3

No.	AREA Y NOMBRE DEL EVENTO	FECHA		NIVEL				PAIS E INSTITUCION OFERENTE	OBSERVACIONES
		INICIO	TERMINO						
	- Hidrologia de Aguas Subterraneas	01-c/ano	01-c/ano					Barcelona-España	Plan de Capacitacion 92 ver requerimientos, elaborar oficio, llenar requerimientos.
	- Hidrologia e Hidrogeologia	09-c/ano.						Bruselas	Plan de Capacitacion 92 analizar, ver requerimientos.
	- Curso Basico de Hidrometeorologia Tropical							Venezuela	Informacion Universidad Centari de venezuela, sobre eventos para el resto 91-92 y requisitos, oficio.
	- Curso de Hidrologia Operativa							Venezuela	Informacion universidad Central de Venezuela, sobre eventos para el resto 91/92 y requisitos, oficio.
	- Curso Hidrologia Aplicada							Venezuela	Informacion Universidad Central de Venezuela, sobre eventos para el resto 91-92 y requisitos, oficio.
	- Ingenieria de Recursos Hidricos	Junio	Agosto					Belgrade	Plan 1992, ver requerimientos.

INSTITUTO NACIONAL DE METEOROLOGIA E HIDROLOGIA

CAPACITACION A TRAVES DE LA COOPERACION DE ORGANISMOS INTERNACIONALES

ANEXO # 3

No.	AREA Y NOMBRE DEL EVENTO	FECHA		NIVEL				PAIS E INSTITUCION OFERENTE	OBSERVACIONES
		INICIO	TERMINO						
	- Hidrologia	Enero	Julio					Budapest	Plan de Capacitacion 92
	- Hidrologia Ambiental para Zonas Aridas y Semiaridas	Mayo	Julio					Cairo	Plan de Capacitacion 92
	- Changing Subjects							Panama	Plan 1992
	- Hidrologia							Delf	Plan 1992
	- Hidrologia							Galway	Plan 1992
	- Tecnicas en Investigacion de Aguas Subterraneas							Austria	Plan 1992
	- Recursos Hidraulicos							Guatemala	Plan 1992
	- Hidrologia Operacional							Lisboa	Plan 1992
	- Hidrologia Aplicada	Enero	Julio					Madrid	Plan 1992
	- Hidrologia	Diciembre	Julio					Italia	Plan 1992
	- Hidrologia							Porto-Alegre	Plan 1992
	- Datos Hidrologicos para la Planificacion de los Recursos Hidricos.	Febrero	Julio					Praga	Plan 1992

INSTITUTO NACIONAL DE METEOROLOGIA E HIDROLOGIA

CAPACITACION A TRAVES DE LA COOPERACION DE ORGANISMOS INTERNACIONALES

ANEXO # 3

No.	AREA Y NOMBRE DEL EVENTO	FECHA		NIVEL			PAIS E INSTITUCION OFERENTE	OBSERVACIONES
		INICIO	TERMINO					
	- WATER RESOURCES ENGINEERING IN DEVELOPING COUNTRIES	No periodico Invitacion Especial					BIRMINGHAM (United Kingdom)	The Graduate School Secretary School of Civil Engineering University of Birmingham P.O. Box 363 BIRMINGHAM B15 2TT
	- ENVIRONMENTAL HYDROLOGY FOR ARID AND SEMI ARID ZONES	Mayo	Junio				CAIRO (Egypt)	Prof. Dr. Mostafa M. Soliman Course Manager International Course on Hydrology for Arid and Semi-arid Regions P.O. Box 5218 Heliopolis-West CAIRO
	- WATER RESOURCES ENGINEERING	Octubre					DAR-ES-SALAAM (Tanzania)	Mr. F.W. Mtalo Disciplinary Area Coordinator for Water Resources Engineering P.O. Box 35131 DAR-ES-SALAAM
	- HYDROLOGY	C/AÑO					Delft (Netherlands)	IHE Oude Delft 95 P.O. Box 3015 2601 DA DELFT
	- HYDROLOGY	Octubre					GALWAY (Ireland)	Professor J.E. Nash Department of Engineering Hydrology University College Galway GALWAY
	- HYDROLOGY	Octubre						Cycle postgrade interuniversitaire en Hydrologie et Hydrogeologie EPFL-IATE CH-1015 LAUSANNE.

INSTITUTO NACIONAL DE METEOROLOGIA E HIDROLOGIA

CAPACITACION A TRAVES DE LA COOPERACION DE ORGANISMOS INTERNACIONALES

ANEXO # 3

No.	AREA Y NOMBRE DEL EVENTO	FECHA		NIVEL				PAIS E INSTITUCION OFERENTE	OBSERVACIONES
		INICIO	TERMINO						
	- HYDROGEOLOGY	Octubre						NEUCHATEL (Switzerland)	Cycle postgrade inter-universitaire en Hydrologie et hydrogeologie CHYN 11, rue Emile-Argand CH-2007 NEUCHATEL
	- HYDROLOGY AND WATER RESOUCES ENGINEERING	Agosto						MADRAS	Centre for Water Resources College of Engineering Anna University 600 025 MADRAS
	- a) HYDROLOGY b) WATER RESOURCES	Octubre							The Registrar Department of Civil Engineering University of Newcastle upon- Tyne NEWCASTLE-UPON-TYNE
	- a) MOBILIZATION OF WATER RESOURCES b) AGRICULTURE c) SANITARY ENGINEERING	C/AÑO						OUAGADOUGOU	Mr. le Directeur de Ecole Inter-Etats d'Ingenieurs de l'Equipement rural B.P. 7023 OUAGADOUGOU
	- TECHNIQUES OF HYDROLOGIC INVESTIGATIONS FOR INTERNATIONAL PARTICIPANTS							U.S.A.	U.S. Geological Survey Water Resources Division 436, National Center RESTON, Va. 22092, USA

COUNTRY REPORT

WATER AND THE ENVIRONMENT

ETHIOPIA

OCTOBER, 1991

ADDIS ABABA

EXECUTIVE SUMMARY

For a reliable economic growth of a nation, the water resources development should be linked with environmental considerations and this demands a proper assesment of the natural resource. Though not adequate, an attempt has been made to assess the water resources potential of the country. The high rate of population growth has caused rapid urban development, and poor living and sanitary condition. The vast majority of the population in the country are without adequate water suplly and sanitation and a number of projects are planned to meet this needs with detailed objectives and financial implication. To satisfy the food requirement of the country, agricultural development with the help of irrigation system is given highest priority and each year about 12,000 ha. land will be developed for irrigation.

The vegetation cover has undergone transformation as a result of unbalanced land utlization, burning and felling of trees and clearing of forests for urban and agricultural development. Deforestation has caused considerable soil erossion to increase the sediment level in the surface water . Intensive agriculture based on the use of fertilizers are a major cause of contamination to water. High rate of population growth and industrial development is expected to increase the volume of waste. Several Cottage type agro-industries have also been developed in the rural areas and their water pollution, although not assessed and quantified, can be quite high.

In Ethiopia, a Ministry and Authorities are established with the objectives to integrate environmental considerations into the development and management of water resources. In a developing country like ours, effective utilization of the water resources and protection of the environment is only possible with technical and financial assistance from the developed nation.

INTRODUCTION

Ethiopia has a total land area of about 1.2 million square killometer and is geographically located within the tropical zone extending between 3° and 18° North Latudes and between 33° and 48° East Longitudes. However, the wide range in altitude from 110 m below sea level in the Dalol Depression to over 4500 m above sea level at Ras Dashan mountain, has created variable and complex ecological zones. The estimated population of the country in 1990 is about 50 million with an annual growth rate of 2.9% and per-capita income of US $130, thereby listing Ethiopia as one of the poorest countries in the world. About 60% of the country's population lives below the absolute poverty line. Ethiopia is endowed with fresh-water resources consisting of large boundary and transboundary rivers, as well as inland lakes. Besides, it has fertile lands suitable for irrigation. The national economy is based to a larger extent on agriculture.

Ethiopia has been in a state of economic crisis for the past two decades or more. The list of those situations with sever socio-economic reprecussions that have featured most prominently during the past few decades includes endemic diseases and epidemics affecting people and animals, famines, prolonged droughts, water and fuel wood shortages, and the impact of ecological degradation and desertification on rangelands and agricultural lands.

The cummulative impacts of rapid population growth, coupled with the ever-increasing domestic demand for food, destruction of forests to clear lands for agriculture resulting an annual soil errosion of 290 tons per hectar per year or a total annual quantity of 1.6 billion tons. Untreated industrial wastes and sewages, washed-out fertilizers, pesticides, and insecticides have polluted the surface water resources specially Awash River Basion. Seasonal rains are also becoming abnormally irratic and temperatures are high for most of the year. In fact, it is due mainly to the above destructive activities thereby damaging the environment with subsequent and devastating results of drought and famine. It is a very sad and recent phenomenon that millions of people and livestock perished in Ethiopia (ie. 1974,1984,1990) and due to this, the country's national economy seriously weakened.

At the national level, it is considered that special and urgent attention needs to be given to sound utilization and management of natural resources. Inorder to achieve these objectives a number of actions are planned at a national level and these include:

A) INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

Water Resources management provide considerable opportunities for socio-economic development. Ethiopia is rich in water resources but the economy has not benefited much from this resources development because it demands proper management of the resources. Expecting an increase in production, the government of Ethiopia has planned to promote irrigation system in the country. Since the water resource development was not integrated with proper management, the effect of salinity and water logging is getting out of control in few of the large scale irrigation progects. A number of researches are conducted to find a proper water resources management methods applicable to Ethiopian condition. Based on the research findings an attempts has been made to adopt new and more comprehensive approaches to water resources developmetn and management.

In addition to economic growth, the objectives of water resources development and management should be the impreovement of environmental and social conditions in the water basin. In Ethiopia, Authorities are established with the objectives to integrate environmental considerations into the development and management of water resources. The existing water resources development capability of the country both technical and financial is very limited compared to the existing demad.

Therefore, it becomes essential to get assisstance from international donor agencies.

B) **WATER RESOURCES ASSESSMENT**

In Ethiopia, available surface water amounts to 110 B. M^3 a year, while ground water is estimated at 2.9 B.M^3 a year. 87.6% of the total water reserve is distributed in 35.6% of the total area of the country. Projected total fresh water use for the year 2000 is 5185.6 M M^3 based on needs of the country. The share demanded by industry and mining, agriculture, domestic and livestock are 6.9%, 67.1%, 15.6% and 10.4%, respectively. The water resources development capacity of the county is very limited compared to the projected demand based on the needs of the nation.

To improve the management of water resources, greater knowledge on status and trends of the water resources including quantity and quality is needed. In Ethiopia, there are serious inadequecies in the availability of reliable data and information on the sources, extent, dependability and quality of water resources. The network on water resources assessment is supposed to address both quantitative and qualitative aspects of water. Irregular, insufficent and often unsystematic hydrological hydrometerological and hydrogeological data collection facilities and a system for processing quantitative and qualitative information for various types of water bodies is existing in the country. At present there are about 500 discharge stations in the country and of which about 400 are operational. In the past few years, data could not be collected in and around war torne areas of the country.

To improve the network densities, mechanisms for data collection, processing and publication and arrangement for monitoring water quality, international organizations and other supporting bodies should offer technical assisstance, including personnel, funds, equipment and training, to strengthen the networks and to establish laboratories for comprehensive water analysis.

C) PROTECTION OF WATER RESOURCES, WATER QUALITY AND AQUATIC ECOSYSTEMS

The availability and quality of water resources have to be protected inorder to satisfy water needs for human activities. In developing and using water resources, priority has to be given to satisfaction of basic needs and safeguarding of ecosystems. Water use per capita expected to increase significantly in Ethiopia with economic and high population growth rates, and also the volume of waste requiring treatment is expected to present a growing problem. Intensive agriculture based on the use of fertilizers and chemical agents for crop protection, is a mojor cause of contamination of water in the large scale irrigation projects of the country. Uless carefully planned and managed, these usage can bring about dramatic increase in contamination of both surface and ground water. Several cottage type agro-industries have also been developed in the rural areas and their water polution, although not assessed, can be quite high.

The legal framework for combating water pollution in Ethiopia is provided by proclamation. Under the provisions of the proclamation, administrative responsibility to protect the quality of surface waters rests with Ethiopian Valleys Development Studies Authority (EVDSA). One of the objectives of EVDSA as stipulated in the proclamation No. 318 of 1987 establishing the Authority, is to conduct studies and research pertaining to ecological resources depletion and environmental pllution for the development of appropriate national environmental policy and strategy in the Valleys of Ethiopia.

National standards for environmental protection and management will soon be established for assessing and monitoring water quality. Use based national surface water quality map will soon be prepared and changes will be monitored from time to time. Planned action is necessary in order to protect and improve the quality of water resources.

D) DRINKING WATER SUPPLY AND SANITATION

The provision of water supply and sanitation is not only a vital ingredient of economic and social development but also an important element of environmental protection. An estimated 80% of the urban population is supplied with potable water including those with low or inadequate services - only 11% of the predominantly rural population has access to safe water, leaving some 40 million rural dwellers to rely on traditional, unprotected sources, often located at greater distance from their dwellings. Sanitation services lag even further behind watr supply coverage. Only Addis Ababa and Asmara, the two largest Ethiopian cities, have partial sewerage systems. Households having access to excreta disposal facilities (principally latrines) are estimated at 57% in urban areas and 2% for rural areas.

The vast majority of the population are without adequate sanitation and this means millions of people defecate openly on land or surface waters. Due to these, surface and ground waters will be subjected to faecal pollution leading to the wide occurance of water borne diseases. In Ethiopia, human waste is the cause of diseases present in the community like hookworm, tapeworm and the viruses that cause such diseases as typhoid and cholera. A large percentage of common diseases in Ethiopia are caused either by dirty water or by lack of sanitation. Water borne diseases cause tens of thousands deaths per year in Ethiopia. In cities and towns, surface streams and drains act as open sewers. Surface waters are more polluted and unsightly due to open dumping of solid wastes from markets, food stalls and individual homes.

For community water supply and waste disposal a short and long term plans are prepared for specific projects with detailed financial impleications. In the Government's ten year perspective plan (1984/5 - 1993/94), a number of projects are initiated in rural water supply, and in the urban sector a different feasibility studies, design and construction projects are in progress. Specific action plans are fomulated at the National level to provid additional and better operation and mantenance, feasibility studies, design and construction capabilities. The plan has established targets to cover 85% of the urban population and 35% of the rural population. For urban sanitation, 40% of Addis Ababa's population is to be served by a sewerage system. Sewerage feasibility studies are to be carried out in 12 major towns, and vacuum tankers are to be located at strategic points throughout the country. For rural sanitation, the plan targets self-help construction of some 6 million latriens.

Adequate, new and additional financial resources are indispensable from multilateral or bilateral sources to carryout special water-supply and sanitation programmes as national undertakings for the effective utilization and protection of fresh water resources.

E) WATER AND SUSTAINABLE URBAN DEVELOPMENT

The urban population in Ethiopia consists 11.29% of the total population and distributed in about 656 centres. High rate of urban population growth have been marked by the growth of large cities, high densities of housing, crowded market centres, exploding slum areas, poor living and sanitary conditions, poor health, industrial effluents , overloaded service facilities and acute social problems. High rate of population growth will increase the need for clean water, schools, health and transport facilities. Well planned sustainable urban development generates resources that can be used to improve the living conditions of the urban population.

The vegetation cover has undergone transformation as a result of unbalanced land utilization, burning and felling of trees and clearing of forests for urban development. Deforestation has caused not only considerable soil erosion to increase the sediment level in the surface water, it has also contributed to drought and desertification. Urban development is the result of the growth of population, industry and intensive agriculture and is bound to overtax not only the vegetation cover but also the water resources and this call for preventive and remedial measures. While pursuing for a sustainable national economic and social development, the environmentaly degrading impact of urban development need to be considered.

Though the government is responsible and accountable for ensuring that urban development programmes and budgets encourage and support sustainable development polices and practices, it is essential that assistance to pursue conservation programmes is provided by international organizations.

F) WATER FOR SUSTAINABLE FOOD PRODUCTION AND RURAL DEVELOPMENT

In the past few decades, it was difficult to satisfy the food requirements of the country due to eratic weather conditions. At the national level, it is considered that the most important need is agricultural development to increase food production security with the help of irrigation system. Potential area for irrigation in the country is estimated to be about 3 million hectar and upto now only 3% of it is irrigated. In the current 5 year plan 36,720 hactar will be developed for irrigation. For rural development a number of projects are initiated annualy and many regional offices are actively ingaged in these projects with financial assistance from both national government and other doner organizations.

The livelhood of poor agricultural producers are deteriorating as deforstation, desertification and land degradation intensify in the countryside. Government polices in rural development sector are designed as to encourage rural population to better manage their natural resources specialy water. To promot efficient use of water, the user community is encouraged to participate in the planning, construction, operation and maintenance of the water resources development projects. Special workshops are conducted to promot community participation in the rural sectors to introduce the concept of sustainable food production.

The Government of Ethiopia has started giving attention to sound sustainable rural development principles. In relation to sustainable rural development, effective untilization of water resources, improvements in land use, and human settlements are encouraged by all concerned ministries and Authorities in the country.

The support of international organization and other bodies should, provide technical assistance in the preparation of long term plans and specific projects, promot and support research on water for sustainable food production and rural development in relation to Ethiopian condition.

G) IMPACT OF CLIMATE CHANGE ON WATER RESOURCES

In the past few decades, it is known that crops have failed and livestock have died over huge areas in Ethiopia due to climatic changes and its subsequent impact on water resources. By the end of 1985, about 8 million people were short of food, many had abandoned their homes and land in search of food, and water. The climate change has caused rainfall deficits at a national level. The impact of climate change on water resources in the country is not properly assessed and quantified. This can only be improved by giving urgent attention to the basic data collection network. The existing data are very scanty, unsystematic and unreliable in most of the cases. In the current 5 year plan, 880 new meteorological data collection stations of different classes, and 9 new air pollution monitoring stations will be established. The existing stations will also be upgraded and closly inspected to improve the capability of the nation to assess the impact of climate change on water resources.

Research will be conducted on a number of topics to understand the cause of climate change in Ethiopia and make a reliable assessment and prediction on a possible impact on watr resources. Climatic conditions will be closely monitored and the result will be communicated to users. About 500 men will be trained in certificate, diploma, graduate and postgraduate level to meet the required trained man-power demand to gather data and monitor the change on climate both in regional and national level. To make a reliable impact prediction and conducts a frutfull research work on the possible impact of climatic change on water resources, the available data must be qualitatively reliable and quantitatively adequate. For accurate collection, rapid processing and efficent dissimination of climatic data, the technical and financial support of the international organization is a must.

In the past, while planning to develop the water resources for economic growth and improvement of the social condition in the country, satisfactory consideration was not given for the linking of environmental condition with water resources development programmes. Often, the political priorities at the government level and poor management and lack of experience at the administrative levels are common obstacles. Furthermore, Ethiopia lacks both the technologies to deal with these development problems, and the massive financial resources required by many proposed projects.

OPTIONS FOR CO-OPERATION AND COLLABORATION AT THE LOCAL, NATIONAL, REGIONAL AND GLOBAL LEVELS

- **Supporting Research in the Assesment and Monitoring of the Water-Climate System in the Nile Basin Under the Impact of Land Use Changes**

  The land use is changing rapidly as a result of unbalanced land utilization, burning and felling of trees and clearing of forests for urban development. A research in the assessment and monitoring of the water - climate system in the Nile Basin will assist managers, planners and decision makers from countries in the Nile Basin to assess environmental impacts of large-scale land use change in the Nile watershad. The impact of both climate and land use change on water resources can be satisfactorily analysed through the establishment of a research laboratories and data base in the Region.

  International organizations need to support seminar and training programmes for transfer of technologies, exchange of experience and the sharing of skills on the hydrological process that have impact on the water resources. Technical and financial assistance is required to monitor water balance changes in the Nile Basin. This programme will help to promot exchange of information, ideas, experience and lesson learned between countries in the Nile Basin. It will also benefit from the experiece gained from a similar research conducted by countries in the Amazon Basin.

- **Establishment of Environmental Information Systems in Ethiopia**

To improve the management of environment in Ethiopia, there is a greater need for a systematic, reliable, regular and adequate information on the environment. The cumulative impacts of rapid population growth, coupled with the ever-increasing demand for food, clothing and shelter has been the cause of environmental degradation. The establishment of a center like this will provide national planners and decision makers with better environmental data for sustainable resource development and utilization. Specialized agencies will have the access to national level data bases in order to update and expand their own data holdings for regional and global assessment.

Technical and financial assistance from international organization should be given in the establishment of this National centre. Collaboration is need to promote the exchange of ideas and sharing of skills in the preparation of long term plas and specific projects. Assistance is also needed for the installation of efficent data aquisition, analysis, processing, dissemination and storage facilities. Convening training and seminar for both technical staff and decision makers will also help to meet local man-power requirement.

REFERENCES

- National Water Resources Commission, 5 year Perspective Plan (1989 - 93)

- Water Resources Development Authority (WRDA), 1 year Perspective Plan (1991 - 2)

- Water Supply and Sewerage Authority (WSSA), 1 year Perspective Plan (1991 - 2)

- Framework For Environmental Protection Programme within the Valleys or Basins of Ethiopia, Ethiopian Valleys Development Studies Authority, Publication No. 22, Nov'98.

- Water Supply and Sanitation Sector Objectives, Strategy, and Implementation. Proceedings of the All African Rural Water Supply and Sanitation Workshop and Water Supply and Sanitation Sector Conference, Volume 2, May 1990, Abidjan, Côte d'Ivoire.

MINISTERIO DE AGRICULTURA

DIRECCION GENERAL DE AGUAS Y SUELOS

CONFERENCIA INTERNACIONAL SOBRE EL AGUA Y EL MEDIO AMBIENTE

CUESTIONES RELATIVAS AL DESARROLLO EN EL SIGLO XXI

ESFERAS PROGRAMATICAS DESARROLLADAS :

A.- El desarrollo y gestión integrado de Recursos Hídricos.

B.- La evaluación de Recursos Hídricos.

D.- El abastecimiento y saneamiento del agua potable.

E.- El agua y el desarrollo urbano viable.

F.- El agua para la producción nacional de alimentos y el desarrollo rural.

MINISTERIO DE AGRICULTURA

A.- EL DESARROLLO Y GESTION INTEGRADO DE RECURSOS HIDRICOS

El Perú se encuentra ubicado en el Hemisferio Sur, aproximadamente, entre las siguientes coordenadas geográficas: 0°01'48" y 18°20'51" de latitud sur y los meridianos 68°39"27" y 81°19'34.5" de longitud oeste, cubriendo una superficie total de 1'285,215 Km^2.

El desarrollo de los recursos hídricos y gestión de los mismos se encuentra dimensionado institucionalmente de conformidad con lo dispuesto en los correspondientes dispositivos de los Sectores que tienen ingerencia en el manejo y aprovechamiento de los recursos hídricos.

La Ley General de Aguas (D. L. 17752) dispone que las aguas sin excepción alguna son de propiedad del Estado y su dominio es inalineable e imprescriptible. No hay propiedad privada de las aguas ni derechos adquiridos sobre ellas. Un uso justificable y racional del agua solo puede ser otorgado en armonía con los intereses sociales y el desarrollo del país.

La Jurisdicción Administrativa en materia de aguas y las conexas a que se refiere esta ley, corresponden al Ministerio de Agricultura, salvo las relativas a las aguas minero-medicinales y las de orden sanitario que competen al Ministerio de Salud.

En este contexto principista, la Dirección General de Aguas y Suelos (DGAS) es el órgano de línea del Sector Agrario encargado de "Normar, realizar, supervisar y evaluar las actividades de regulación de los recursos hídricos, de conservación y uso de los suelos, y de las irrigaciones para mantener la infraestructura de riego y drenaje".

En forma genérica es posible definir a otras entidades cuyas funciones presentan relaciones de coordinación bastante estrechas como son la Oficina Nacional de Recuros Naturales (ONERN), el Servicio Nacional de Meteorología e Hidrología (SENAMHI) y los Ministerios de Vivienda y Construcción, Energía y Minas y Salud, principalmente.

En una dimensión global a nivel nacional actúa el Instituto Nacional de Planificación (INP) en su carácter de organismo rector del Sistema Nacional de Planificación e intérprete y orientador del marco doctrinario del Gobierno Central, quien a su vez fija los preceptos y lineamientos fundamentales del desarrollo general del país.

Sin embargo, al analizar la situación actual de los recursos hídricos en el Perú, se observa una serie de problemas que interesa resolver en favor de los propios recursos y de la labor planificadora de los mismos. Estos problemas derivan de una situación de fondo, como son la escasez de recursos económicos y la falta de una planificación nacional.

MINISTERIO DE AGRICULTURA

A través del tiempo se han ejecutado numerosos proyectos relacionados al manejo, aprovechamiento y conservación de los recursos hídricos, tanto en cantidad como en calidad. Estos proyectos hoy en día tienen que ser enmarcados para su estructuración y desarrollo tomando en consideración el Código del Medio Ambiente.

MINISTERIO DE AGRICULTURA

—— o ——

B.- LA EVALUACION DE LOS RECURSOS HIDRICOS

Los ríos de los sistemas fluviales del Perú están distribuídos en tres (03) vertientes:

	Superficie (Km.^{2})
Vertiente del Pacífico	279,689
Vertiente del Atlántico	956,751
Vertiente del Titicaca	48,775
	1'285,215 Km^2

Los ríos de las cuencas de la vertiente del Pacífico, son generalmente, de corto recorrido, discurriendo perpendiculamente a la costa con fuertes pendientes. En su mayoría, presentan caudales intermitentes. En esta vertiente se han considerado 53 cuencas hidrográficas, cuya superficie representa un 22% de la superficie total del país.

Los ríos de las cuencas de la vertiente del Atlántico en su mayoría presentan un curso muy sinuoso, drenando en diversas direcciones pero confluyendo al final hacia el río Amazonas. Este sistema se ha dividido en tres grandes sub-sistemas; el Marañón, el Ucayali y el Amazonas. La superficie de ésta vertiente representa el 74% de la superficie total del país.
La vertiente del Titicaca está constituída por una serie de ríos que la cruzan en forma radial. Estos ríos nacen en la falda de las cordilleras occidental, Vilcanota y Oriental, entre los 4,000 y 6,000 m.s.n.m. y alimentan sus cursos de agua con las precipitaciones que ocurren en la parte alta de sus cuencas, la superficie de esta vertiente representa sólo el 4% de la superficie total del país.

En total se encuentran 1,007 ríos, de los cuales 381 corresponden a la vertiente del Pacífico, 564 a la del Atlántico y 62 a la del Titicaca.

La vertiente pacífico presenta una irregular distribución del recurso agua en el espacio y en el tiempo, lo cual pone de manifiesto el gran desequilibrio hidrológico existente en esta vertiente, debido a que el escurrimiento superficial se encuentra en función de la precipitación, lo que origina regímenes muy irregulares y de contrastes. Así, en los meses de diciembre a marzo el escurrimiento es normalmente de carácter torrentoso y en este período se estima que escurre entre 60 y el 70% de la masa anual y el resto se descarga en el período crítico de estiaje.

En la vertiente Atlántico, los ríos se originan de las precipitaciones estacionales que ocurren en las partes altas de las cuencas, que ocasionan escurrimientos de comportamiento irregular, con un período de estiaje entre los meses de abril y setiembre.

MINISTERIO DE AGRICULTURA

El escurrimiento de los ríos de la vertiente del Lago Titicaca se encuentra sujeto a la estacionalidad del régimen pluviométrico en las partes altas de las cuencas, originando regímenes de escurrimiento irregular y torrentoso. Generalmente en los meses de diciembre a abril escurre del 60 al 80% del total anual y el resto del año presenta una sequía extrema que limita la posibilidad de realizar dos campañas agrícolas al año, agravándose este problema por la temperatura mínima extrema ambiental.

A nivel nacional se ha determinado una disponibilidad de los recursos hídricos en las vertientes hidrográficas del Perú del siguiente orden:

VERTIENTE	RECURSOS HIDRICOS SUPERFICIALES	(10^6 m^3/año) SUBTERRANEOS
Pacífico	34,625	1,508
Atlántico	1'998,735	---
Titicaca	10,172	2.4

En cuanto al uso consuntivo del agua por vertientes hidrográficas se ha determinado los siguientes valores:

VERTIENTE	Volumen (10^6 m^3/ año)				
	Agrícola	Poblacional	Minero	Industrial	Pecuario
Pacífico	11,987	722	70	149	23
Atlántico	1,996	162	43	6.4	38
Titicaca	71	12	0.9	0.13	9

De acuerdo a la información disponible, es factible señalar que a nivel nacional se utiliza un volumen total anual de 22,222'350,000 m^3 del cual el 68.8% (15,292'926,000 m^3) es consuntivo y el 31.2% ---- (6,929'424,000 m^3) no consuntivo.

D.- EL ABASTECIMIENTO Y SANEAMIENTO DEL AGUA POTABLE

ABASTECIMIENTO DE AGUA

El abastecimiento de agua a los asentamientos humanos en el país, se realiza de diversas formas entre las cuales cabe mencionar :

- Conexiones Domiciliarias.- Procedimiento por el cual el agua se entrega al usuario a domicilio, conduciéndose y distribuyéndose mediante tuberías desde plantas de tratamiento más o menos sofisticadas.

- Pilones Públicos.- Forma por la cual el agua se entrega al usuario mediante pilones de uso público o comunal, conduciéndose a éstos mediante tuberías. Se emplea para poblaciones de escasos recursos, pero plantea riesgos desde el punto de vista sanitario.

- Camiones Cisterna.- Procedimiento por el cual el agua se conduce al poblado mediante camiones cisterna, vendiéndose al usuario por cilindros.

- Pozos Domiciliarios.- Forma por la cual el usuario se abastece de agua perforando generalmente dentro de los límites de su propiedad, pozos a tajo abierto.

- Toma Directa.- Procedimiento por el cual el usuario toma el agua que requiere directamente de la fuente, sea ésta río, pozo tubular, manantial o puquio.

Como resultado del inventario realizado, se ha establecido que existen aproximadamente, 1,464 poblados servidos de los cuales 435 son urbanos y 1,029 rurales; estos poblados se ubican: 670 en la vertiente del Pacífico, 716 en la del Atlántico y 78 en la del Titicaca. Asimismo, que existen en dichos poblados 1'089,975 conexiones domiciliarios y 1,304 públicas.

La población urbana que para los fines de abastecimiento de agua es aquella localizada en poblados de más de 2,000 habitantes, es atendida por el Ministerio de Vivienda y la población rural, la restante, por el Ministerio de Salud.

Como resultado del estudio, se ha establecido que de la población total del país 41.8% corresponden a la población servida y 58.2% a la no servida. La población servida se ubica en las vertientes hidrográficas de la siguiente manera: 82.6% en la vertiente del Pacífico; 16.3% en la del Atlántico y 1.1% en la del Titicaca. La población no servida, como sigue: 44.4% en la vertiente del Pacífico; 48.2% en la del Atlántico y 7.4% en la del Titicaca.

MINISTERIO DE AGRICULTURA

Cabe señalar que en algunas ciudades importantes del país, debido al creciente desarrollo demográfico se ha incrementado la demanda de agua potable. Esta situación ha generado, no solamente problemas sociales sino de carácter técnico, como la sobre-explotación de acuíferos, tal es el caso de Lima.

- Servicio de Alcantarillado

Considerando la información proporcionada por SENAPA, se ha determinado que, de un total de 177 localidades evaluadas a nivel nacional el 40% cuentan con conexiones domiciliarias de Servicio de Alcantarillado. Las instituciones encargadas de éstos servicios vienen desarrollando proyectos con el propósito de ampliarlos al resto de la población urbana.

La población rural, generalmente evacúa sus efluentes a pozos ciegos, letrinas, tanques sépticos, cauces de aguas superficiales y en otros casos a los propios campos de cultivo y/o terrenos eriazos.

El inventario del sistema de alcantarillado, para 177 centros urbanos del Perú, desarrollado por SENAPA, reporta que 19 localidades presentan un caudal de evacuación mayor de 50 l/s. y 9 ciudades mayor de 100 l/s.

El mismo inventario indica que 72 localidades evacúan el agua residual a los cauces de los ríos, 18 localidades evacúan al mar y el resto (87 localidades), evacúan el agua sobre terrenos eriazos y/o de cultivos.

En una evaluación de 177 localidades, SENAPA reporta que 32 localidades (18%) presentan sistemas de tratamiento a través de lagunas de estabilización, pero éstas son generalmente de baja capacidad y la mayoría se encuentran inoperativas o en un estado de abandono; asimismo, en 121 ciudades (68%) las aguas servidas no cuentan con algún tipo de infraestructura de tratamiento.

MINISTERIO DE AGRICULTURA

E.- EL AGUA Y EL DESARROLLO URBANO VIABLE

El agua es un recurso que desde el punto de vista de la planificación de los recursos hidráulicos, se entiende como el "Requerimiento" de los diversos grupos de usuarios para satisfacer sus necesidades en cuanto a calidad y cantidad de agua.

Dentro del sistema de desarrollo se consideran dos tipos de demanda: para el medio urbano y para el medio rural.

Para la proyección de la demanda para uso urbano, generalmente se establece un modelo Prospectivo el mismo que constituye el Marco de Referencia, ya que el crecimiento esperado de las ciudades determinará su cuantía.

La estimación de la demanda a este nivel, comprenderá las que corresponden al uso doméstico, municipal e Industrial-urbano. El uso comercial se incluirá dentro del uso doméstico directo, para mantener una estrecha correlación entre la población, su estandar de vida y el comercio.

La cuantía de la demanda : está en función del crecimiento poblacional y la dotación por habitante. Esta última, a su vez, está determinada por el tamaño del centro poblado, el nivel de vida, la localización, el clima y otros factores variables.

En el país, el desarrollo urbano viene ocurriendo en una forma heterogénea como producto de la fuerte migración de la zona rural hacia la zona urbana. Este proceso genera un desequilibrio en torno a la disponibilidad de recurso y servicio de agua potable a la población.

Mas aún, este desequilibrio se complica con la falta de un adecuado y suficiente sistema de alcantarillado, lo cual en muchos casos genera contaminación de los recursos al ser evacuados a los cauces naturales.

Ultimamente esta situación se ha notado con la presencia de enfermedades endémicas como por ejemplo el cólera.

MINISTERIO DE AGRICULTURA

—— o ——

F.- EL AGUA PARA LA PRODUCCION RACIONAL DE ALIMENTOS Y EL DESARROLLO RURAL

Es preocupación del Estado mejorar las condiciones de vida del poblador peruano, siendo el factor básico la alimentación, cuyos indicadores con fines de planificación alimentaria son las calorías y proteínas.

¿Cómo imaginar el desarrollo del País, si gran parte de su población se encuentra deficiente y crónicamente mal alimentada?

Al respecto, el Instituto Nacional de Planificación (INP), indica que la producción agropecuaria y alimentaria en el Perú fué deficiente entre - 1970/1984. En este período la disponibilidad global de alimentos por habitantes disminuyó en 20%. Cerca del 50% de la población total se encontró en situación de alto riesgo nutricional.

En la década de 1975/1985, el INP indica que las importaciones de alimentos se incrementaron en 123%, de 671,000 Tm. auamentó a ---- 1'500,000 Tm.

Por otra parte, la Oficina de Estadística Agraria (OEA) del Ministerio de Agricultura, informa que el consumo medio de calorías y proteínas - por persona/días ha decrecido considerablemente, en los últimos 15 años. La información referente a la "Valorización per Cápita del nivel de calorías y proteínas en relación con la superficie cultivada" detalla que la relación tierra cultivada/hombre, ha decrecido de 0.18 a 0.14 Ha/habitante representando una caída del 22%.

En el período 1970-1985, el consumo de calorías y proteínas per-cápita se incrementa hasta el año 1972, para luego decrecer gradualmente. En 1985 se reportó 1,781 calorías per-cápita, nivel muy inferior a las 3,365 consideradas en los países industrializados.

Por otro lado, en la década 1970-1979, el área cultivada ha permanecido casi estacionaria. A partir de 1980 se presentan relativos incrementos. Sin embargo, la producción se ha mantenido casi constante.

La disponibilidad a nivel nacional en 1970-85 de los productos: papa , camote, yuca, maíz, plátano, carne de vacuno y leche, ha disminuído mientras que el pollo, el pescado y el arroz se han incrementado.

Por otro lado, los volúmenes de exportación han decredido en 66% y los de importación se han duplicado, ocasionando un mayordrenaje de divisas con el problema de la dependencia externa.

La población peruana requiere de una mejor alimentación. El sub-consumo, la desnutrición, el hambre y la dependencia alimentaria son carac-

MINISTERIO DE AGRICULTURA

terísticas de la sociedad peruana, lo que viene acentuándose en los últimos años. Existe un grave deterioro en el volumen y calidad del consumo de alimentos. De 430 kg. ha decrecido a 300 Kg. por persona/año en el período de 1970-1985, lo que representa una disminución del 30% del volumen total de alimentos que se consumían hace 15 años.

El consumo per-cápita de energías y proteínas, en los primeros años de la década de 1970 (2,300 calorías y 55 gramos de proteínas) contrasta con los niveles registrados en los primeros años de la década 1980 de 1,850 calorías y 50 gramos en proteínas.

El problema nutricional resulta más grave aún cuando se analiza su distribución a nivel de estratos socio-económicos de la población. Es notorio que la población ubicada en los estratos de menores ingresos padece de una aguda y crónica desnutrición y es más vulnerable a todo tipo de enfermedades.

Como es de conocimiento general, la disponibilidad del agua es un factor limitante y decisivo para la producción agraria. El riego permite asegurar una o dos cosechas al año, y posibilita incrementar la superficie cultivada y los niveles de rendimiento por unidad de superficie.

De la información referida al "Uso Actual y Potencial de la Tierra Cultivable por Regiones Naturales" se ha determinado que existen posibilidades de incorporación, mejoramiento y rehabilitación de tierras, en una proporción de casi el doble del uso actual de las tierras cultivables.

En la costa el área bajo riego puede duplicarse, concentrándose en esta región la descarga de los ríos durante 4 a 5 meses del año (de diciembre a abril).

En la sierra hay pocas posibilidades de la incorporación de nuevas áreas agrícolas; por el contrario, algunas de las tierras cultivadas son poco aptas para la agricultura intensiva, siendo mas indicadas para pastos y forestales. Por tanto, el aumento de la producción en la sierra básicamente debe provenir de una mejora en la productividad de las tierras bajo cultivo; para ello es necesario la aplicación de tecnologías adecuadas en diversos aspectos, tales como: Manejo de Tierras, Uso de semillas mejoradas, abonamiento, control fitosanitario, etc. Una de las alternativas más efectivas en este sentido es la ejecución de irrigaciones, que además de sus propios efectos beneficiosos, potencia los efectos de las demás técnicas agrícolas.

En la selva, los recursos hídricos abundan en cantidad y es la región que ofrece mayores oportunidades de ampliación de la frontera agrícola, sobre todo en la ceja de selva, donde se encuentran las tierras de mejor calidad agrológica.

Lo expuesto demuestra que el país tiene suficiente recursos de tierras, que con el apoyo de una agricultura de riego puede mejorar sustancialmente los problemas de demanda de productos alimentarios.

