

RESEARCH ON  
WATER FOR DEVELOPMENT ISSUES  
A FUTURE RESEARCH AGENDA  
FOR THE HEALTH SCIENCES DIVISION AND IDRC

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Which determines research priorities more - the rural situation and the needs and wishes of the people, or the professional situation and the needs and wishes of the professional?

*Robert Chambers,  
Identifying Research Priorities in Water Development (1978)*

. . . but most evaluations are still conducted at the behest of external donors, rather than on the initiative of local governments.

*Sandy Cairncross  
Water Supply and Sanitation: an agenda for research (1989)*

EXCERPTS FROM RESOLUTION A/RES/45/181  
CONCERNING THE INTERNATIONAL DRINKING WATER SUPPLY AND SANITATION DECADE

Recognizing that the 1990s will require an intensification of national efforts and international co-operation to provide adequate and safe drinking water and sanitation for all by the end of the century;

4. Urges Governments, in their efforts to implement the recommendations contained in the report of the Secretary-General and in the New Delhi Statement, to stress the following important objectives:
- a. to assign greater priority to the allocations of development financing to water supply and sanitation by seeking a better integration of the sector within the overall development planning process;
  - b. to implement programmes aimed at expanding service coverage within the framework of integrated water resources and environmental planning and management, in the context of sustainable national social and economic plans and urban and rural development policies;
  - c. to mobilize additional funds from existing and new sources, including governments and donors;
  - d. to assess the current status of institutions with a view to strengthening national capacities to plan and manage water supply and environmental sanitation programmes;
  - e. to increase their efforts to improve the efficiency and use of available financial resources by, *inter alia*, continuing to expand the use of cost-effective appropriate technologies, and to intensify South-South co-operation in that regard;
- ...
7. Emphasizes the importance of intensifying the co-ordination of national activities undertaken with assistance of different agencies in the field of water supply and sanitation through the Steering Committee for Co-operative Action for the International Drinking Water Supply and Sanitation Decade and the Water and Sanitation Collaborative Council;

Adopted by the United Nations General Assembly  
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## INTRODUCTION AND SUMMARY

Over the past 15 years, the International Development Research Centre has approved funding for over 200 applied research projects, for which the primary or secondary focus is a water-related issue. The value of total appropriations exceeds \$ 30 million. However, the significance of IDRC's contribution goes beyond simply the number of projects approved and their monetary value. It relates, among other things, to the increase in knowledge about water-related issues, institutional capacity strengthening, and, the improvement of the research capabilities of developing country nationals. The Centre has collaborated in research initiatives that have pioneered developments in the water sector. Among the more notable are: the development and use of polyvinyl chloride and other plastic materials in below-ground handpump components; the development of dynamic models for the analysis of subterranean waters; the development of alternative technologies for water harvesting, such as devices to capture water droplets in coastal fog; the development of micro-computer based information systems for the management of bibliographic materials; investigation into the effectiveness and impact of the training and deployment of villagers, particularly women, as village handpump manufacturers and maintenance technicians; the development of innovative, rapid and low-cost methods for water quality analysis; and, the development and application of a software package for water source classification. The Centre, and the researchers with whom it has been associated, are recognized as leaders for their contributions to knowledge on water-related issues.

The Centre has contributed also to the promotion and the implementation of mechanisms to support greater collaboration and cooperation among the multitude of multilateral, bilateral, and specialized agencies involved in the International Drinking Water Supply and Sanitation Decade. Its involvement extends from the initial discussions about the formation of an inter-agency committee on water supply and sanitation issues in the early 1970s, through to active participation on the Collaborative Council of External Support Agencies and its various working groups. The Centre was the first to promote and provide financial support to developing country researchers and scientists affiliated with indigenous institutions to attend international workshops and conferences, and to publish and disseminate their research experiences.

The activities supported and carried out by IDRC and other external support agencies, NGOs, and developing country government agencies and academic institutions, have served to contribute to addressing many of the issues deemed as priority concerns during the recently completed International Drinking Water Supply and Sanitation Decade (1981 - 1990). The experience of the past 15 years demonstrates that water remains a primordial concern in both industrialized and developing countries. However, the majority of issues addressed over this ten year period focus on one area, that of water supply. But there are many more issues, such as water resources management (particularly water stress and scarcity issues), that require further study. The shift in emphasis of the role of central government, from that of a provider of water services to that of a promoter and facilitator to improve the health and social well-being of people, demands also the study of the effectiveness and impact of new institutional arrangements, financing and service modes for water systems, and their comparative impact on health and social well-being of people.

The majority of the water-related research activities funded by the Centre since 1974 were developed and supported under the auspices of the Health Sciences Division. Prior to the restructuring of this Division in 1988, its Water Supply and Sanitation sector was the most active among the Centre's subprograms in identifying, developing and funding applied research projects on water issues. In fact, between 1974 and 1988, the year this subprogram was dissolved, it generated and was responsible for the administration of over 63% of the total number of water-related projects supported by the Centre during this period. As the subprogram matured, the scope of definition of the projects it supported expanded considerably. By 1988, it was evident that the focus extended well beyond the research

agenda and interests of the Health Sciences Division. Simultaneously, the orientation of the Division's research agenda was being redefined, moving away from a tendency to support technology-linked approaches to improvements in public health towards a more holistic approach, that placed a greater emphasis on the contextual variables that influence the health of disadvantaged populations. After 1988, support to water-related issues within the Health Sciences Division decreased dramatically, reflecting the divergence in the research foci of the subprogram and the Division.

The decision of the Canadian government to decrease significantly its level of funding for official development assistance (ODA) has required IDRC to reduce substantially its plans to expand support to existing and launch new programs. It has also prompted reviews of research agendas of particular issues, to determine the future role for IDRC support. In late 1989, the Division took a decision to commission a study, the purpose of which would be to evolve a new Divisional policy with respect to water, health and development, congruous with the holistic model of health adopted by the Health Sciences Division in 1988. This study, though focusing on water and health issues, and on the particular case of the Health Sciences Division, takes into account as well the research activities undertaken on water-related issues supported by the Centre's other program Divisions. The study is meant to provide guidance to both corporate and divisional management at IDRC, concerning the direction and substance of water-related of a research agenda for water-related issues at the Centre, and the appropriate support mechanisms.

The goals of the study are multiple: to provide a rationale for continued financial support by the Centre to water-related research issues; to evolve a more corporate and coherent approach to the identification of and support for water-related research activities; and, to encourage the Centre to maintain its role as a leader in the support of research on water-related issues, particularly from the developing country perspective. Given the prevailing resource constraints at IDRC, a conservative, iterative approach has been adopted for this purpose. The study provides an overview of the current global situation as pertains to water, and presents the experiences of the past twenty years concerning the identification of priority water issues, and the initiatives launched to address them. It presents a review of the applied research agenda adopted and supported by the major external support agencies over the past two decades. The study also contains the first content analysis of the slate of projects on water-related activities, funded by the Centre's program divisions. Based on this information, the final chapter provides recommendations for a future research agenda for water, and an institutional arrangement that could be adopted by the Centre in support of this agenda.

The information contained in this study was drawn from a variety of sources:

- archival documents from IDRC's library;
- review of many published and unpublished reports, articles and project reports prepared by developing country researchers and scientists;
- discussions with Centre personnel involved in water-related activities;
- collection and analysis of documents and reports from multilateral and bilateral agencies, academic institutions and non-governmental organizations (both developed and developing country-based) involved in sector activities, and the reports and proceedings of a wide variety of international and regional conferences and meetings that have taken place over the past 20 years;
- review of published articles authored by internationally-recognized sector experts; and,
- reaction and comments to the initial draft of this report.

Chapter 1 provides a general contextual framework upon which research on water-related issues can be based. It argues that the influence that water has upon man, and the reciprocal equation, must be understood within the context of the quantity and quality of available water resources. Water may not be as 'renewable' a resource as is assumed. Research on water and health issues must take this situation into account.