ORGANIZACION METEOROLOGICA MUNDIAL

CONFERENCIA INTERNACIONAL SOBRE EL AGUA Y EL MEDIO AMBIENTE

CUESTIONES RELATIVAS AL DESARROLLO EN EL SIGLO XXI

INFORME PERU

Esfera Programática C.

Protección de los Recursos Hídricos, la Calidad del Agua y los Ecosistemas Acuáticos:

- PROTECCION DE LOS RECURSOS HIDRICOS:

La Protección de los Recursos Naturales, y dentro de ella los Recursos Hídricos, ha sido preocupación constante del gobierno peruano, en cuya Constitución Política, art. 119 dice: " El estado evalúa y preserva los recursos naturales; asimismo fomenta su racional aprovechamiento, promueve su industrialización para impulsar el desarrollo económico".

La Protección de los Recursos Hídricos, tiene un amparo legal através de la Ley General de Aguas (D.L. 17752) y el Código del Medio Ambiente y los Recursos Naturales (D.L .611), algunos de cuyos artículos expresan aspectos referidos a evitar las pérdidas, usos inadecuados, eficiencias en el manejo, condiciones adecuadas para el uso y evacuación, se prohiben cualquier tipo de vertimientos que puedan contaminar las aguas, dañar o poner en peligro la salud humana, el desarrollo normal de la flora y fauna; el cumplimineto de estos dispositivos están a cargo del los ministerios de Agricultura y Salud, quienes aplican sanciones apropiadas según la magnitud del daño efectuado.

Sin embargo, restricciones económicas presupuestales asignadas a dichas instituciones públicas, así como la falta de concientización del público usuario del agua, no han hecho posible el fiel cumplimiento de las normas establecidas, dando como resultado el deterioro de la calidad de las aguas y pérdidas considerables, así como también variaciones en su disponibilidad y uso.

LA CALIDAD DEL AGUA:

La escasez o abundancia de las aguas, características propias de nuestro país en algunas regiones naturales, se han visto afectados debido al deterioro de su calidad, con lo cual se ha convertido en un factor limitante para su aprovechamiento en bien del desarrollo económico y social.

El desarrollo de diferentes actividades humanas está n logrando que el agua se convierta en recurso escaso sujeto a disminución, al incrementar su uso y originar su contaminación. El crecimiento de la demanda y la paulatina disminución de la disponibilidad por efecto de la contaminación y el mal uso, permiten vislumbrar un futuro incierto para el aprovechamiento de los recursos hídricos y señalan ineludiblemente la necesidad de retomar las acciones iniciadaspor el Plan Nacional de Ordenamiento de los Recursos Hidráulicos (PLANORH).

El estudio "Diagnóstico Nacional de la Calidad del Agua", que viene ejecutando la Oficinal Nacional de Evaluación de los Recursos Naturales (ONERN), ha permitido disponer de abundante información sobre el contenido de contaminantes en las aguas superficiales del país, asi también detectar las principales fuentes de contaminación como son los "relaves mineros", que por encontrarse en su mayoría en las partes altas de las cuencas, afectan a casi la totalidad de las aguas de los ríos; adicionalmente se ha constatado que los ríos, lagos y el mar son considerados como puntos de disposición final de las aguas servidas, creando lógicamente problemas para su utilización posterior.

Para solucionar los problemas de contaminación y mal uso planteados líneas arriba, se están tomando acciones necesarias en cada uno de los sectores; asi como por ejemplo, se están incrementando los sitemas de tratamiento de desagues de varias ciudades del país, y en algunos casos estas aguas están siendo reutilizadas en la agricultura; ademas, hay una clara conciencia sobre la necesidad de establecer planes de vigilancia de la calidad de las aguas superficiales y subterráneas.

ECOSISTEMAS ACUATICOS:

El Perú tiene un gran número de ecosistemas acuáticos, tanto marinos como continentales.

El Ecosistema Marino es de aguas salobres, está considerado como uno de los mas ricos del mundo, tanto por la variedad como por la calidad y cantidad de los recursos hidrobiológicos que contienen; dicho potencial, está estrechamente relacionado con las características ecológicas de la Corriente Peruana de Humboldt.

Los Ecosistemas Acuáticos Continentales, estan relacionados con las aguas quietas (lagunas) y Corrientes (ríos), estas últimas llamadas aguas dulces, que albergan una diversa fauna nativa, introducida y migratoria, variable de acuerdo a las características propias de las regiones naturales (costa, sierra y selva), las cuales determinan diferencias notables tanto en calidad como en cantidad de las especies hidrobiológicas; de todas éstos, las existentes en la selva son las de mayor riqueza biótica.

El clima predominante de cada una de los ecosistemas acuáticos, es determinante para la adaptación de las especies de flora y fauna, por lo que en los climas andinos habrá predominancia de las especies de aguas frías, y en los climas de la costa o amazónicos, habrá mayor número de especies de aguas calientes.

Ing Gastón Moreno Rivera
Director de Recursos Hídricos
Oficina Nacional de Evaluación
de Recursos Naturales

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

DEVELOPMENT ISSUES FOR THE 21ST CENTURY

Dublin, Ireland, 26-31 January 1992

Country Paper: Shri Lanka

by

M.W.P.Wijesinghe
Chairman
Water Resources Board

International Conference on Water and the Environment
Development

Issues for the 21st Century - Dublin, Ireland

26-31 January, 1992

U

Country paper: Shri Lanka

By:

M.W.P. Wijesinghe
Chairman
Water Resources Board

LEGEND

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

DEVELOPMENT ISSUES FOR THE 21ST CENTURY

26-31 JANUARY 1992

Dublin, Ireland

ICWE SECRETARIAT

Country Paper: Sri Lanka

By: M.W.P. Wijesinghe, Chairman, Water Resources Board

Paper on Water and the Environment:

EXECUTIVE SUMMARY

Water is a prime national resource, a basic human need and a precious national asset. The resource becomes an asset when it is developed (harnessed) and made to satisfy society's need. Considerable amount of investment have gone in developing both surface and groundwater resources of the nation. Within Sri Lanka, competition among subsectors is growing more acute and government must provide water to their rapidly growing population for domestic use, agriculture to feed them and for industries to employ them, keeping in mind that these water related activites should create minimal less environmental degradation.

Hitherto, the emphasis has been mainly on supplying water to agriculture, hydropower generation, drinking and industrial water supply with very little attention paid to environmental protection. The water related planning and implementation process took into account only local needs, but neglected basin and regional impacts; it emphasises short term gain, but ignored long term sustainability; and its focus on structural components, but paid less attention on non-structural measures.

Water supply projects provide both positive and negative impacts. Some of the most viable adverse impacts are :

- environmental degradation and losses to flora and fauna
- large scale settltment of people from their original habitat
- public health consequences with water acting as a carrier disease, toxics and carcenogens
- water logging and soil salinity degrading agricultural lands
- sea water intrusion into coastal sedimentary aquifers and densely populated and intensively cultivated Northern peninsula and islands
- lack of equity and social justice in water distribution
- clashes among policies and strategies among competing users

Sri Lanka is at cross roads; it has opened up its economy for private investment with large scale restructuring of its public sector undertakings and involved in radical changes in policy transformation, rapid industrialization and urban development is taking place; the irrigated agricultural sector, participatory management and group diversification are assumed greater importance.

All these transformations are intimately related to water resources development. The government now is in an advantageous position to initiate mechanism for intergrated water resources planning according to priority to all aspects of water demand.

Endowed with a highly favourable hydrological regime with 103 river basins and widely distributed groundwater resources, it can be estimated that about two-third of the surface water resources in the less rainfall dry zone and about one-third in the wet zone have already been used. With regard to groundwater resources no appreciable extraction has yet taken place, except for very limited extraction for irrigation and other purposes by means of shallow wells and recently developed deep hand pump wells for rural water supply.

Major areas identifiable as recommendations for action on national level to protect the water resources and resulting environmental degradation are:

1. Protect waterways within developed coastal areas from harmful effluents from industries.

2. To carryout sufficient investigations of all resourceful coastal sedimentary aquifers that are being developed to protect from over extraction and possibly sea water intrusion.

3. To conduct districtwise detail hydrogeological studies with available data to assess a reasonable water balance within regions for future extension programmes on rural water supply with deep groundwater extraction.

4. To take into account the geomorphological and terrain conditions for environmental protection on large scale settlement projects.

In all these endeavours the primary requisite is the development of a meaningful master plan for water, outlining the availability of water supply and demand for sustainable development.

Country paper on Water and the Environment:

INTRODUCTION

1. Surface Water Resources

Sri Lanka is an island nation with a land area of 65,525 square kilometers. Among the 170 nations of the world, Sri Lanka ranks 112th in area. 49th in total population and 21st in population density. The population has grown from about 3.0 million in 1900 to just under 17 million at present (1991) and is expected to reach 20 million by the year 2000.

The average annual rainfall is about 2000 mm. which is more than double the world average, but the distribution is uneven, both spatially, with there being three zones, the dry, intermediate and wet, and by time, with two monsoons and periodic droughts and floods.

Successive governments since independence in 1948 have carried out many programmes to develop and utilize the water resources, mainly for irrigated agriculture and for hydro-power, culminating with the giant Accelerated Mahaweli Programme, implemented from 1978. At present, the last of the major reservoirs, Samanalawewa, on the Walawe Ganga, is about to come on stream. It is estimated that about 2/3rd of the water resources in the dry zone and about 1/3rd in the wet zone have already been utilized.

CLIMATE

Sri Lanka is situated in the large belt of monsoon climate in South Asia and experiences both SW and NE monsoon circulations. Apart from the general monsoon circulations, Sri Lanka's climate is governed by local factors such as: the central highlands a barrier for both monsoons, and cause large differences in climate between the windward and the leeward regions especially with respect to rainfall; its position in the Indian ocean has a moderating effect on the climate. Thus the tropical climate conditions in Sri Lanka are characterized by the pattern and distribution of rainfall originating from the southern-west and north-east monsoons. The monsoon season also defines the Sri Lanka 'hydrological year' which runs from October until September.

RAINFALL

Rainfall is the source of all available fresh water in Sri Lanka. When compared with most other countries, Sri Lanka is well endowed with an abundance of surface water resources. Rain occurs in four distinctive weather patterns of the south-west monsoon, the north-east monsoon, the convective cloud or thunderstorm and the pattern of weather caused by disturbances in the neighbourhood of Sri Lanka. The south-west monsoon is from May to September, the north-east monsoon from December to February, the thunderstorms occur during March and April, and the inter-monsoonal period and the disturbance during October and November. The mean annual rainfall in the island which is around 2080 mm is almost three times higher than the world average of 750 mm. However, the variation of rainfall over space and time and its sub-optimal utilization makes it a crucial constraint in water resources development and use in many parts of the country, and in particular in the 'dry zone.'

The maha rainfall varies from 800 to 3000 mm. The yala rainfall varies from 150 to 3000 mm. The 1200 mm isohyet covers almost half the island during maha while during yala it covers about a quarter of the island. Also the maha rains are more dependable with lesser coefficient of variation.

The distribution of rainfall within a year shows a seasonality of varying degree throughout the country in accordance with the seasonality of the atmospheric phenomena.

The annual distribution of rainfall in the dry zone is unimodal while in other parts of the country, it is bimodal or uniform or may show a tendency to very short dry spells.

There exists a marked dry season from January to September in the dry zone and from January to May in the wet zone in veiw of the low monthly rainfall. Meteorological conditions, rainfall variability and reliability, and water balance characteristics all indicate that there is an inbuilt tendency for rainfall departures to occur. Such random events occur frequently enought for concern. The 'abnormal' conditions pose a basic dilemma in planning measures for the mitigation of this adverse impact. This is all the more so because in development planning average water availability conditions are taken as the normative; this assumption may be valid for the country as a whole or in the case of long-term planning but is patently inadequate for local operational purposes.

There is an urgent need to define and formulate norms and criteria for identifying and measuring droughts and to develop efficient methods for drought forecasting and warning.

A thorough assessment of the current policies and action programme in anticipation of, during and subsequent to drought situations should be undertaken with a veiw to laying down the guidelines for a long-term strategy and unified national policy for drought mitigation which are conspicuous by their absence now.

Floods are natural phenomena which are an off-shot of incessant rainfall. Damages occur because man has exposed himself to the hazards of inundation. Human response to the phenomenon of flooding in the order of increasing costs of implementation are: human adjustment to minimize damage; socio-economic and engineering measures to abate floods; and engineering methods of flood control.

The problem of inundation and damages by floods in Sri Lanka are prominent in three major river basins, namely Kelani, Kalu and Mahaweli rivers. Although the duration of the floods is relatively short, in most instances less than four days, the inconveniences caused to the affected population and the concomitant government costs are significant. With the increasing population, there is likely to be a large scale encroachment of river banks and flood plains restricting the waterways and thereby increasing the flood stage.

Modern methods of flood forecasting, flood plain zoning, flood plain regulations and management of rivers are very essential to reduce future flood damages.

STREAMFLOW

Sri Lanka has a predominantly monsoonal and tropical climate. The radial drainage pattern emanating from the high watersheds has demarcated 103 distinct natural river basins that cover over 90 percent of the island. River basins originating in the wetter parts of the hill country are perennial, while many of those in the dry zone are only seasonal. Only a few river basins, such as the Mahaweli Ganga that drains 16 percent of Sri Lanka, carry water from the wet to the dry zone.

Although there are 103 distinct river basins, many of them are so small, often less than 100 km in the area and the beds of some of them vary nearly at mean sea level, that regular streamflow measurement is hardly justifiable in terms of manpower development and financial resources. There are about 40 river basins out of a total of 103 where stream gauging could be meaningfully performed.

An assessment of water resources available in the island is given in Table No.1. It is evident from Table No. 1 that Sri Lanka has a total annual surface runoff of around 42 million acrefeet of water. A considerable proportion of this amount is now utilized in irrigation and hydropower projects and what escapes to the sea is less than 27 million acrefeet. With the development of Mahaweli project, a considerable portion of the dry zone runoff had already been utilized.

TABLE NO. 1. Surface Water Resource

	Wet zone	Dry Zone	Island Total
Rainfall (Annual) mm	2424.18	1449.83	1937.00
Inches	(95.44)	(57.80)	(76.26)
Runoff (Annual) HM*	2.58×10^6	2.55×10^6	$5\times13\times10^6$
Acrefeet	20.93×10^6	20.66×10^6	41.59×10^6
Runoff rainfall ratio	65.1%	35.8%	40.5%
Escape HM	2.04×10^6	1.30×10^6	3.33×10^6
Acrefeet	16.50×10^6	10.56×10^6	27.00×10^6
Escape as a Runoff	78.83%	51.11%	64.91%

(*HM = Hectare Meters)

The Hydrology Division of the Irrigation Department has arrived at a quantitative estimate of the surface water potential in Sri Lanka on the basis of available data on streamflow, rainfall and reservoir replenishment (Table No.2). This gives only the potential available. In order to find out how much of this can be economically utilized (utilizable flow) additional studies need to be carried out. Table No. 2 clearly indicates regional variations in surface water potential over the island. It can vary between 21 cm and 253 cm from the lowest to the highest. While Kalutara, Galle, Ratnapura, Kegalla and Colombo districts records over 243 cm most dry zone districts have values below 30 cm. A large proportion (over 60%) of water that escapes to the sea is from the wet zone rivers like Kaluganga which has the highest discharge for any river except that for Mahaweli.

TABLE NO. 2. Surface Water Potential

District	N.E. Monsoon (Maha)		S.W. Monsoon (Yala)		Annual	
	cm.	ft.	cm.	ft.	cm.	ft.
Colombo	111.86	3.67	135.33	4.44	247.19	8.11
Gampaha	76.81	2.52	82.91	2.72	159.72	5.24
Kalutara	119.18	3.91	164.29	5.39	283.41	9.30
Kandy	55.78	1.83	66.75	2.19	122.53	4.02
Matale	42.37	1.39	6.71	0.22	49.07	1.61
Nuwara Eliya	85.04	2.79	144.78	4.75	229.82	7.54
Galle	119.18	3.91	134.42	4.41	253.59	8.32
Matara	98.45	3.23	73.36	2.42	172.21	5.65
Hambantota	34.44	1.13	29.26	0.96	63.70	2.09
Jaffna	9.75	0.32	2.74	0.09	12.50	0.41
Killinochchi	14.63	0.48	2.74	0.09	17.37	0.50
Mannar	22.25	0.73	2.66	0.12	25.91	0.85
Vavuniya	24.08	0.79	3.05	0.10	27.13	0.89
Mullaitivu	20.42	0.67	1.83	0.06	22.25	0.73
Batticaloa	19.20	0.63	1.83	0.06	21.03	0.69
Ampara	19.51	0.64	1.83	0.06	21.34	0.70
Trincomalee	19.81	0.65	1.52	0.05	21.34	0.70
Kurunegala	33.53	1.10	27.74	0.91	61.26	2.01
Puttalam	20.42	0.67	13.41	0.44	33.83	1.11
Anuradhapura	25.30	0.83	3.96	0.13	29.26	0.96
Polonnaruwa	27.74	0.91	17.68	0.58	45.42	1.49
Badulla	50.90	1.67	35.66	1.17	86.56	2.84
Moneragala	34.14	1.12	35.66	1.17	86.56	2.84
Ratnapura	127.10	4.17	127.41	4.18	254.51	8.35
Kegalle	106.98	3.51	143.87	4.72	250.85	8.23

Note: Surface Water Potential is expressed in terms of water depth distributed over the land surface.

HYDROMETRIC NETWORKS

The hydrometric network collects information on rainfall, streamflow, evaporation, reservoir storage and groundwater accretion and depletion. River basins of Sri Lanka, although small in size exhibit remarkable variability in terms of morphology, climate, geology, soils and landuse patterns. Therefore, their hydrologic characteristics are markedly different and calls for closer monitoring networks.

Measurement of rainfall in Sri Lanka dates back to the early 19th century when plantation agriculture kept records of daily rainfall measurements. Today the country has a comprehensive rainfall data network.

Hydrological information system of the country include over 700 daily read rainfall stations with records over 100 years in some of them. There are over 100 stream gauging stations with records for ptriods about 40 years. Available network is considered sufficient for basic planning purposes and gathering information for project identification and formulation. For preparing a comprehensive master plan, more refined data with greater reliability and additional advanced information systems will be necessary. This should be a priority consideration particularly in the area of weather forecasting, for future operations and plans. Automatic recording and monitoring devices may be the best option.

In Sri Lanka, the collection of hydrological data is being done by several government departments and statutory boards.

1. Department of Meteorology - rainfall

2. Department of Irrigation - rainfall, streamflow, evaporation and inflow to selected reservoirs.

3. Department of Agriculture - evaporation and evapotraspiration

4. Water Resources Board - hydrogeologic data

5. Water Supply and Drainage Board - hydrogeologic data

6. Water Management Secretariat, MEA - rainfall, streamflow, and inflow into the reservoirs in the Mahaweli area

The results of meteorological data analysis are published in the year books of Irrigation Department.

Although hydrometeorological data are collected by a number of agencies, there is no systematic procedure and organizational mechanism to develop a systematic hydrometeorological data bank for processing, storage, retrieval and dissemination. It is very essential to develop such a data bank which will form an important part of management information system for water resources planning, development and use.

Modern water management practiced often aided by computer simulation and operational research require a mass of hydrological information which should have a comprable degree of reliability. Modern methods of operational hydrology provides this need by adopting optimally designed networks, modern methods of data observation, transmission, processing and storage. The operation of these instruments needs highly skilled and trained personnel. Motivation and incentives for personnel are essential continuous process in a program of hydrologic data collection. Most observations are so soutine that the work may soon become monotonous. Recruitment, training, providing requisite facilities, motivating and monitoring and reviewing their performance is a prerequisite in the data collection.

2. Ground Water Resources

Ground water is one of the most widely distributed and most widely used resources in domestic water supplies in Sri Lanka. Conventional shallow open wells have also been used for agriculture from time immemorial where large supplies could be drawn as from cavernous limestone formations in Jaffna Peninsula. Aerial distribution of ground water, depth at which it occurs, its potential i.e. quality and quantity available for exploitation, are all dependent largely on the physiographic and hydrogeologic conditions. Geologically, the island can be divided into the following hydrogeological zones that show characteristic potentialities.

The north western and northern coastal belt of sedimentary karst (cavernous) aquifers of lime stone formations. This belt including Jaffna Peninsula is subjected to sea water intrusion. At many locations aquifers with or without artesian pressure have been located and partially developed for agriculture by means of deep tube wells (50 to 100 metres deep). Karst aquifers i.e. limestone basins have very high specific capacity and normal yields per well would range between 5 to 25 l/s, having sufficient development potential. A few of the investigated ground water basins are namely Vanathavillu, Murunkan, Silvaturai, Mulankavil, Paranthan, Visvamadu, Puthukkudiyiruppu and Mullaitivu. First, these basins have been investigated and potential evaluated for development. In Jaffna Peninsula detailed investigations have been carried out since 1969 to manage and conserve the limited freshwater available from annual recharge of the lensform aquifers (fresh water) floating on sea water. This Peninsula requires extensive research programmes in order to conserve water and manage exploitation without which, intrusion and upcoming of sea water cannot be avoided if its present rate of expansion in pumping wells for agriculture continues.

Coastal sand deposits and river alluvial formations in flood plains are the second resourceful hydrogeologic units of the island. Coastal sand aquifers are predominant in areas from Negombo upto Chilaw and also from Akkaraipattu to Mullaitivu. In these coastal stretches groundwater could be developed from shallow tube wells upto 30 m. depth for agriculture and industrial purposes with capacities ranging from 5 to 10 l/s per well. For example all the water requirements for the Free Trade Zone at Katunayake (1 million gallons/ day) is developed by means of about 60 tube wells. Average depth of wells is around 25 m. each well having a safe discharge of around 3 to 5 l/s. In order to maintain these renewable resource of water supply adequate care should be taken not to over exploit the aquifers beyond its annual recharge from rainfall.

River alluvial deposits are usually extensive in the flood plains particularly in river out-fall areas. Groundwater potential is quite large in such basins and water could be tapped continuously for industrial and agricultural purposes. Notably larger alluvial basins found in Sri Lanka are associated with Kelani, Kalu, Walawe and Mahaweli river basins.

Crystalline hard rock regions with limited groundwater storage capacity from the most extensive hydrogeologic zone which cover nearly nine-tenths of the total land area. The thickness of overburden mantle of weathered residual soil that blanket the rock strata is relatively thin ranging between zero to 10 metres. Occasionally deeper sections may be encountered, associated with faulted and fractured geological structure or alluvial basins in eroded river courses and flood plains.

Groundwater availability in the hard rocks is mainly within rock basins and/or in intensely fractured zones at a depth range normally upto 100 metres or so. It is most certain to locate limited source of water in a given restricted land area, but the nature of the source i.e. well type, its depth, quantity and quality all depend on the geological, geomorphological and climatic conditions of the area.

Groundwater potential in hard rock terrain is limited and successful development in a water source locality is only possible by means of systematic and scientific survey techniques that involve geological, geophysical methods and instrumentation to locate well sites, may it be shallow dug wells (normally upto 10 to 12 metres) or deep tube wells that may range in depths normally between 20 to 50 metres. Borehole discharge capacities in fissured and fractured hard rock formations vary largely on lithological, structural and basin characteristics. Climatic zonal effects are not that influential on yield since rainfall distribution over the entire island cover the requirement of annual recharge of any fissured hard rock basin in the country. Hence, discharge capacity depend only on the medium permeability. Normally, tested discharge from tube wells average to about 0.5 to 2 l/s, in almost entirety of the hard rock areas. However, occasionally much higher yields even upto 25 l/s have been observed in very special geohydrological situations associated with special geological structures.

In a recent publication on rural water supply and sanitation in Sri Lanka Peiris (1982) estimated that there are over one million wells spread out all over the island of which 40% are used mainly for drinking and cooking purposes, 30% for bathing only and the balance for both. However, the percentage of safe water remains at 10 to 15% and greater emphasis is obviously needed in the development of safe water in Sri Lanka.

Recognising the scarcity and difficulties encountered in getting drinking water in the Dry Zone, where 6.5 million rural population mainly depend, on shallow dug wells (often seasonal), the widely distributed groundwater resources in fissured hard rock terrain at depth must be considered as most vitally important in terms of national health and socio-economic potential generation.

3. Major Issues and Strategic Action Plans

In considering water and the environmental issues and their positive and negative impacts, it has to be accepted that rapid ongoing development projects would continue to create adverse affects progressively. The major issues could be identified as follows:

- Environmental degradation due to soil erosion in the central highlands due to unplanned settlements and intensive agricultural extension programmes on mountain slopes and valleys. In this regard proper land utilization has to be planned compatible with population distribution and water resources regimes.

- Reforestation within denuded forest cover on upper reaches of hills and mountains have to be planned and programmed more effectively than at present to control soil erosion and silting of major reservoirs and tanks.

- With agricultural activities expanding under major projects with new settlements, particularly under Mahaweli development programme have to be carefully planned and implemented to maintain environmental sustainability.
  Further, intensive fertilizer users would pollute the waterways and canal network to a greater degree in the future, affecting the water uses. It also could be said that the anticipated growth of industrialization in the rural areas associated with waterways have to be protected with immediate action taken under suitable planning programme.

- Under major irrgation projects such as the Mahaweli, water logging and soil salinization degrading the agricultural lands has already occurred to a manageable degree and an immediate action programme have to be drawn up to rectify this situation by proper drainage facilities and circulation of groundwater to keep the water table at reasonable depths.

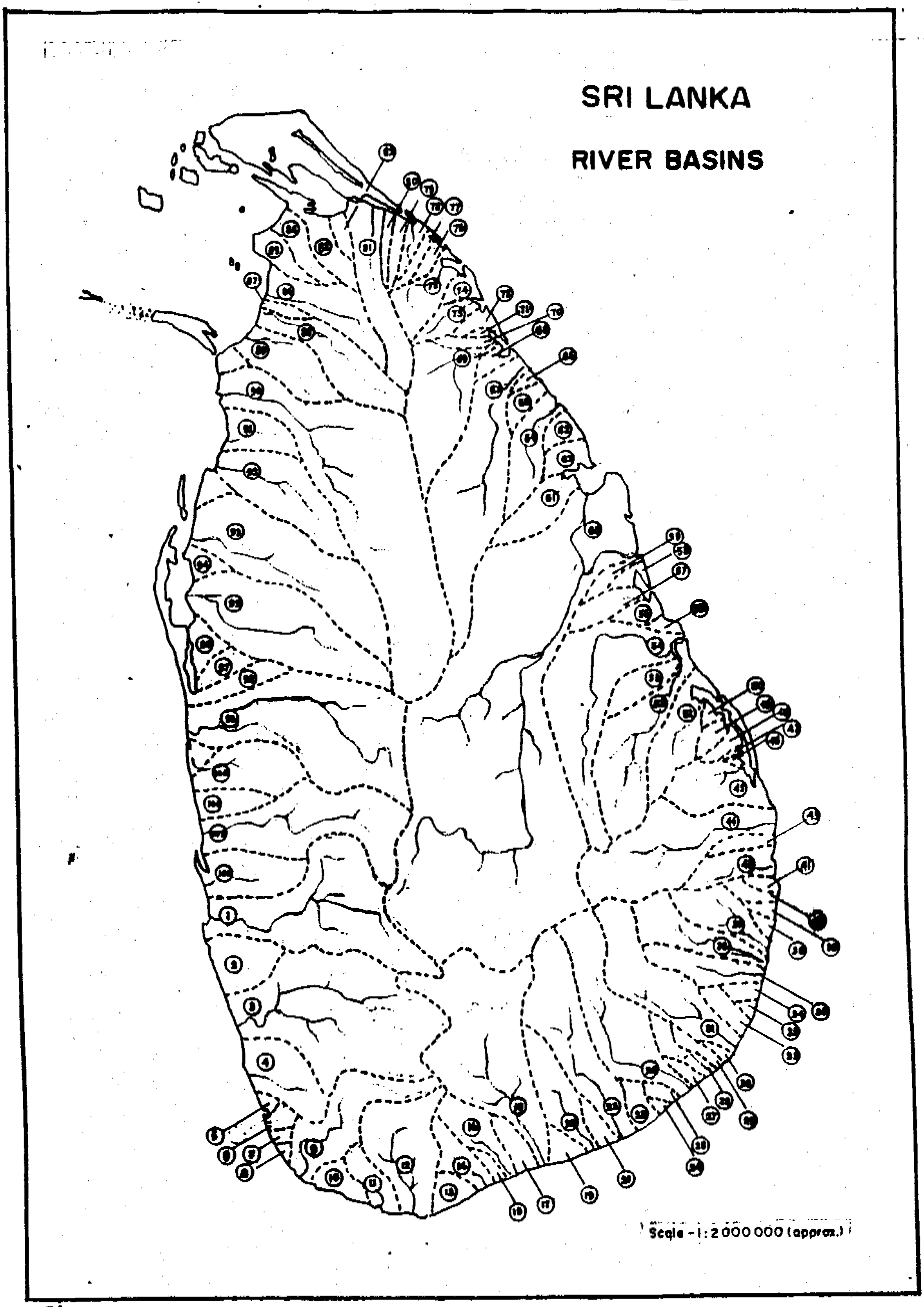
- With regard to groundwater development, the coastal sedimentary aquifers have to be protected with proper evaluation of safe limits of extraction under particular projects where systematic and scientific investigations of hydrogeological conditions have to be given priority. In this context, the Jaffna Peninsular in the North is particularly concerned with management strategies to avoid over extraction from shallow wells for irrigation with power pumps. Groundwater in this Peninsula which is 400 sq. miles in extent, exists under sensitive water balance with fluctuating lenses of fresh water not deeper than 10-20 metres floating on sea water. Salinity intrusion into the fresh water lenses would occur mainly through upconing of the interface with brackish water and also with lateral flows from the ocean, particularly into the coastal strip.

- Lack of equity and social justice in water distribution has heightened up with the increase of irrigation command areas and it is now envisaged to have agro large diameter shallow wells within valleys and low-lying plateaus for limited irrigation practices. This programme is being launched recently and reaching high proportionate without any control or regional groundwater potential studies to enforce any limitation.

- An action plan is being drawn now to assess the groundwater potential throughout the country within groundwater basins suitable for shallow dug wells with high water table. Proper hydrogeological study is a pre-requisite to have a more feasible programme to continue this ambitious groundwater development for irrigation to work out strategies for sustainable development.

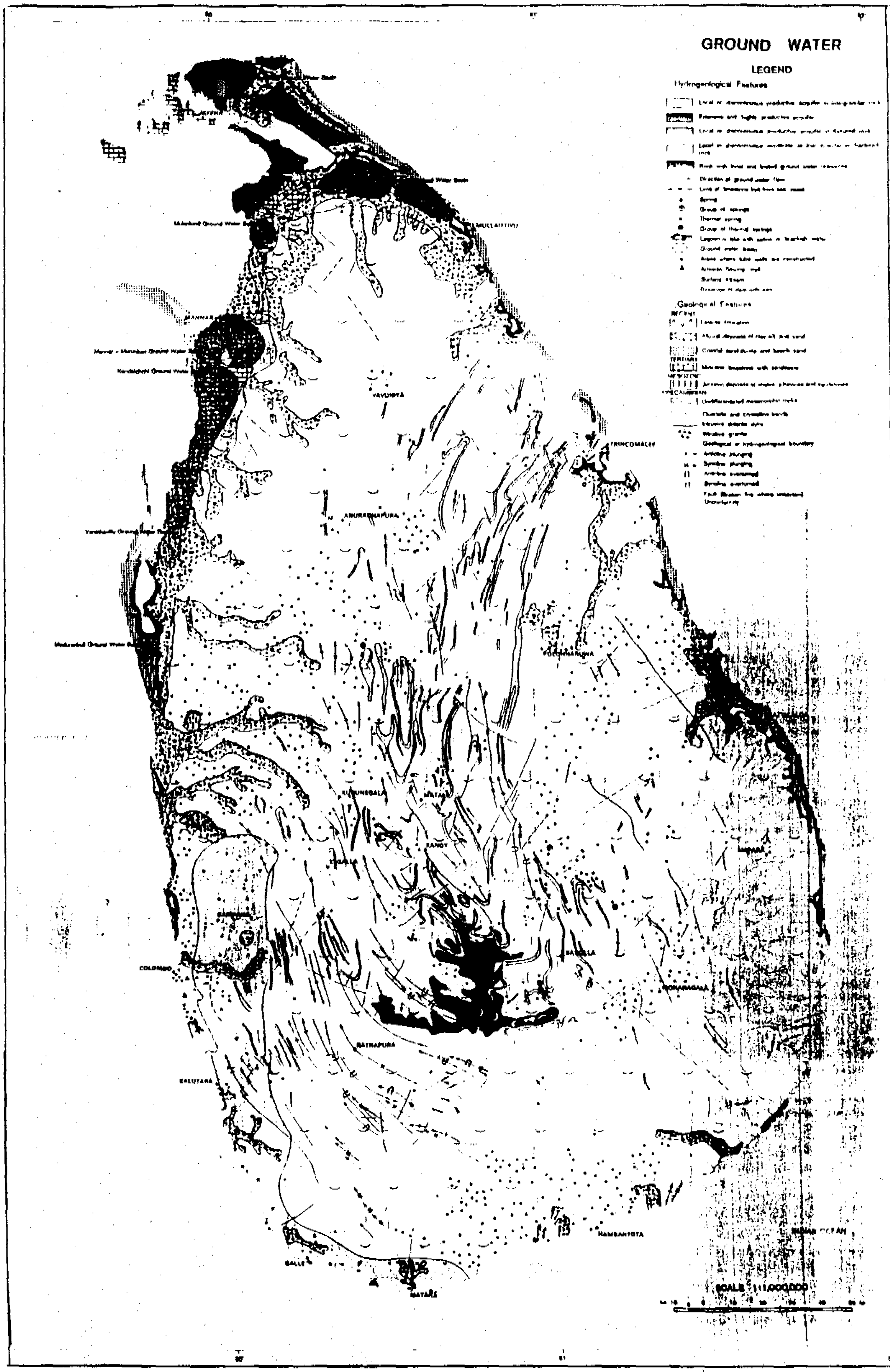
With this brief report on development issues that would extend to the 21st Century on Water and the Environment of Sri Lanka, it is hoped that all strategies would be identified and suitable action plan drawn that may need foreign funding for major programmes, particularly on groundwater resources development studies.

FIG. I



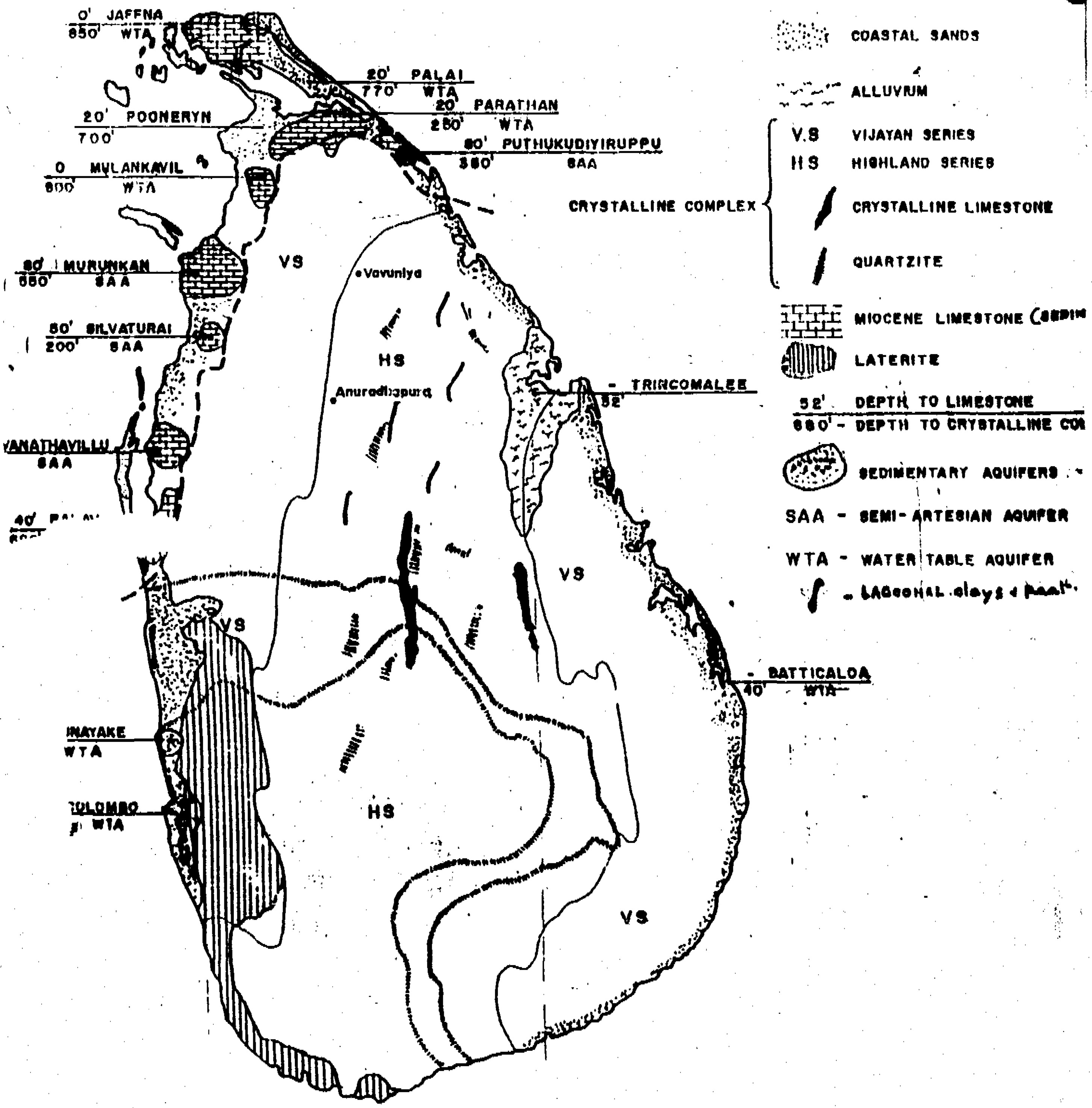
DA

2



GROUND WATER
LEGEND
Hydrogeological Features
Spring
Group of springs
Thermal spring
Group of thermal springs
Ground water basin
Artesian flowing well
Surface stream
Geological Features
RECENT
Alluvial deposits of clay silt and sand
Coastal sand dunes and beach sand
TERTIARY
PRECAMBRIAN
Antiline plunging
Syncline plunging
Antiline overturned
Syncline overturned
MULLAITTIVU
VAVUNIYA
TRINCOMALEE
ANURADHAPURA
POLONNARUWA
KURUNEGALA
MATALE
KANDY
KEGALLA
COLOMBO
BADULLA
MONARAGALA
RATNAPURA
KALUTARA
HAMBANTOTA
GALLE
MATARA
INDIAN OCEAN
SCALE 1:1,000,000

PRINCIPAL HYDROGEOLOGIC DOMAINS AND AQUIFER TYPES.



The country report of Viet Nam

CLIMATE, WATER RESOURCES - THE ENVIRONMENT AND SUSTAINABLE DEVELOPMENT ISSUES IN VIETNAM

VIETNAM is a long, narrow country with a total land area of 331,000 km^2 forming the Eastern seaboard of the Indochinese Peninsula. From latitude N8°30' to N23°22', the length of the country exceeds 1600 km, its width ranging between over 400 km in the North to about 200 km in the South with a very narrow, only 50 km wide, centralportion. Nearly 80% of the country's land surface is hilly-mountainous, with the bulk of the country's agricultural land located in two major deltas - the Red River Delta in the North; the Mekong River Delta in the South and in the narrow central coastal plain.