Chapter 2 provides an overview of the conceptualization about water issues, and the concomitant activities that ensued, since the 1960s. The establishment of an International Drinking Water Supply and Sanitation Decade was a major step in promoting and popularizing a better understanding of sector issues, and for highlighting the need for increased resources into action on prevailing issues, especially those dealing with access to safe water for the world's disadvantaged populations. But the Decade, and other associated initiatives during the 1970s and 1980s, did not receive the support required. Consequently, the Decade fell short of achieving its goals and targets. The chapter reviews both the achievements and shortfalls of the Decade.

Chapter 3 provides an analysis of thinking about current and emerging issues relating to water. It is argued that the definition of current research agendas on water-related issues are source-dependent. Opinion varies widely and the choice of key agenda items depends on the nature, quality and quantity of the information that is readily accessible. The professional standing of the authors and editors of published materials exerts also a significant influence on what is considered as relevant input into the development of a research agenda. But the information published to date on this topic tends to originate from developed country-based organizations, institutions and individuals. Their focus tends to be defined from a centralized, professional point of view, related often to the corporate philosophies and mandates and perceived needs of development aid agencies and experts. While the topics identified as priority areas for research on water-related issues over the next several years may merit both attention and further investigation, the perspective that they represent is primarily that of developed country-based professionals. It is difficult to claim that its generation is 'demand-driven'. A prescription for a future research agenda requires input from both developing and developed country sources. The chapter then focuses on four issues (the impact of human activity on water; the impact of water on human well-being and productivity; management issues; and, technology development and application) in an attempt to define several of the more pressing water-related issues from a developing country perspective, that merit further study.

Chapter 4 presents a content analysis of the 214 projects on water-related issues that IDRC has supported since 1974. The projects specific to each of its program divisions are reviewed, with particular emphasis given to the slate of projects supported by the Centre's Health Sciences Division. Between 1973 and 1988, this Division was the focal point for water-related research and development activities for IDRC. A review of the research activities funded under the Division's water supply and sanitation sector indicate a tendency towards the support of research on technology-related interventions. Improvements in health were seen to be a function of the correct design, implementation and management of technologies. However, following the restructuring of the Division and the implementation of a new guiding philosophy as to the nature of research on health issues that would henceforth be supported, the visibility formerly given to water as a distinct program was withdrawn.

The current approach places water among a number of factors that may affect health. The research focus shifts from, therefore, water as an end, to water, and its use and management, as a means to achieve the goal of health.

Finally, in Chapter 5, a series of recommendations relating to a renewed policy and program for water-related research at the Centre, and within the Health Sciences Division, are proposed. The recommendations are intended to assist in strengthening the capacity of the Centre, and its program Divisions, to respond to requests from developing country researchers for support for applied research



on pressing and priority water-related issues, through modifications both to the guiding philosophy within the Centre and the Health Sciences Division for thinking about and action on water-related research issues and activities, and structural and process changes to achieve a more cohesive and coherent approach towards this goal. This report concludes that a strong rationale exists for IDRC, and particularly to its Health Sciences Division, to continue, and if resources permit, to increase its support to water-related issues. There are few sources of funds for applied research activities that are identified, developed and carried out exclusively by developing country researchers and scientists. IDRC has an important role to play in this regard. It has the experience and expertise in-house, to continue its important contribution to knowledge on water-related issues. The issue at hand is how to ensure that the limited resources that are available are used most effectively to this end.

The projects funded by the Centre over the past 15 years have made a significant contribution to the creation of new knowledge about water-related issues. Several have been responsible for establishing new directions for and approaches to applied research on specific topics. IDRC support to developing country institutions has assisted as well to increase the research capabilities of developing country-based people, and the research administration capacities of the institutions with which they are affiliated. The Centre has also made an important contribution to the advancement of cooperation among external support agencies, and has been a strong and consistent advocate for the promotion and active involvement of developing country scientists and technicians in the process of conceptualization about and action on research issues within the sector.