1. CLIMATE

The climate in Viet Nam is humid tropical which is influenced by South-East Asia monsoon.

1.1. Temperature

The mean annual temperature changed from 13°C in the North to 28°C in the South. The annual amplitude of temperature changed from 3°C to 12°C and decreasing from the North to the South. The annual mean total temperature changed from 9000°C to 10,000°C in Nam Bo and southern Trung Bo, From 7,700°C to 8,500°C in Bac Bo. In general, the annual total temperature was over 7500°C in the regions which their altitude were less than 500-800 m in the North and 800-1000 m in the South.

1.2. Solar Radiation

In average, there were about 1400 - 3000 sunshine hours per year. In Bac Bo and the sea-coast of Trung Bo, the number of sunshine hours in Summer were higher than Winter and the lowest value was occurred in February or March. In Nam Bo and Western Highland, the sunshine hours in Winter were higher than Summer. The relationship between the sunshine hours and the total radiation was closely. In the whole country, the annual total radiation changed from 95 to 155 $kcal/cm^2.yr$

1.3. Rainfall

Rainfall was abundant in Viet Nam : the annual mean rainfall was 1900 - 2000 mm.Its spatial distribution, however was complex: the lowest value was 500 - 600 mm/yr in the sea-coast of Thuan Hai province and the highest value was 4000 - 5000 mm/yr in Bac Quang, Nam Chau Linh, Ba To... The beginning of rainy season was end of April-begin of May in Bac Bo, Thanh Hoa, Western Highland, Nam Bo and from August - September in the central and southern Trung Bo. The end of rainy season was in September (Tay Bac, Dong Bac and Viet Bac), in October (the other parts of Bac Bo, Western Highland and eastern Nam Bo), in November (western Nam Bo), in November - December (eastern Truong Son)

The maximum monthly rainfall occurred in June-July (the mountainous regions of Bac Bo), in August (Bac Bo plain), in September-October (north of eastern Truong Son, Western High land and Nam Bo), in November (south of eastern Truong Son). Rainfall was concentrated in the rainy season. It occupied 80 - 85% of the annual total rainfall in Bac Bo, 70 -75% in the sea-coast of Trung Bo and 90% in Western Highland and Nam Bo. Rainfall was very few in dry season, sometime it was not enough for evaporation.

1.4. Typhoon

Typhoons were usually appeared in Summer. In average, there were about 5 typhoons coming to the sea-coast of Viet Nam in each year. This number, however, may be more than 10 in some years and it may be no typhoon in other year. During the last 2-3 decades, the number of typhoons was more than before. The rainfall which caused by typhoons occupied about 10 - 35% of the annual total rainfall.

Generally speaking, climate in Viet Nam was abundant on temperature, radiation and rainfall. It was convbnient condition for development agriculture, forestry, fishery and other economic activities. It was also, however, caused some dangerous natural disasters such as typhoon, flood, storm - surge, overflooded, drought...

2. WATER RESOURCES

The monsoon tropical climate has an important influence on water resources. Rainfall is abundent, so the river den - sity is rather high. There are more than 2345 rivers which their length are longer than 10 km. The rivers flow mainly into the East Sea with an outlet every 20 km approximately along the coast.

The river density reachs 1.5 - 2 km/km^2 in the high mountainous regions of Hoang Lien Son, Tay Con Linh, the upper of Thu Bon River, Dong Nai River. In the moderate mountainous regions, it reachs 1 - 1.2 km/km^2 (the upper of Western Highland rivers). The average density is from 0.5 to 1 km/km^2. In some karst regions such as Tra Linh, Moc Chau, Ke Bang... the density is less than 0.5 km/km^2. The rivers in our country are fostered by rainfall.

The two biggest river systems are the Mekong and the Red rivers. The former has biggest volume (520.6 km^3/yr) and the second - 122 km^3/yr. The volume of runoff varies from year to year. It may be from 1.5 to 3 times for the big rivers and from 10 to 30 times for the small rivers.

2.1. Flood season

The flood season is also the rainy season but its length is changed from place to place. The flood season lasts from June-July to September-October in the North Viet Nam; from September-October to December-January (next year) in the eastern Truong Son; from July to November in the western Truong Son and Nam Bo. During the flood season, the runoff distribution is also different. In the Red-Thai Binh system, the monthly maximum runoff is appeared on August (15-35% of the annual total runoff). The rivers in the South Viet Nam reached maximum runoff on September or October.

The time of the recession segment of flood hydrograph was rather long in the deltaic rivers. The dike system was soaked in a long time then it was easy to collapse. At the same time, big rainfall occurred in the fields so that water could not be drained away. It caused difficult problems for crops and the agricultural activities.

Typhoons were usually occurred during the flood season When typhoons coming, the water level in rivers rose up higher than usual. At the same time, there were much rain in the plateau near by the sea-coast. The daily maximum rainfall was 537 mm/day in Kim Boi, 413 mm/day in Van Dinh ... during the typhoon 9-10 November 1984. The total rainfall in two days was 1680 mm (Hoa Duyet), 1037 mm (Linh Cam)...

2.2. Low-flow season

After the flood season, river goes down : the low-flow season begins. Some of streams became dry. The inadequacy of water in the low-flow season caused difficult problems for irrigation, transportation and water supply. The ground water was the main sources. The low-flow season lasts 7 or 8 months and its distribution is different from place to place. The volume of runoff was about 10 to 30% the annual total runoff.

In average, the volume of runoff in the low-flow season was about 90-100 km^3. In the regions which have much rain and the forest cover was thick, the monthly minimum runoff reached 20-25 $l/s.km^2$. In the regions which having few rain deforestation developed, the monthly minimum runoff was less than 5 $l/s.km^2$. The role of forest upon low-flow was significant.

During the low-flow season, the influence of tide was also important. In the Red River Delta, the tidal phenomenon could be seen at the place 180 km far from the sea. In the Mekong Delta, that distance was about 400 km. At Tan Chau hydrological station (200 km far from the sea), the tidal amplitude was over 1 m.

2.3. Long-term variation of annual runoff

The annual average flow was 881.97 km^3 and changed from year to year. There was a period which the values of the annual average flow were high (the much water period) and the other period - these values were low (the few water period). This characteristic was important for water resources management and development as well as for water regulation

The much water period could be lasted 20 years (1932 - 1951) and the few water period could be lasted 16 years (1952 - 1967) in the Red River. Meanwhile, these values were

17 years (1937 - 1953) and 24 years (1954 - 1977) correspondingly for the Mekong River.

2.4. Water Quality

Water quality could be shown by sediment and the soluble materials in rivers. The total volume of sediment was high in the flood season (90% of the annual total volume) and low in the low-flow season. The annual total volume of sediment flowed into the sea was from 200 to 250 millions tons, in which 90% from the Red and Mekong rivers. These values showed that the erosion was serious and the study for land use processes played an important role in Viet Nam now.

Generally speaking, the mineralization in river water was low. In the Red River system, the average value was about 200 mg/l, in the Mekong River - 150 mg/l and the Dong Nai River - was less than 50 mg/l. The pH value was less than 6 in Dong Nai River. Especially, pH value was less than 3 in Dong Thap region at the beginning of rainy season.

Because of urbanization and industrialization, water supply was increasing and waste water was also increasing They have affected river water quality. The pollution of water occasionally occurs in many areas: in Ha Noi, water in To Lich, Kim Nguu rivers was very dirty (its colour was dark and has a stinking smell), the average value of BOD were over 30 mg/l, NH_4^+ was over 10 mg/l .In Ho Chi Minh City, water in Tham Luong channel has a dark colour and stinking smell, too. The value of COD reached 596 mg/l; BOD was 184.5 mg/l... The other regions (such as Lam Thao, Viet Tri, Thai Nguyen areas) have also the same situation.

One of the important characteristics of water resources in Viet Nam was hydropower potential. In average, the hydropower potential was about 94 kW/km^2. At the present, according to the technical ability, it could be produced 60 billion kWh per year. Generally speaking, the hydropower potential in our country was abundant, its distribution was rather equal in the whole country. Beside the water supply for irrigation and hydropower, the other characteristics of water resources in Viet Nam could be developed for fishery, transportation, recreation...

3. ENVIRONMENT AND SUSTAINABLE DEVELOPMENT ISSUES

Although the situation regarding pollution from industrial sources, atmospheric and water pollution is still good as compared to other countries, Viet Nam is presently faced with serious environmental problems such as flooding drought, deforestation, soil erosion, overexploitation of coastal resources, threats to ecosystems. especially, aquatic ecosystem, and depletion of genetic resources.

The continuation of current trends in environmental degradation will lead to the total elimination of the nation's forests by the early part of the next century. This, in turn, will intensify a variety of problems related to watershed degradation, including soil erosion, siltation seasonal water shortages, flooding and other natural disasters. It also will destroy the wood fuel supply and contribute further, along with overhunting, to the already rapid decline in the country's wildlife.

Climate change and its consequence - sea level rise, in future - will be a new challenge for Viet Nam. Especially, the situation will be seriously for two low-land deltas in Bac Bo and Nam Bo, where people and economic conditions are concentration. It will be the same for the coastal regions.

3.1. The strategy in Water Resources Management

A reliable supply of freshwater is a critical factor in relation to health and overall quality of life, particularly in relation to domestic use but also for agriculture and industry. The development of water supply is thus an ongoing effort in Viet Nam and one which has made significant progress, both in urban and rural areas.

However, several trends in the country manifest a growing risk to the supply of reliable and safe water in certain areas. These include, in particular, watershed degradation from deforestation and unsuitable cultivation practices and the pollution of surface and groundwater resources from sewage industries and agrochemical use.

The main options of the sustainable development strategy for water resources in Viet Nam are:

- Ensure that a high priority is placed on integrated head-watershed management
- Promote the prevention of water pollution via standards and controls on industrial effluents, integrated pest management in the agricultural sector and proper systems of sewage treatment, solid waste management and recycling
- Adopt water quality standards in relation to particular uses, e.g. drinking, recreation and fishing
- Ensure that water resources planners remain informed about future land use plans (e.g. for industrial development, mining, etc) so that the development of new water supplies can focus on sources that are least likely to become polluted in the future.

3.2. Management of environmental disasters which relying water resources : Flood control

Floods are an almost annual event in varying degrees during the rainy season, causing untold hardships to human settlement and loss of livestock, crops and farmlands.

Flood control has been traditionally, particularly in the Red and Mekong River Deltas, attempted through construction works such as dams, levees, channels and seawalls. Such structural solution alone usually have a negative long-range impact on the environment if remedial measures are not undertaken, such as controlling urbanization, preventing overgrazing and deforestation that could increase surface runoff.

Long-range flood control methods need to be planned through the construction of multi-purpose dams (usually a series of dams on a river system), development of watershed management programmes of levees, overflow basins and floodways and a network of multipurpose channels.

3.3. Some environmental and water resources problems which need to be solved in Viet Nam

(1) Determining the policy of water resources management in Viet Nam for sustainable development and effective protection to the ecology system
(2) Evaluating the environmental components in the water resources development projects

(3) Paying attention to improve the hydrometry instruments the laboratories as well as the methods to survey and calculate in hydrology which are suitable for the special conditions in each region

(4) Studying the environmental impact assessment for the big reservoirs, natural lakes, swamps, deltas. At the same time, studying the methods to evaluate the water pollution which are suitable for our conditions

(5) Studying the urban hydrological problems

(6) Studying the influence of climate change to water resources. Especially, paying attention to acid rains, the frequency of storms, flood, drought..

(7) The cooperation and aid of international organizations and developed countries are needed.

DOC
Country papers
from Dublin
D

WATER RESOURCES AND THE ENVIRONMENT IN SUDAN

CONTENTS

I

BASICS AND GENERAL

1. DEMORPHOLOGY

The conditions and characteristics of the water resources of any area are a direct function of its location, geology, relief and topography.

1:1. AREA AND LOCATION

The Sudan has an area of 2.5 million sq km. ranking the country as the largest in Africa and the ninth in the world. The water surface area is only 4%.

The Sudan has an entirely tropical and semi-continental location. It is situated in north-east Africa and lies between latitudes 3°N and 22°N and longitudes 22°-45' and 38°-30' East.

For the most part, the Sudan is land locked, separated by more than 1,000 km. from the major water bodies. The only sea contact is the 500 km. stretch of coast on the Red Sea.

The Sudan has a common border with nine African countries, and has close, social, cultural, historical, political and human ties with all its neighbours.

The Sudan also shares, bilaterally and multilaterally, several surface and ground water basins, of varying sizes, capacities and importance with twelve African countries. Furthermore, the Sudan's natural environment, in particular concerning the climate and water resources, are vulnerable and responsive to change, as regard to human activities resulting in significant upset of the ecological balance especially of the vegetation cover in neighbouring countries to the south and east. A location map is shown on Plate No.1A.

1:2. GEOLOGICAL STRUCTURE

The Sudan has an old crust, that has for long resisted tectonic movements, and has been extensively subjected to morphological processes including weathering, rock disintegration, erosion, creep, transport and levelling. The total area of rock outcrops is only 9% of the area of the country.

According to ground water availability in the Sudan there are seven formations, as illustrated on Map No.(1B). Geologically the Sudan structure includes three main groups and several small localized formations. The Basement complex covers 49% of the country area, the water bearing Nuba and Um Rwaba Series have a coverage of 28% and 18.5% respectively. The geological formations are shown on Map 1b.

1:3. RELIEF AND TOPOGRAPHY

The most prominent land feature is the extensive and flat central plain, forming 91% of the total area.

On the east, the plain extends to the Ethiopian Foot-Hills and the Red Sea Hills. Near the southern border, it elevates to relatively high ground that includes a scatter of hills and two massifs. On the north and west it extends beyond the border.

The apex of the Southern High Lands, forms both Sudan's southern political border, as well as the natural north-south water shed, the Nile-Congo Water Divide being the most important feature.

Major rock outcrops and massifs are: The Basement Complex; The Red Sea Hills in the north-east and the Nuba and the Ingassana in the centre. Young formations are Jebel Mara in the mid-west and the Imatong and Didinga in the south. The country relief structure is shown on Map 1C.

1:4. SOILS

The Sudan is very rich in suitable agricultural soils. The major soil groups include:

(a) The central clay plain (vertisols)

Located in the Semi Savanah and Savanah Belts, the vertisols cover the area enclosed between the White and the Blue Nile and most of the mid south.

They are dark heavy clays, chemically and organically rich, with low to medium physical properties. They are well suited for major irrigation and rainfed projects.

(b) The western Goz lands

These cover the whole of the West and are also located in the Semi Savanah and Savanah Belts. They are generally a mixture of sand dunes (Oxisols), and a variable amount and depth of vertisols. They are suited for rainfed agricultural crop production and ranching.

(c) The southern red soils (laterites)

These soils are mostly located in the Equatorial Highlands, they are generally thin and erodible; but this area has relatively high altitude, better weather and high rainfall. It is suited for small irrigation projects, in good soil pockets, for the production of equatorial crops with high returns. The main land uses however, are timber forests and game preservation.

(d) The riverine lands (entisols)

They lie along the Nile and its tributaries and along the courses of seasonal streams and the deltas of torrents. They are of high suitability and value, for the production of horticultural crops especially.

(e) Desert sand dunes (oxisols)

These cover the Semi Desert and Desert throughout the north. Generally of no value, they form a great impediment to development.

1:5. PRESENT LAND USE

(a) Areas

Areas classified as arable total 85×10^6 Hec; while the marginal productive areas cover about 56×10^6 Hec.
The reasonably managed areas total 26.5×10^6 Hec comprising; a gross cropped area of 15.5×10^6 Hec, reserved forest with a total area of 11.9×10^6 Hec. of which 3.5×10^6 Hec are Acacia forests, producing Gum Arabic, and the remaining 1.6×10^6 Hec are game reserve areas.

Nomadic livestock grazing covers 35×10^6 Hec of pastures; and the unaltered forests and brush cover 80.5×10^6 Hec.

The Gross irrigated area is 1.85×10^6 Hec with an average cropping intensity of 0.8; giving a net cropped area of 1.48×10^6 Hec.

Typical of semi-dry areas, rainfed agriculture, has a low level of sustainability. It is highly vulnerable to wide fluctuations to the weather changes.

The maximum, minimum and the average net cropped, rainfed areas were respectively 7.8, 2.4, and 5.3 10^6 Hec, the gross rainfed area being 13.6×10^6 Hec. The vegetation zones are shown on map 1d

(b) The development rates

The rate of development as well as the upkeep of the working agricultural projects has deteriorated tremendously during the last two decades.

When considering the two consecutive periods 1956 - 1975 and 1976-1990, within the earlier period the irrigated area increased from 0.67×10^6 Hec. to 1.69×10^6 Hec. giving an average rate of 51×10^3 Hec or 4.7% per year.

In contrast, in the most recent 15 year period, the total horizontal increase amounted to only 160 thousand x 10^3, which has an average annual rate of (10.7×10^3 Hec) only 1.1% per year.

Furthermore the net cultivated area stayed rather constant, since the new small development area increases were offset by the progressive deterioration of the main bulk of the irrigated area.

(c) Livestock

Livestock is mainly concentrated in the Savanah and the Semi-dry Belts, since the presence of the Tse-tse fly in the wet areas has prohibited breeding.

The 1980 livestock estimates give a large population of about 40 million head; comprising, 16 million cattle, 14 million sheep, 8 million goats and 2.5 million camels.

The continued impact of the drought, resulting in progressive quantitative and qualitative deterioration of the pasture and water supply; coupled with the abnormally dry year, 1984, has inflicted drastic damage on livestock.

The present (1990) estimates of the livestock population are only about 60% of the 1980 estimates.

(d) Other land uses

The other land uses have also been badly affected. The forests in one way have severely suffered from the drought, and the other way have been subject to widespread cutting.

2. HYDROLOGY

2:1. CLIMATE

The Sudan climate is highly influenced by the seasonal positioning of the Inter-tropical Convergence Zone (ITCZ) which is consistently located somewhere in the country.

During spring and summer in the northern hemisphere the ITCZ moves northwards, allowing the humid south-east monsoons, originating from the Indian Ocean, to sweep over the country. During the second half of the year as the ITCZ recedes southwards the country is open to prevailing dry northeasterly winds generated by the Euro-Asia landmass.

Typical of the flat topography, and the period of the humid monsoons, the weather conditions in the Sudan, tend to improve rather steadily moving from north to south.

Table 1 presents the climatic belts and their corresponding weather parameters. Map 1e shows the rainfall distribution.

2:2. EFFECTIVE CATCHMENTS

Typical of the flat and dry physiography, the country has a poor runoff response. The countrywide total runoff yield of 29.4 milliards, reflects an average effectiveness ratio of 2.9%, which comes to less than 10% of the global average. Table 2 gives the details of the local runoff. The effective precipitation isohyets are shown on Map 1f.

The main catchments include:

(a) The equatorial highlands

These afford the largest and most effective catchment in the country with runoff averaging about (8%) of the rainfall. Although this catchment area represents only about 7.5% of the Sudan, its runoff yield of 16.9 milliards, amounts to 58% of the country total.

(b) The Savanah highlands

These include the isolated massifs; Mara, Nuba, and Ingassana, and a few scattered hills - with an effectiveness ratio of between 3 and 6%. They generate a yield of 8 milliards, of which 3.3 milliards are Non Nilotic.

(c) The dry highlands

These areas include the Red Sea Hills in the east and the Medob Hills in the west, and a scatter of small isolated outcrops. Their total yield is estimated to be 2.5 milliards of which 1.6 milliards are Non-Nilotic.

The runoff is flashy and is conveyed by small watercourses, the sizes of which have been established by historical abnormal floods.

The Red Sea Hills drainage descends quickly onto the narrow sandy coastal strip and into the Red Sea.

The interior drainage sometimes ends in small inland deltas, and in some cases these retain some water in the streambeds. These two aspects are of vital importance in these semi-dry and dry lands.

Note: One milliard is equal to one thousand million m^3

2:3. LAND DRAINAGE AND RUNOFF

The Nile Basin is by far the most important and prominent feature as well as focus of the drainage systems, not only in the Sudan, but also regionally. The Nile Basin in the Sudan is shown on Map 1g.

231 The regional Nilotic systems

River Jebel, the southern major tributary of the White Nile flows north from the central African plateau catchment; namely the Basins of Lakes Victoria, Kioga and Albert. The catchment extends over seven central African states.

The drainage of the Ethiopian Plateau is conveyed into the Sudan by eight Nilotic Rivers; seven of these rivers are entirely Ethiopian, while, the Setit river rises within both Ethiopian and Eritrean territory.

232 The Nile Basin

(a) The White Nile

The White Nile is formed by the confluence of its three major tributaries in the Malakal area. Both the southern tributary, the R. Jebel, and the eastern tributary, the R. Sobat are regional rivers, while the catchment of the western tributary, the Bahar El Ghazal River, lies entirely within Sudan.

The three tributaries, while en-route to their confluence, experience substantial water losses in the extensive White Nile Swamps of the mid-south.

The White Nile at Malakal has a total annual supply of 29.2 milliards. The discharges are highly regulated by the central African lakes and the swamps, though the Sobat contribution is rather torrential. The normal minimum and maximum discharges are 576 cumecs and 1270 cumecs, respectively. Between Malakal and Jebel Aulia, the White Nile joins a supply of 2.5 milds, raising its supply at Melut to 31.7 milliards.

The White Nile joins the Blue Nile at Khartoum forming the Main Nile. The White Nile supply to the Main Nile, allowing for utilization and abstraction, and the high evaporation losses in the extensive, shallow Jebel Aulia Reservoir is 29.2 milliards. The net yield at Khartoum being 26.4 milliards.

(b) The Blue Nile

The Blue Nile and its tributaries, the Dinder and Rahad, rise in the western and central part of the Ethiopian Plateau their normal annual yields at the border, being 50.6, 3.0 and 1.1 milliards respectively; plus 1.2 milliards from various torrents.

The Blue Nile has a strongly seasonal character, the normal minimum and maximum discharges being 46 cumecs and 6600 cumecs, respectively.

The Blue Nile yield is partly regulated by the storage of Roseires and Sennar Dams, which support the irrigation of 650,000 hectares and the hydro-energy generation of 1300 G.W.H.

The Blue Nile contribution to the Main Nile, including all abstractions and reservoir losses, averages 54.2 milliards per annum.

(c) The Atbara River

The three tributaries of the Atbara River the Setit, Atbara, and Ba-Salam, rise in the northern part of the Ethiopian Plateau, and have supplies of 7.0, 3.6 and 0.6 milliards respectively.

The Atbara River is a seasonal torrent. 91% of its supply is delivered during the flood season (July-Sept) while during the period, December to May, the river is dry.

Khashm el Girba Dam and Storage support the irrigation of 160,000 hectares, and a seasonal hydro-energy generation of about 25 GWh.

The contribution of the Atbara to the Main Nile is unaffected by abstractions and reservoir losses are 11.6 milliards.

(d) The Main Nile

At Khartoum, the Main Nile has the combined supplies of the Blue and White Niles, totalling 83.4 milliards.

From Khartoum, along its 1,000 km course through the dry north, it traverses five cataracts, supplies a large number of pump irrigation schemes with a total of 1.41 milliards. The Nile is joined by its last tributary, the Atbara, about 400km north of Khartoum.

The average total supply of the Nile to Lake Nubia, at the border with Egypt, is 86.4 milliards according to the period of record used in this paper (1912-1977), while the Sudan - Egypt Nile Water Agreement has been based on the 1905 - 1955 period which had a normal supply of 84 milliards.

(e) The White Nile Swamps

The topography of the mid-south is that of a great lake. It has concentric contours, sloping inwards, with the narrow course of the White Nile in the north forming the only exit. Accordingly, the drainage of the whole of the south flows from all directions into this trough.

The White Nile Swamps are remnants of a silted lake and they comprise three basins, the Jebel River swamps in the centre, the Sobat River swamps to the east and the western Baher El Ghazal swamps.

The swamps incur heavy losses on the inflows of the three rivers, as well as the total loss of the supplies of several small torrents, sheet flows, and the direct precipitation on the swamps themselves. Table 3 illustrates the hydraulic characteristics of the swamps.

The ecology of the swamps is, in itself, a serious natural hazard. On the health and sanitary side, the swamps are ideal hosts for several epidemic vectors, worms and parasites. Socio-economically, they have been inflicting an utterly difficult and inhuman way of life on the local population, forming a barrier between the north and south of the country, and incurring huge losses in the vitally important, strategic and expensive resource, water.

Furthermore, without the effective control of these swamps the world will never achieve the eradication of malaria, filariae and bilharzia. Consequently, the control of these swamps has to be a world-wide concern.

(f) The regional non-Nilotic drainage

Rising in Eriterea are the Gash and Baraka Rivers. They are of nearly equal characteristics. Both are flashy seasonals ending in self made inland deltas. Each has a highly variable yield, with a normal value of 0.6 milliards, supporting flood irrigation of 20,000 hectares. The Gash also feeds a ground water aquifer that supports the irrigation of 3000 hectares of horticultural crops. The torrent, Azum, rises in the Mara Plateau in the west, and flows across the border into Chad. Azum is a flashy seasonal with a normal supply of 0.35 milliard.

(g) Local drainage

About 85% of the drainage generated within the country joins the Nile Basin.

The entire drainage of the south of 16.9 milliards debouches into the White Nile Swamps, while about 40% of the drainage of the three major catchments of the Savanah Belt joins the Nile Basin.

3. SOCIO-ECONOMIC RELATED FACTORS

3:1. DEMOGRAPHICS

(a) Population

The present estimate of the population, for 1990, indicates a total of 26 million, with an annual growth rate of 2.8%.

Within the last two decades, large immigration fluxes, from the rural to the urban areas, as well as from neighbouring countries into the Sudan, have been very active. These major population transfers, and the problems they have created, are attributed to several adverse natural and socio-economic factors, of which the prevailing severe drought has been a major cause.

(b) Settlements

The urban population forms 28% of the total and has been increasing at an annual rate of 7.4%. The nomads form 18%, while the rural villagers form the bulk, 54%.

(c) Occupations

Agricultural production is the main occupation. The actively productive segment of the population, forms about 28%; of which 73% are directly connected with agricultural production. About 92% of the total population depend directly or indirectly on agricultural earnings.

3:2 PREVAILING FACTORS AFFECTING DEVELOPMENT

(a) The factors

The rate of growth, as well as the upkeep of existing water resources projects, has been seriously affected by three major adverse factors within the last two decades.

1. The long-term prevailing drought over North Africa.
2. The thirty-year state of unrest in the south of the country.
3. The severe imbalance in international trade resulting in continued increases in the cost of imported industrial production inputs, contrasted to the relative stagnation of the prices for agricultural out-puts. This continuing imbalance in the output - input relationship, resulted in progressively diminishing returns.

(b) Production practices

Agricultural production, including water resources operations is labour-intensive, but the decline of agricultural returns, has affected the ability of the sector to attract labour.

The practical resolution of this difficult situation is to turn towards machine-intensive, and modern technology, and elevate production levels. But these options need large capital inputs and adequate training.

With the co-ordination and help of the World Bank, and other international agencies, The Sudan is presently implementing a major rehabilitation program, not only of the agricultural and water resources infrastructure, but including, as well, the country's services sector.

3:4. THE SOCIO-ECONOMIC IMPACT OF W.R. PROJECTS

The Water Resources in the Sudan, are basically and fundamentally responsible for shaping the socio-economic inheritance and trends.

The water resources projects cover several important production and services sectors.

(a) Agriculture

Agricultural production including livestock is the backbone of the country's economy. The other production sectors are relatively very small, and they are either dependent on agriculture, or are an input service to agriculture.

Agricultural production accounts for about 92% of the domestic food requirement, and about 95% of the country's exports.

Irrigated agriculture is more oriented to the production of cash crops; but also meets the country's need for specialized crops; pulses, spices, sugar and horticultural crops. It also contributes to the production of cereals, livestock, poultry and forests.

Cotton used to account for 60% of Sudan's export, followed by oil seeds 14%, gum arabic 10%, livestock 8%, and the remaining 7% was made up of sorghum, horticultural crops and others.

The recent policies and programmes aim for diversified exports and improving self-sufficiency. In sugar production self-sufficiency has been achieved and wheat production is picking up. But the programmes for the production of tea, coffee, tobacco and structural timber are hampered by the state of unrest in the south.

(b) Hydro-electric energy

The present generation of H.E.E. includes, Rosieres Station (280MW), Sennar Station (15 MW), and Girba Station (7MW). The annual H.E.E. production of (1,300 GWh) represents about 65% of the total countrywide electricity production. Furthermore, H.E.E. generation has the important role of stabilizing the cost and pricing of electricity. The Sudan has a total hydro power potential of about 4,800 MW, with an annual energy output of 25,000 GWh. The details are given on Table 4.

(c) Navigation

Navigation is totally contained within the Nile and its major tributaries. The Nile Basin potentially affords a major means of transport, covering the country from south to north thereby linking North Africa with Central Africa. But the Main Nile cataracts, and the River Jebel cataracts, have been a major handicap.

The present navigable reaches are unconnected and have a total length of about 3300 km. The regular navigable reaches have a total length of 2100 km, of which the Khartoum - Juba reach of 1900 km is the main link. The irregular flood season navigable reaches have a total length of about 1400 km.

The annual capacity has been about 300×10^6 Ton km carried by 50 steamers and 200 barges. But both the capacity and the service structure have deteriorated substantially.

(d) Fisheries

The Nile and tributaries, afford an appreciable catch of high quality fish, particularly in the main Nilotic water bodies; the White Nile swamps and the storage reservoirs.

The present average annual fish yield of about (8000 tons), represents only about 30% of the cultivatable capacity.

The management of fisheries is rather poor and neglected. The absence of effective laws, and unrestricted fishing practices are very damaging; especially for catching fish on their breeding migrations; Also the taking of young fish that can grow to several times larger than the sizes when caught.

(e) Sustainability

The relatively large irrigated agricultural development has helped the Sudan to have a rather better resilience to drought, famines and catastrophes. Certainly The Sudan has been experiencing the main effects of the drought, and the country has been suffering terribly but yet, the suffering was substantially alleviated.

II

THE SELECTED SUBJECTS

4 WATER RESOURCES ASSESSMENT

4:1. WATER RESOURCES ACTIVITIES

Several institutions shoulder the water resources assessment development and upkeep. The assessments inventories include:

(a) The Meteorological Department

The network comprises 48 first order stations, 41 second order stations, 1264 rain gauges, and 31 evaporation stations. The spatial distribution of the stations is rather consistent with W.M.O recommendations, but compared to world standards the network needs to be doubled.

The maps on figures (2:1),(2:2-a) and (2-2-b) demonstrate the distribution of the stations, as well as the extent of the network deterioration that has lately taken place.

(b) The Ministry of Irrigation and Water Resources

The Ministry is responsible for the Nile Basin and the Regional seasonals.

The hydrological network of the Nile and tributaries inside the Sudan comprises stage, discharge and sediment data observations. At present 236 stations are operating out of a total of 254 stations, of which 31 stations are recording.

Sediment sampling is poor, and is conducted intermittently in only 5 stations. While sediment transport problems cause major operational difficulties and large economical commitments.

(c) The Rural Water Development Corporation

The Corporation is responsible for the monitoring, utilization and upkeep of the rural water supplies. The Corporation includes two departments; one with responsibilities for surface run-off and one for ground water.

(i) Rural surface run-off

The present hydrological network covers 37 seasonals, forming about 30% of the prospective coverage.

Data collection includes, catchment studies, stage and discharge measurements. Typical of the run-off conditions, the assessment of discharges is conducted by float measurements and from the characteristics of the cross-sections.

The corporation also undertakes hydro-geological land surveys for the implementation of surface reservoirs.

(ii) Ground water

The corporation is responsible for ground water observations, development and upkeep. The resource assessment activities include, hydro-geological information and salinity data.

All dug wells are treated as test wells and data from these wells is included in the data base used for the assessment of the characteristics of the ground water basins.

(d) The Permanent Joint Technical Commission For Nile Waters (P.J.T.C)

The P.J.T.C. was formed by an act of the 1959 Water Agreement, to undertake the technical execution of the agreement. Its responsibilities include; the assessment of the Nile annual yields and utilization in the two countries, the evaluation of the Nile normal yield and appropriate inventories and plans for the increase of the Nile yield.

(e) The Geological Survey Department

The department is an organ of the Ministry of Energy and Mines. The department participates in the Ministry's geological and mining activities by providing the basic data for the ground water assessments.

(f) The Hydraulic Research Station

The station is a semi-autonomous organ of the Ministry of Irrigation. Within its hydraulic research capacity, the station undertakes the collection, analyses and modelling of the fluvial hydraulics data, channel and canals regimes, and the profound hydromorphological sedimentation problems, in storage reservoirs, and the composite aggradation and degradation problems of the Nile channel.

(g) The Agricultural Research

The water related functions of the agricultural research comprise crop-soil-water relations, and the evaluation of crop water factors.

Three research agronomy stations include specialized water relations departments. Several methodologies are used for the determination of the characteristics of the soil-crop water relations.

For the evaluation of (ETO), Penman formula is selected as the most suitable, and some of its functions have been adapted to suit indigenous characteristics.

4:2. WATER QUALITY OBSERVATIONS

Water quality observations are carried out by four specialized organs.

(a) The Hydrobiological Unit (University of Khartoum)

The unit undertakes routine hydrobiological analysis of the surface flows with emphasis on large water bodies.

(b) Ministry of Health, Water Quality Unit

The unit carries out the analysis of drinking water samples, but the analysis is not performed on a programmed routine basis.

(c) The Ground Water Section (Rural Water Dept.)

The section undertakes salinity and chemical composition analysis for all dug wells.

(d) The Pest Control Department (Ministry of Agriculture)

The water weeds section undertakes observations of water weeds at several check points, particularly for water hyacinth. The analyses include growth and spreading characteristics and environmental and control aspects.

4:3. DATA ANALYSIS AND EVALUATION

(a) Nile Basin record

Most of the water resources data records cover a sufficient lengthy period.

Nile Basin gauging in the Sudan was started in 1869. The present hydrological records of the Nile Basin cover 60-80 years. The records are sufficient and competent for the determination of the salient flow and yield characteristics, but the sediment transport data is poor, and not commensurate with the colossal sedimentation problems.

(b) Climatological and Hydro-Meteorological records

The climatological records cover a span of 40-60 years, and afford reasonably adequate basic hydro-meteorological data for the determination of the salient characteristics of the different parameters, and the determination of the effective reliable rainfall typical of the different zones. However it is regretted that concurrent with the prevailing drought era, the capacity of the network has declined considerably.

(c) The seasonal runoff

Special attention and effort have been given lately to the assessment and utilization of the rural seasonals, in conjunction with the surmounting rural water supply problems that have been substantially increased by the drought.

Already present developments on some seasonals have signified the need and importance of extending the data coverage to enable the safe and reliable utilization of these seasonals.

4:4. UP GRADING AND SUPPORT

The water resources assessment inventories require urgent support to undertake the following upgrading objectives:

- (i) the rehabilitation of the existing inventories;
- (ii) renewal and renovation of the defective units;
- (iii) extension of water quality and rural water supplies inventories;
- (iv) modernization of the systems.

The estimate of the capital requirement for upgrading is U.S.$20 million.

4:5. REGIONAL WATER RESOURCES ASSESSMENTS

(a) Scope and objectives

The Sudan has common water basins with 12 African States. Accordingly, the Sudan realizes and advocates the importance of effective regional co-operation, involving the following criteria:

- (i) adequate assessment of the resource characteristics;
- (ii) realistic assessments of the riperian countries' demands:
- (iii) the formulation of just and agreeable principles for sharing;
- (iv) the establishment of a utilization sharing agreement;
- (v) national projects are to be negotiated with other neighbouring countries;.
- (vi) national projects are to respect regional integrated interests;.
- (vii) countries benefiting from projects in other riperian countries have to participate in the project costs within the capacity of their benefits.

(b) Present regional co-operation in resource assessment

(i) The Hydrometeorological Survey of the Catchments of the Central African lakes

An eminent accomplishment is the multilateral co-operation for the hydro-meteorological survey of the catchments of Lakes Victoria, Kioga and Albert.

With the support and participation of UNESF, Sudan, Egypt, Uganda, Kenya and Tanzania agreed in 1967 to participate in the project. Brunds, Urnds and Zaire joined in 1972, while Ethiopia, though not riperian to the catchment, joined as an observer on the Technical Committee managing the project.

The first phase finished in 1975, comprising the setting out of a modern hydro-meteorological network, and the formation of a properly equipped data centre.

The second phase was started in 1975 with the objective of formulating a mathematical model representing the catchment to assist in the resource assessment and conservation. By 1984 the model was properly formulated and tested.

The third phase has the objective of the assessment of the national demands of the riperian countries. The third phase is still within its preliminary stage. This phase is however, of basic importance for the fourth phase, which will include setting out the principles for sharing the resource and ultimately the accomplishment of a utilization agreement.

(ii) The Ethiopian Catchment

While Egypt is interested in the whole Nile yield from the catchment, The Sudan and Ethiopia's interests cover eight Nilotic Rivers and two non-Nilotic streams one of them also shared with Eritrea. Consequently, the negotiations with Ethiopia are sometimes inclusive to the whole yield and sometimes specifying in one or two rivers. The continuing dialogue included:

The Ethiopian contact to the UNDP to formulate agreement with the Sudan for the hydrological studies of the Non-Nilotic torrents Gash and Baraka.

The UNDP proposal to Sudan and Ethiopia to conduct the hydrometeorological study of the Blue Nile catchment.

The continuing dialogue between Sudan, Ethiopia and Egypt for setting out a basis for co-operation.

The old agreements included:

The 1891 Agreement between Britain, acting for Sudan, and Italy, acting for Ethiopia, that no works affecting the yield of River Atbara to be undertaken in Ethiopia.

The 1902 Agreement between Ethiopia and Britain, acting for Sudan, that Ethiopia will not undertake any projects over the Blue Nile, Lake Tana and River Sobat without the consent of The Sudan.

(c) The 1959 Nile Water Agreement

Nile water use in Sudan and Egypt has always been bound by agreements since the dawn of the century. The prevailing 1959 Nile agreement was based on the long term normal annual yield of 84 milliard at the common border, as given by (1905-1955) records. The agreement allocations, being 10 milliards for the High Dam Reservoir losses, and the utilizable remainder of 74 milliard, is shared in the ratio of 1:3, i.e., a Sudan share of 18.5 milliard and an Egypt share of 55.5 milliard.

By allowing for the 10% channel conveyance losses, between the centre of Sudan utilization projects and the border, the Sudan utilizable share becomes 20.55 milliard.

Both of the shares are liable to future increase or decrease, subject to the following aspects, that have been well allowed for in the agreement.

(i) When the future demand of any of the riparian countries is established, the two countries have to provide for the commitment, in equal amounts from their allocations.

(ii) The two countries are to participate on equal terms and also in sharing the benefits, in the water conservation projects. Most important being the water reclamation projects of the White Nile Swamps.

(iii) The continued assessment of the Nile normal annual yield in relation to the advance of the records.