Not only is there recognition on the international scene as to the Centre's contribution in addressing the major issues that were identified as central to water and human development over the past 15 years, but the very nature of the Centre is amenable to increasing knowledge on such issues, particularly at a point in time when the issues facing the very survival of many people living in the Third World is directly linked to water. The Centre also possess several characteristics that allow it to respond very effectively to requests for research support from developing country sources (one element of the Centre's 'comparative advantage' over other funding and development agencies). **Hence, within funding limits, the Centre should continue to provide support to water-related research, as well as to its active involvement in international sector-related activities.**

The study also serves to indicate the absence of a corporate policy to guide Centre thinking and action on water issues, and a multidisciplinary approach for the identification and development of research projects. The traditional approach within the Centre, as exemplified by the low number of interdivisional projects to date, has been for each Division to develop its own unique and distinct research agenda on water-related issues. This is not to say that projects were developed without taking under advisement the comments from colleagues in other Divisions. However, few water-related proposals were developed through a truly multidisciplinary and interdivisional approach. This shortcoming was identified in PPR VII as a factor that limits the operational effectiveness of the Centre. **The second policy recommendation therefore relates to the need to address the issue of an absence of a corporate and cohesive approach to the discussion of issues, and the identification and development of water-related research activities. The Centre should evolve as quickly as possible a corporate policy concerning applied research on water and development issues.**

The pursuit of a more corporate approach to water-related issues does not exclude the identification of new and innovative research issues and activities from a singular disciplinary perspective, nor should it limit the role of program Divisions in developing water-related initiatives related directly to their distinct research agendas. However, given the resource constraints facing the Centre, and the broad spectrum of water-related research topics that have, and continue to obtain, Centre support, a consolidation of knowledge gained over the past decade and a half, from a wide variety of

sources, to assist in the exercise of determining the relevance and scientific and technical merit and validity of the proposal, may be called for. The Centre should, therefore, consolidate its approach to water-related research activities, building upon the efforts and experiences gained over the past several years. Given the experience gained by the Centre over the past fifteen years, and the expertise presently available in-house, it is proposed also that the Centre should consider the following as the principle elements of a program framework for the corporate water policy:

1. water resources management
2. the planning and management of urban-based water services, with particular reference to peri-urban populations
3. structural adjustment and water resources
4. community-based planning, management and evaluation of water resources and supply systems
5. the impact of water on human health
6. the socio-cultural dimension of human interaction with water
7. Institutional capacity building/human resources development

The Health Sciences Division has a rich and extensive heritage in supporting water-related research. The linkage between health and water issues is irrefutable. However, the Division should not base a decision to continue providing support to water-related issues based solely on the fact that the Division has accumulated considerable experience in the sector, nor that it has a heritage and reputation to maintain in this regard. Rather, the criteria for such a decision should be based on the need for new knowledge on water and health issues, the potential impact this will have on improvements to human health and well-being, and the comparative advantage of the Division as a contributor to this objective. As mentioned previously, there remain numerous and considerable gaps in knowledge about the relationship between many aspects of water at both the micro and macro levels, and human health and well-being. There is also evidence that many of the prevailing conditions in many developing countries that have an impact on human health and well-being are water-related. Finally, as discussed in a previous chapter, there is evidence as well that many studies that seek to demonstrate a causal relationship between particular water improvement schemes and human health are fraught with methodological problems.

Finally, the holistic approach to health-related research adopted by the Health Sciences Division supports a research agenda that would identify and critically analyze the contextual and proximate variables that explain the 'why' and the 'how' of the relationship between water and health. This fresh approach to research on water and health issues, one not encumbered by the conventional technology-focused approach, could serve to generate new and innovative knowledge about water-related issues, which in turn could serve to influence thinking and action about development issues on a wider scale. On this basis, a recommendation is made that the Health Sciences Division should continue to identify and provide support to applied research projects that focus on the relationship between water-related issues and health.

The substance of a research agenda for the Division on water-related issues is another issue reviewed in this study. While there are a host of meritorious and important health-related water issues that may deserve support from the Division, the primary program elements of a renewed water-related research agenda for this Division must have realistic expectations, and operate within the bounds of the financial and human resource limitations available to it. Hence, a recommendation is proposed, that Working within current funding limits, and given the wide range of expertise available within the Health Sciences Division, the experience and knowledge gained over fifteen years of support

to research on water-related issues, existing gaps in knowledge about current water and health issues, and the substance of emerging priority issues, the following are proposed as the primary elements of a water/health-related research agenda for the Division:

1. the development and investigation of the effectiveness of alternative approaches for the control of water-related vector-borne diseases;
2. the assessment of the health implications of water resources development activities;
3. investigations into the relationship between current agricultural production management practices, such as rice irrigation, and health;
4. investigations on the use of wastewater for crop irrigation and the implications for human health;
5. investigations into the relationship between the siting of latrines and water sources, and human health;
6. the development and testing of surrogate measures to 'health impact' for water supply interventions, for the purposes of public health policy formulation;
7. studies into the cost-effectiveness of alternative approaches to the protection of the quality of drinking water at the household level;
8. the development of guidelines for the study of hygiene practices, their impact on health, and innovative methodologies; and,
9. the examination of the cost-effectiveness of alternative institutional arrangements (community-based; government-centred) for the planning, implementation, monitoring and evaluation of water supply systems.

A related issue facing the Division is that pertaining to the visibility accorded to water within the Division's program structure. Presently, only the description of the workplan for the Health and the Environment program makes specific mention of a water subprogram. There is also the question of how this subprogram, if one is to be maintained, is defined. However, assigning a special designation to 'water' within any one program carries with it both positive and negative implications. After a review of the strengths and weaknesses associated with a distinct Water and Water Use subprogram, a recommendation is made that the Division retain this subprogram within the Health and the Environment Program, but give serious consideration to redefining its substantive research agenda to specific environmental issues. The Division should also give serious consideration making specific mention of water as one element considered for support within the defined agendas for the Health and the Community and the Health Systems programs.

As for the Centre, a recommendation is proposed that the Division consider using a roundtable discussion approach with representatives from its three programs for the review of water and health research proposals and activities, given the multidimensionality and need for a more corporate and cohesive approach to the identification and development of applied research activities relating to health and water issues.

However, before the Division can adopt a renewed research agenda, it must deal with the fate of active water-related projects, particularly those for which the research focus is outside of the focus of the Division and the expertise of in-house professional staff. Given the slate of water-related projects that remain active, the fact that several appear not to be assigned to the most appropriate program, and changes that have occurred within the Division's complement of professional staff over the past few years, it is recommended that the Division use the forthcoming Annual Staff Meeting to review the status of each project, to ensure that it is assigned to the most appropriately qualified member of the Division.

The Health Sciences Division has supported a rich diversity of issues and topics relating to water over the course of fifteen years. It has provided support to the creation and expansion of several viable research networks on water issues. Some have evolved into important mechanisms for the exchange of information on research experiences, and as means of identifying emerging issues, and innovative approaches and research methodologies. It has nurtured as well formidable multi-disciplinary research teams that transcend national boundaries. Exciting opportunities have arisen in which solid research products have been produced. Considerable momentum has been generated.

However, before the Health Sciences Division takes a decision about future financial support for projects, networks and activities supported presently, it should undertake, or commission to be carried out, in-depth reviews of their achievements, priority research issues on the topic that remain to be addressed, emerging issues, and the nature and status of research being carried out on the same topic, supported by other funding sources. Therefore, the recommendation is proposed that the Health Sciences Division should undertake, as a precursor for decisions on future support to on-going research initiatives, a comprehensive review of the status of research and development initiatives, lessons learned from these experiences, and strategies for the support of the wide-scale application of their products for the following topics:

- PVC handpump technology
- groundwater pollution from on-site sanitation facilities
- rainwater catchment systems
- wastewater treatment/resource recovery and reuse
- health/environmental impact of improvements in water supply facilities
- community-based strategies for the planning, implementation and management of water supply improvement activities.