(d) The assessment of the water reclamation yield

Water reclamation possibilities though, cover the whole Basin, including improvements in the flow regimes; yet the White Nile Swamps stand as the main resource for tapping. The hydro-morphological characteristics of the swamps are shown in Table 2.

The Permanent Joint Technical Commission for the Nile Waters supervises the assessment studies of the swamps environment as well as the planning for the water harnessing projects.

The first project, Jonglei Phase I, is already 75% accomplished, but presently the work is stopped temporarily for security reasons.

Formulation of the coming three projects is in hand, masher project, Jonglei II project, catchment lakes storage project, and Bahar El Ghazal Phase I project. The envisaged contribution of these projects is 15 milliard.

4:6. ASSESSMENT OF THE RIVERS CHANNEL RESOURCES

(a) Hydro Energy

The Nile Basin in The Sudan has a hydro-energy potential of about 4000 MW with an envisaged total output of 22 thousand G.W.H. The characteristics and location of the potential sites are shown in Table 4.

(b) Navigation

The present navigation courses have been discussed in chapter (3). The extension of navigation to be more connected and stable, depends to a great extent on the future harnessing of the cataracts sites in conjunction with hydro-energy development.

(c) Agriculture and domestic water supply

These two items, being of eminent importance to the subject of the paper, are discussed at length in Subjects 5 and 8 following.

5 INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

5:1. THE CAPACITY AND LIMITATIONS OF THE AVAILABLE SUPPLY

(a) Rainfall

Rainfall according to capacity, and ease of development in conjunction with the extensive land resources, stands as the major water resource of the country. The countrywide normal rainfall yield is (1024 milliard), giving a country average of (400 m.m.). Table (No.) gives the salient characteristics of rainfall for the different belts.

The sustainability of rainfall production is very low, as affected by several factors typical to the qualities of the resource and the rainfed production practices in The Sudan. viz:

(i) The wide variability and low reliability of the rainfall yield;
(ii) The inconsistency of the rain season;
(iii) Erratic and inconsistent distribution of rainfall over the rainy season;

(iv) Severe water shortage starting immediately after the end of the rainy season;

(v) About 35% of the rural population depend for living on the rainfall prospects of the semi-dry belts (150-600) m.m.;

(vi) Nearly 75% of the nomads' herds graze during the rainy season in the semi-dry belts;

(vii) The selection of crops in rainfed areas is not based on a safe reliable capacity of the rainfall yield.

Notwithstanding all these limitations, the potential rainfed development is substantial. But, in order to attain a higher degree of the production sustainability, and effective relaxation of the summer season water supply problems, well oriented integrated planning, based on proper knowledge of the water supply demand relations, is needed.

(b) The Nile Basin

The present capacity of the Sudan share is 20.55 milliard. The committed utilization was 16.2 milliard in 1978, and 18.1 milliard at present. The long term utilization plan for the period 1990-2010 is based on an increased share of 26.68 milliard, as including the contribution of the first three water reclamation projects of the White Nile Swamps.

Originally, the Nile Water utilization plan was prepared by the support and supervision of The World Bank, and the participation of a consortium of international consultants. The original implementation period was 1980-2000. But due to difficulties in obtaining the financial support, the implementation was hampered.

The plan has been reviewed lately, partly amended, and rescheduled for implementation within 1990-2010 period.

Already active work has started, with priority given to the low cost, high return components of the plan. The present early stage is as such emphasizing the rehabilitation, modernization, and the vertical upgrading of production. Also the upgrading of the management and the undertaking of the studies pertinant to the plan.

The main limitation facing the Nile Waters utilization is the involvement of large capital and high level of technology, for which The Sudan has to depend on international support and participation.

On the other hand the Nile Water development is multi-objective and has high returns. It also has the eminent national benefits, of being the main shrine for export, while its sustainable production has been (especially in the difficult drought years) the safety stud of the country, compacting hunger and famine.

(c) The non-Nilotic streams

The total normal supply of these seasonals is 4.9 milliard. The utilizable yield allowing for a reasonable reliability level, is 2.5 milliards. As subject to the location and effectiveness of the catchments.

The present utilization is about 0.10 milliard, while the studied streams can allow a utilization capacity of 0.52 milliard. Gash and Baraka are not included in these statistics. They are both regional streams, and both have reached full utilization capacity.

The main limitation concerning the utilization of the seasonal supplies concerns their erratic, variable yields, a condition requiring ample knowledge of the catchment and flow characteristics.

However, the seasonal supplies, together with the shallow bed water they return, afford the most effective and economical water supply in the inland areas, within the localities they can serve. It is important to note that the drought has aroused high concern and interest as regards speeding the utilization of the inland streams, so as to relax the water shortage problems. Further details of the seasonals are given in Table 2.

(d) Ground water

The present estimates of ground water basins give,a total storage capacity of about 4940 milliard, an annual recharge of about (6.8 milliard) a potential allowable utilization capacity of about 4 milliard, and a present utilization of 0.53 milliard shared by 0.18 milliard drinking supply and 0.35 milliard irrigation. Table 5 gives the distribution and characteristics of the ground water basins.

The main utilization limitations include:

- (i) ground water assessment and utilization is still in its early stage;
- (ii) large potential areas lack ground water (basement complex);
- (iii) uncertainty of the capacity and salinity of the potential sites;
- (iv) high variation of the costs (as to different localities);
- (v) Ground water tapping is more expensive than other resources;
- (vi) energy supply difficulties;
- (vii) operation and maintenance require large numbers of trained personnel.

However, ground water tapping is not only the main resource for about 50% of the inland areas, but has also the merit of being a continuous supply. Furthermore, it does not involve water harnessing losses, nor is it affected by sedimentation, and water quality deterioration.

The anti-thirst campaign, has attracted important international support. The relevance of ground water tapping, to the compacting thirst and hunger in the non-nilotic areas, has made the main weight of the campaign a concentration on ground water.

(e) Rainfall harvesting

The basement complex covers 49% of the country area, and includes about 50% of the potential protective savanah belt. At present, rainfed utilization in these areas is at great risk and difficulty.

Few small localities have small ground water resources in the deep faults and usually the water is of small capacity and low quality. Also bed water of the seasonals is very limited.

Traditionally the harvesting and storage of rain water in natural ditches or constructed small reservoirs was the only option.

This practical methodology has been given more technological formulation for planning, implementation and upkeep. Some of the large surface reservoirs carry water on an annual continuity basis. The total number of the constructed reservoirs (Haffirs) is 831, allowing a total capacity of 25×10^6 M^3.

5:2. INTEGRATED PLANNING

(a) Forward

Typical of the Sudan natural environment, the supply demand water relations are numerous, involved and difficult. Whereas the appropriate utilization of the water resources is fundamentally the key factor for the country's welfare, progress and socio-economic stability, the wide and tough aspects of time and place distribution of the water resources have been a major limitation for the country to develop its natural resources; including the water resources itself.

The effective approach to resolve this difficult water issue, is through undertaking well co-ordinated integrated planning based on a sound knowledge of the supply and demand capacities, technical, environmental and human aspects.

The undertaking of such planning requires capable, effective management, proper utilization of modern techniques and facilities, and efficient organizations for the design, implementation and upkeep of water resources projects.

(b) The effective approach

The effective approach, as typical to The Sudan, has to be based on, and allow for, the following principles.

(c) The present management

It is well understood that the present management is not properly fitted to cope with the responsibilities of integrated water resources planning. The main limitations being:

- First the present set up is formed of several organizations each concentrating on one type of resource or one of the utilization objectives; without effective links between the units.
- Second, the units composition involves a narrow spectrum of disciplines, usually a main technical body and a service department.
- Third, the units are activity oriented, but not purposes and objectives oriented.
- Fourth, unhealthy egosimic relations, rather than co-operation.

(d) The proposed management

The formation of a capable and effective set-up has been under consideration for about twenty years. The base work for the new formation included local and international expert studies, meetings and conferences.

The proposed set up is umbrella shaped, radiating up and down the apex to the broad base.

<u>The Water Resources Council (W.R.C.)</u>

At the apex is the high level policy maker (W.R.C). Its participation is to be multidisciplinary including not only the whole spectrum of the water resources and their utilization components, but also all relevant socio-economic, environmental, and federal concerns.

The responsibilities of the Council include setting out the purposes, and the framework of the objectives and priorities. Also to set out The Sudan policies as regards international co-operation, as well as the local water use laws, regulations and specifications. And to undertake the top supervision of the performance and production of the whole set-up.

The Central Planning Board (C.P.B.)

The composition of the (C.P.B) is to be multidisciplinary including all the disciplines required for integrated and effective planning.

The (C.P.B.) is to be equipped with all modern technological facilities, and to include a capable data base unit as well as be supported by research, modern programming and optimization techniques.

The (C.P.B) is to be fully responsible for all water resources, harnessing, conservation and utilization planning.

The Executive Organs (E.Os)

The E.Os. are responsible for the design, implementation and upkeep of the water utilization projects. They are to be well connected by liaison and standing committees to facilitate co-operation and co-ordination.

The Special Duty Units

These units include the commissions responsible for the technical execution of regional and international agreements, also the National Committees of international and regional agencies and commissions. The formation, supervision and the setting out of their terms of reference is to be shouldered by (W.R.C)

The Federal Units

These units undertake the execution, and upkeep of the small federal projects, which are originally included in the national plan. The Executive Organs are responsible for the support and supervision of the F.Us. performance.

The F.Us. are to be the broad base for basic data monitoring and feeding.

5:3. THE INTEGRATED WATER RESOURCES DEVELOPMENT

(a) Integration of the water resources

The integrated utilization of the water resources common to any locality, is of special importance to arid countries, as it provides a better, more effective and sustainable utilization. Pertinent examples include:

- for rainfed cropping, a subside single irrigation from ground water, torrents or haffirs may improve the sustainability of production.

- in the case of drinking water supplies, the haffirs storage can be made of a more continuous nature if supported by feeding from ground water.
- water transport from areas with a surplus to distressed areas, while the transport lines are to be integrated with the limited supplies of the distressed areas, affords a highly important solution.

(b) Integrated Basin Development (I.B.D.)

The proper and effective undertaking of I.B.D. requires as a prerequisite, a sound knowledge of the following criteria:

(i) the resources, quantitative, qualitative and environmental characteristics;
(ii) the present and future demands and interests in the whole area or reaches covered by the resources;.
(iii) the multi-objectives of the resource, whether they are contradicting or linear and their socio-economic and technical inherent development characteristics and their sustainable capacities.
(iv) laying out of a master plan for utilization with a proper beneficial setting out of priorities.

To a reasonable degree (I.B.D) is recognized and applied in the Nile Basin development, but are highly lacking in the development of the other resources. The exploitation of some important basins serving large towns has already by far exceeded their capacities, and the conflict for using the limited inland supplies for drinking and agriculture, and above all the wide on and off rainfed production which is not relying on proper understanding of the supply and demand inherent relations.

(c) Multi-objective water resource development

A well balanced integration of the different utilization objectives is of great merit for multi-sectorial benefits and attractiveness for financement. Nile Water planning and development has always been of multi-objective nature. In fact, the high returns from hydro-energy have been lately a major support to agriculture.

But some of the important objectives like navigation, and recreation are not given the recognition they stand for. True, it is difficult to define their weight in a feasibility study according to their low present status, but in essence, navigation, if properly upgraded, will stand for a very prominent position in the country base and infrastructure.

5:4. THE WATER RESOURCES DEVELOPMENT PLAN

The recent widespread miseries of the 1984 abnormal drought and also on the contrast the 1988 extensively damaging floods, have alerted a consensus opinion, to give more attention and support to the water resources harnessing and development.

The details of the water resources development plan to be implemented within the period 1990-2010 are given in Table 6.

The plan has been well developed to cater to important objectives, growth rates, and the abilities of the infrastructure, the service structure, and the execution abilities. Rural Water Supply is more emphasised to relax the problem of thirst and to give more support to the rural production to improve its reliability and sustainability.

The development capacity of the plan is within the development rates experienced within the sixties and the seventies, but higher than the slowdown of the 80s. The main limitation being, securing the financement and ascertaining its flow to be in uniformity with the plan schedules and priorities. The total estimate cost is US$14 billion. The foreign component constitute 84% of the total capital. The details of the prospective increases of the outputs of the different sectors are illustrated in Table 6.

6 WATER FOR SUSTAINABLE FOOD PRODUCTION AND RURAL DEVELOPMENT

6:1. GENERAL

Subject to the high importance and relevance of this topic to The Sudan, it has been discussed in several parts of the paper.

Rural life and production evolves from the largest sector of the population, and forms the broad base of the socio-economic cultural and moral inheritance and habitant of the country.

Furthermore, the future of the whole country relies significantly on the efficient and appropriate development of the vast agricultural potential of the rural mass of the country.

But this colossal potential depends nearly entirely on arid region rainfall. The rainfall that has the difficult and severe characteristics of inconsistancy and low reliability, as well as erratic distribution within the short and highly variable rainy season.

The relaxation of the rural difficulties, and to improve on the utilization and production levels and qualities, can only be achieved through attaining sound and adequate knowledge of the water supply demand relations, so as to establish a reasonably sustainable conformity of the utilization.

6:2. THE SUPPLY-DEMAND LIMITATIONS

The limitations include inherent characteristics of the supply and the incompatitable conformity of the demand capacity and trends.

(a) The supply limitations

- (i) Rainfall limitations (have been discussed and illustrated).
- (ii) Nile Basin supplies are limited and are serving basin areas. The transport of Nile Water to Non-Nilotic areas is not practised.
- (iii) The rural streams are few with very sparse distribution, while their yield is affected by the coupled limitations of the rainfall and the effectiveness of the catchment. (Lower runoff rates for low rainfall).
- (iv) Ground water occurrences cover only about 50% of the total productive and potential rural areas. The total capacity of the Basins is large (4800 milliard), but the main bulk is practically dead storage. The total annual recharge is about 6 milliard. The salinity, transmutability and depth vary considerably. Ground water tapping other than being uncertain is highly costy.

(b) Conditions of the demand

- (i) Localities with better conditions of water supply have been over-exploited, to become in certain cases the most distressed areas.
- (ii) Most of the traditional localities forming the summer water supply centres for the nomadic herds, have been taken over by irrigation, urbanization, or surrounded by large rainfed farming. The nomads are always being pushed into harder and more severe water supply conditions.
- (iii) To establish adequate water supply systems, is beyond the country's present capacity.
- (iv) The rural water supply activities, do not have clear objectives whether it is a development, service or a moral issue. Accordingly, the priorities are set by political decisions rather than properly weighed planning decisions.
- (v) The best solution is to form a network of watering points. The second best is to have a line system. But the present systems are constituted of a scattering of remote watering points.
- (vi) The flocking of herds around the watering points is in several cases larger than the holding capacity of the water supply and the surrounding grazing. A case that has led to degrazing, loss of top soil and practically the desertification of several water point localities.

(vii) The rainfed cropping does not allow properly for the reliability of rainfall (The water requirement is determined on the average rainfall yield).

(viii) Cropping patterns are not diversified, in fact, single crop practices are carried at a wide scale; resulting in exhausting the land fertility and increasing aridity.

(ix) In many cases the lower parts of the stems and the roots are left over after the harvest. Several adverse effects on the land and the production result.

(x) Last and not least the surveillance and the progressive advance of the drought, has affected seriously all aspects of the water supply, increased aridity and failure of vegetation cover, poorer pasture and large scale desert encroachment.

6:3. THE IMPROVEMENT OF RURAL PRODUCTION

To save the rural bulk of the Sudan from deterioration and collapse, and to set out quick and effective improvement programmes, have been lately the most important issue. Accordingly, consolidated efforts including conferences, seminars, debates and specialized studies have been focused for the generation of effective and applicable major improvement plans and programmes of all aspects of rural areas.

The framework of the plan covers the following criteria and objectives:

(i) to attain a wider participation in the setting and the implementation of the improvement programmes. The provincial government system is being changed into federal state systems;

(ii) to warrant safe and proper utilization of the water resources, the planning and top management is to be central, multi-disciplinary, including rural participation;

(iii) issue of laws and acts for the conservation of both the supply and demand;

(iv) to increase the participation of the Federal States, their role includes widening data collection base, formulation of projects and the design implementation and upkeep of small projects as well as other delegated responsibilities from the central institutions;

(v) drinking water supply is given the top over-riding priority;

(vi) drinking water supply exploitation is to be based on a high reliability above 80%;

(vii) better analyses and understanding of the water resources salient characteristics is to be achieved. Emphasis is to be given to the reliability of yields;

(viii) integrated water supply development is to be enhanced for all cases;

(ix) the combined utilization of the water resources pertinant to any locality so as to attain better sustainability of the supply;

(x) water transport from localities with surplus, including the Nile Basin to achieve wider and better sustainability of the rural drinking water supplies;

(xi) balanced land water use including all aspects for the conservation of the environment;

(xii) choice of crops varieties is to conform with a high reliability of the rainfall;

(xiii) mixed and diversified farming to achieve better use and better sustainability of production;.

(xiv) human and animal transfer from the highly distressed areas;

(xv) development programmes are to be based on well oriented, short term and long term planning, with well defined objectives and scheduling of priorities;.

(xvi) international participation in this human cause is highly welcomed, appreciated and to be properly looked for.

7 DRINKING WATER SUPPLY AND SANITATION

7:1 GENERAL

About two thirds of the population and one third of the livestock are located along the Nile Basin, and have a relatively better water supply situation. At least they have accessability to a continuous water supply.

The Non-Nilotic part suffers tremendously from the severe scarcity of water within the long, hot, severely dry summer of 6-9 months. Most difficult being the case of the basement complex areas.

The problem of thirst being a vital human cause, and the overriding factor affecting development, welfare, settlement and happiness, has always been given high concern, but subject to the capacity of the country. The afforded water supply is shorter than the demand. The present capacity of the present drinking water supply of 230 million m^3, affords about 30% of the actual demand; while the demand is based on very humble and low utilization per capita rates.

With the availability of water being the vital issue, emphasis has been put more on the quantitative achievements rather than the qualitative requirements. However, water quality testing and specifying are conducted in an unsystematic manner mostly in large urban centres.

Fortunately both the Nile water, and the ground water are healthy and hygienic, and are still within their original natural status, hardly affected by pollution hazards.

7:2. DRINKING WATER SUPPLY

(a) Urban areas water supply

The proportion of the urban population presently with access to improved water supplies is under 50%, and there has been practically no important improvements in the coverage since the seventies and, added to that, most of the utilities are obsolete.

Further serious aggravation of the situation has been drought affected in a dual manner; extensive increase in the demand and sharp decrease in the supply capacity.

The demand has been vastly increased by the large immigration from rural areas to urban centres, to the extent that the population of large towns is doubling in small periods of less than 10 years.

The shortage of the supply has severely affected the non-Nilotic towns. Already important large towns, (Port Sudan, Gedarif, El Obeid) are in very acute and grave difficulty. The afforded supply is less than half the low level, tightly suppressed demand.

(b) Rural areas water supply

About only 30% of the rural population is served with improved water supply. But most of this humble service is concentrated within areas of easy supply, Nilotic and large seasonal basins areas.

For the provision of drinking water supplies, both for human and animal use, in the Non-Nilotic areas, three practices are in use:

(i) small dams for storage on seasonal and inferior water lines. The present 35 dams have a total capacity of 20 million m^3;

(ii) Haffirs are concentrated in hilly areas, and areas that generate some sort of runoff. The present 990 hafirs have a total supply of 25 million m^3;

(iii) Ground water is obtained from three sources; 3500 water yards composed of 6000 deep bore holes fitted with turbine pumps giving a total supply of 150 million m^3/year; 6000 bore holes with hand pumps supplying 20 million m^3, and 5000 hand dug wells supplying 10 million m^3.

The total supply of the Non-Nilotic rural areas is 225 million m^3. The rural Nile Basin areas have 142 schemes providing a capacity of 5 million m^3. Accordingly the total rural supply is 230 million m^3. By allowing 40% for stoppages, failures and losses, net drinking water supply afforded to the entire rural area is 156 million m^3.

For the case of the demand, and in accordance with the present suppressed per capita use, the immediate need is expressed as follows:

-	human need at 25 L/capita per day is	173 Mm^3
-	livestock at 20 L/day	292 Mm^3
	Total vital need	465 Mm^3

Thus the present deficit is about three times the present capacity of the supply.

In applying a demand annual growth rate of 2.8% for human demand and 0.5% for livestock, the added annual extra need is 6.25 Mm^3/year.

However, if total balance of the supply and demand is to be achieved in twenty years, and allowing for the provided rates of the annual growth, as well as raising the human use to the humble 40L/D, then the total volume of the needed supply in the year 2010 shall be 924Mm^3.

To accomplish this vital need, an average annual supply rate of 39.3 Mm^3 is required. When allowing for losses of 20% only then the practically needed development annual rate is 47Mm^3.

7:3. SANITATION

(a) Urban sanitation

It is estimated that between 70 to 80% of the urban population is either connected to sewers (only Khartoum) or uses conversional on-site facilities, including; septic tanks, aqua privies, cesspits and pit latrines. No accurate data is available, and a tentative estimate of the coverage is as follows:

-	Sewers	5%
-	Septic tanks	35%
-	Pit Latrines	35%
-	Dry privies or no facilities	25%

(b) Rural sanitation

Little attention has so far been given to rural sanitation. No records exist to provide an estimate of the present status of rural sanitation. In general it may be assumed that only 10 - 20% of the rural population is served with pit latrines where as the rest of the population defecate under bushes and in open areas.

However the standard of living and other social conditions, as well as some important international programmes have allowed some areas to have better coverage. The irrigated Gezira area has pit latrines coverage exceeding 40%.

7:4. INTERNATIONAL SUPPORT PROGRAMMES

There has been active international support on both of the provisions of drinking water supply, and sanitation, as well as the related aspects of water quality, health, pollution and water carried diseases.

The United Nations Blue Nile health project is a fully wide scale integrated project, covering the whole Gezira area. The programme included the formation of several specialized units to serve the different aspects of water supply, sanitation and the water quality and protective health measures. The programme is supported by multi-disciplinary extentioning.

Already the programme has achieved remarkable success as illustrated by the relatively high coverage of improved water supply and sanitation in the Gezira area, as well as the advanced works in setting the direct and direct measures for the control and eradication of the water borne diseases, pilharsia malaria and dysentry.

UNICEF has carried out an integrated project of slim bore holes with VIP in more than 5000 sites, mainly in Kordofan. The project on its own has raised the sanitation coverage of rural areas by about 10%.

7:5. FUTURE ASPECTS

The provision of an adequate and safe drinking water supply, and proper, hazard free sanitation is the most valued basic human need. The United Nations, International Drinking Water Supply and Sanitation Decade, and Programme of "Health for All by the Year 2000", emphasize the priority of drinking water supplies.

But typical of all arid countries the provisions of water supplies and sanitation are well below requirement. The problem is large, complex and requires large capital and diversified technological needs, that are much beyond their capacity.

That the needs are colossal, and that the problem is typical to the entire arid zone, it is not intended here to put lengthy list of the needed diversified multidisciplinary and multitechnological support. But this vital human cause is set for international co-operation and the world common cause and unity.

8 PROTECTION OF WATER RESOURCES

WATER QUALITY AND AQUATIC ECOSYSTEMS

8:1. FORWARD

The Nile system has dominated ecological efforts in The Sudan and it has to be stressed that the ecological impacts on the Nile system have been systematically investigated and studied in a proper disciplinary proceedure, covering the entire system.

Lately, within the last three decades, the Nile system has witnessed some major events that have affected its ecology. Some were natural, while others were man made.

8:2. THE NATURAL ECOLOGICAL IMPACTS

Within the last thirty years two major natural episodes have been affecting the ecology of the water resources systems.

The substantial expansion of the White Nile swamps consequant to the big rise of Lake Victoria levels that took place in the early sixties. In contrast, the second episode being the prevailing drought that started in the mid-sixties and proceeded progressively to the present.

The ecological impacts of both cases was substantial. But the excessive flooding of the swamps was confined to the Nile system. While the drought impact was collosal and radical, including drastic adverse changes of all disciplines, natural, economical social, cultural, political and human. It was in reality the slow death of everything.

8:2. MAN MADE IMPACTS

The invasion of the Nile system by water hyacinthe could be regarded as one of the most remarkable unintentional human impacts on the environment that had befallen the Nile system recently. The vast and extensive spreading of the hyacinthe was helped by the ideal habitant afforded by the extensive increase of the swamps areas, and the inclusion of vast areas of no or dead slow velocities.

The mid-sixties witnessed the start of operation of three Nile Basin large dam structures, involving huge storage capacities. Girba Dam on the Atbara River with storage of 1.3 milliard was commissioned in 1964; Egypt High Dam with a storage, subtending in the Sudan of 153 milliard was commissioned in 1965, and the Roseires Dam on the Blue Nile with storage of 3 milliard was commissioned in 1966.

The combined storage of the three reservoirs surpasses the prior storage volumes by 25 fold, and can room twice the normal annual Nile supply.

The water impact has affected for better or worse several disciplines including the flow regime, flood control, morphological changes, irrigation capacity, domestic water supplies quantity and quality, hydro-biological changes, and disease and health aspects.

The most extensive adverse impact has been the large morphological changes of aggradation upstream of the dams and serious degradation covering all downstream reaches and affecting all sorts of utilities along the banks of the Nile.

The alteration of the hydro-biological regime of the Blue Nile, affected by Roseires storage, resulted in increases in its biological productivity and diversity.

The creation of the large Reservoir of the High Aswan Dam (Lake Nasir/Nuba) has produced an eutrophic water body offering substantial fishery production, as well as an ideal habitant of other ecological changes.

The recent appearance (1980) of ceratium hilundinell (dianoflagellate) in Lake Nuba, of Potamogetom Crispius, and other emmigrant macrophytes in the originally macrophytes-free Nile. Several other indications, lead to the understanding that the Nile Basin is undergoing significan morphological changes. This emphasis the high importance that all types of Nile water uses and installations should be based on sound understanding of the natural ecosystems and to allow for the proper conservation of the environment.

9 IMPACT OF THE CLIMATE CHANGE ON WATER RESOURCES

9:1. CLIMATIC CHANGES

There is a universal concensus about the global warming. The temperature rise experienced in the last three decades is due to the increase of the release of carbon dioxide and other greenhouse gases, (methane, nitrous oxide) into the atmosphere.

Forest destruction, overgrazing and all other fauling with the vegetative cover, have contributed to the increase of CO_2 releases.

The absence of closed forests in the Sudan, ranked the country fourth in carbon emission among all African countries.

The magnitude of the global rise in temperature being of manute rates, is still faced with uncertainty and doubt.

In the case of The Sudan there is enough evidence that the rainfall has substantially decreased, and that there is a slight increase in temperature. Table 7 and Plates 3:1 to 3:4 show the long term rainfall series and the decline of normal yield.

9:2. THE DROUGHT PRONE AREAS

The dry regions of the world form about 30% of the world land mass, but their share of the fresh water resources comes to about one percent of the world total. The high evaporation and evaprotranspiration sets the tropical dry areas in a worse position than the cold climate dry areas, (Siberia).

Dry, arid, and drought prone, are different names reflecting different qualities of mostly tropical areas with poor or little rainfall. The absolutely dry deserts do not count since they are lifeless, with the exception of localities with transient water resources.

Africa Sub-Sahara, the Sudano-Sahil belt has been seriously affected by the severe prolonged, (three decades) drought. Eight African states of the Region have been drastically hit and suffered from hunger, thirst and collapse of their socio-economic structure, while humanity, morality and mortality became a real issue.

It is true that this human misery has been focused on by the international media, and that there was world aid, but the entire aid for this real vital human case, for eight countries within three decades was far less than the armament support sometimes provided for one country in one year.

9:3. THE IMPACT OF THE DROUGHT ON THE WATER RESOURCES

a. The annual rainfall yield

During the last thirty years, not only the normal annual rainfall decreased considerably (by 14.7%) as compared to the normal yield of the previous similar period, but the decrease has been progressive. (decreasing by about an additional 7% each decade). Moreover, the occurrence of abnormally low yield years is becoming more frequent.

The frequency of very dry years also increased. 1984 and 1990 respectively had total yields of 49% and 54% of the normal yield.

The isohyetal maps given in Figures 3a and 3b and the standard deviation in Figure 3c illustrate the decrease of the normal yield.

b. The rainfall belts

The severity of the drought was more profound on the dry and simi-dry areas than the Savana and the Equatorial areas.

It is true that the quantity of the deficit is higher in the wet areas, but the ratio of the deficit to the normal is catastrophic in the case of the dry areas. Illustration of the decrease of the rainfall belts is illustrated in Table #.

c. **The desert creep**

The relatively higher rates of dryness in the dry and semi-dry areas has given the rainfall belts a quicker dryness movement. Within the last 30 years, the 25 mm belt has shifted into higher rainfall belts by about 180 kilometers. Similar movement for other belts was as follows, the 200 mm belt subsided by about 120 kilometers, the 400 mm belt by about 100 kilometers. And for the (600, 1000 and 1400)mm belts the respective movement was about (80, 65 and 50) kilometers.

The rapid movement of the dry belts, resulted in a high rate of expansion of aridity and desertification. Desert encroachment was further helped by the failure of the weak vegetative cover to support it's typical traditional uses. This aspect helped in quick removal of the vegetative cover, and soil erosion.

d. **Runoff**

The runoff of the seasonals has declined more severely than the conditions of the rainfall itself. Since runoff is affected by two factors; the rainfall intensity and its distribution characteristics, and the effectiveness of the catchment. The effectiveness of catchments being low for low intensity rainfall, drastic decrease in seasonals runoff resulted.

It is becoming of very frequent nature that the seasonals water supply reservoirs as well as haffirs come up short by more than 50% of their filling capacity, while several inferior water lines got to be completely dry.

Even the Nile yield has been affected, (mainly the major contribution from the Ethiopian plateau as well as the small contribution from Sudanese catchments).

The normal Nile yield at Aswan for the period 1905 - 1955 was 84 milliard, while for the wet period 1950 - 1970 it was 93 milliard and was only 80.5 milliard within the recent period 1970 - 1990.

e. **Sediment transport**

The dryness of the catchments resulted in a high increase of the transported sediments. The transported sediment loads of the Blue Nile and the Atbara River, that had normals of 80 and 60 thousand tons/year, have increased within the last decade by about 40 and 30 percent respectively.

The sediment transport has been given difficult operational problems and large and expensive desedimentation works.

9:3. DROUGHT MITIGATION REQUIREMENTS

a. Data collection and research

Research is needed for more understanding of the weather and drought relations, and characteristics, including the following activities:

- (i) support and upgrading of the climatological networks;
- (ii) modern data centre for storage analyses of records;
- (iii) research and studies on cycles, trends, and the climatological and environmental impacts.

b. Drought mitigation

- (i) Data collection and analyses of the land and water uses, for the different rainfall belts, quantitatively and qualitatively;
- (ii) studies and research pertinent to the conformity of land and water uses, as related to the sustainable capacity of the resources;
- (iii) studies pertinent to drought mitigation including aforestation, water transport, and safe mixed and diversified practices to protect the vegetative cover;
- (iv) regional and international co-operation in all aspects concerning drought mitigation, as well as the preservation and conservation of the environment.

TABLE 1

THE SUDAN CLIMATOLOGICAL BELTS

(1950 - 1980 RECORD)

WEATHER PARAMETERS	UNIT	CLIMATOLOGICAL BELTS					TOTAL SUDAN
		DESERT	SEMI DESERT	SEMI SAVANAH	SAVANAH	EQUATORIAL WOODLANDS	
LOCATION	LAT.	18°N-23°N	15°N-18°N	10°-18°N	6°-10°N	3°N -6°N	3°N-23°N
AREA	$KM^2 x10^6$	620	460	550	710	160	2500
Average Min.Temp	C°	20.5	21.3	22.4	21.8	21.4	21.5
Average Max.Temp	C°	37.2	36.9	34.8	34.6	34.6	35.7
Belt Range of Annual R.F.	mm.	0-50	50-200	200-600	600-1200	1200-1600	0-2200
Normal Av. Annual R.F.	mm.	12	77	348	811	1342	409
Normal Annual Yield	$M^3 x10^9$	7	35	191	576	215	1024
Length of Rain Season	Month	NIL	0-2	2-4	4-6	6-8	0-9
Max Storm	mm.	65.8	205.5	193.0	176.0	157.0	240
Av. Annual ETo	mm.	7592	6643	5657	3760	2810	5597

TABLE 2

DETAIL OF LOCAL RUNOFF SUPPLIES (IN MILLION M^3)

A:-NON-NILOTIC RUNOFF SUPPLIES						
CLIMATE BELT	ESTIMATE OF COUNTRY TOTAL		MONITERED SUPPLIES			
	Average Yield	80% Reliable Yield	Number of Torrents	Average Yield	80% Reliable	Present use
SEMI-DESERT	350	90	8	93	24	11
SEMI-SAVANAH	1250	560	11	227	102	36
SAVANAH	3300	1830	18	901	500	84
	4900	2480	37	1221	626	131

B:- NILOT C RUNOFF SUPPLIES			
WATER SYSTEM	WATER COURSE	NORMAL YEILD	80% RELIABLE YEILD
W H I T E N I L E	R. Ghazal	14300	10500
	R. Sobat	3200	2200
	R. Jebel	2600	1700
	W. Nile	2500	1250
BLUE NILE	B. Nile	1100	600
	R. Rahad	50	10
R. ATBARA	Setit Br.	30	10
	Atbara Br.	400	120
M A I N N I L E		150	15
REGIONAL TORRENTS	Gash	10	-
	Baraka	80	15
TOTAL NILOTIC SUPPLY		24500	16420
TOTAL NON-NILOTIC SUPPLY		4900	2480
TOTAL NATIONAL RUNOFF SUPPLY		29400	18900

TABLE 3

THE HYDROLOGY OF THE WHITE NILE SWAMPS
(Flows and Losses in Milliards)

SWAMP SYSTEM	AREA IN SQ.KM. x 1,000	RAIN-FALL (mm)	INFLOW SUPPLY TO THE SWAMP						OUTFLOW TO W.NILE	LOSSES FROM SWAMP	RECLAIMABLE SUPPLY	
			RUNOFF SUPPLIES				DIRECT RAINFALL	GROSS SUPPLY			POTENTIAL	STUDIED
			REGIONAL		LOCAL TORRENT & SHEET	TOTAL RUNOFF						
			RIVERS	TORRENTS								
R. JEBEL	7	840	22.6	6.5	2.6	31.7	5.9	37.6	14.7	22.9	10.7	9
R.SOBAT	20	800	18.7	6.2	3.2	28.1	16.0	44.1	13.7	30.7	8.8	4
R.GHAZAL	40	910			14.3	14.3	36.4	50.7	0.6	50.1	10.8	7
TOTAL	67	2550	31.3	12.7	20.1	74.1	58.3	132.4	29.0	103.7	30.3	20

TABLE 4

DETAILS AND DEVELOPMENT STAGES OF POTENTIAL HYDRO ENERGY SITES

STAGE	HYDRO ENERGY SITE	STORAGE $M^3 X10^6$		HEAD (M)		NORMAL RIVER SUPPLY	GENERATION	
		TOTAL	DEAD	MAX	MIN		M.W.	G.W.H
PRESENT GENERARTION (1)	Roseries I	3000	750	38	17	51.0	260	1200
	Sennar	930	400	19	5	50.0	15	70
	Girba	1300	700	32	15	12.7	7	30
	Total	5230	1850				302	1300
SHORT TERM	Roseires II			30	15		100	250
	Sennar II			30	17		30	70
	Jebel	3000	200	6	2.5	29.2	40	160
	Total	3000	200				170	480
PHASE I 2001	Roseires III	4000		48	17			480
	Sennar III							70
	Merowe	10800	5600	53	36	67.0	1300	5500
	Juba	300	200	12	9	30.0	30	180
	Total	15100	5800		800		1330	6230
PHASE II 2011	Kinyeti	20	10	800	38	0.1	20	140
	Dal	6000	3000	45	28	66	600	4500
	Lukki	1500	1000	32	50	24	240	1400
	Kit	300	150	60	25	0.7	10	50
	Jur	600	300	35	70	5.0	40	200
	Yei	400	250	80		2.0	45	210
	Total	8826	4710		57		955	6500
PHASE III 2021	Fola	8000	5000	65	17	30.5	720	3600
	Shreik	1500	500	22	45	68	300	1600
	Kala	400	200	55	30	1.4	20	100
	Lol	500	250	40		3.9	40	180
	Total	10400	5950		31		1080	5480
PHASE IV 2031		1400	800	36	15	31.0	300	1800
	Abunagma	900	500	20	15	66.5	200	900
	Singa	600	400	20	8	50.5	180	1000
	Sabaloka	700	500	12		68.5	120	700
(2)	Cascade + Others	500	200				200	1000
	Total	4100	2400				1000	5400
TOTAL	Potential	46650	20940				4837	25390

TABLE NO.5

GROUND WATER AVAILABILITY

IN DIFFERENT GEOLOGICAL FORMATIONS

GROUND WATER BASINS		AREA		GROUND WATER ZONE					PRESENT USE	
SIN	LOCATION	$(K.N)^2$ $X10^3$	% OF COUNTRY	THICK-NESS(m)	DEPTH TO ZONE	STORAGE VOLUME $M^3 \times 10^9$	ANNUAL RE-CHARGE $M^3 \times 10^6$	SALINI-TY P.P.M	CAPAC ITY $M^3 \times 10^6$	AV. DEPTH OF WELLS (m)
BIAN SUDANESE	N.M	325	13	100-1000	50-60	975	20	200-500	1.2	150-300
BIAN RWABA	WEST	196	8	100-2000	25-100	1640	2200	300-800	23.0	150-500
NUBIAN NDSTONE	W.C	6.8	0.3	50-900	75-175	170	20	200-600	2.5	150-200
RWABA ARA	CETRE.	190	8	100-1500	25-75	950	150	100-500	7.5	100-250
LE BIAN	C & N	375	15	100-500	10-100	1120	3750	100-500	330	100-250
BASALT BIAN	E.C.	28	1	200-500	150-290	35	50	200-1200	17	150-300
ALLUVIUS BASINS	MOSTLY SAVANAH	5	0.3	30-50	5-10	50	600	50-200	150	30-50
SEMEN MPLEX		1230	49.1	5-20	100-1000	5	10	300-6000	1	
COUNTRY	TOTAL	2358	94.7			4945	6800		532.2	

TABLE 6:1a

WATER RESOURCES DEVELOPMENT PLAN (1991 - 2010)

A: WATER HARNESSING PROJECTS

1. WATER RECLAMATION PROJECTS			
PROJECT	ADDED SUPPLY M X 10	SUDAN SHARE M X 10	COST U.S.$ X 10
PRESENT SHARE		20.55	30
JONGLEI - I	2.13 (1)		120
SOBAT	1.90		300
JONGLEI - II	2.10		350
TOTAL SHARE (2010)	6.13	26.68	800
AVERAGE ANNUAL RATE - IN (M^3 X 10^6)		306.5	
ANNUAL GROWTH RATE - IN (%)		1.31	

2. STORAGE PROJECTS			
PROJECT	STORAGE CAPACITY IN M^3 X 10^9	EVAP. LOSSES IN M^3 X 10^9	COST IN U.S.$ X10
EXISTING PROJECTS	8.23	0.54 (2)	50
ROSEIRES HEIGTING	4.00	0.34	220
MEROWE	10.80	1.25	1300
LUKKY	1.50	0.15	400
RUMEILA	0.60	0.30	300
YEI-JUR	1.00	0.05	160
KIT & KINYETI	0.32	0.02	60
TOTAL STORAGE (2010)	26.45	2.63	2490
AVERAGE RATE (STORAGE IN (M^3 X 10^6)		911	
ANNUAL GROWTH RATE %		6.01	

NOTE:- 1. Jonglei capacity is recently increased to 2.5 miliards

2. Sennar and Jebel Aulia losses not included

3. Costs for Dam structures and rehabilitation only

TABLE 6:1b

WATER RESOURCES DEVELOPMENT PLAN (1991 - 2010)

B: WATER USE PROJECTS

WATER SYSTEM	PRESENT USE (1990)		TARGET USE (2010)		DEVELOPMENT RATES			COST IN U.S.$ 606
	DESIGN CAPACITY	ACTUAL USE	TOTAL CAPACITY	ACTUAL USE	ADDED CAPACITY	ANNUAL INCREASE RATE	GROWTH RATE %	
- MAJOR PROJECT WATER USE (IN $M^3 \times 10^9$)								
NILE BASIN	15.63	13.60	23.60	22.70	9.10	0.455	2.59	60 (1)
GASH AND BARKA STREAMS	1.10	0.60	1.10	1.00	0.20	0.015	1.12	20 (1)
NON-NILOTIC	0.08	0.05	0.70	0.55	0.50	0.025	12.74	400
GROUND WATER	0.35	0.30	1.50	1.40	1.10	0.055	8.01	920
RESERVOIR LOSSES	0.54	0.54	2.63	2.63	2.09	0.105	8.23	20 (1)
TOTAL	17.70	15.29	29.73	28.28	12.99	0.652	3.12	1120
4 - RURAL AREAS WATER SUPPLY (IN $M^3 \times 10^6$)								
STREAMS STORAGE	55	35	155	120	85	4.25	6.35	100
HAFFIRS	25	15	60	40	25	1.25	5.03	100
GROUND WATER	180	160	500	460	300	15.00	5.42	400
WATER TRANSPORT			320	280	280	9.00		320
TOTAL	230	210	1035	900	690	34.50	7.55	920

NOTE (1) Cost is for rehabilitating Water System Only.

TABLE 6:1c

WATER RESOURCES DEVELOPMENT PLAN (1991 - 2010)

C: AGRICULTURAL AREAS

5:- Irrigated Agriculture in (hec x 10³)							
LEGEND	PRESENT AREAS (1991)		TARGETED AREAS (2010)		DEVELOPMENT RATES		
	GROSS	NET/AV.	GROSS	NET	AV. ADDED ANNUAL NET AREA	GROWTH RATE %	COST US$ X 10
NILE BASIN PROJECTS	1850	1220	3000	2250	51.5	3.11	2400
GASH AND BARAKA	80	50	80	60	0.5	0.01	40
SEASONAL STREAMS	12	5	90	55	2.5	12.74	140
GROUND WATER	40	30	180	150	6.0	8.34	270
TOTAL IRRIGATED	1920	1305	3350	2515	60.5	3.33	2850
G:-RAINFED AGRICULTURE							
6a: RAINFED CROPPING IN (HEC. X 10⁶)							
MECHANIZED	4.8	2.9	25.0	15.0	0.61	6.56	2000
TRADITIONAL FARMING	8.85	2.4	12.0	6.0	0.18	4.69	400
TOTAL	13.65	5.3	37.0	21.0	0.79	7.13	2400
6b: FORESTS							
RESERVED FORESTS	8.3	1.8	30	20	0.91	15.61	600
CONSERVED FORESTS + GAME	5.2	2.3	15	10	0.39	7.63	500
TOTAL FORESTS	13.5	4.1	45	30	1.30	10.46	1100
6c: GRAZED PASTURE	35.0	6.0	75	40	1.70	9.95	800
TOTAL ITEM 6	62.15	15.4	157.0	91.0	3.78	9.29	4300

NOTE:-ARE THE AREAS WITH PROPER ATTENDENCE

TABLE 6:1d

WATER RESOURCES DEVELOPMENT PLAN (1991 - 2010)

D:-HYDRO-ENERGY & NAVIGATION

7 HYDRO-ENERGY:-(CIVIL WORKS NOT INCLUDED IN COSTS)					
PROJECT	PRESENT (1991)		TARGETED (2010)		COST U.S.$ X 10^6
	M.W.	G.W.H.	M.W.	G.W.H	
ROSEIRES	280	1200	380	1930	40
SENNAR	19	7	45	140	20
GIRBA	7	30	-	-	-
JEBEL			40	160	25
JUBA			30	180	15
MEROWE			1300	5500	500
LUKKY			240	1400	100
KINYETI			20	140	10
YEI			45	210	20
JUR			40	200	20
KIT			10	50	5
TOTAL	302	1300	2150	9910	755
ADDED ENERGY (G.W.H)					8610
AV. ANNUAL RATE					430.5
GROWTH RATE %					10.68
8. NAVIGATION					
PRESENT CAPACITY (TON K.M.) X 10^6					150 (300)
TARGETED CAPACITY (TON K.M.) X 10^6					600
ADDED CAPACITY (TON K.M.) X 10					450
GROWTH RATE %					7.10
COST U.S $ X 10^6					500

TABLE 6:2

WATER RESOURCES DEVELOPMENT PLAN (1991-2010)

SUMMARY

DEVELOPMENT SECTORS		UNIT	DEVELOPMENT CAPACITY		DEVELOPMENT RATES			PRODUCTION RATE		COSTS IN US$ X 10	
SECTOR	SUB SECTOR		PRESENT (1991)	TARGET (2010)	ADDED CAPACITY	AV. ANNUAL RATE	GROWTH RATE %	VERTICAL GROWTH RATE %	TARGET OVER PRESENT	DEVELP. COST	EXPECTED AID
-WATER SUPPLY	NILOTIC	$M^3 X 10^9$	20.55	26.68	6.13	0.307	1.31	0.38	1.40	600	60
	DRINKING		0.21	0.90	0.79	0.04	7.55	0.77	5.0	920	640
	TOTAL		22.45	33.26	10.81	0.54	1.98	0.48	1.63	2840	1280
-STORAGE			6.28	15.29	9.01	0.45	4.55		4.50	2490	250
-IRRIGATED AREAS	NILOTIC	HEC X 10^3	1220	2250	1030	51.5	3.11	2.46	3.0	2400	240
	NON-NILOTIC		65	265	180	9.0	5.85	1.35	4.0	450	270
	TOTAL		1305	2515	1210	60.5	3.33	2.40	3.07	2850	510
- RAINFED CROPPING		HEC. X 10^3	5300	21000	15700	785	7.13	4.73	10.0	2400	960
5- ATTENDED PASTURE AND FORESTS		HEC X 10^6	10.1	70	59.9	3.0	7.13		4.0	1900	1330
-HYDRO-ENERGY		G.W.H	1300	9910	8610	430.5	10.68		7.62	755	55
7-NAVIGATION		K.M. TON X 10	300/150	600	150	7.5	2.05	5.0	4.0	500	100
8-TECHNICAL AND STRUCTURAL INSTITUTIONAL SUPPORT										765	465
TOTAL COSTS										14500	495

NOTES:-(1) ALL CAPACITIES ARE EITHER THE NET OR AVERAGE (NOT GROSS)

(2) EXPECTED AID IS WITHIN THE ACTIVITIES OF HUMAN ISSUES INCLUDING DRINKING WATER SUPPLY, RESETTLEMENT PROJEC

FOR THE SOUTH, CONSERVATION OF THE ENVIRONMENT.

(3) ALREADY SPENT CAPITAL=U.S.$.950X$10^6$: NEEDED CREDIT = U.S.$ 8,600X10^6, i.e. AT U.S.$430 PER ANNUM.

TABLE 7

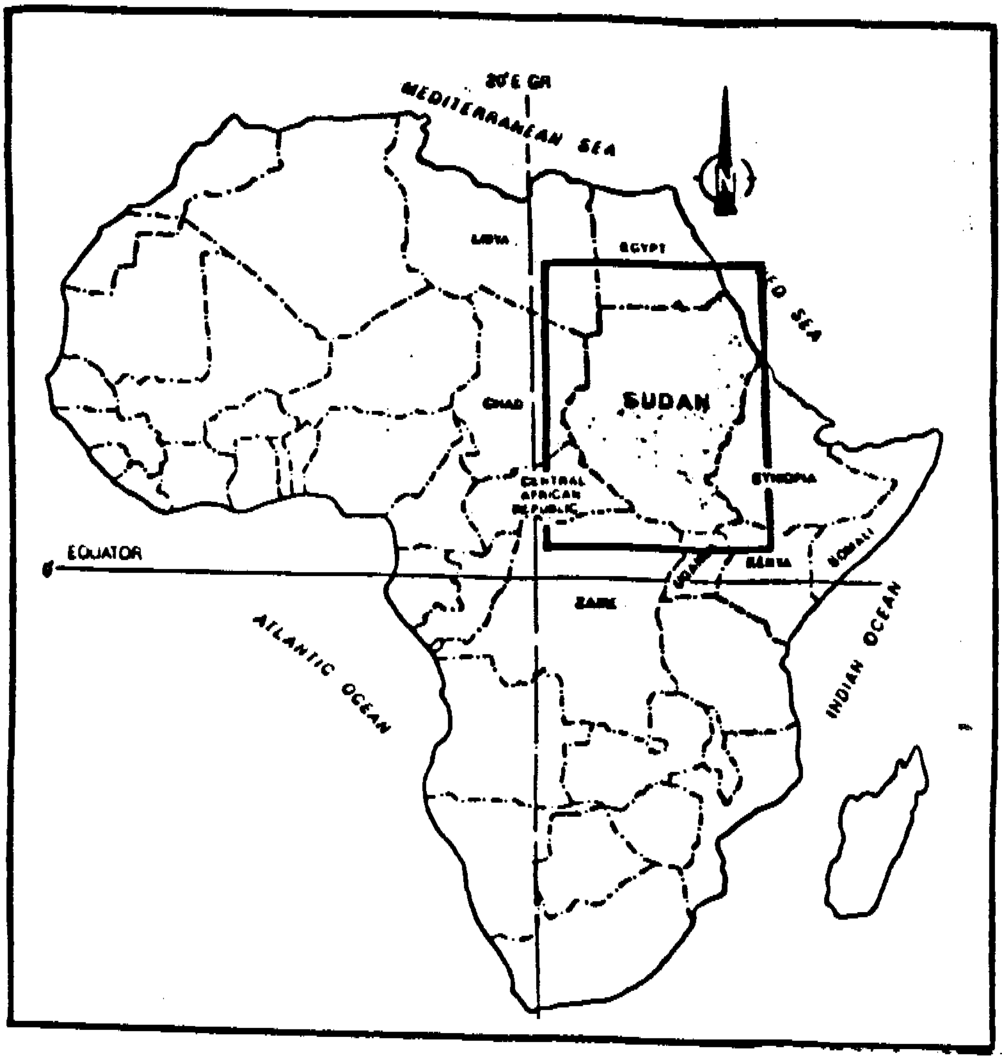
THE DRAUGHT EFFECT ON RAINFALL SUPPLY AND RAINFALL FLOOD PRONE BELTS

RAIN FALL BELT	BELT TOTAL R.F. SUPPLY $M^3 \times 10^9$	REPRESENTATIVE STATIONS LONG TERM NORMAL R.F. IN (m.m.)			DRAUGHT EFFECT			ERRATIC FLOOD EFFECT	
		STATION	1941/ 1965 TERM	IN mm	TERMS DEFICIT IN m.m.	TERMS DEFICIT % OF FULL RECORD	R.F. SUPPLY DEFICIT $M^3 \times 10^9$	MAXIMUM R.F. STORM m.m.	MAX STORM TO NORMAL ANNUAL %
DESERT	7	KARIMA	41.2	20.8	20.4	65.8	4.6	63.1	203.5
SEMI-DESERT	35	ATBARA	70.1	57.9	12.2	19.6	6.0	98.1	153.3
		KHARTOUM	169.7	146.3	23.4	14.8		205.5	125.7
SEMI-AVANAH	191	KASSALA	318.8	246.0	72.8	25.8	35.6	104.5	37.0
		KOSTI	402.7	344.3	58.4	15.6		193.0	51.7
		UM BENEIN	581	502	79	14.6		106.2	19.9
AVANAH	576	KADUGLI	740	594	146	21.9	84.7	120.0	18.0
		MALAKAL	794	696	98	13.2		176.0	23.0
		JUBA	992	907	85	9.0		137.5	14.3
QUATOR AL	215	WAU	1147	1021	126	11.6	21.2		
		YAMBIO	1477	1362	115	8.1		121.0	8.5
COUNTRY OTALS	1024					14.9	152.1		

1. NORMAL AREA FOR (1941/1960) AND (1961/1980) FOR YAMBIO

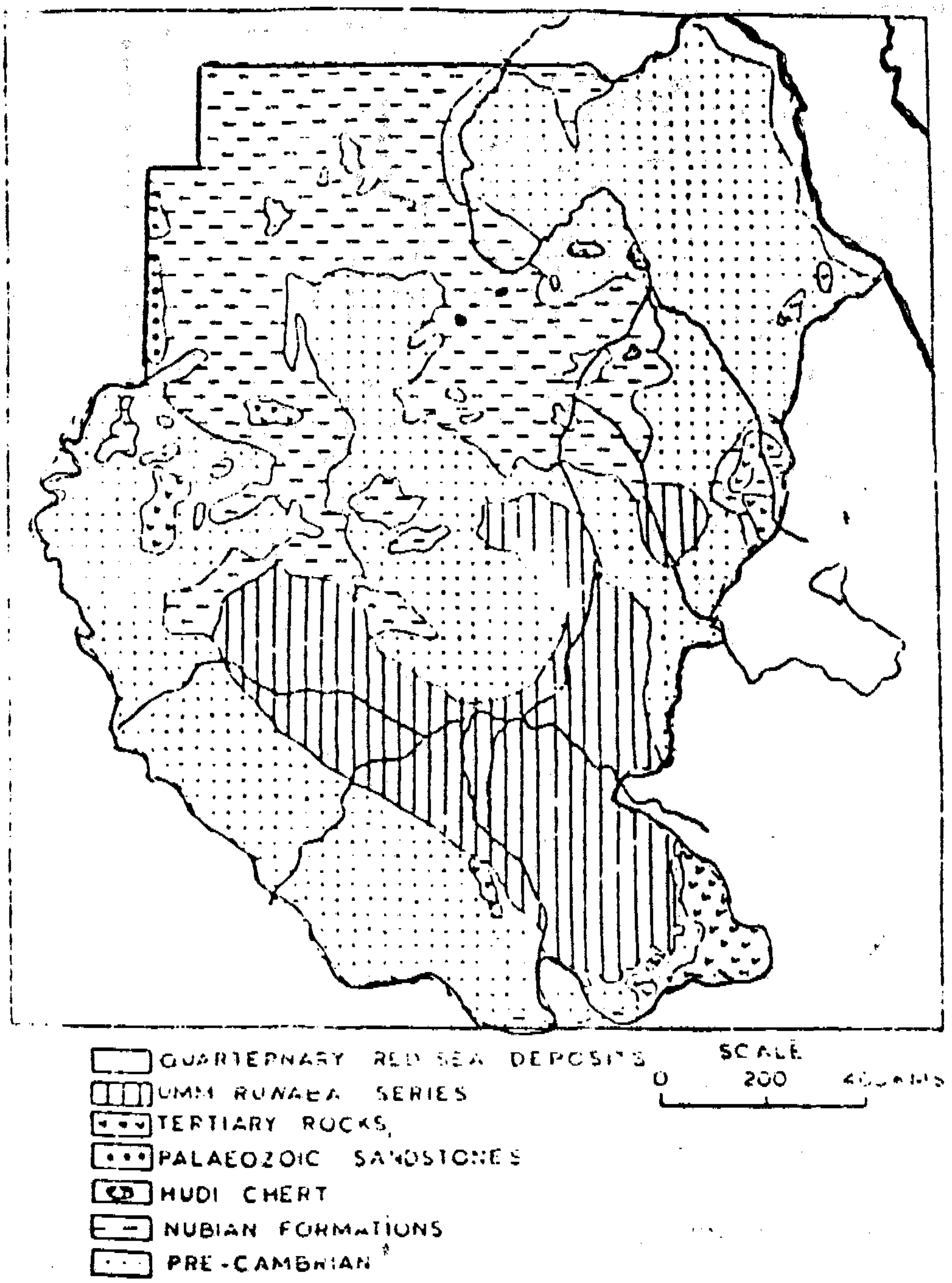
LIST OF FIGURES

SUDAN LOCATION MAP

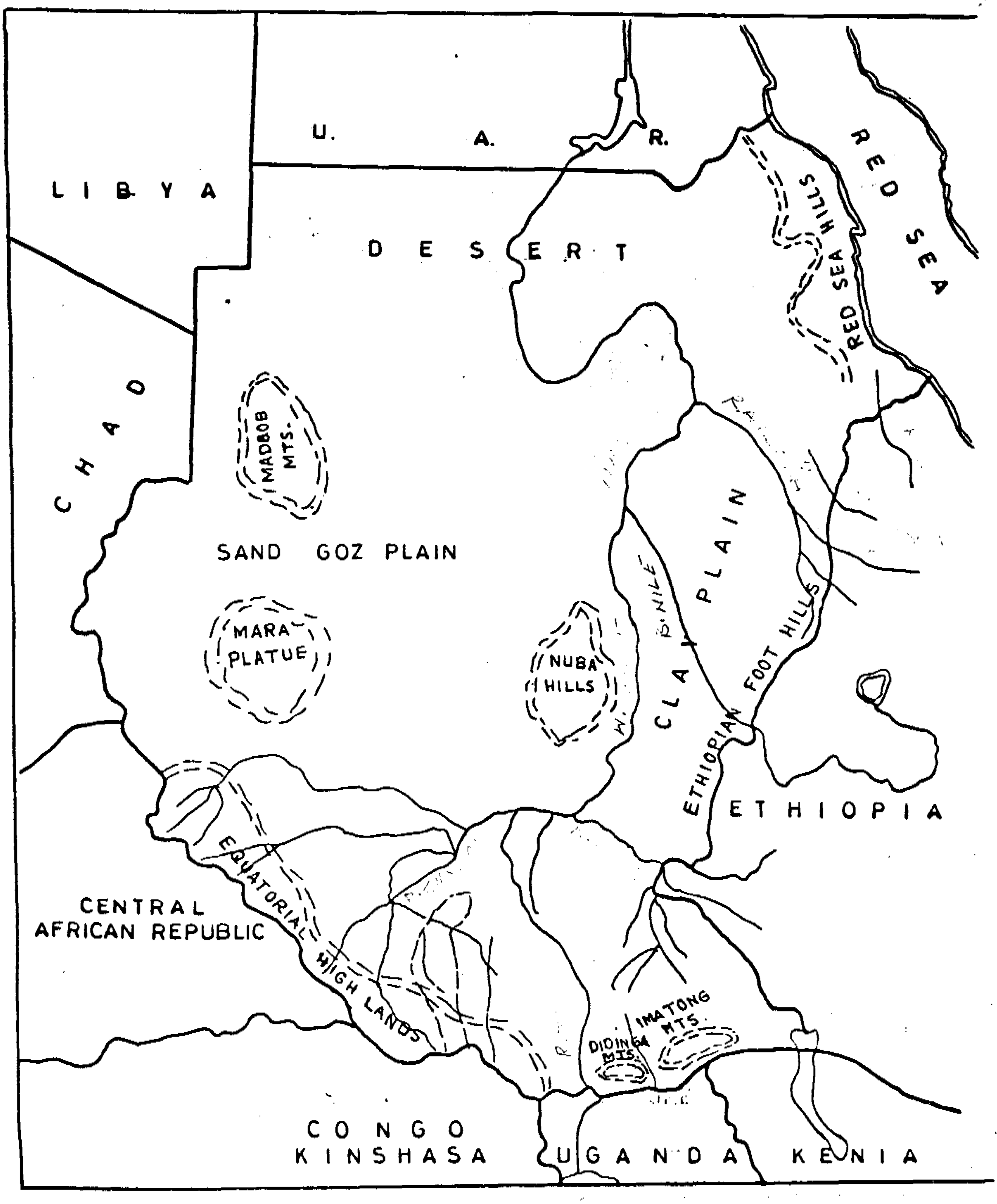


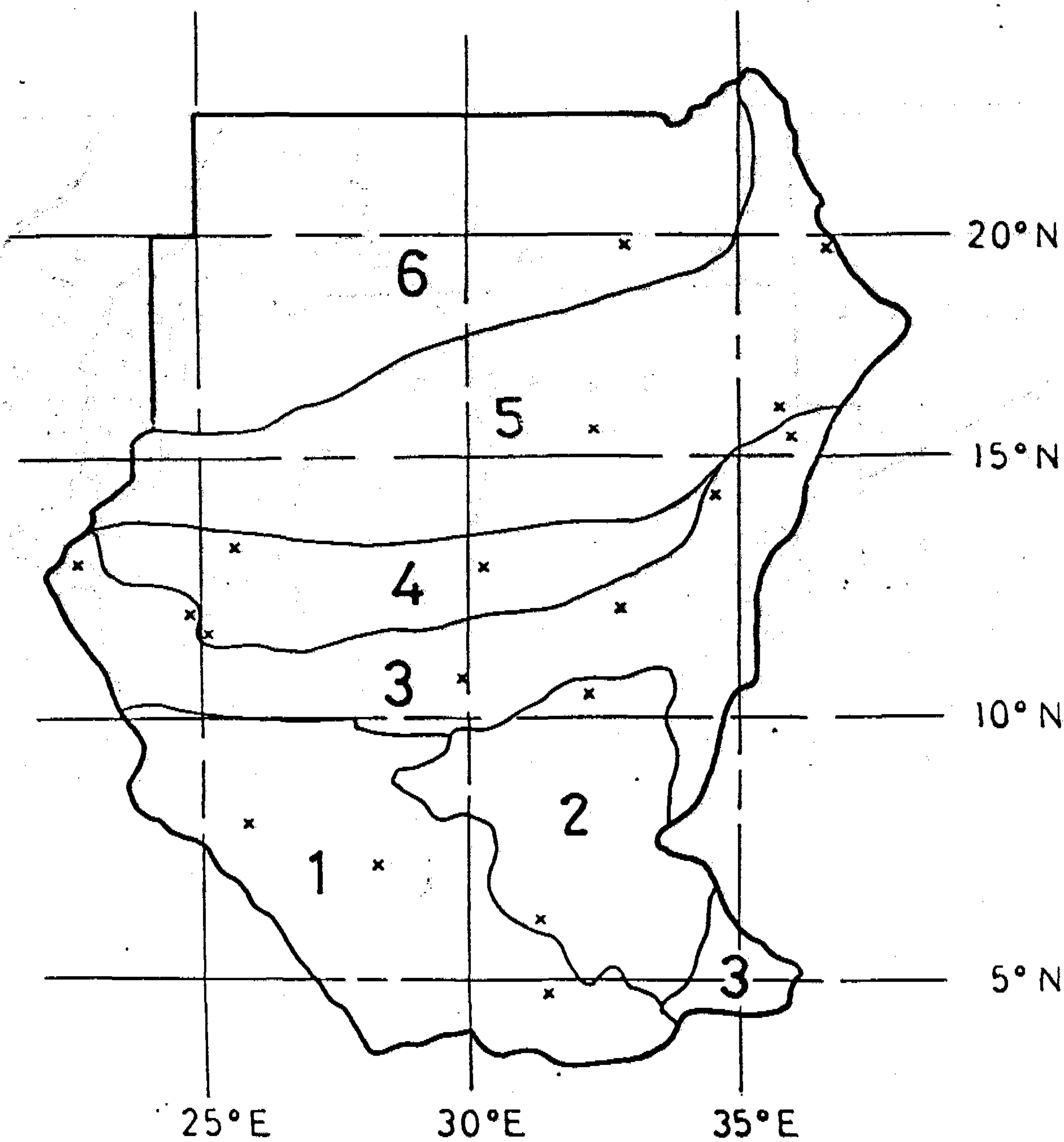
MaP 1 : b

GEOLOGICAL FORMATIONS



SUDAN RELIF STRUCTURE





Sudan vegetation classification, after Tothill, 1948.

1. 70% Deciduous broad-leaved woodland
   30% perennial grass

2. 25% broad-leaved woodland
   75% perennial grasses

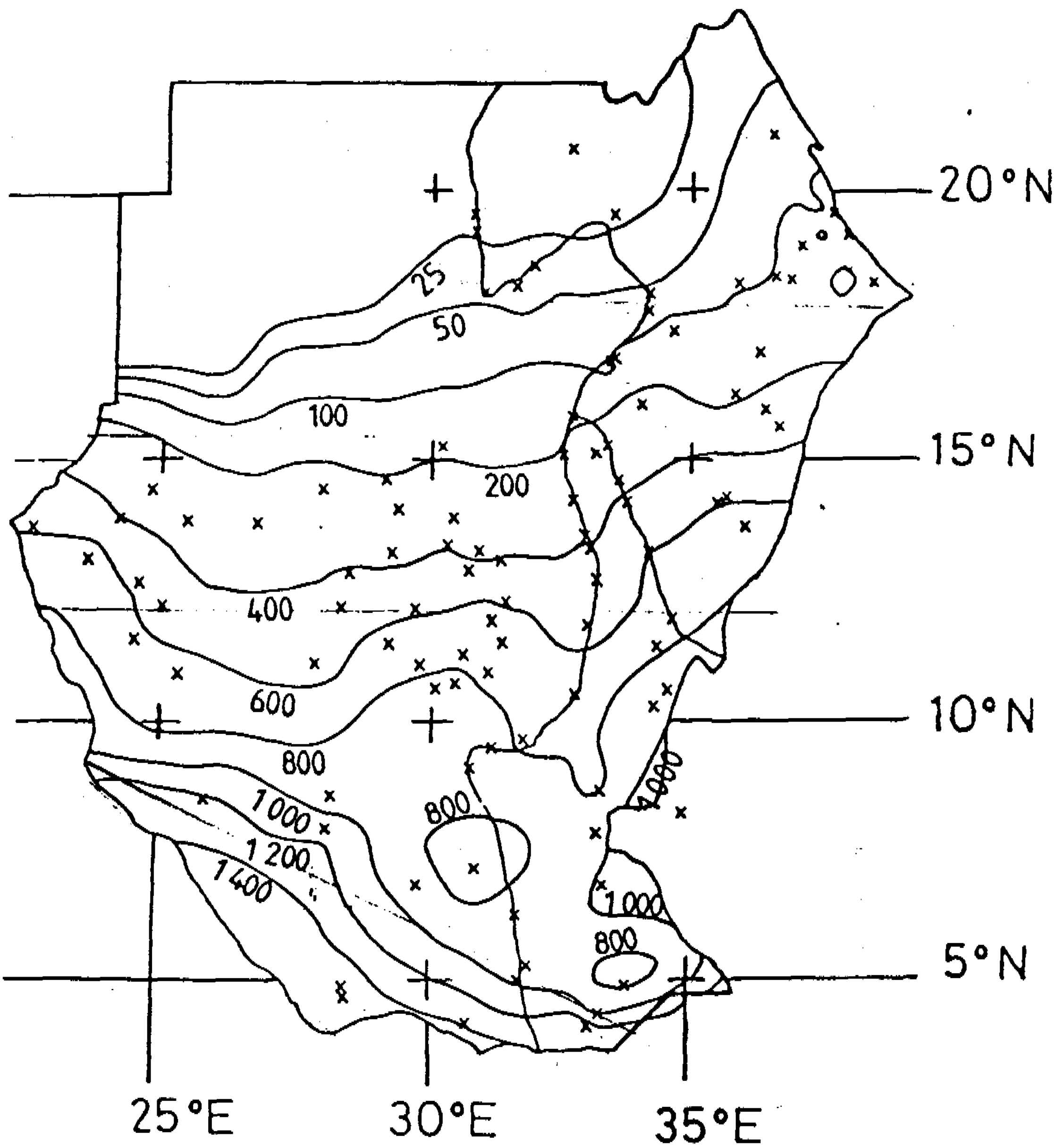
3. 30% acacia
   45% perennial grassland
   25% bare soil

4. 20% acacia
   20% Annual grasses
   10% perennial grasses
   50% bare soil

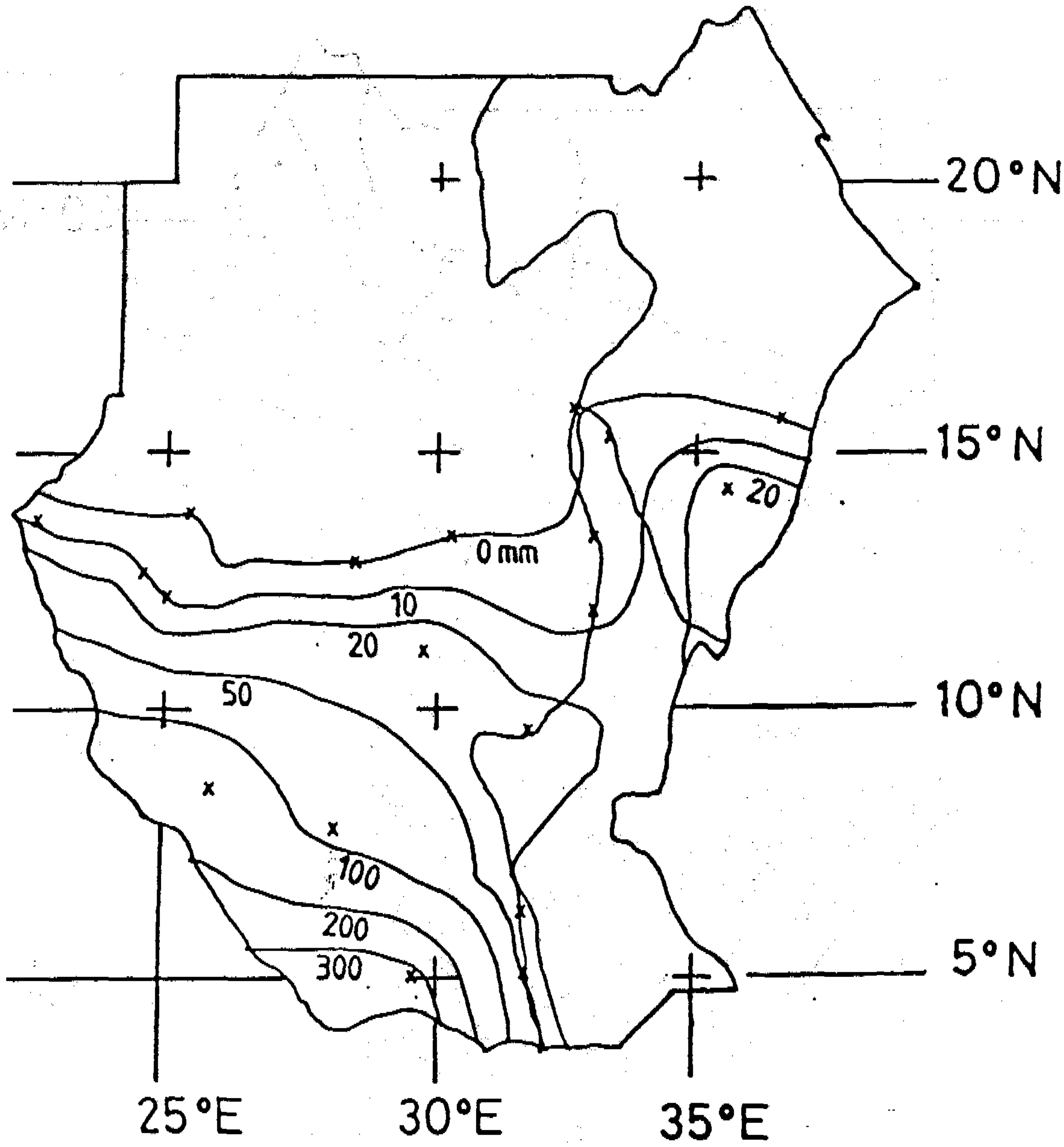
5. 2% acacia
   30% annual grasses
   68% bare soil

6. Desert

SUDAN VEGETATION CLASSIFICATION



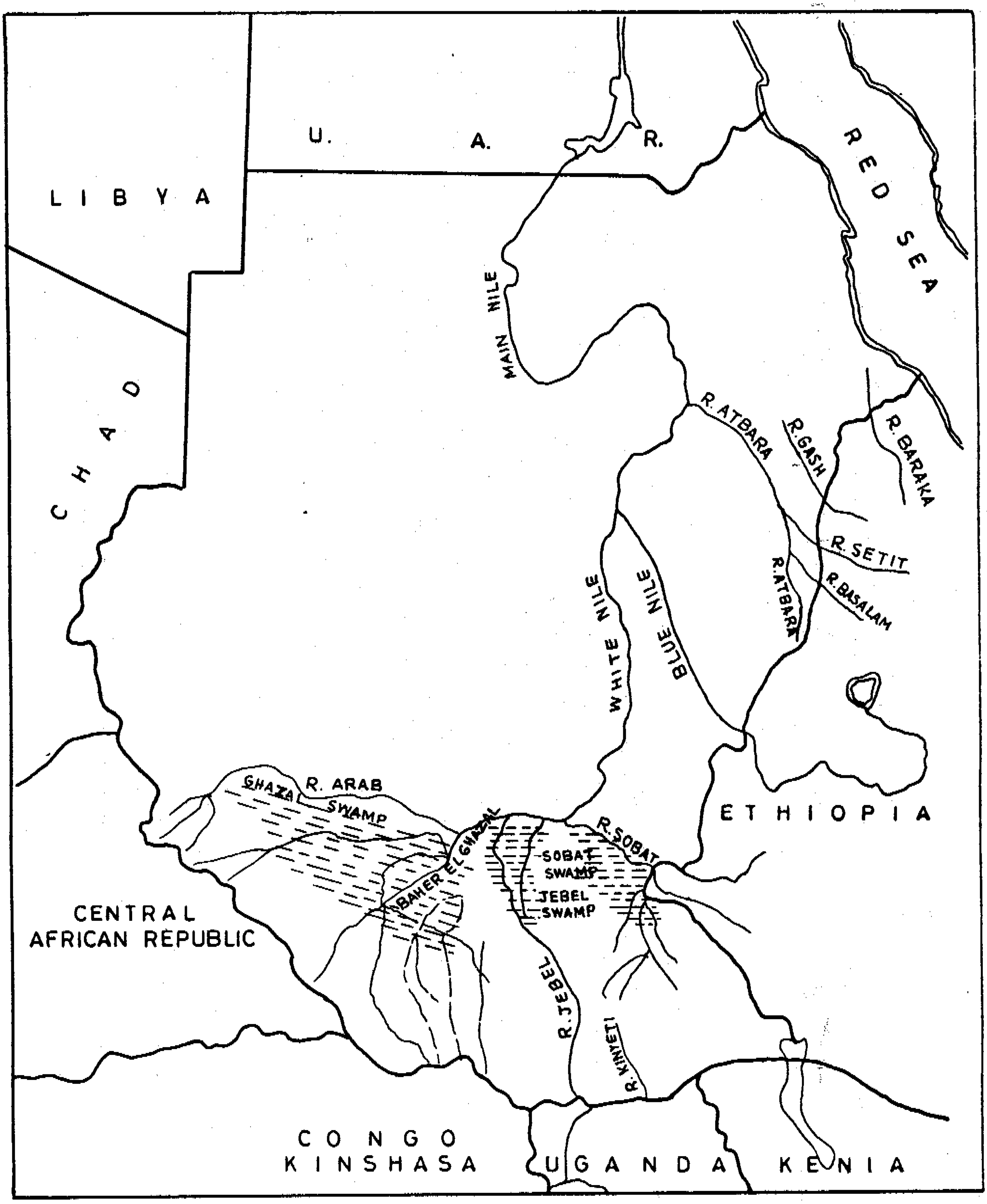
Mean annual rainfall, 1950-67, Sudan
x indicates stations contributing to the analysis



mean annual hydrological net precipitation
over Sudan, 1968-86.

Map 1-g

NILE BASIN IN SUDAN



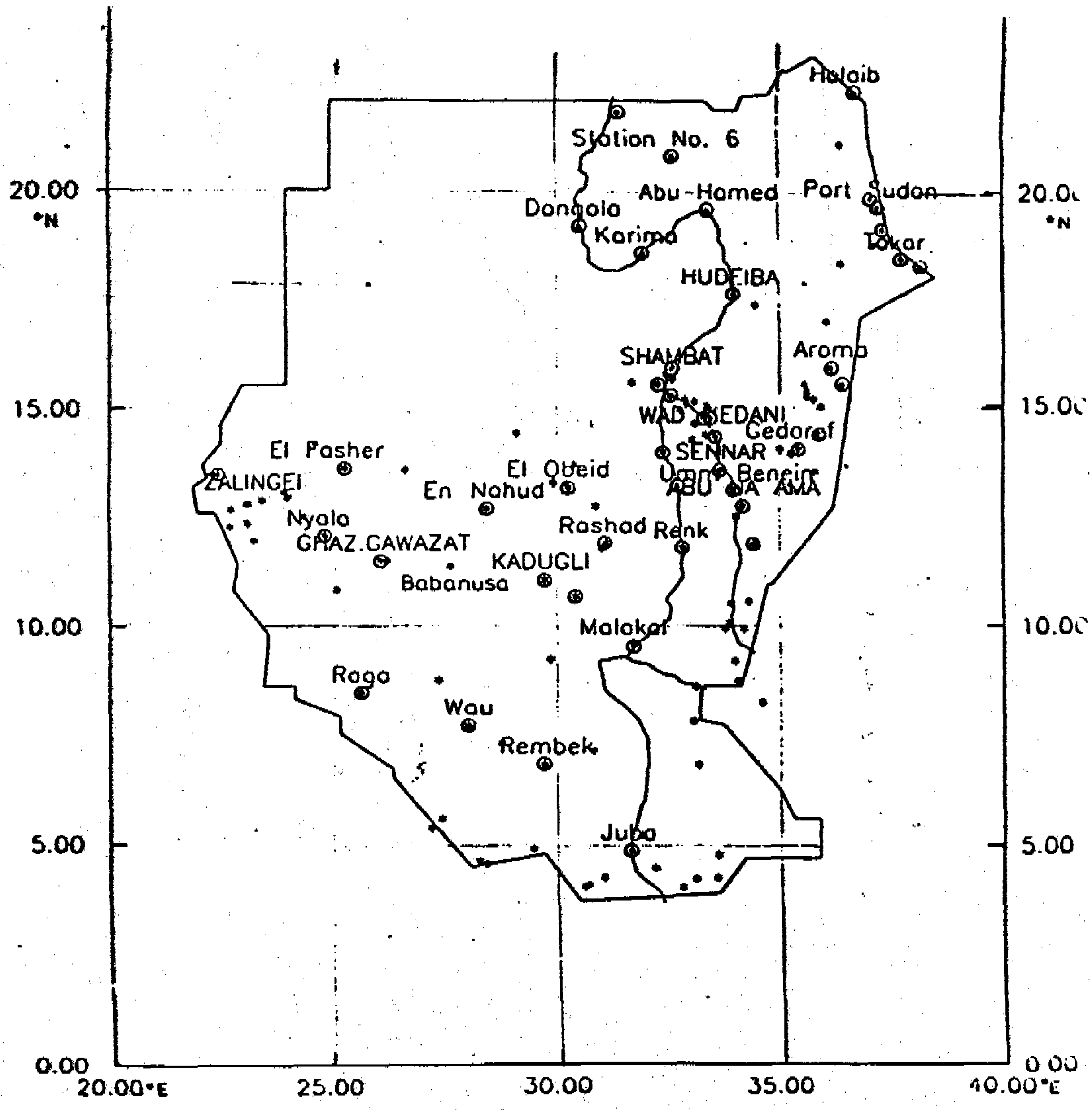


FIGURE 2.1: Climatological station distribution, Sudan. Not all individual stations are marked where density is greatest.