Finally, if the Centre is to adopt a more holistic and corporate approach to the definition and implementation of a water-related policy, and given the resource constraints under which it functions presently, the Centre should utilize as effectively as possible all of the resources it possesses to its advantage. One of the comparative advantages enjoyed by the Centre is the wealth of professional qualifications and experience possessed by its program staff. To overcome the often fragmented approach that tends to characterize the approach within the Centre as relates to the development of water-related research projects, a mechanism should be adopted and implemented that draws upon the wide range of expertise found within the Centre. The Centre has experience in such mechanisms already, some more formally structured than others. However, current resource constraints and the internal environment within the Centre may not be amenable to the establishment of a formal water unit. Hence, it is recommended that **Centre management give consideration to the creation of an ad hoc Technical Advisory Group on Water Issues.**

The TAG concept builds upon the informal nature of contact among program staff already existent in the Centre. It also has the advantage of a greater degree of flexibility than a more formal 'unit' structure, and allows for maximum input from interested representatives. It would, in essence, reflect and provide a corporate perspective on water-related research issues and activities. The TAG would serve as a forum, to review research proposals for which the Centre does not have a policy, or for which there is no in-house expertise. It could make recommendations to the program Divisions as to whether the Centre should consider supporting the research, and the most effective means to review, develop and administer the resultant project. The TAG could also serve as the focal point for regional input on sector-related issues and activities.

The TAG could serve also to reinforce the Centre's intention to continue to support water-related research activities, and to communicate this message to other donor agencies. It could serve as well as a focal point for inquiries about Centre sector-related activities and opinion. The TAG could serve also to coordinate Centre representation on international councils and committees, and promote a sharing of information emanating from them to other Centre personnel, and to the regional offices. It would also serve to ensure continuity of representation, and to promote a more corporate representation of IDRC at international fora. Most importantly, through the development of a corporate policy on water-related issues, and continued active involvement by Centre personnel on international committees and at international fora, on a coordinated basis, the Centre could use its influence and reputation to guide thinking and action on issues. Therefore, it is recommended that the TAG **should meet quickly, to identify who should represent the Centre on water-related international councils and committees, and who should retain the responsibility to maintain correspondence with these and other international agencies and organizations concerning water-related issues and activities at IDRC.**

The Centre, and the Health Sciences Division, have developed a very important heritage in water-related research. The emerging trends and issues indicate that water will continue to be a major issue in many developing countries through to the end of the century. The Centre plays a unique role in the international development process, and has much to contribute. The recommendations presented in this study are designed to assist IDRC, and in particular the Health Sciences Division, to fulfil their mandates, to assist in the process of improving the standard of living and wellbeing of disadvantaged populations, in an effective manner.

## CHAPTER 1 -

### WATER IN THE GLOBAL CONTEXT

#### 1.1 Water as a physical resource

Water is one of the principal elements for sustainable development. Not only is it an essential element of mankind's sustenance, but it is critical to the production of agricultural goods and it is a basic input to industry. Its impact on mankind is paradoxical. To quote from the IDRC film *Prescription for Health*<sup>1</sup>, water is both the giver and taker of life. On the one hand, without sufficient quantities of clean water, the ability of mankind to survive and function fully is constrained severely. On the other, too much water can be a destructive force, and its poor quality undermines the well-being and very survival of humanity.

The Report of the World Commission on Environment and Development<sup>2</sup> highlights water as a critical element in influencing the direction and shape of future development activities. The Commission holds mankind's response to five water-related issues as critical to the survival of the planet:

1. the climatic anomalies during the past two decades and their deleterious impact on world food crop production, particularly in the less developed countries;
2. the search for energy alternatives to fossil fuels, and the consequences the development of large-scale hydroelectric power developments will have on the environment, human welfare, and on industrial output;
3. the impact on human well-being of the escalating demand for increasingly scarce clean fresh-water resources by agriculture and industry;
4. the consequences of pollution of inland and coastal waterways and oceans as a result of the discharge of untreated effluent from industrial, agricultural and daily human activities; and,
5. the accessibility and availability of safe water, particularly within the rapidly expanding urban centres of the less developed countries, and in recognition of the finite carrying capacity of global freshwater resources.

There appears to be a popularly held myth that clean, fresh water is an infinite resource. Fresh water is a renewable resource of finite and stable quantity. The amount available to support societal needs is only the volume of precipitation that is not returned to the atmosphere through evapotranspiration. This net residual is what feeds the world's aquifers and surface water reserves. Surprisingly, this represents less than 1% of the world's total fresh water supply, which is sufficient, in terms of volume, to sustain the earth's population.