* indicates station operating some time during 1950-85

⊛ indicates station operating in 1985

Agrometeorological stations are named in capitals

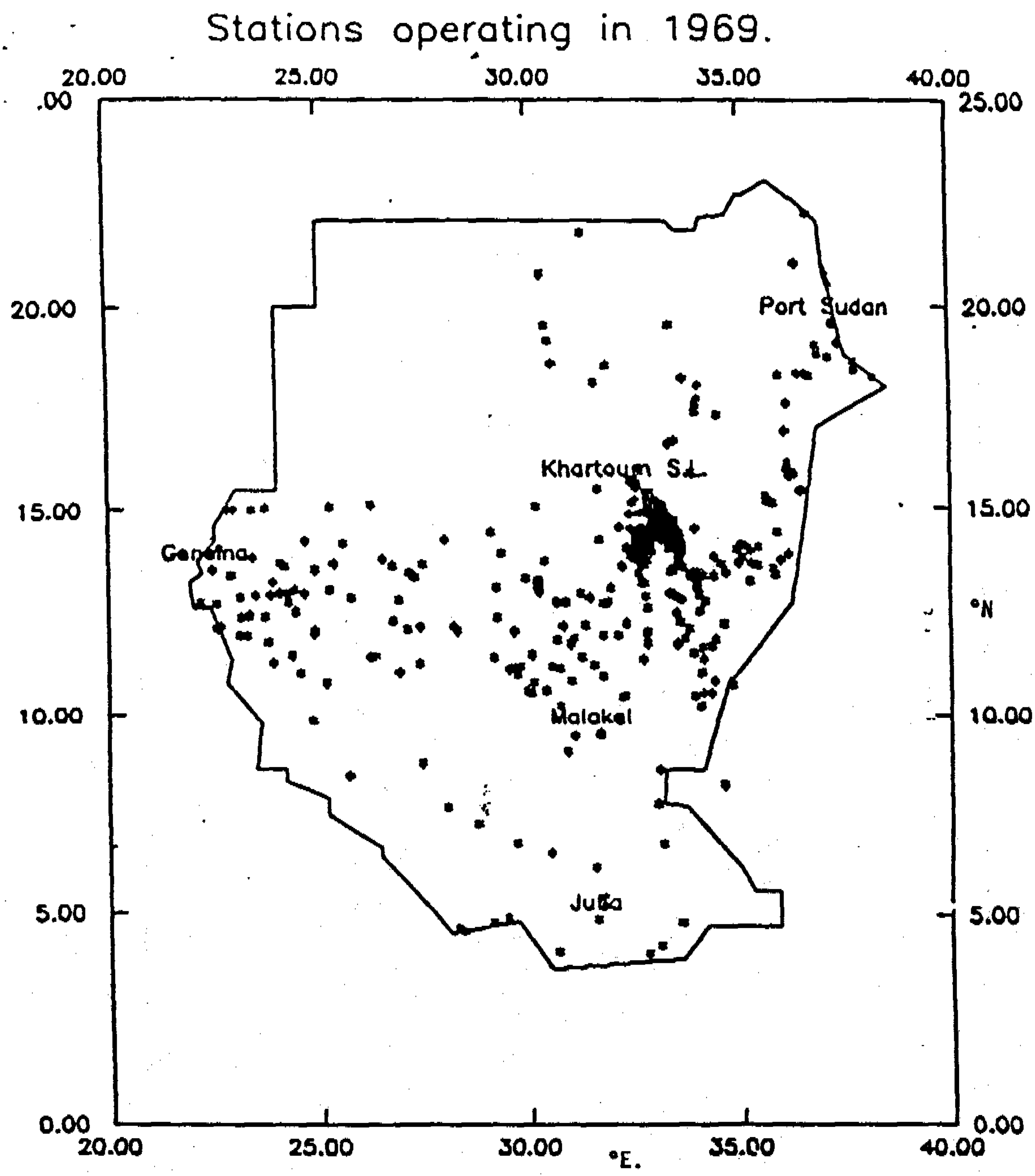


Figure 2.2a: Sudan raingauges operating in 1969

RAINGAUGE NETWORK, 1969

FIGURE 2.2a

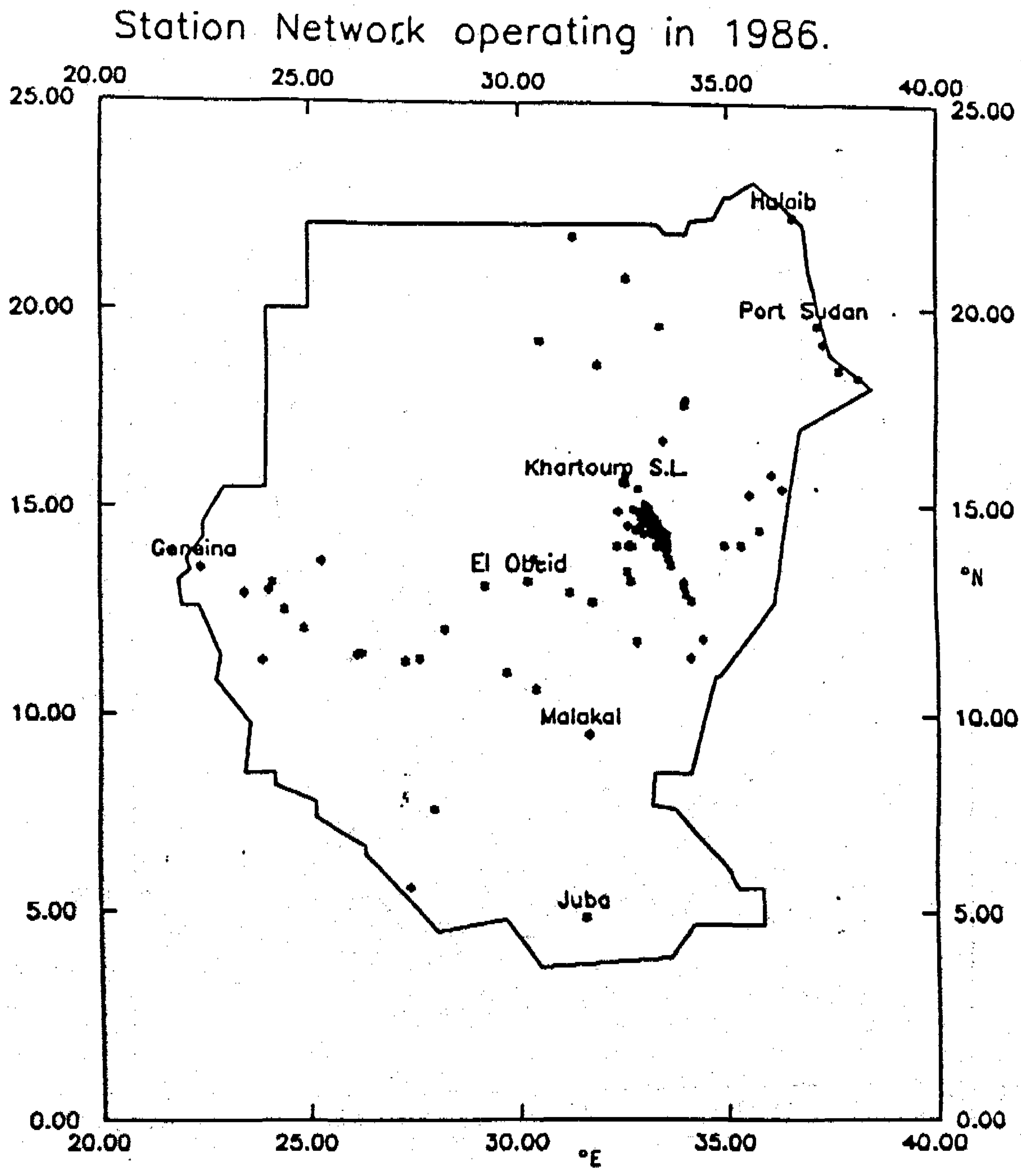
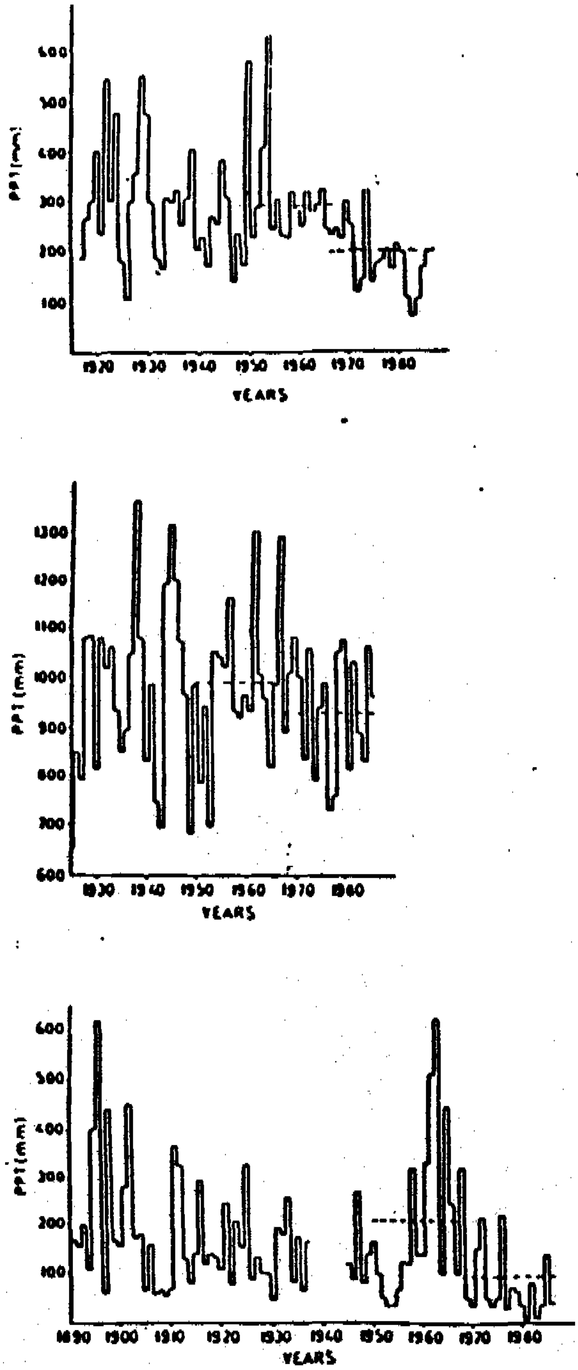


Figure 2.2b: Sudan raingauges operating in 1986

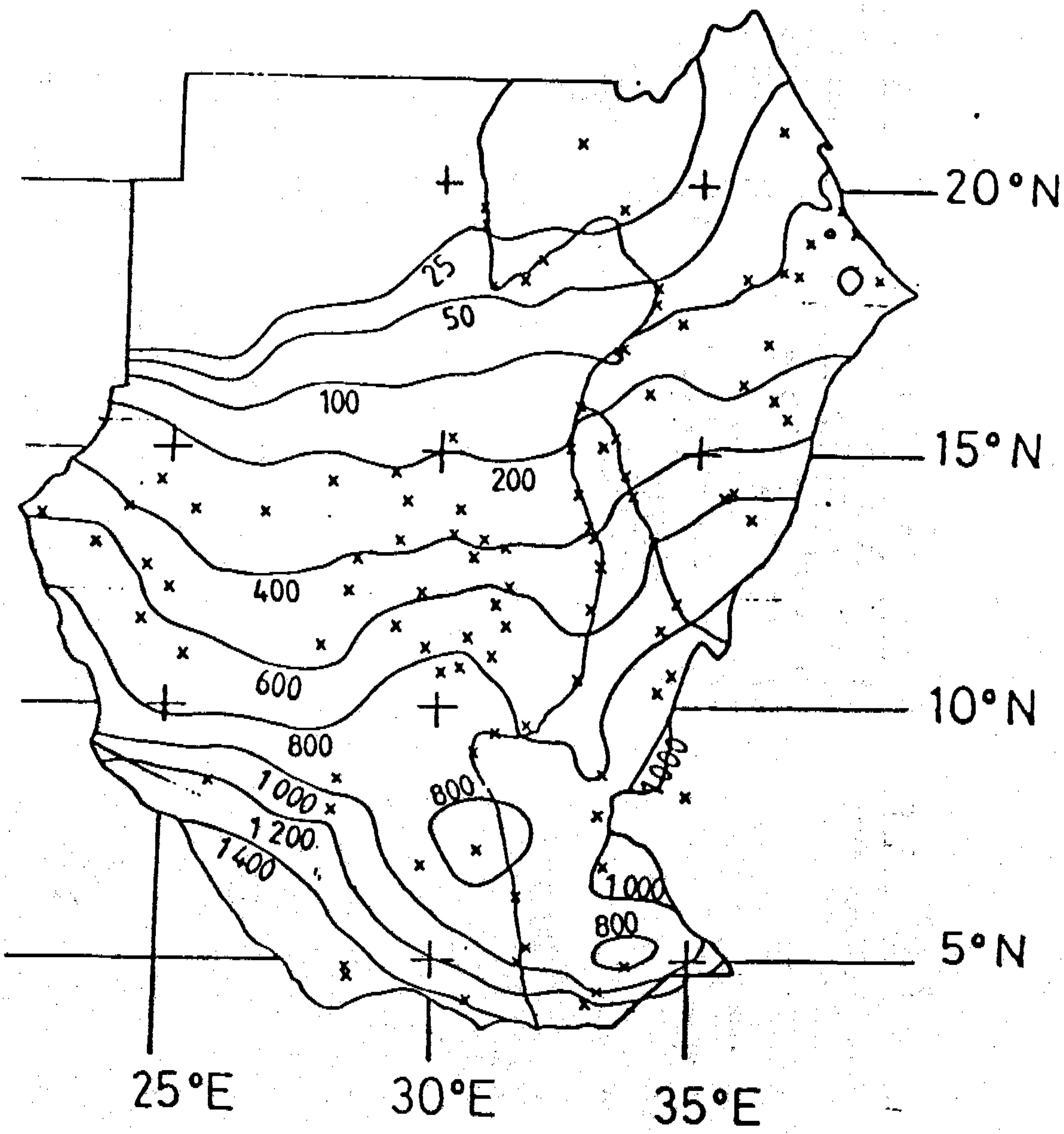


(a)

(b)

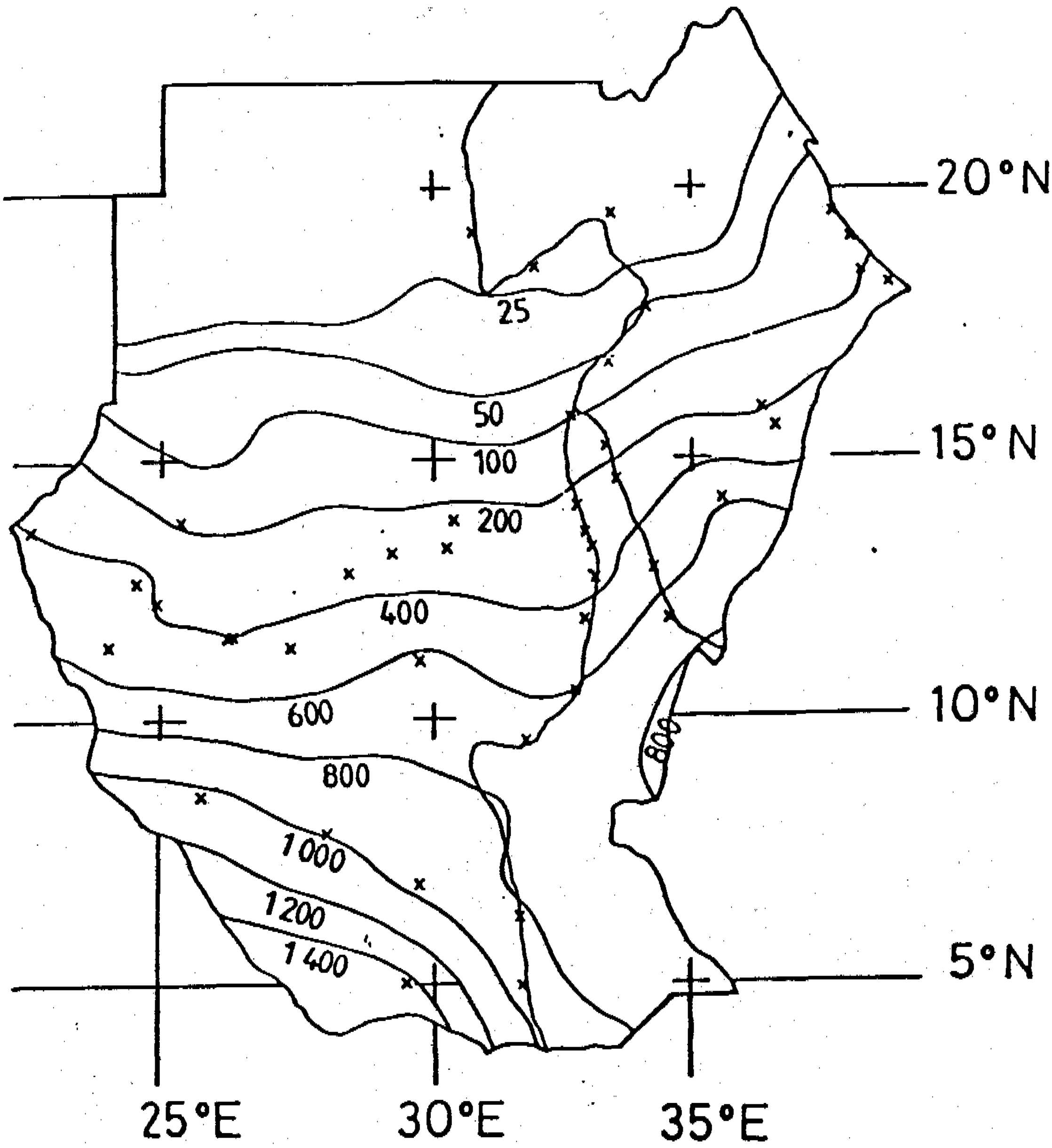
(c)

Figure 3.1: Long term rainfall series, Sudan.
(a) El Fasher, (b) Juba, (c) Suakin. In each case dashed lines show means over 1950-67 and 1968-86.



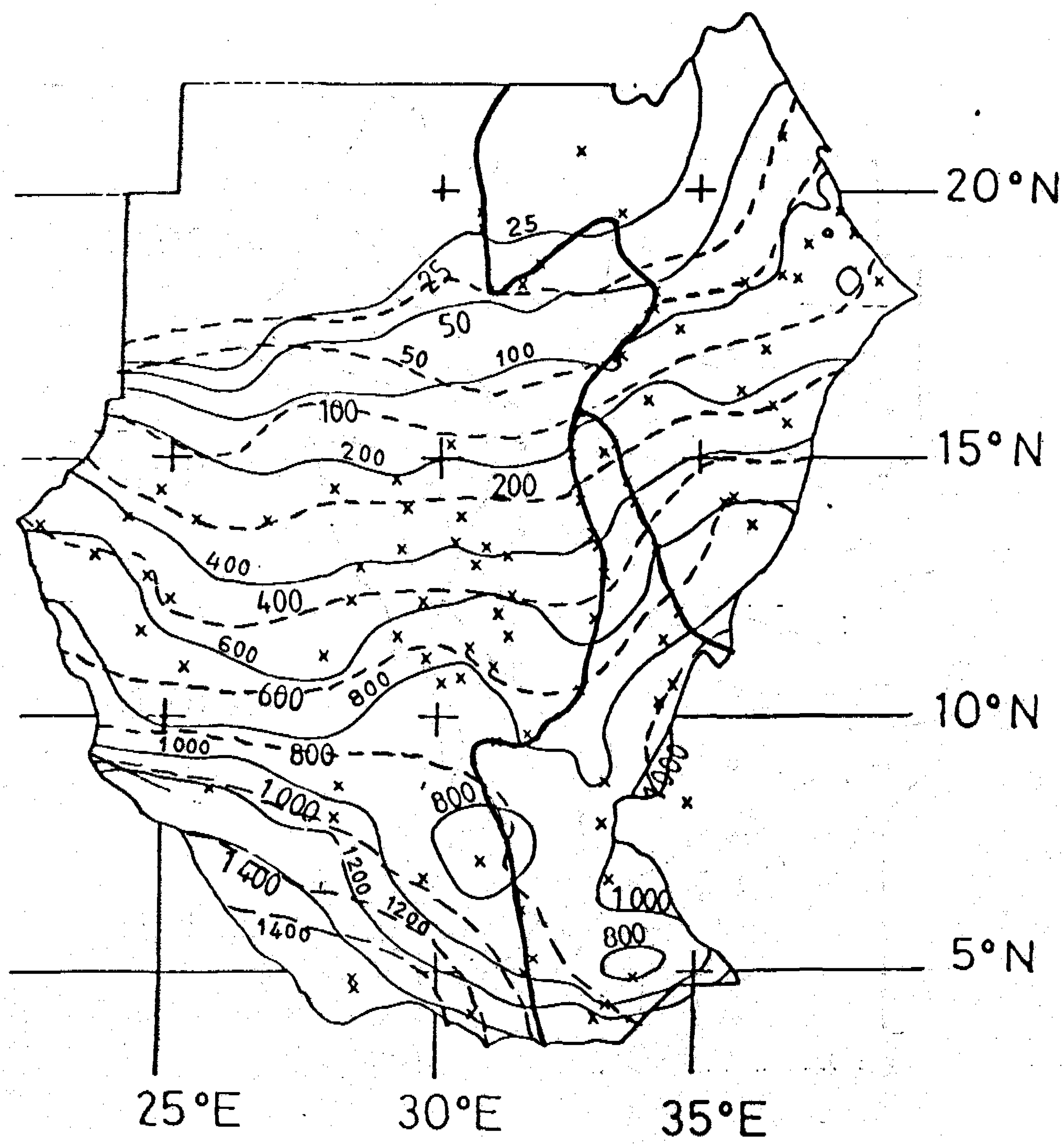
Mean annual rainfall, 1950-67, Sudan
x indicates stations contributing to the analysis

Map 3 : 3a



Mean annual rainfall, 1968-86, Sudan
x indicates stations contributing to the analysis

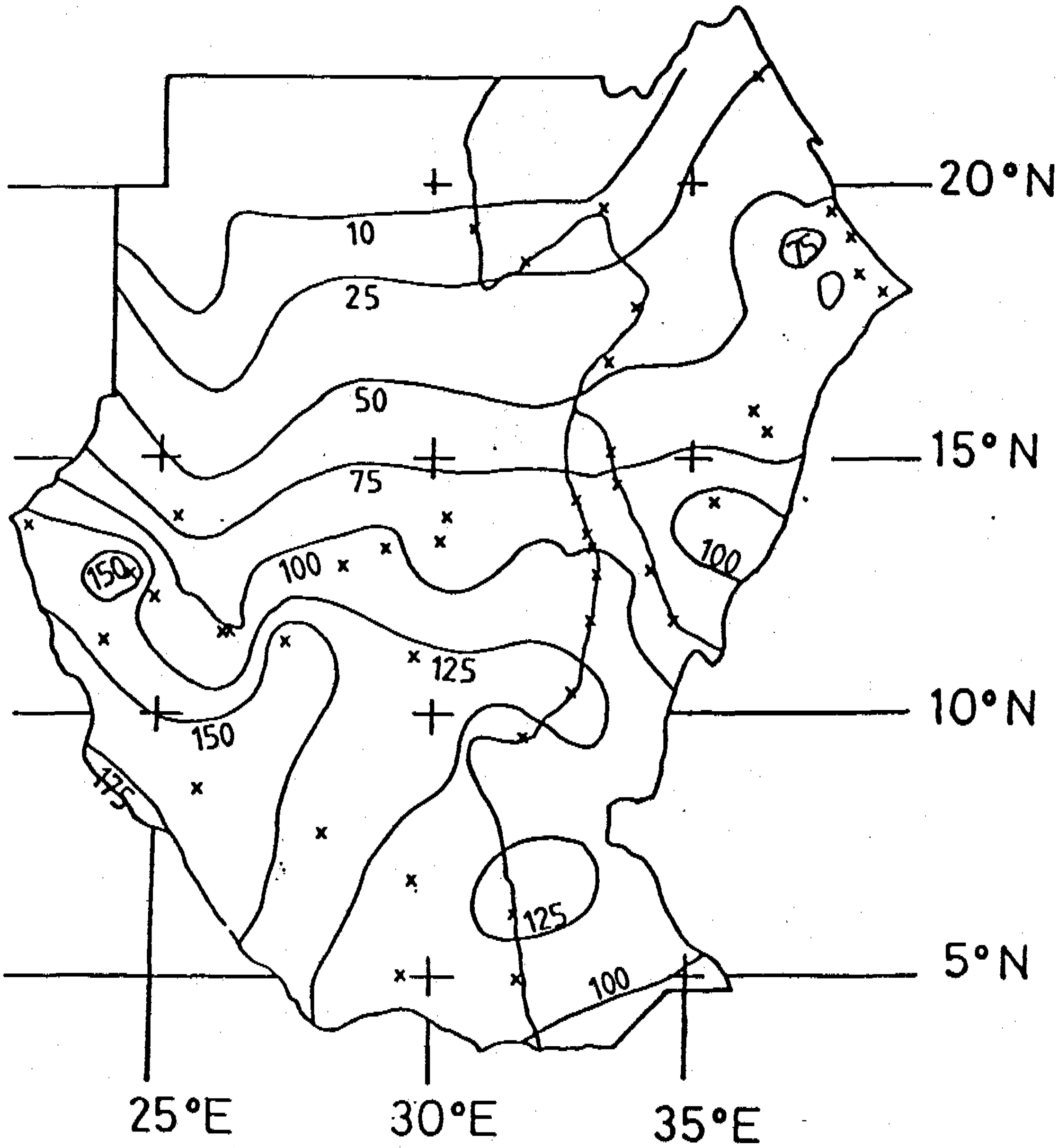
Map 3.3b



Mean annual rainfall, 1968-86, Sudan

Mean annual rainfall, 1950-67, Sudan

x indicates stations contributing to the analysis



Standard deviation of annual rainfall
over Sudan, 1950-67

International Conference on Water and the Environment

• Development Issues for the 21st century • 26-31 [illegible]

MEDIA KIT

ICWE LOGO TWO COLOUR
GREEN: Pantone 348
BLUE: Pantone 311

INTERNATIONAL CONFERENCE
ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26-31 January 1992, Dublin, Ireland

CONFERENCIA INTERNACIONAL
SOBRE EL AGUA Y EL MEDIO AMBIENTE:
El desarrollo en la perspectiva del siglo XXI.
26-31 de enero de 1992, Dublín, Irlanda

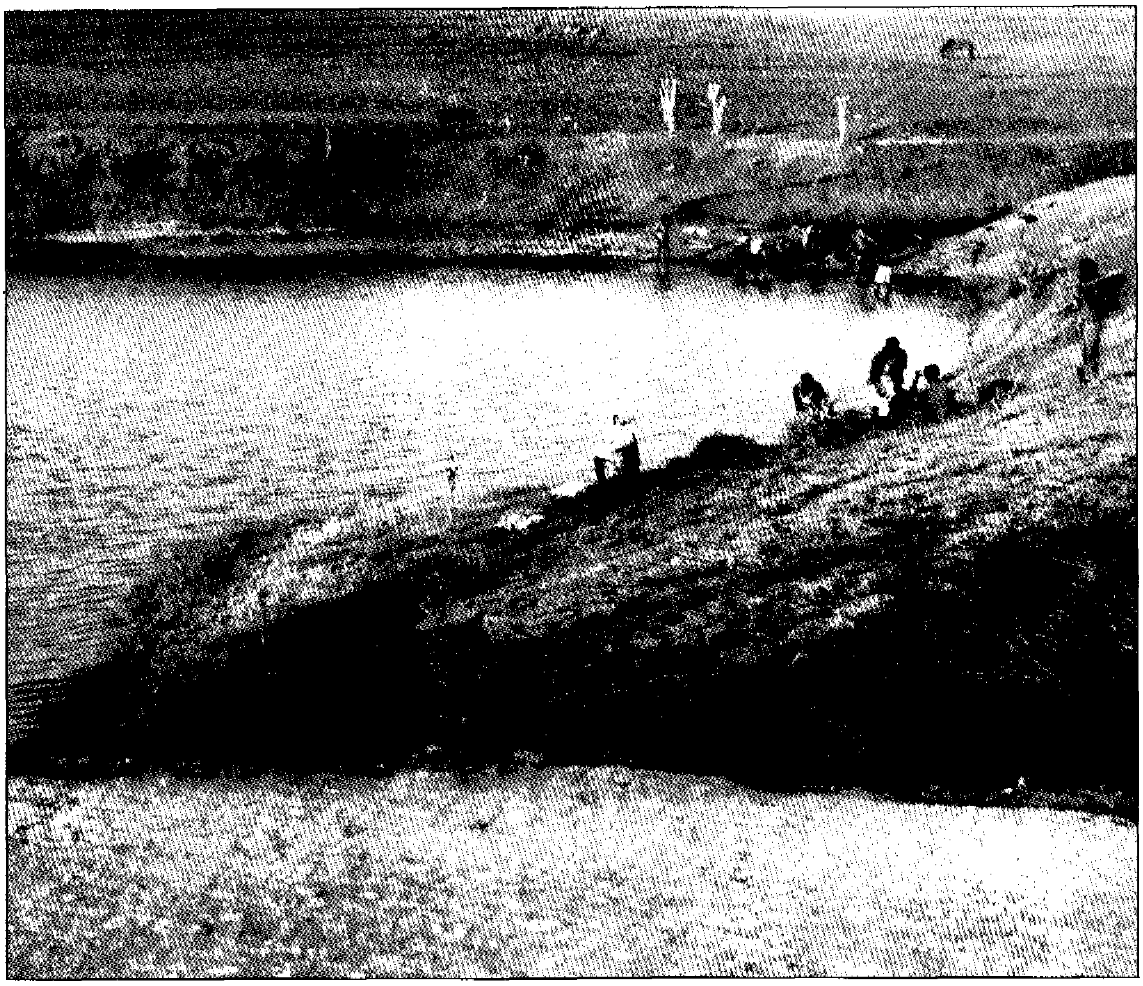
CONFÉRENCE INTERNATIONALE
SUR L'EAU ET L'ENVIRONNEMENT:
Le développement dans la perspective du 21e siècle
26-31 janvier 1992, Dublin, Irlande

ONE COLOUR ICWE LOGO
Print black only

INTERNATIONAL CONFERENCE
ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26-31 January 1992, Dublin, Ireland

CONFERENCIA INTERNACIONAL
SOBRE EL AGUA Y EL MEDIO AMBIENTE:
El desarrollo en la perspectiva del siglo XXI.
26-31 de enero de 1992, Dublín, Irlanda

CONFÉRENCE INTERNATIONALE
SUR L'EAU ET L'ENVIRONNEMENT:
Le développement dans la perspective du 21^{e} siècle
26-31 janvier 1992, Dublin, Irlande



1.

2.

3.

PHOTO CREDITS:
1. FAO 2. UNICEF/S. Sprague 3. WFP/FAO/F. Iovino 4. UNICEF/C. Watson **NOTE:** Reproduction is free only for use with material in the Media Kit

4.

International Conference on Water and the Environment

Development issues for the 21st century

26-31 January 1992, Dublin, Ireland

1. Water - an essential element of life but too often taken for granted. *This on-farm water reservoir in* Ethiopia *provides water* that is used for irrigation, fish culture and domestic needs.
- L'eau est indispensable à la vie. Y avoir accès ne va pas de soi comme on a trop souvent tendance à le croire. Le réservoir de cette exploitation éthiopienne fournit l'eau nécessaire à l'irrigation, *à la pisciculture et aux usages domestiques.*
- El agua, elemento esencial para la vida, pero que con demasiada frecuencia se da por sentado. Este depósito de agua en una granja de Etiopía abastece de agua que se destina a la irrigación, la piscicultura y las necesidades domésticas.

2. More than 1.2 billion people in the developing world still lack access to safe water. The toll is high: illness from water-borne diseases including diarrhoea, debilitates and kills many, particulary young children. Children living in urban areas such as these in the "kampungs" of Indonesia may be the next victims.
- Dans le monde en développement, ils sont encore plus d'un milliard à ne pas avoir accès à une eau saine. Le tribut est lourd: les maladies liées à l'eau, les maladies diarrhéiques en particulier, affaiblissent les populations et font de nombreuses victimes, surtout parmi les jeunes enfants. Les prochaines seront peut-être les enfants des zones urbaines, ceux notamment des "kampungs" indonésiens.
- Más de 1.200 millones de personas de los países en desarrollo aún carecen de agua potable. El costo de esta situación es elevado: las enfermedades relacionadas con el agua, entre las que se cuenta la diarrea, provocan la debilidad o la muerte de muchas personas, sobre todo de niños de corta edad. Los niños que viven en zonas urbanas como estos "kampungs" de Indonesia pueden ser las próximas víctimas.

3. To meet requirements for agricultural production both today and tomorrow, vast amounts of renewable and reliable sources of freshwater are needed.
- Pour satisfaire les exigences de la production agricole, on aura besoin, aujourd'hui comme demain, de ressources en eau douce, abondantes et fiables.
- Para satisfacer las necesidades de la producción agrícola en la actualidad y en el futuro se necesitan grandes cantidades de fuentes de agua potable renovables y fiables.

4. Before the installation of this India Mark II handpump at a rural water supply project in Galbi, Niger, women walked as much as five kilometres a day to fetch water of questionable purity.
- Avant l'installation de cette pompe India Mark II, dans le cadre d'un projet rural d'approvisionnement en eau (Galbi, Niger), les femmes devaient parcourir chaque jour cinq kilomètres à pied pour récolter une eau de qualité douteuse.
- Antes de la instalación de esta bomba India Mark II en el marco del proyecto rural de abastecimiento de agua en Galbi, Níger, las mujeres recorrían diariamente a pie hasta cinco kilómetros para ir a buscar agua de dudosa calidad.

ICWE Secretariat
c/o World Meteorological Organization
41, avenue G. Motta
Case postale no. 2300
CH-1211 Geneva 2
Switzerland

International Conference on Water and the Environment:

Development issues for the 21st century

26-31 January 1992, Dublin, Ireland

WMO
UNITED NATIONS
UNICEF
UNCED
undp
IAEA
UNEP
UNIDO
WORLD BANK
UNCHS/HABITAT
WHO
UNDRO
INSTRAW
WFP

CONFERENCE INFORMATION

MEMBERS OF THE UNITED NATIONS ADMINISTRATIVE COMMITTEE ON COORDINATION INTER-SECRETARIAT GROUP FOR WATER RESOURCES (ACC/ISGWR)

United Nations Department of International Economic and Social Affairs (UN/DIESA)
United Nations Department of Technical Cooperation for Development (UN/DTCD)
United Nations Children's Fund (UNICEF)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations University (UNU)
United Nations Economic Commission for Africa (UN/ECA)
United Nations Economic Commission for Europe (UN/ECE)
United Nations Economic Commission for Latin America and the Caribbean (UN/ECLAC)
United Nations Economic and Social Commission for Asia and the Pacific (UN/ESCAP)
United Nations Economic and Social Commission for Western Asia (UN/ESCWA)
United Nations Centre for Human Settlements (UNCHS/HABITAT)
United Nations Disaster Relief Coordinator, Office of the (UNDRO)
International Research and Training Institute for the Advancement of Women (INSTRAW)
World Food Programme (WFP)
International Labour Organization (ILO)
Food and Agriculture Organization of the United Nations (FAO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Health Organization (WHO)
World Bank (IBRD)
World Meteorological Organization (WMO)
United Nations Industrial Development Organization (UNIDO)
International Atomic Energy Agency (IAEA)
United Nations Conference on Environment and Development (UNCED)

The ICWE logo

Constructed in a similar way as traditional celtic knotwork
the ICWE LOGO represents 3 elements:

- unification of people - symbolized by interconnecting knots and the joining of 5 continents;
- enlightenment - the burning flame depicting time and the urgency of the environment dilemma;
- nature - the droplet of water falling on a flower shaped like the Gentian which grows in the Burren - a world famous habitat in the West of Ireland.

International Conference on Water and the Environment:
Development Issues for the 21st Century

26 - 31 January 1992

Dublin, Ireland

The Conference will be hosted by the Government of Ireland and convened by the World Meteorological Organization (WMO) on behalf of the United Nations Administrative Committee on Coordination Inter-Secretariat Group for Water Resources (ACC/ISGWR)

FINANCIAL CONTRIBUTORS TO THE INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT

(to be completed)

STEERING COMMITTEE FOR THE INTERNATIONAL CONFERENCE ON WATER AN THE ENVIRONMENT (ICWE)

John C. Rodda	Chairman, ACC ISGWR (WMO)
Gordon J. Young	Conference Coordinator, ICWE
Eirah Gorre-Dale	Public Information & Promotion Coordinator, ICWE (UNDP)
Lawrence Anukam	UNCED Liaison, NGO and IGO Affairs
Clare Dunne	Department of the Environment (DOE), Ireland
Borjana Bulajich	UN/INSTRAW
Henny Colenbrander	COWAR
Kenneth A. Edwards	UN/DTCD
Rainer Enderlein	UN/ECE
Cengiz Ertuna	UN/ESCAP
Bede N. Okigbo	UNU
Frank Hartvelt	UNDP
Richard Helmer	UNCED
Jorge Illueca	UNEP
Terence R. Lee	UN/ECLAC
Guy Le Moigne	World Bank
Peter N. Mwanza	UN/ECA
Pierrre Najlis	UN/DIESA
Ahmad Radjai	UN/ESCWA
Carel de Rooy	UNICEF
Alexander Rotival	Water Supply and Sanitation Collaborative Council (until 1 October 1991)
Swayne Scott	FAO
Gehan Sinnatamby	UNCHS/HABITAT
Andras Szöllösi-Nagy	UNESCO
Dennis Warner	WHO
Ranjith Wirasinha	Water Supply and Sanitation Collaborative Council (from 1 October 1991)
Yuecel Yurtsever	IAEA

TABLE OF CONTENTS

INTRODUCTION

Water is a basic and essential component of life on this planet. Its availability and quality are of critical importance to our natural and human environments. Food and energy production and many other activities are intimately linked to a safe, reliable and affordable water supply. Judicious management of this precious resource is central to the success of global strategies for sustainable development.

Concern for freshwater resources was demonstrated at the 1977 United Nations Water Conference held in Mar del Plata, Argentina, which adopted the Mar del Plata Action Plan. The Plan resulted in several initiatives of which the UN International Drinking Water Supply and Sanitation Decade was the prime example.

During the last decade there has been a growing realization that problems of freshwater availability and quality are linked to broader environmental concerns and therefore should not be viewed independently. There is also now a strong perception that most aspects of economic development are dependent on reliable water resources. Hence, many international, national and local conferences convened in recent years have stressed increasingly that an integrated approach to water resources management is essential.

The International Conference on Water and the Environment will address critical freshwater issues and related development issues for the 21st century. It will act as a formal entry for these issues into the United Nations Conference on Environment and Development (UNCED) to be held in Rio de Janeiro, Brazil, in June 1992.

PREPARATORY MEETINGS

A number of conferences and meetings have taken place during 1991 which lead into and contribute towards the synthesis of opinion at the Dublin conference. Foremost among these are the following:

a. UNDP Symposium on a Strategy for Water Resources Capacity Building in Delft, The Netherlands, June 1991;
b. Water Quality Assessment and Management in Bratislava, Czech and Slovak Federal Republic, August 1991;
c. Consultation on Water Supply and Sanitation Collaborative Council Global Forum in Oslo, Norway, September 1991;
d. ESCAP Workshop on Sustainable and Environmentally Sound Development of Water Resources in Bangkok, Thailand, October-November 1991;
e. Copenhagen Informal Consultation on Integrated Water Resources Management, "The Nordic Initiative", in Copenhagen, Denmark, November 1991;
f. ASCEND 21: ICSU International Conference on an Agenda of Science for Environment and Development into the 21st century in Vienna, Austria, November 1991.

In addition, the subjects to be covered will also have been partially considered at other major national, NGO and international gatherings such as the "Global Consultation on Safe Water and Sanitation for the 1990s" held in New Delhi, India, in 1990.

MAIN OBJECTIVES

The Conference is convened to:

a. Assess the current status of the world's freshwater resources in relation to present and future water demands and to identify priority issues for the 1990s;
b. Develop coordinated inter-sectoral approaches towards managing these resources by strengthening the linkages between the various water programmes;
c. Formulate environmentally sustainable strategies and action programmes for the 1990s and beyond to be presented to the UNCED Earth Summit;
d. Bring the above issues, strategies and actions to the attention of governments as a basis for national programmes and to increase awareness of the environmental consequences and developmental opportunities in improving the management of water resources.

The third Preparatory Committee for UNCED which met in Geneva in August - September 1991 prepared a draft "Agenda 21" document, with an important freshwater component, which will be further revised at the fourth UNCED Preparatory Committee meeting in New York in March-April 1992.

The Preparatory Committee invited ICWE to consider the material in the draft Agenda 21 document and to:

- identify options for appropriate mechanisms for implementing and coordinating programmes;
- identify options for improved coordination and cooperation on water management at the local, national, regional and global levels;
- submit the report on results of the meetings to the fourth Preparatory Committee in New York.

CONFERENCE PROGRAMME

GENERAL PROGRAMME

The official Conference Programme runs from Sunday, 26 January to Friday, 31 January 1992. A summary of the main activities for participants is as follows:

Sunday, 26 January	PM	Participants registration Press Conference Opening ceremony and Cultural Programme
Monday, 27 January	AM	Opening remarks by the Minister for the Environment Election of Chairpersons and Rapporteurs Plenary sessions 1 & 2 (Keynote Papers) Lunch
	PM	Plenary sessions 3 & 4 (Keynote Papers) Administrative session
Tuesday, 28 January	AM	Working Group sessions A, C, E Lunch
	PM	Working Group sessions B, D, F State Reception at Dublin Castle
Wednesday, 29 January	AM	Working Group sessions A, C, E Working Group sessions B, D, F Lunch
	PM	Exhibition at Dublin Castle to Saturday, 1 February Poster sessions at Dublin Castle
Thursday, 30 January	AM	Working Group of the whole Lunch
	PM	Working Group of the whole Excursions State Dinner
Friday, 31 January	AM	Adoption of Conference Report and Dublin Statement Press Conference Lunch
	PM	Closing ceremony

KEYNOTE PAPERS

(Monday, 27 January 1992)

1. The world's water: assessing the resource.
   By N.B. Ayibotele (Ghana)

2. Water - the environmental and developmental dimensions - striking a balance. By J. Kindler (Poland)

3. Water for the people - community water supply and sanitation.
   By Aminata Traoré (Mali)

4. Water for sustainable food and agricultural producton.
   By J. Rydzewski (UK) and Shahrizaila bin Abdullah (Malaysia)

5. Environmental issues in rural water management.
   By J. Lutzenberger (Brazil)

6. The importance of water resources for urban socio-economic development. By D.B. Gupta (India)

7. Environmental and health issues: impacts of water waste.
   By A. Horchani (Tunisia)

8. Integrated urban water resource management.
   By P. Rogers (USA)

9. Coping with multi-cause environmental challenges - taking a water perspective. By J. Lundqvist and M. Falkenmark (Sweden)

10. Water and sustainable development. By R. Koudstaal, F.R. Rijsberman and H. Savenije (The Netherlands)

11. Scientific and technological challenges. By E. Plate (Germany)

TOPICS OF WORKING GROUPS

TOPICS TO BE ADDRESSED BY ICWE AS REQUESTED BY PREPCOM III	WORKING GROUPS
Integrated Water Resources Management	A. Integrated Water Resources Development and Management
Identify options for improved coordination and cooperation on water management	B. Mechanisms for Implementation and Coordination at Global, National, Regional and Local Levels
Water Resources Assessment	C. Water Resources Assessment and Impacts of Climate Change on Water Resources
Impacts of Climate Change on Water Resources	
Protection of Water Resources, Water Quality and Aquatic Ecosystems	D. Protection of Water Resources, Water Quality and Aquatic Ecosystems
Water and Sustainable Urban Development	E. Water and Sustainable Urban Development and Drinking Water Supply and Sanitation in the Urban Context
Drinking Water Supply and Sanitation	
Water for Sustainable Food Production and Rural Development	F. Water for Sustainable Food Production and Rural Development and Drinking Water Supply and Sanitation in the Rural Context

SCHEDULE OF WORKING GROUPS

Tuesday morning 28.01.92	A. Integrated Water Resources Development and Management	C. Water Resources Assessment and Impacts of Climate Change on Water Resources	E. Water and Sustainable Urban Development and Drinking Water Supply and Sanitation in the Urban Context
Tuesday afternoon	B. Mechanisms for Implementation and Coordination at Global, National, Regional and Local Levels	D. Protection of Water Resources, Water Quality and Aquatic Ecosystems	F. Water for Sustainable Food Production and Rural Development and Drinking Water Supply and Sanitation in the Rural Context
Tuesday evening	Drafting of working group outputs		

Wednesday morning 29.01.92	A. Integrated Water Resources Development and Management	C. Water Resources Assessment and Impacts of Climate Change on Water Resources	E. Water and Sustainable Urban Development and Drinking Water Supply and Sanitation in the Urban Context
	B. Mechanisms for Implementation and Coordination at Global, National, Regional and Local Levels	D. Protection of Water Resources, Water Quality and Aquatic Ecosystems	F. Water for Sustainable Food Production and Rural Development and Drinking Water Supply and Sanitation in the Rural Context
Wednesday afternoon + evening	Drafting of working group outputs		

Thursday morning 30.01.92	Working group of the whole. Final discussion of output of each working group. Discussion on options for collaboration and co-ordination.
Thursday afternoon	Working group of the whole. Final discussion of conference report. Discussion of Dublin Statement.

SPECIAL ACTIVITIES

Opening ceremony

The Conference will be opened by the Prime Minister of Ireland in the presence of dignitaries of the Government, and high-level official of organizations which have supported the Conference. A cultural programme will follow the formal opening and there will be a reception for participants immediately following the programm in the National Concert Hall. Formal attire is requested.

Receptions

Refreshments for the media will follow immediately after the Press Conference on Sunday, 26 January at 5.30 pm. at the National Concert Hall.

A State Reception will be hosted by the Government of Ireland for all participants on Tuesday, 28 January at 7.00 pm. at Dublin Castle.

A State Dinner will be hosted by the Minister for the Environment on Thursday, 30 January.

Exhibitions

A variety of exhibits by the participating organizations will be on display at nearby Dublin Castle, from Wednesday, 29 January until Saturday, 1 February 1992. The exhibition will be open to the general public from Thursday, 30 January 1992 to Saturday 1 February. Only exhibits of a non-commercial nature will be accepted. Participants should inform the ICWE Secretariat of their intention to mount exhibits or send their exhibit materials to arrive one week before the Conference. Quoting reference to the "Water Conference Exhibition" they should be sent to Dublin Castle in care of: *Mr. Tom Doyle, State Apartments, Dublin Castle, Dublin 2, Ireland.* Participants who will be bringing their exhibits to Dublin should contact the ICWE Conference Secretariat upon arrival.

Poster sessions

Poster sessions will be held in Dublin Castle on Wednesday, 29 January from 2.00 - 6.00 pm. Posters will be on display and simultaneous one-hour sessions on different topics related to the Conference will take place in different rooms at the Castle. Sessions could range from static poster displays, to computer-aided demonstrations, and brief presentations followed by discussions. Participation in poster sessions is restricted to non-profit making organizations. A poster session programme will be available to participants upon registration.

Excursions and accompanying persons' programme

There will be a very interesting programme of excursions and sightseeing tours available for participants and accompanying persons, organized by the Local Organizing Committee. Full details will be available in the final Conference Programme. For planning purposes, please indicate on the hotel reservation form whether or not you will be accompanied to the conference.

Conclusions and Closing ceremony

The Minister for the Environment and other dignitaries will officiate at the closing ceremony which will follow the adoption of the Conference report and the Dublin Statement.

GENERAL INFORMATION

Interpretation

Simultaneous interpretation will be provided in English, French and Spanish during the plenary and working group sessions.

Participants

Participation is restricted to invited experts nominated by their respective governments and organizations. These include representatives from departments or ministries of planning, finance, public works, water, the environment and other related bodies, as well as United Nations bodies and agencies, non-governmental organizations, external support agencies and other bodies actively involved in the water and environmental sectors.

A provisional list of participants will be distributed at the opening plenary session. This list will be revised as soon as all participants have registered, and an updated list will be distributed.

Registration

Registration for the Conference will take place at the Registration Desk in the Burlington Hotel Conference Centre, during the afternoon of Sunday, 26 January 1992.

Media accreditation

Bona fide representatives of the mass media - press, photo, radio, television and film - will be accredited for coverage of ICWE. Journalists and other media representatives wishing to cover the Conference may register on Sunday, 26 January from 10.00 am at the Press Room located on the first floor of the Burlington Hotel.

Special media accreditation by the Irish Government is required. Details on media participation are provided in the attached Media Advisory Note (Appendix 4). Prior to the Conference, additional information on media arrangements can be obtained from the Public Information and Promotion Coordinator, ICWE Secretariat in Geneva, Switzerland. Application forms can also be obtained directly from Mr. Pat Macken, Media Director, Department of the Environment, Dublin, Ireland (telephone and telefax numbers are shown under "Further information" on Page 24).

Documentation

Major pre-Conference documentation will be available in English, French, Spanish, Arabic, Chinese and Russian. Other pre-Conference documentation will be issued in English, French and Spanish. In-conference documentation will be issued in English, French and Spanish only. Post-Conference documentation consisting of a conference report and a concise 'Dublin Statement' will be issued in the six official UN languages.

Upon registration, each participant will receive the following:

a. Final Conference Programme
b. A background paper for each of the six Working Groups
c. Summary worksheets for each Working Group
d. The keynote papers
e. UN background strategy documents
f. Reports of relevant meetings as well as country, NGO and IGO Reports.

During the Conference, documents will be available at the Documents Desk located in the Conference area. After the Conference, a copy of the Proceedings will be mailed to participants.

LOGISTICAL ARRANGEMENTS

Conference location

At the kind invitation of the Government of Ireland, ICWE will be held in Dublin from 26 to 31 January 1992. The Conference will be convened at the Burlington Hotel Conference Centre, located at Upper Leeson Street, Dublin 4.

The opening ceremony will take place at the National Concert Hall, located at Earlsfort Terrace, Dublin 2.
The exhibition and poster sessions will be held at Dublin Castle. A shuttle service will be available between the Burlington Hotel and Dublin Castle on Wednesday, 29 January 1992.

Hotel reservations

Block reservations have been made in four Dublin hotels, offering participants a range of prices from which to choose. The Local Organizing Committee has negotiated very competitive rates with these hotels and the rates quoted in Appendix 1 are inclusive of breakfast, service charges and all local taxes. All hotels are within easy reach of the conference centre, but for participants'convenience, those staying in any of the three hotels other than the Burlington

Hotel, will be transported to and from the conference centre by coach each day. These coaches will be available to transfer participants to and from any official functions organized in the evenings.

Reservations should be requested by completing and returning the hotel reservation form given at Appendix 3, as soon as possible but not later than 31 December 1991 to the official Travel Agent for the conference, quoting reference "ICWE".

ABBEY TOURS		
City Gate	Tel.:	(353-1) 6799144
22 Bridge Street Lower	Fax.:	(353-1) 6791486 / 6799722
DUBLIN 8, Ireland	Telex.:	31435 / 91567

Please note that all correspondence concerning hotel reservations should be directed to the above address. The Travel Agent will confirm your hotel reservation.

The Local Organizing Committee assumes no responsibility for confirming or holding reservations. No guarantee can be given for late reservations. The Travel Agent will have a desk at the Burlington Hotel for the duration of the conference.

Transportation

Aer Lingus, Ireland's national airline, has been appointed Official Carrier for the Conference. A list of Aer Lingus' overseas booking and information offices is attached at Appendix 2. All of these offices will be fully informed of the conference and are in a position to secure the best possible routes for participants.

Upon arrival at Dublin Airport, participants will be met by local staff at a clearly signposted ICWE Information Desk. Each participant will be given an information pack which will include a map of Dublin. Details of transportation to the Conference Centre and to the various hotels will be made available. The cost of a taxi ride to the Burlington Hotel is approximately 10-12 Irish pounds (about US$16-20).

Entry requirements

All participants will require a valid passport for entry to Ireland. Citizens who require visas to enter Ireland should apply to Irish visa authorities overseas well in advance of their departure. Instructions and a sample visa application form are included in Appendix 1. Citizens from countries listed in Appendix 1 do not require a visa to enter Ireland.

Health requirements

There are no specific vaccination requirements for international travellers entering Ireland at the present time. However, should there be an outbreak of a contagious disease somewhere in the world at that time, there may be a requirement for specific vaccinations.

In the event of participants encountering unexpected illness or accidents during their stay in Ireland, the Local Organizing Committee will provide emergency medical assistance. Participants with particular health requirements should inform the Local Organizing Committee in advance of their arrival.

Medical insurance

It is recommended that prior to arrival each participant should arrange for personal medical insurance for the duration of the conference since neither the Irish Government nor the organizers will cover medical expenses.

Currency exchange

Currency exchange can be made at Dublin Airport, on arrival, as well as in the many local financial institutions and banks in Dublin. Normal banking hours are Monday to Friday, 10.00 am to 12.30 pm and 1.30 to 3.00 pm. On Thursdays, banks remain open until 5.00 pm. Participants arriving in Dublin at the weekend are advised to change currency at the airport. There will be a Bureau de change in operation at the Conference Centre with opening hours as above.

The currency unit in Ireland is the Irish pound (punt). The current exchange rate is approximately US$1.6 per punt.

Post, telephone, telex and telefax services

During the Conference mail for participants may be addressed as follows:

International Conference on Water and the Environment
Burlington Hotel Conference Centre
Upper Leeson Street
DUBLIN 4
Ireland

Special ICWE telephone, telefax and telex numbers are as follows:
ICWE Secretariat telephone nos. at the Conference Centre (to be added in the final Conference Programme)

Telephone No. :	Telex No. :
Telefax No. :	Press room No. :

Local Weather

Situated as it is in the zone of mid-latitude westerly winds, variability is one of the chief characteristics of Dublin's weather in any month. It will be rainy and cool in January, therefore paticipants are advised to bring along an umbrella and warm clothing.

COUNTRIES NOT REQUIRING VISAS TO IRELAND

If you are a national of the following countries, a visa is not required for Ireland.

ANDORRA
ARGENTINA
AUSTRALIA
AUSTRIA
BAHAMAS
BARBADOS
BELGIUM
BOTSWANA
BRAZIL
CANADA
CHILE
CZECH & SLOVAK FEDERAL REPUBLIC
COSTA RICA
CYPRUS
DENMARK
ECUADOR
EL SALVADOR
FIJI
FINLAND
FRANCE
GAMBIA
GERMANY
GREECE
GRENADA
GUATEMALA
GUYANA
HONDURAS
HUNGARY
ICELAND
ISRAEL
ITALY
JAMAICA
JAPAN
KENYA
KOREA (REPUBLIC OF)
LESOTHO
LIECHTENSTEIN
LUXEMBOURG
MALAWI
MALAYSIA
MALTA
MAURITIUS
MEXICO
MONACO
NAURU
NETHERLANDS
NEW ZEALAND
NICARAGUA
NORWAY
PANAMA
PARAGUAY
PORTUGAL
SAN MARINO
SIERRA LEONE
SINGAPORE
SPAIN
SWAZILAND
SWEDEN
SWITZERLAND
TANZANIA
TONGA
TRINIDAD AND TOBAGO
UGANDA
UNITED KINGDOM
UNITED STATES OF AMERICA
URUGUAY
VATICAN CITY
VENEZUELA
SAMOA
YUGOSLAVIA
ZAMBIA
ZIMBABWE

If you are a national of the United Kingdom and colonies and you were not born in Great Britain or Northern Ireland, you must have a valid passport or national identity document.

IRELAND

VISA INFORMATION

The granting of an Irish visa is, in effect, only a form of pre-entry clearance. It does **not** grant permission to enter Ireland. The visa holder is subject to inspection at the port of entry by Irish immigration officers who have authority to deny admission. The visa holder should therefore carry with him/her, for possible presentation to the Irish immigration authorities, the documents submitted to the Irish authority to which application was made.

The visa does **not** grant permission to stay in Ireland. The date of validity shown on the visa indicates only the date before which it must be presented. The length of stay is decided by the immigration officer at the port of entry. The visa holder who stays longer than the permitted length of stay in Ireland may become liable for prosecution and/or subject to deportation .

Department of Foreign Affairs.
Dublin.

IMPORTANT — PLEASE READ CAREFULLY

1. Please **print** clearly in **capital letters** (illegible answers may prevent your application form being processed).

2. **All** questions must be answered. Failure to do so will result in delay in processing the application.

3. **All** applications must be made through an Irish Embassy, Consulate-General, Consulate or directly to the Consular Section at the Department of Foreign Affairs, 72-76 St. Stephen's Green, Dublin 2, Ireland.

4. Please submit 3 photographs taken within 6 months of the date of this application. You may be required to produce your passport with the completed application form. Your passport should be valid for a period of at least 12 months after the date on which the visa is granted.

5. The application form must be **signed** by the applicant.

6. Allow a **minimum of 3 to 4 weeks** for the processing of the application from the date of lodgement. If a reply is needed before then communication expenses will have to be paid.

7. Each applicant is given a reference number which should be quoted when an enquiry has to be made.

8. The fee of .... must accompany this application. It will not be refunded in case of refusal.

9. In addition to this application visa holders may also be required to submit documents to the Irish immigration authorities at the port of entry which show why they are visiting Ireland and that they can maintain themselves while in Ireland.

10. A visa which is obtained on the basis of false and/or misleading information will be subsequently declared invalid. The holder of such a visa may become liable for prosecution and/or subject to deportation.

O/No. 160625. 50m. OVAL PTG. (852) 12/89.

United Nations

18.12.91 56712

HvDL

cc

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:

Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

ICWE Secretariat
c/o World Meteorological Organization

41, Giuseppe-Motta
Case postale nº 2300
CH 1211 Geneva 2
Switzerland

Dear Editor,

Re: **International Conference on Water and the Environment Development issues for the 21st century (ICWE), 26-31 January 1992, Dublin, Ireland**

I have pleasure in sending you the media kit for the above Conference.

The media kit contains basic information on ICWE including media features which focus on some of the key issues to be addressed at Dublin: striking a balance between the development of the water resource and its environmental protection, the critical nature of water to agricultural productivity; water scarcity and its impact on rapidly expanding urban populations, the devastating effects of water-borne diseases on human health, hydrological recycling, and the involvement of people in managing their own water systems.

We hope this kit will be of interest to you and your readers. We would very much appreciate receiving cuttings of articles and editorials, and notification of broadcast material drawn from its contents.

I would also like to take this opportunity to invite you and your publication to provide coverage of ICWE in Dublin this coming January and to highlight the critical issues to be discussed at the Conference, the outcome of which will feed into "Agenda 21" and the forthcoming "Earth Summit" in Rio de Janeiro next June.

Thanking you in advance for your support and looking forward to hear from you.

Sincerely yours,

G. J. Young

Gordon J. Young
Conference Coordinator, ICWE

cc: Eirah Gorre-Dale

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

41, Giuseppe-Motta
Case postale n° 2300
CH 1211 Geneva 2
Switzerland

MESSAGE BY

MAURICE F. STRONG

**Secretary-General,
United Nations Conference on Environment and Development (UNCED)**

to the

The International Conference on Water and the Environment: Development Issues for the 21st Century (ICWE)

There can be no issue that more conclusively demonstrates the integrated nature of environment and development than that of freshwater. The challenge of securing for all the basic human need of a reliable supply of freshwater, adequate in quality and quantity, is perhaps the most fundamental development issue. At the same time, the question of freshwater is connected to most major environmental issues.

A casual examination of the main linkages between freshwater and other issues in environment and development reveals just how pervasive an issue it is. Agriculture, for example, is almost totally dependent on the regular supply of freshwater, accounting for roughly two-thirds of its use. Recent investigations have shown that a major source of contamination of freshwater can be traced to air-borne pollutants. Both surface and ground water are increasingly contaminated by toxic chemicals and hazardous wastes, and some of these substances can pose a serious threat to health on the timescale of hundreds of years. Health, of course, is most directly associated with problems in the supply of freshwater: data suggest that some 5 million children under five years of age die each year from lack of potable water and sanitary facilities. In general, 80% of all diseases and more than 33% of deaths in developing countries have been linked to consumption of contaminated water, and on the average as much as 10% of each person's productive time is sacrificed to water-related diseases.

The International Conference on Water and the Environment to be held in Dublin will address these concerns in an integrated manner that takes into consideration their linkages to other issues. The Dublin meeting is an extremely important part of the UNCED process. The discussions at Dublin by government-designated experts and professionals from intergovernmental and non-governmental organizations will offer valuable substantive submissions that will assist in shaping up and finalising the freshwater component of the UNCED Action Programme, otherwise called "Agenda 21."

Complex and demanding though the task in Dublin may be, I am convinced the outcome of these important deliberations will help, through Agenda 21, to chart the future course for effective and integrated management of our vital and fragile freshwater resources, and I look forward to receiving the results of this Conference, which will be extremely valuable.

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland
ICWE Secretariat
c/o World Meteorological Organization

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

41, Giuseppe-Motta
Case postale n° 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

WATER, ENVIRONMENT AND DEVELOPMENT: AN OVERVIEW

Every day we hear news of water. We hear of persistent droughts in Africa, sudden and catastrophic floods in Bangladesh, lack of freshwater for the urban and the rural poor and pollution of major rivers and lakes. The world is beset by problems relating to water.

> **There is no doubt that over the course of the next few decades the problems of availability of clean water will assume crisis proportions in most regions of the world.**

Water is essential to life on Earth. Plant and animal life are vitally dependent on water which is the medium which allows life to function. In the atmosphere, on the Earth's surface, in the soil and in the rocks beneath the soil, life is sustained and nurtured by water. Life can be affected adversely if there is too little or too much water and if it becomes polluted then the life dependent upon it suffers and may disappear.

> **Water is essential to life. It is the lubricant of the natural environment. It is also vital to human well-being and to economic development.**

Human activities are also dependent on water. Basic human survival depends on a reliable supply of potable water for drinking and cooking. Health is highly dependent both on clean water for human consumption and on water for sanitation. Agriculture, industry and energy production all depend on a reliable water supply at reasonable cost. Water availability and the reliability of supply vary greatly from one part of the world to another, putting very real constraints on socio-economic development and affecting the quality of human life.

Quality of life is closely linked to the availability of natural resources and to the demands on those resources. As human populations increase so demands for resources, especially water, also increase. Populations, especially in many parts of the developing world are exploding at unprecedented rates. Cities are expanding, boosted in many instances by large scale migrations from rural areas, to such an extent that by the turn of the century there may be 22 mega-cities each with populations in excess of 10,000,000 people. Eighteen of these mega-cities will be in developing countries and at least two of them will have populations greater than 30,000,000. These rapidly increasing numbers are putting very great strains on water delivery systems, making the supply of potable water less reliable and reducing living standards.

> **Demand for water is increasing with exploding populations and economic growth.**

High standards of living are associated with high water consumption. It is not surprising that the relative abundance and reliability of water supply

Co - sponsored by the members of the United Nations ACC Inter-Secretariat Group for Water Resources (ISGWR)

United Nations Department of International Economic and Social Affairs (DIESA)
United Nations Department of Technical Co-operation for Development (DTCD)
United Nations Children's Fund (UNICEF)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations University (UNU)
Economic Commission for Africa (ECA)
Economic Commission for Europe (ECE)
Economic Commission for Latin America and the Caribbean (ECLAC)
Economic and Social Commission for Asia and the Pacific (ESCAP)
Economic and Social Commission for Western Asia (ESCWA)
United Nations Centre for Human Settlements (HABITAT)
United Nations Disaster Relief Co-ordinator, Office of the (UNDRO)
International Research and Training Institute for the Advancement of Women (INSTRAW)
World Food Programme (WFP)
International Labour Organization (ILO)
Food and Agriculture Organization of the United Nations (FAO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Health Organization (WHO)
World Bank (IBRD)
World Meteorological Organization (WMO)
United Nations Industrial Development Organization (UNIDO)
International Atomic Energy Agency (IAEA)
United Nations Conference on Environment and Development (UNCED)

in the highly developed countries has, to a large extent, allowed economic growth to take place. It is reasonable for less developed countries to enjoy the high living standards of the industrial countries and the prosperity associated with development. But development nearly always implies greater demand for water. Development will be hampered if water is not available in sufficient quantity and quality.

These important social and economic changes are set against a backdrop of changes in the natural environment. For instance, there is strong evidence of climate change, in large part induced by human activities. Climate change may affect natural systems, primarily the water cycle. As temperature and precipitation patterns change, rivers change their regimes; the length of periods of low flows may be increased, the reliability of discharge may change, the incidence of floods may increase. In many places these processes are almost impossible to reverse in the short time-frames necessary to avoid human catastrophe.

In many parts of the world changes in climate may result in reduced water supply. Indeed, in many areas the resource is already so scarce, whether it be in ground or suface waters, that major international efforts will have to be made to address the impending crises.

Clearly it will be very difficult to supply expanding populations with adequate water supplies at reasonable costs, especially in areas where the resource base is inadequate. The provision of sufficient potable water to supply basic drinking and cooking needs and provision of water for sanitation, so essential for human health, is a challenge. The provision of the much greater quantities needed to sustain agricultural productivity, promote industrial development and enable energy to be produced is an even greater challenge.

Attitudes to water are different in developed countries compared to less developed countries. In the last two decades the industrialised world has come to realise the importance of preserving the environment if development is to be sustainable. There has been a realisation, too, that environmental concerns should not be viewed as independent of other sectors of economic concern.

In the developing world there is an overriding concern for improving standards of living and especially the elimination of poverty. Less developed countries justifiably demand their share of growth and prosperity, to be gained through rapid economic development. It is understandable that immediate concern for preservation of the environment might be regarded as secondary to economic growth.

The perspectives on environment and development are very different in the developed and developing countries.

It is this dual perspective which underlies the preparation of the United Nations Conference on Environment and Development (UNCED) to be held in Rio de Janeiro in June 1992. The same concerns are at the basis of preparations for the International Conference on Water and the Environment (ICWE) to be held in Dublin in January 1992. ICWE is the official United Nations lead in freshwater issues to the UNCED "Earth Summit".

ICWE will be attended by invited participants, most of whom will be government- designated experts in the water field, but who will also include invited experts from Non-governmental and Intergovernmental Organizations. The purpose of the Conference is to discuss crucial issues in water management and to recommend options for specific action to address needs in countries and regions and to put forward options for better co-operation and collaboration in water management at international, national and local levels of decision making. The recommendations from ICWE will be taken to

The International Conference on Water and the Environment, Dublin 26–31 January 1992, will be pivotal in recommending action-oriented strategies for water-resources management.

the Fourth Preparatory Committee for UNCED, to be held in New York in March 1992 and thus be integrated into the Earth Summit.

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland
ICWE Secretariat
c/o World Meteorological Organization

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

41, Giuseppe-Motta
Case postale nº 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

WATER AND AGRICULTURE: HOW TO FEED MILLIONS MORE

(Contributed by the Food and Agriculture Organization of the United Nations)

The challenge

By the year 2025 the world will have over 8,000 million people to feed. That is 60 per cent more than today. In just 10 years time, today's 5,000 million will have already grown to 6,000 million. Most of this increase will occur in the developing world. How will they be fed? What will they eat? Meat, fish, fruits and vegetables, but, more than any other food, people's diets will depend on cereals and grains.

Land is scarce and becoming more so as populations expand. Countries may be large, but the amount of cultivable land is often limited. FAO estimates that 45 per cent of South America's land, only about 30 per cent of Southeast Asian and African land, and as little as 10 per cent of Central America is capable of sustained production of rain-fed crops. Approximately one quarter of this is used. Much of the remainder is primary forest and should be conserved to maintain and protect its rich store of biodiversity.

Water is limited as well. In Africa, for instance, as much as two-thirds of the continent may be subject to drought each year. Even in regions of the world where the overall rainfall is sufficient, the rains might come late, or finish early, or it may not rain at a critical point during the growing season. Traditional agricultural practices developed over the centuries to cope with these all too familiar conditions are inadequate in the face of today's population growth. To meet requirements for agricultural production, both today and tomorrow, substantial, renewable and reliable sources of freshwater are needed.

Co - sponsored by the members of the United Nations ACC Inter-Secretariat Group for Water Resources (ISGWR)

United Nations Department of International Economic and Social Affairs (DIESA)
United Nations Department of Technical Co-operation for Development (DTCD)
United Nations Children's Fund (UNICEF)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations University (UNU)
Economic Commission for Africa (ECA)
Economic Commission for Europe (ECE)
Economic Commission for Latin America and the Caribbean (ECLAC)
Economic and Social Commission for Asia and the Pacific (ESCAP)
Economic and Social Commission for Western Asia (ESCWA)
United Nations Centre for Human Settlements (HABITAT)
United Nations Disaster Relief Co-ordinator, Office of the (UNDRO)
International Research and Training Institute for the Advancement of Women (INSTRAW)
World Food Programme (WFP)
International Labour Organization (ILO)
Food and Agriculture Organization of the United Nations (FAO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Health Organization (WHO)
World Bank (IBRD)
World Meteorological Organization (WMO)
United Nations Industrial Development Organization (UNIDO)
International Atomic Energy Agency (IAEA)
United Nations Conference on Environment and Development (UNCED)

If the area of cultivable land cannot be increased substantially and the basic supply of water cannot be augmented, how are we going to feed the world in the future? The answer is that increased food production will depend upon more and more on making better use of what is already available. Agriculture, as we enter the 21st century, will be defined by the struggle to grow more food for more people with the land and the water that we have.

Farmers: the key players

Farmers will be at the forefront of the struggle but, throughout much of the developing world, they lack capital, technical support and even land. In their struggle to survive, poor farmers have often used agricultural methods that are wasteful or that degrade and destroy the soil. Every year thousands of poor peasants are compelled to abandon the rural areas for an uncertain urban future.

Every effort must be made to understand the farmer's constraints, motivations and aspirations in order to ensure that technical assistance is appropriate and truly useful. Farmers must have access to the basic elements needed to produce food that poor people, in turn, can afford to buy. They need better tools and inputs, help in organizing and advice on how to conserve their land. Most of all, they must be able to improve their use and management of water and irrigation.

Making better use of water

Irrigation has always played a prominent role in increasing agricultural production, making up for variable rainfall and allowing farmers to grow multiple crops during the year. By the mid-1980s, more than a third of the world's total crop production was grown on less than 15 per cent of the arable land which was irrigated.

Many irrigation systems, however, are suffering from serious technical difficulties. An estimated 60 per cent of irrigation water is lost before it ever reaches a plant. Irrigation becomes very expensive when more than half the water is wasted. The cost in terms of environmental damage is even higher with waterlogged soils, widespread soil salinity and depressed crop yields.

Waterlogging and salinity are particularly serious in arid and semi-arid regions such as the Euphrates Valley, the Lower Indus Plain and the Nile Delta. In Pakistan, the yield from 11 million of the country's total of 15 million hectares of irrigated land has been drastically reduced. Nor are examples restricted to developing countries - salinization is having a dramatic impact in the San Joachin Valley in the United States.

FAO estimates that some 125,000 hectares of irrigated land becomes uncultivable annually throughout the world as a result of waterlogging and salinization. If this rate of loss were to continue, over 2 million hectares of irrigated land would become completely unproductive by the year 2000.

The failure or disappointing performance of some large irrigation schemes and the serious environmental set-backs they have caused, have helped focus attention on small-scale irrigation and the need for “appropriate” technology - technology developed and adapted to the specific needs and capacities of farmers in developing rural areas.

In Egypt, where 60 per cent of crop production is at risk, the Government with assistance from FAO has installed tile drains, collectors and pumping stations across a vast area. In Pakistan, where 30 to 50 per cent of agricultural land is suffering from salinization, FAO has helped operate a salinity control and reclamation project. In Iraq, some 40,000 hectares in the Greater Mussayib Area have been rehabilitated.

Water has not been considered by most authorities to be a scarce or threatened resource. Governments are now trying to come to grips with how to manage supplies which traditionally have been regulated only in terms of its use. Health ministries, for example, looked after sanitation, agricultural ministries concerned themselves with agricultural implications. As a result, many countries have not built up ways of managing and conserving their water resources which are increasingly at risk.

They have begun to realize that water is a limited resource that must be shared by competing, yet closely related interests - domestic, sanitation, agriculture and industry, and administered accordingly. The essential “glue” is a long-term plan and accompanying legislation that will enable governments to implement specific water management strategies and programmes.

An International Action Programme

FAO has devised an International Action Programme on Water and Sustainable Agricultural Development — a 10-year plan to promote wiser use of water. It tackles core problems such as inefficient use, salinization and waterlogging, drainage and pollution.

Priority is given to small-scale development projects that help farmers and local communities develop water supplies and build small-scale irrigation schemes, encouraging a more balanced approach to agricultural development. Special help is being given to countries facing chronic shortages of water and those prone to periodic shortages.

The Action Programme identifies a set of priorities that lead to sustainable agriculture through the best use of water resources. It brings into focus the vital role of local communities and farmers in expanding agricultural production through a better use of that most precious resource: water. How it is pumped or diverted from lakes and rivers, how it is carried to the farms and channelled or sprinkled onto the fields, when it is applied and in what quantities, and how it is drained and recycled. Ultimately, our ability to feed many more millions of people will depend on how well we use and manage our limited supplies of water. (By Ann Pulver)

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland
ICWE Secretariat
c/o World Meteorological Organization

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

41, Giuseppe-Motta
Case postale nº 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

SINCE WATER IS THE SOURCE OF LIFE, CONSERVE

(Contributed by the United Nations Centre for Human Settlements/HABITAT)

The vital ingredient

Underlying the 1981-1990 International Drinking Water Supply and Sanitation Decade were the basic tenets that clean drinking water is undeniably necessary to life, while adequate sanitation is a prerequisite for good health. Survival itself and a decent quality of life depend on water supply and sanitation services; so do agriculture, industry, mining, and service industries, the mainstays of a country's economy. Even after the end of the Decade, the protection and management of freshwater continue to be on the agenda of conservationists, environmentalists, and economists alike. The topic is one of the nine main areas of concern at the forthcoming United Nations Conference on the Environment and Development to be held in Brazil next June.

The urban situation: survival in the city

At the end of the "Water Decade", the supply of both drinking water and sanitation facilities had increased noticeably, yet failed to keep pace with the increasing population, especially in urban areas. In 1990, 31 million more people were unserved by water supply, and 85 million more were without sanitation services than in 1981. And by the end of *this* decade, many countries will have only about half as much water as they had in 1975, yet will have to meet much greater and even exponential demands from industry and agriculture as well as for domestic use.

The consequences of failure are forbidding. Already, over 80 per cent of all disease and over one third of deaths in developing countries are caused through the ingestion of contaminated water, and as much as one tenth of each person's productive time is said to be sacrificed to water-related diseases. The urban poor are often worse off than high-income town dwellers or even their rural counterparts, with disastrous implications to their health. For example, in Port-au-Prince, Haiti, the infant mortality rate in urban slums is almost three times that in rural areas; the incidence of tuberculosis in Soweto is more than 100-fold that among high-income communities in the same city.

Not only is this mortality and morbidity a tragic human loss, it also carries serious economic repercussions. By 1989 urban areas which then accounted for only one third of the total population, were responsible for over 60 per cent of Gross Domestic Product in most developing countries. It is the urban slums and squatter settlements which provide the bulk of the labour force both for industry and the informal sector, the latter accounting for some 20 per cent of total outputs. And those in ill health can hardly be at the peak of productivity.

The conditions in informal settlements are a threat both to the health of the inhabitants and to the overall environment. Developing country cities collect only some 30 to 70 per cent of the solid waste generated. Even when collected, these wastes are more often than not put in open dumps. Not that "developed" countries are that advanced. In the USA alone, officials are looking into the safety of 50,000 landfill sites. Similarly, only 40 per cent of the sewerage is pumped away. Human excrement is the single most serious pollutant of the urban environment in developing countries. Poor stormwater drainage, the location of informal settlements on poorly-drained areas, on low-lying land and along waterways, exacerbates the problem.

Nor can the menace be regarded cynically as a "poor people's problem". In Lima, for example, the recent cholera epidemic spread rapidly across local and national frontiers. Ironically, the amount lost in exports and tourism in the first three months could have provided a high level in-house water supply and sanitation system for the entire population of Lima. If only in self-interest, action must be taken before such disasters become common place. More gradual effects are also being felt in the immediate environment. Some cities, such as Bangkok and Jakarta are literally sinking, while in others, such as Riyadh, rising groundwater is the problem. In developing countries, approximately two thirds of water pollution is caused by human settlements by-products: human waste, industrial by-products, and official neglect combine to reduce the quality and quantity of urban water resources.

Suggesting some solutions

The problem seems grave — ever-increasing demands by competing users of a limited and ever-more-contaminated resource. Nor is it easy to separate interlinked issues: water, sanitation, health; agriculture, industrial and domestic use; community, city-wide and even national demands.

Yet the resources, techniques and knowledge for effective urban water management do exist. Sustainable and socially equitable progress can be made if collaborative efforts are begun now. The April 1991 Expert Group Meeting on Management of Water Resources for Urban Use set forth five main issues, along with some policy options for each:

(1) **Access to water, sanitation and waste-disposal services, particularly for the poor.**

The urban poor are both willing and able to pay for water and sewerage services. In fact, they already pay many times more for far inferior services such as water vendors and nightsoil sweepers, than their counterparts in the formal parts of the city pay for similar, "up-market", services. Sustainable services and reliable supplies may be obtained, for example, through the use of low-cost alternatives to conventional sewers such as the shallow-sewer system. Communities may organize and manage their own maintenance, including the repair of standpipes and the upkeep of their own sewer branch. Promotion and education will help such efforts to achieve maximum health impacts.

(2) **Depletion and degradation of water resources**

Halting or reversing this trend will involve preventing surface and groundwater contamination and depletion, reducing environmental impacts, and providing surface-water drainage. In this case, the "polluter pays" principle will have to come into effect, for indeed it is agriculture and industry which account for the bulk of both water consumption and contamination. Given first priority for this limited resource, they consume huge amounts of water, and pay minimal fines for pollution. In the Federal District of Mexico, which has to go farther and farther afield for its water sources, tariffs are so low that industries find it cheaper to use public potable supplies for cooling and process water rather than recycle. Yet in terms of urban water sources, reduction of polluting discharges through recycling is just as important as reducing demands.

(3) **Allocation of water resources**

Domestic water consumption accounts for only about 5 per cent of the total demand for water in developing countries, compared with 85 per cent for agriculture and 10 per cent for industry. Thus a 2 per cent improvement in the use of irrigation water would on average release enough water to meet domestic needs for the next 5 years. Also in this category fall demand management and the adequate pricing of services.

We have seen that poor people are prepared to pay realistic prices for dependable water supplies; it remains for the rich to pay more realistic rates for their "excess consumption" through graded tariffs. In developed countries, such simple devices as improved toilets, showerheads and washing machines can cut water consumption by one fifth. Reducing leakage in developing countries which can range from 60 per cent to some 12 per cent in developed countries would mean that more than double the amount of water would be available for use.

(4) **Institutional, legal and management aspects**

The key here is integrated water management. It means not only taking cognizance of the obvious links between water, sanitation and health; between the economy and the environment; between the city and its hinterland. It also means integration of water and sanitation infrastructure with land-use planning and housing policies, cooperation across disciplines and sectors, and a comprehensive and coherent approach to setting and enforcing realistic standards. Capacity-building has been identified by specialists from developing countries and external support agencies alike as a priority for the 1990s. It extends the capacity of individuals or institutions in various ways, such as offering them legality, financial resources, training, additional responsibilities and the authority to carry them out. An over-riding criterion for successful water management is a confident and qualified staff, with adequate incentives for efficient performance. This leads to the fifth priority issue.

(5) **Resource mobilization**

Skilled people need to work in an enabling environment of supportive policies, legislation and incentives, in institutions which have power, responsibility and financial viability. Obviously the community must also be involved, with users setting priorities, choosing, for example, to use wastewater for irrigating their small plots, or to separate garbage into organic for on-site composting and inorganic that can be used for scale waste-recycling industries. Both NGOs and the private sector can be involved in a whole range of new partnerships.

The opportunities are there, and must be taken advantage of now, in order to make the future itself not only sustainable but enjoyable, guaranteeing not only life itself but a better quality of life for those who are already paying without seeing results.

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland
ICWE Secretariat
c/o World Meteorological Organization

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

41, Giuseppe-Motta
Case postale n° 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

SAFE WATER AND SANITATION:
— The Global Situation —

(Contributed by the World Health Organization)

The recent devastating surge of cholera, a water and food-borne disease that has bedeviled parts of the world for centuries but is now reaching peak levels unknown in modern times, has focused new attention on the need to guarantee clean water supplies in urban and rural parts of the world.

Although the global total of cholera cases - put at 332,828 by the World Health Organization (WHO) as at 8 August 1991 - has made for startling headlines and prompted emergency measures by governments in collaboration with WHO, the impact of this disease, while significant and rising, is small compared to the global impact on health of inadequate water and sanitation systems around the world.

"The catastrophic epidemic of cholera sweeping through some Latin American and African countries reminds us yet again of the value of safe water and sanitation," says Dr. Hiroshi Nakajima, Director-General of WHO. "Safe water and sanitation are the foundation for health. And health is the foundation for global development".

Indeed, despite major advances achieved during the International Drinking Water Supply and Sanitation Decade conceived in 1977 and launched with great hopes and expectations by the United Nations in November 1980, over one quarter of the world's population still lacks safe water and sanitation.

According to recent WHO estimates, of the approximately 4400 million people living in the world today, about 1200 million people live their daily lives without a clean and safe supply of water, while almost 1800 people live without adequate sanitation.

While these statistics are shocking in themselves, they mask a large number of equally shocking health conditions. Classic water-borne diseases include cholera and typhoid fever, as well as infectious hepatitis and shigellosis. More common, and in the long run more deadly, are the diarrhoeal diseases due to poor hygiene and faecal-oral transmission. A third type includes water-related parasitic diseases of which dracunculiasis, schistosomiasis, onchocerciasis, and malaria cause an enormous amount of human misery. And now one must include a fourth major category — illnesses resulting from the nitrites, heavy metals, and pesticides that have become both the life-blood of our industrializing societies, and unfortunately, too often the pollutants of our drinking-water.

What are the most serious water-related diseases causing death and ill health in the world today?

* **Diarrhoea**

  It is estimated that diarrhoea causes between four and five million deaths annually in children under the age of 5 years in developing countries. In the first two years of life, as many as 15 of every 1000 children will die from diarrhoea. Recent studies indicate that water and sanitation improvements can reduce the overall incidence of infant and child diarrhoea by one-quarter and more importantly, total infant and child mortality by more than one half.

* **Dracunculiasis, or guinea worm disease**

  This disease, caused by a minute crustacean, Cyclops, infected with larvae of the female Guinea worm, infects approximately 10 million people each year. Over 100 million people are at risk of infection in some 21 countries of Asia and Africa. Since the disease is transmitted only by drinking contaminated water, it can be eradicated through the provision of safe drinking-water. WHO has targeted guinea worm disease for eradication within the next few years.

* **Schistosomiasis**

  This disease is found in 76 countries, where it infects around 200 million persons, while placing another 400 million at risk of infection. It is acquired by coming into contact with fresh water contaminated with larvae released by certain species of fresh water snails. Modern expansion of irrigation systems and water resources has led to an explosion of the disease into new areas during this century. Providing adequate supplies of uncontaminated drinking-water and safe excreta disposal can break the main transmission routes of infection.

Overall, providing safe water and sanitation can reduce the incidence of the above diseases, as well as a host of others, including cholera, typhoid, leptospirosis, trypanosomiasis, scabies, yaws, inflammatory eye diseases, trachoma, bacillary dysentery, amoebiasis, tinea, gastroenteritis, ascariasis, poliomyelitis and dengue fever.

The problems of rapid population growth, migration of people the world over from rural areas to cities, economic dislocation, war, civil strife, famine and drought have all added to the vortex of problems in water and sanitation systems, preventing the application of solutions. The problems of the 1980s were so acute, in fact, that the United Nations system has described this period as a "lost decade of development." Nevertheless, progress made during the International Drinking Water Supply and Sanitation Decade raises hopes for a solution.

In the early 1970s, only about one-third of the people of the developing world had access to safe water and sanitation. In the rural areas, this number may have been as low as one tenth. At that time, diarrhoea in all of its different forms probably killed upwards of six million children per year, and parasitic worms infected perhaps half of the total of the population in the developing countries.

The International Drinking Water Supply and Sanitation Decade involved unprecedented efforts that achieved good results. For example, during the Decade, approximately 1600 million people received water supply, who had never had it before, and about 780 million people received adequate levels of sanitation for the very first time. In rural areas, the increase in services was particularly dramatic: the level of safe water coverage rose from 30% to 63% of the population, for example, while the number of additional people receiving urban sanitation services rose by 350 million.

How was this achieved?

Ironically, it was the lack of financial and human resources needed to promote rapid expansion of coverage that eventually forced governments and external agencies to adopt radical new approaches to promoting safe water and sanitation. These changes rose from the realization that many more facilities could be built with existing resources, and their use and maintenance could be improved, if the intended beneficiaries were involved at all stages of development and operation.

Water and sanitation agencies also began to be sensitive to the key roles that could be played by women, community leaders, and other groups with recognized competence and authority.

In many traditional societies, for example, women and young children are the water carriers - they are the people responsible for obtaining and preparing food, taking care of the water supply, washing clothes and so on. Nevertheless, it is usually the men of the village who control the main decisions and expenditures.

Community-centered concepts became increasingly important over the course of the Decade as emphasis regarding the leading role for water and sanitation development shifted from the outside development agency to the community and the individuals within it. As the Decade progressed, it became increasingly clear that the success of water and sanitation projects in rural and peri-urban areas is highly dependent on the degree of community participation in projects and their responsibility for continued operations. The establishment of a sense of ownership requires that the system users have a major decision-making role in project development.

The WHO community water supply and sanitation programme, therefore, is broad-based, stressing both education and training and the provision of useful options, such as various types of water treatment and storage. WHO also works with national development agencies to ensure that they are providing people with water which is safe to begin with. In addition, WHO considers that the framework defined to achieve the goal of "Health for All by the Year 2000", and the principles of primary health care can promote a healthy environment and help water and sanitation programmes to achieve their objectives.

The Decade also brought about some remarkable improvements in drilling, water treatment, and sanitation technologies. As a result, many more effective, appropriate and cheaper methods of providing services exist. Instead of looking to hardware technology as a solution, WHO is advocating looking to "software" solutions which involve the use of people-oriented technologies. That includes organizing communities, procedures for trying to determine what it is people really want, how much are they prepared to pay for water, and what is their capacity for taking care of systems once they are done.

An international conference in Dublin, Ireland, scheduled for January 1992, will emphasize the linkages between water and the environment. Water will be considered in its broadest sense, including water for drinking, irrigation and drainage, as well as the water found in sanitary wastes. The Conference in Dublin, in turn, provide the input on fresh water to a much larger conference, the United Nations Conference on Environment and Development, to be held in Brazil in June 1992, which will look at the wider picture of environment and development as a whole.

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

ICWE Secretariat
c/o World Meteorological Organization

41, Giuseppe-Motta
Case postale n° 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

HYDROLOGICAL RECYCLING

(Contributed by the World Meteorological Organization)

Recycling of glass, paper, metals and wastes of all kinds is fast becoming an enormous enterprise. Some of the world's future Fords, Gettys and Sasakawas are now making their millions out of the things we use one day and throw away the next. But recycling is "old hat" in the water business. Dutchmen are drinking the same water that the Germans and Swiss have already quaffed and then swilled down the Rhine. The coffee you drank today may have contained water molecules that were part of Julius Caesar's bath on the day he was despatched by Brutus, or which may have helped quench the thirst of a dinosaur millions of years before then.

Water is the ultimate amongst the world's renewable resources. Virtually every particle liquid, solid and gas is connected by the hydrological cycle which continuously transports vast quantities of water around the globe, removing water here, renewing it there. Some of this movement is rapid. For example, water vapour enters the atmosphere by evaporation and stays there, on average for only about a week before being precipitated. This precipitation drains to the streams and rivers where it resides for about the same length of time. This time, the residence time increases to months for water in vegetation and in the soil, to years in the surface layers of the seas and oceans and to tens of thousands of years for water deep below the ground or locked up in the Antarctic ice.

However, the volume of freshwater which is readily accessible for mankind to use, the water resource, is but a tiny portion of the total transported globally by the hydrological cycle. This accessible water, is mainly in rivers, reservoirs and lakes or situated a short distance below the ground. It is characterized by a brief residence time, and because of the spatial and temporal vagaries of the hydrological cycle, it is also extremely varied in its distribution from one part of the world to another. These

Co - sponsored by the members of the United Nations ACC Inter-Secretariat Group for Water Resources (ISGWR)

United Nations Department of International Economic and Social Affairs (DIESA)
United Nations Department of Technical Co-operation for Development (DTCD)
United Nations Children's Fund (UNICEF)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations University (UNU)
Economic Commission for Africa (ECA)
Economic Commission for Europe (ECE)
Economic Commission for Latin America and the Caribbean (ECLAC)
Economic and Social Commission for Asia and the Pacific (ESCAP)
Economic and Social Commission for Western Asia (ESCWA)
United Nations Centre for Human Settlements (HABITAT)
United Nations Disaster Relief Co-ordinator, Office of the (UNDRO)
International Research and Training Institute for the Advancement of Women (INSTRAW)
World Food Programme (WFP)
International Labour Organization (ILO)
Food and Agriculture Organization of the United Nations (FAO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Health Organization (WHO)
World Bank (IBRD)
World Meteorological Organization (WMO)
United Nations Industrial Development Organization (UNIDO)
International Atomic Energy Agency (IAEA)
United Nations Conference on Environment and Development (UNCED)

variations cause serious problems for the assessment of the water resource globally, nationally and even for a single river basin. But without such assessments there is no rational basis for planning how water resources should best be utilized and managed, against prescribed goals.

Currently, sustainable development and management is *the* ubiquitous goal for the resource utilization and this includes water resources. So the continuous measurement of these resources from basin to basin and from one country to another is essential. Indeed without the continual accumulation of hydrological knowledge of water resources, sustainable development and management of these resources is impossible.

This knowledge is normally acquired by national hydrological services, hydrometeorological services and related agencies. They undertake continuous measurements of river flows, groundwater levels, precipitation, evaporation and other variables such as the volume of moisture in the soil and the extent of glaciers and ice sheets. They also measure the quality of these waters. All these measurements are stored on computer and processed to provide regular assessments of the state of the nations' water resources. They are processed to produce the data for designing hydraulic structures, such as dams and bridges and they are carefully checked to identify trends to see if there is degradation of the resource.

Models are used with these data to predict future water resources scenarios, including the consequences of changes to precipitation and evaporation regimes that may result from climate change. In support of these activities of the world's hydrological services, WMO has for more than 25 years undertaken its Hydrology and Water Resources Programme.

The programme is responsible for:

- assessing water resources to ensure adequate water for many purposes including drinking, agriculture, industry, power productions;
- flood forecasting to protect people against natural hazards;
- environment protection to safeguard the characteristics of the aquatic environment against degradation.

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

ICWE Secretariat
c/o World Meteorological Organization

41, Giuseppe-Motta
Case postale nº 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

THE DECADE AND BEYOND

(Contributed by the United Nations Children's Fund)

Universal access to water and sanitation by the year 2000 could cost a massive US$36 billion annually. However, by shifting resources to low-cost technologies, 30 per cent of the total capital investment could provide for 80 per cent of the unserved.

Decade Performance

The International Drinking Water Supply and Sanitation Decade (IDWSSD) also known as "The Decade", was launched in November 1980 when several new ideas learned from past evaluations of water and sanitation programmes in several countries were introduced. When the Decade came to an end in 1990, it had not achieved its numerical objective of universal access to water and sanitation. It was, however, successful in creating awareness about the sector and in developing workable strategies and models that enhance sector sustainability.

In the early 1980s, the downturn in the world economy had begun to be felt in the developing countries. Gross Domestic Product growth rates started to drop and their long-term debts more than doubled over the decade. Demographic growth, particularly in urban areas, further complicated the problem of extending water and sanitation facilities to a fast-growing population. Thus, two main factors — inadequate funding and high population growth — contributed significantly in curtailing the coverage rate for water and sanitation, thereby preventing the achievement of universal access to these facilities. But the Water and Sanitation Decade was not only about numbers, it was about people too. It succeeded in introducing low-cost technologies, and in focusing attention on the user communities as active participants in the developmental process, rather than their being merely passive recipients as before.

Progress in Rural Areas

The most dramatic increase in coverage took place in rural water supplies, where the number of people in the developing world with access to facilities increased by 240 per cent during the decade. The number of rural inhabitants with new sanitation facilities also increased, though less spectacularly, by 150 per cent. However, given the rapidly expanding population, the increases in the number of inhabitants provided with adequate services do not necessarily translate into equally significant increases in the proportion of people with services, relative to the total population.

By 1990, water and sanitation coverage in developing countries had reached the following levels: urban water 82 per cent, rural water 63 per cent; urban sanitation 72 per cent; and rural sanitation 49 per cent. But, in absolute terms, there are still an estimated 1.23 billion people in developing countries without access to adequate and safe water supplies, and 1.74 billion without access to appropriate sanitation; that is 31 per cent without water, and 43 per cent without sanitation as of 1990.

As expected, there are significant variations from region to region. A review of the progress in Africa is of particular interest since this continent contains most of the world's least developed countries, and suffered acute water problems associated with drought during the 1980s. Despite significant gains in the absolute numbers of people served, the proportion for urban water supply coverage increased by a mere 5 per cent, from 77 per cent in 1980. For the urban sanitation, the coverage increased by only 3 percentage points.

The Future

The total cost of attaining universal coverage by the year 2000 is estimated at $36 billion per year. When apportioned, this figure allows for $15 billion for water supply and $21 billion for sanitation per year. But as this $36 billion funding is unlikely to be forthcoming in the current economic climate, greater cost efficiency and effectiveness will be required in order to accelerate this coverage rate.

But with approximately 30 per cent of the total capital investment required to provide water and sanitation services to all by the year 2000, 80 per cent of the unserved could be reached through more vigorous promotion and application of low-cost technology programmes, especially in rural and some marginal-urban areas with emphasis on technical co-operation among developing countries and dissemination and exchange of information among the scientific community.

Currently, Bangladesh, China, India, Indonesia, Pakistan, and Viet Nam in Asia; Egypt and Nigeria in Africa; and Brazil and Mexico in Latin America, account for 75 per cent of the developing countries' population. What happens in these countries will therefore largely dictate global coverage figures by the year 2000.

The 1980s witnessed, for the first time in history, a concerted effort to provide needy people in urban and rural areas with water and sanitation services on a large scale. One of the outcomes of this effort was the emergence of an array of low-cost approaches and technologies which have effected significant cost reductions as they were transferred from their research and developmental phase into large scale implementation programmes. For example, in one UNICEF-supported rural areas and sanitation programme of Nigeria, the average cost of a handpump-equipped borehole was reduced from over US$20,000 in 1982, to under US$4,000 by 1990.

The water and sanitation sector, during the 1990s should place greater focus on at least the following three approaches if significant, sustainable coverage is to be effected: promote low-cost technologies; concentrate efforts in the rural and marginal-urban areas where most of the unserved reside; utilize community management to fully involve users in the decision-making process, systems development, and maintenance.

Thus, the strategies of the 1990s must be such that their combined effect will make an enormous difference with respect to sector performance. A more management-oriented sector, based on frequent and systematic monitoring at country and global levels, with an institutionalized entity for global advocacy, should form the corner-stone of the thrust for the 1990s.

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland
ICWE Secretariat
c/o World Meteorological Organization

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

41, Giuseppe-Motta
Case postale n° 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

SOUTH PACIFIC: MOBILIZING WOMEN AND MEN FOR WATER

(Contributed by the United Nations Development Programme)

Solevu, Fiji — At mid-morning here on Malolo Levu island in the South Pacific, as the climbing sun casts a blanket of heat over this small fishing community, the thoughts of the men turn to *kava*, the traditional national beverage made with water and the pulverized roots of pepper plants. Spreading woven mats over the ground, they seek shade under the breadfruit trees and quench their thirst on the cloudy, grey and mildly narcotic liquid. Among those partaking is George Stephens, a Fijian community development officer whose wife was born on the island. As he sips, he casually turns the conversation to village needs, specifically the importance of repairing and maintaining their current water systems.

About two years ago, the 10-year-old gravity drinking water system installed by the government began to break down. The community approached the University of the South Pacific (USP) for help. A regional institution with 12 member countries, USP is well known in the South Pacific for its focus on "women and water".

But Solevu is a community where it was necessary to involve men as well as women in repairing the water system. Fixing the deteriorating systems would require heavy physical labour and skills such as cementing, normally found among men. Another consideration was the community's strong tradition of male decision-making, prevalent throughout the South Pacific. Men had plenty of time to devote to the task at hand. Repair and maintenance activities could easily be fit within existing farming and fishing responsibilities.

But motivating the men to get involved was a challenge. "Water is a non-issue with Fijian men," says Cema Bolabola, a lecturer in continuing education at

Co - sponsored by the members of the United Nations ACC Inter-Secretariat Group for Water Resources (ISGWR)

United Nations Department of International Economic and Social Affairs (DIESA)
United Nations Department of Technical Co-operation for Development (DTCD)
United Nations Children's Fund (UNICEF)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations University (UNU)
Economic Commission for Africa (ECA)
Economic Commission for Europe (ECE)
Economic Commission for Latin America and the Caribbean (ECLAC)
Economic and Social Commission for Asia and the Pacific (ESCAP)
Economic and Social Commission for Western Asia (ESCWA)
United Nations Centre for Human Settlements (HABITAT)
United Nations Disaster Relief Co-ordinator, Office of the (UNDRO)
International Research and Training Institute for the Advancement of Women (INSTRAW)
World Food Programme (WFP)
International Labour Organization (ILO)
Food and Agriculture Organization of the United Nations (FAO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Health Organization (WHO)
World Bank (IBRD)
World Meteorological Organization (WMO)
United Nations Industrial Development Organization (UNIDO)
International Atomic Energy Agency (IAEA)
United Nations Conference on Environment and Development (UNCED)

the USP Fiji Centre in Suva, the country's capital. "Men in Fijian villages are only interested in water when it comes to mixing their *kava*." It was therefore decided to bring in Mr. Stephens, who has a thorough knowledge of local conditions and a deep understanding of island traditions, such as the importance of the *kava* drinking ritual.

While a female community development worker conducted seminars on hygienic water handling for Solevu's women, Mr. Stephens sat down with the men and spelled out the island's water problems, suggesting possible solutions. Then he left it to the men to decide what action they would take.

This approach took time, but it succeeded in stirring the men's interest in fixing the old water systems, which consist of a gravity piped spring water system, wells that tap underground reserves, and rainwater catchment tanks. Soon the men were busy recementing worn out storage facilities, fitting wells with concrete aprons and tube-shaped casings and patching up eroded rainwater collection tanks. "The villagers will do what is necessary once set on the right path," says Mr. Stephens.

That patch was blazed by Kerrick (Rick) Knauth, a United Nations Volunteer civil engineer attached to a Pacific islands water resources project supported by the United Nations Development Programme (UNDP) and the UN Department of Technical Co-operation for Development (UN/DTCD). Mr. Knauth added his technical expertise to Mr. Stephens' motivational work. Together with the community, they set three main tasks. One was to improve the flow of the gravity-piped water system at source. Second was to cover the nine shallow wells and fit them with handpumps. Thirdly, they would install a communal laundry.

Development of drinking water supplies for Fiji's 800,000 population has long been a major priority of the government. Recent annual investments of nearly US$500,000 have brought coverage to nearly 100 per cent in the 97 inhabited islands. But as is the case in Solevu, water systems installed years ago are showing signs of wear and tear. Moreover, climatic changes and population growth are likely to increase future water demands.

Years of forest fires and deforestation on Mololo Levu have reduced seepage of rainwater into the water table. "When we came here over 30 years ago, this place was covered with *noko noko,*" recalls Mr. Stephens, referring to a type of evergreen tree which now grows only in sparse clumps on the gently sloping hillsides.

While the villagers of Solevu can do little in the short-term to improve underground water reserves, they can do much to raise the volume and quality of their other water supplies. Mr. Knauth taught the village men how to re-cement the main water storage tank. Under his direction they also cleared away sediment to improve the flow of spring water channels and sealed them off from outside pollution.

After consulting with the women, a communal laundry facility with six sinks was built in the middle of the village, again with the men doing the construction. "Before, women carried their washing almost a mile (1.6 kilometres) down to a sandy stretch of the coast," says Mr. Knauth. "Once wet, it was so heavy they would let it dry there for a day then go back and get it."

Other activities included improving the village's shallow hand-dug wells, which were at risk of pollution and subject to possible collapse. Under the guidance of Mr. Knauth, the men dug the wells about half a metre deeper and fitted them with concrete linings for stability. To finish off, they were shown how to build concrete aprons around the well heads. "When they get to the apron stage, we leave", says Mr. Stephens. "There is a temptation to complete the job, but that's the villagers' responsibility.

The improved wells will be fitted with pumps to be supplied by a Fijian engineering company. These pumps were tested and improved under an earlier project supported by UNDP, UN/DTCD, the USP Fiji Centre, the Australian Embassy, and the World YWCA. "The experts had recommended the Mark II pump," says Ms. Bolabola. "But getting it to Fiji was too expensive".

Besides installing well linings, the men of Solevu have learned how to patch up their large galvanized iron rainwater collection tanks. On one visit to Solevu Mr. Knauth showed a local plumber how to repair them and on his next visit he was delighted to find a tank nearly as good as new. The patch job cost less than $15, while a new galvanized tank would have cost over $200. "Just a little bit of knowledge and perseverance is all that is necessary," says Mr. Stephens.

Back under the breadfruit tree, Mr. Stephens patiently discusses the next steps to be taken with the village men. In what order should the wells be fitted with casings? What other rainwater storage tanks should be repaired? Never insisting, he quietly sets out the options, letting the group determine their own priorities. "When we're gone they'll sit and talk about it," he says, taking a sip of *kava*. Experience suggests that when the last drop of *kava* is gone, the talk will lead to action. (By Mary Lynn Hanley)

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland
ICWE Secretariat
c/o World Meteorological Organization

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

41, Giuseppe-Motta
Case postale nº 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

ARAB WATER SYSTEMS - A HERITAGE RE-EVALUATED

(Contributed by the United Nations Educational, Scientific and Cultural Organization)

In an age that values novelty and innovation as highly as ours does, it is easy to ignore ideas and methods that work, but that have the disadvantage of not being new but hundreds, or even thousands of years old. This applies to systems for managing water as well. Enthusiasm for new revolutionary technologies and innovations caused more functioning, but old technologies and ideas to be neglected in the recent past.

However, the old systems, such as those that were and are used in the Arab States, are proving quite workable under certain conditions. And once augmented with new technology and materials, they can prove very useful indeed, as was discovered in a study by the UNESCO Regional Office for Science and Technology of the Arab States in cooperation with the Arab Centre for the Studies of Arid Zones and Dry Lands.

Methods in use in Jordan, the United Arab Emirates, Bahrain, Tunisia, Algeria, Saudi Arabia, Sudan, Syria, Iraq, Oman, Kuwait, Lebanon, Libya, Egypt, Morocco, Mauritania and Yemen were compared and evaluated in the study.

Necessity — the mother of invention

The basis for this re-evaluation is the realization that the old water systems had to be efficient in order to allow people to live and prosper in arid or desert surroundings. If you lived in a dry climate in the time before boreholes hundreds of metres deep and desalinization plants, you had two options - learn how to get along with the water you have, or go live somewhere else.

Co - sponsored by the members of the United Nations ACC Inter-Secretariat Group for Water Resources (ISGWR)

United Nations Department of International Economic and Social Affairs (DIESA)
United Nations Department of Technical Co-operation for Development (DTCD)
United Nations Children's Fund (UNICEF)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations University (UNU)
Economic Commission for Africa (ECA)
Economic Commission for Europe (ECE)
Economic Commission for Latin America and the Caribbean (ECLAC)
Economic and Social Commission for Asia and the Pacific (ESCAP)
Economic and Social Commission for Western Asia (ESCWA)
United Nations Centre for Human Settlements (HABITAT)
United Nations Disaster Relief Co-ordinator, Office of the (UNDRO)
International Research and Training Institute for the Advancement of Women (INSTRAW)
World Food Programme (WFP)
International Labour Organization (ILO)
Food and Agriculture Organization of the United Nations (FAO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Health Organization (WHO)
World Bank (IBRD)
World Meteorological Organization (WMO)
United Nations Industrial Development Organization (UNIDO)
International Atomic Energy Agency (IAEA)
United Nations Conference on Environment and Development (UNCED)

Thousands of years in an arid climate did teach the Arab peoples a thing or two about water — how to gather it, store it and spread it efficiently. Elaborate systems for gathering water were developed. Terraces were found to be a solution for growing crops on steep slopes, preventing erosion and using water efficiently. Drinking water was stored in underground tanks, leather bags, or even hollowed-out trees. Where there was not enough water available to grow date palms, holes were dug in the ground, closer to the ground water, and the palms grown there.

The methods frequently resemble each other across the Arab world, due to the close contacts between different regions — first in the time of colonization by the Greeks and the Romans — then with the arrival of Islam. In the period between the fourth century and the 16th, a number of improvements and renovations on the prevailing water systems were introduced, which spread rapidly from one part to another.

Some systems have since fallen into disuse, but others are functioning to this day, to ensure water for drinking, livestock and irrigation of crops.

In many Arab countries, there are parts that are less developed than others — remote, thinly populated and inaccessible areas where resources are scarce, and whose inhabitants are moving to the cities to make a living. The water reserves may be insufficient. The money for investments and modernizing goes to parts of the country with better development potential, with the consequence that the differences in development between different regions of the country grow more aggravated.

In these undeveloped areas, traditional water systems can make a difference. With their help, disadvantaged regions can create jobs, improve their self-sufficiency and reduce their dependency on imports of food from other regions.

The traditional systems fall into several categories — there are methods of distributing ground water, such as Foggaras, canals or tunnels hundreds of metres or several kilometres long, that funnel water out of wells onto fields. There are methods of storing water, such as cisterns, dams and Hafirs.

Spreading water from streams or rivers by controlled flooding is another common method. Miskat, then again, is a way of gathering rainwater on a larger area, and concentrating it where the crops are grown.

In some cases, when it was too difficult to move the water to the plants, the plants were moved to the water. Ghoutas are deep wide holes in the ground, where crops are grown to bring their roots closer to the water table.

Sustainability

Mining water from fossil aquifers creates an abundance of water for a certain period. But these aquifers, formed thousands of years ago, are not inexhaustible.

When there is nothing left to extract, other solutions must be found, of either transporting water from elsewhere or of making more efficient use of what is available.

Traditional systems, augmented with modern technologies and materials, are a way of doing the latter.

These systems can and do benefit from modern technological improvements. New materials in construction, and a better understanding of the hydrological characteristics of a region can help choose the right method for an area.

Choosing the right method is a challenge, that requires knowledge of the rainfall in the region, the geology and the topography, and the needs of the community using it. The right system can make a huge difference for life in a small rural community in an arid climate. At best, a working water system creates jobs, encourages agriculture, and promotes a sustainable and environmentally sound use of the available water resources. (By Nina Tornüdd)

United Nations

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:
Development issues for the 21st century
26 - 31 January 1992, Dublin, Ireland

Tel : (+41) 22 730 82 75
Fax : (+41) 22 734 23 26
Telex: 414 199 OMM CH

ICWE Secretariat
c/o World Meteorological Organization

41, Giuseppe-Motta
Case postale nº 2300
CH 1211 Geneva 2
Switzerland

MEDIA FEATURE

HARNESSING RIVER RESOURCES: THE ZAMBEZI ACTION PLAN

(Contributed by the United Nations Environment Programme)

Draining some 1.4 million square kilometres of almost the entire central southern region of Africa, the Zambezi River and its tributaries form the fourth largest river basin on the Continent. The Zambezi provides water to more than 20 million people in eight countries: Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. Pollution, from sewage treatment plants as well as industry and mining, is serious in some areas.

Since 1985, the United Nations Environment Programme (UNEP) has been helping the river basin countries to formulate a plan to develop their river resources in an environmentally-sound and sustainable manner. In January 1987, the country representatives of the Working Group of Experts on the Zambezi River System approved the action plan for the Zambezi River basin and, in May 1987, governments of the member countries officially adopted the programme called ZACPLAN.

The basic input to ZACPLAN is a diagnostic study based on reports submitted by the ministries responsible for water resource development in each member country, and on contributions from such UN Agencies as United Nations Educational, Scientific and Cultural Organization (UNESCO), World Meteorological Organization (WMO) and World Health Organization (WHO). The study identified the problems of managing of the river basin including inadequate information on water quantity and quality, soil erosion, deforestation, lack of coordination at the national and international level, and degradation of flora and fauna.

Co - sponsored by the members of the United Nations ACC Inter-Secretariat Group for Water Resources (ISGWR)

United Nations Department of International Economic and Social Affairs (DIESA)
United Nations Department of Technical Co-operation for Development (DTCD)
United Nations Children's Fund (UNICEF)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations University (UNU)
Economic Commission for Africa (ECA)
Economic Commission for Europe (ECE)
Economic Commission for Latin America and the Caribbean (ECLAC)
Economic and Social Commission for Asia and the Pacific (ESCAP)
Economic and Social Commission for Western Asia (ESCWA)
United Nations Centre for Human Settlements (HABITAT)
United Nations Disaster Relief Co-ordinator, Office of the (UNDRO)
International Research and Training Institute for the Advancement of Women (INSTRAW)
World Food Programme (WFP)
International Labour Organization (ILO)
Food and Agriculture Organization of the United Nations (FAO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
World Health Organization (WHO)
World Bank (IBRD)
World Meteorological Organization (WMO)
United Nations Industrial Development Organization (UNIDO)
International Atomic Energy Agency (IAEA)
United Nations Conference on Environment and Development (UNCED)

The action plan recommends that priority be given to eight areas, each supported by a project. The cost of implementation is approximately US $12 million. These funds come from participating countries, national and international donors, and from UNEP's Environment Fund (US $1.2 million).

The first project collects information on all national projects related to ZACPLAN. This will establish a pool of experiences which can be drawn upon for future planning.

The second project deals with the legislation required to protect the Zambezi's water resources and its environment. Existing national laws must be reviewed and a regional convention must be developed and adopted.

Projects three and four will survey and strengthen national capabilities to undertake water-related research, and plan and carry out appropriate programmes in response to environmental problems.

For the fifth project, ZACPLAN will develop a basin-wide monitoring system, covering data on surface and ground water, sediment, water pollution and water quality. The system will link and strengthen existing national information gathering networks.

The sixth project is the development of an integrated water management plan for the Zambezi River Basin based on a series of sub-basin plans dealing with water pollution control and the reuse of waste water.

Promoting people's participation in different ares such as the development of sanitary facilities, soil conservation, forest protection and fuel-wood plantations is the goal of the seventh project.

The last and eighth project will plan drinking water supply and sanitation systems, in cooperation with WHO.

UNEP has recently donated an amount of US $170,000 for phases one, two and five of ZACPLAN and it is the South African Development Coordination Conference (SADCC) who will be responsible for their application.

INTERNATIONAL CONFERENCE ON WATER AND THE ENVIRONMENT:

Development Issues for the 21st century

Dublin, Ireland
26-31 January 1992

MEDIA ADVISORY NOTE

The International Conference on Water and the Environment (ICWE) will be held at the Burlington Hotel Conference Centre in Dublin, Ireland, from 26 to 31 January 1992.

Hosted by the Government of Ireland, the Conference is being convened by the World Meteorological Organization (WMO) on behalf of the United Nations Administrative Committee on Coordination Inter-Secretariat Group for Water Resources (ACC ISGWR).

The Conference will be attended by over 500 government-designated experts from more than 100 developing and developed countries, by representatives from over 50 external support agencies and bodies, including non-governmental and inter-governmental organizations as well as by correspondents from the local and international press.

All meetings will be held at the Burlington Hotel Conference Centre. Poster sessions and an exhibition by the co-sponsoring UN organizations, country participants and NGOs will be held at Dublin Castle on Wednesday afternoon, 29 January. The exhibition will be open to the general public from Thursday, 30 January until Saturday, 1 February 1992.

MEDIA ACCREDITATION AND REGISTRATION

Bona fide representatives of the mass media - press, photo, radio, television and film - will be accredited for coverage of ICWE. Access to the press room, press conferences and other events related to the Conference will be restricted to registered participants wearing special media badges. To obtain badges, accredited press must register at the Press Registration Desk in the Press Room of the Burlington Hotel, which will be open from 10.00 am to 5.00 pm on Sunday, 26 January and from 9.00 am to 5.00 pm from Monday to Friday. Registration will be possible at all times during the Conference.

To register, journalists must appear in person and present valid press credentials bearing a photograph. Members of the press who are not based in Ireland and who do not have current press credentials, such as those issued by national or local authorities or professional bodies, must attach to their accreditation forms a signed letter of assignment from the editor or Bureau Chief of the publication for which the journalist is covering the Conference, together with a national passport or comparable identification card bearing a photograph. Without such credentials, journalists will not be able to register.

PRESS ROOM

The Press Room will be located on the first floor of the Burlington Hotel and will open at 10.00 am on Sunday, 26 January 1992. It will have about 40 desks available on a first-come, first-served basis. Each desk will be equipped with a telephone from which local calls can be made free of charge. Collect and telephone company, credit card long-distance calls may also be made. The charges will be billed directly to correspondents. A representative of the Irish postal, telephone and telegraph service will be present during working hours for payment. The Irish telecommunications representative will be located in an adjacent room. The Press Room telephones can also be used for data transmission. Additional public telephones will be available in the lobby of the Conference Centre.

Telefax service will be available in the Press Room, and charges may be settled with the Telecommunications representative. Telex service will not be available.

The Press Room will also have interview rooms adjacent to it. Journalists who wish to book interviews should do so through the Press Information Desk which will be staffed at all times.

Full details on telephone and telefax numbers of the Press Room and the ICWE Secretariat at the Burlington Hotel will be available in the final Conference Programme.

DOCUMENTATION

Journalists will be presented with a media kit containing all the necessary information related to the Conference upon registration. A documents stand will be located in the Press Room. Major background documentation, conference working documents and reports will be available as well as press releases as they are issued.

PRESS CONFERENCES

Two official press conferences are scheduled. The first press conference will be held before the opening ceremony at 5.30 pm on Sunday, 26 January 1992 in the National Concert Hall located at Earlsfort Terrace, in Dublin. The second press conference will take place on Friday, 31 January 1992 at the Burlington Hotel Main Conference Hall at around 12 noon following the adoption of the "Dublin Statement." Simultaneous interpretation will be available into English, French and Spanish only during the closing press conference on Friday, 31 January 1992.

Individual delegations or participants may plan press briefings in consultation with the ICWE Secretariat. A list of briefings will be posted on the Press Room bulletin board as information is received.

INTERVIEWS

The Public Information and Promotion Coordinator and Media Director will assist journalists in identifying experts for individual interviews on specific topics relevant to the Conference. Interviews between interested journalists and participants will be arranged as necessary. A list of experts and an updated list of participants will be available in the Press Room.

RECEPTIONS

Refreshments for the media will take place at the National Concert Hall immediately after the 26 January press conference. All accredited media representatives are cordially invited.

OPENING CEREMONY AND CULTURAL PROGRAMME

The opening ceremony will be held at 7.00 pm at the National Concert Hall in Dublin. The Prime Minister of Ireland, the Minister for the Environment, other Government dignitaries and high-level officials from the co-sponsoring organizations will be present. A cultural programme will follow the ceremony featuring a premiere live performance of "A Thin Halo of Blue," by Ireland's foremost composer of contemporary classical music, Mr. John Buckley, accompanied by the RTE Concert Orchestra with full choir. More details on the programme will be available in the information pack that will be provided to journalists upon registration.

POSTER SESSIONS

A half-day of Poster Sessions will take place at Dublin Castle on Wednesday, 29 January 1992 from 2.00 pm until 6.00 pm. Posters will range from static displays of print and audio-visual materials, to computer-assisted demonstrations, to brief presentations and discussions on a variety of topics. A final list of topics to be covered will be available on opening day.

EXHIBITION

A number of Conference participants will be mounting exhibits - ranging from unusual water containers from selected parts of the world to video shows, displays describing the programmes and activities in freshwater by the different countries, development assistance agencies, United Nations organizations and non-governmental organizations.

THE DUBLIN STATEMENT

The main outcome of the Conference - the "Dublin Statement" - will be available in English at around 12.00 noon or during the closing press conference, following its adoption on Friday, 31