Fresh water of requisite quality is becoming scarce. While the total volume of water on earth for all stages of the hydrosphere under different phases has been estimated to be 1380 million km<sup>3</sup>, the volume of fresh water amounts to only about 3.5% of this total.<sup>3</sup> The bulk of this lies in the glaciers and ice covers of the polar regions, or below ground at inaccessible depths.

The availability of the planet's fresh water resources is another issue, as they are distributed unevenly across space and time. While Canada possesses over 9% of global fresh water reserves, with an annual average volumetric availability of 3,000 km<sup>3</sup>, countries with populations of equal size, such as Peru and Kenya, must contend with water availabilities which are 70 and 190 times smaller, respectively. Population density, location of water resources and climatic conditions have a major

bearing on the relative availability of water across regions and among nations. The volume of surface runoff changes seasonally and annually. Variations in the spatial and volumetric distribution of fresh water resources as a result of prolonged drought conditions in several parts of the world have been well documented. Massive population movements in search of water are becoming more frequent. Water is not available 'on demand', particularly in those areas which rely on groundwater. The availability of adequate and continuous flows from drilled boreholes is dependent largely on the geological characteristics of a region. For example, Africa has a particularly difficult problem with its supply of fresh water, especially for human consumption. The African shield possesses relatively few sedimentary basins with good groundwater, and most aquifers are small and intermittent or discontinuous, making it difficult to site wells.<sup>4</sup>

Another factor which impinges on the capacity of the Earth's global freshwater resources to sustain life is the demand for water. It has been estimated that the demand on the limited water resource is increasing in geometrical proportion due to fast growing population and its insatiable needs. Global water use doubled between 1940 and 1980. It has been estimated that 73% of the total available fresh water runoff is devoted to crop irrigation, 21% goes to industry, and the remaining 6% is used for domestic and recreational needs such as drinking and washing. The demand for fresh water is expected to double again by 2000, with two-thirds of the projected water use going to agriculture.<sup>5</sup>

Yet 80 countries, with 40 percent of the world's population, already suffer serious water shortage.<sup>6</sup> Add to this the degradation of fresh water resources through an increasing propensity to dispose directly into them untreated human and solid wastes, untreated effluent from industrial activities, and runoff of nitrates and phosphates from agricultural land, and the effect of the leaching of all effluent into the groundwater system. Lvovich (1973) estimated the prevailing total global volume of freshwater runoff contaminated by industrial wastewater to be 4,000 km<sup>3</sup>/year, or equivalent to approximately 9% of the estimated total global annual volumetric runoff.<sup>7</sup> Given the general and particularly the urban population growth rates in less developed countries, and the inability of most developing countries to build, operate correctly and maintain water and wastewater treatment facilities, the prognosis for the availability of sufficient, safe water for human consumption is poor.

In fact, urbanization, population growth, industrialization and ambitious agricultural projects are rapidly polluting and exhausting surface and ground waters. Recharge rates of groundwater sources are decreasing significantly, with some aquifers dissipating quickly, and others disappearing. Water tables are dropping as a consequence. Hence, the carrying capacity of existing freshwater resources is quickly being reached. In some countries, it has already been surpassed. The economics of developing and maintaining fresh water resources is increasing. For example, Dubai, like its Arab neighbours, is driven to expensive desalination programmes or importing water to keep itself supplied. Saudi Arabia has made itself self-sufficient in grain, but at a terrible cost. Production costs are six times world market rates, and irrigation is using up approximately 90% of Saudi's non-renewable fossil water supplies.<sup>8</sup>

In the future, competition by irrigation, industry, and domestic use for water will increase dramatically. River water disputes have already occurred in several places. From Turkey to Egypt, only three river systems water the arid deserts. All of them are currently bones of contention between states already at odds. Turkey's ambitious plan to tap the headwaters of the Tigris-Euphrates is straining relations with Syria and Iraq; Iraqi villagers are already importing water by truck. Palestinians and Israelis are at odds over the Jordan and underground reserves in the West Bank and Gaza. The situation is not unique to the Middle East. It has been estimated that the uncontaminated groundwater resources of the continental United States will reach critically low levels shortly after the turn of the

TABLE 1.1

Water stress profile of African countries sharing international river basins

WATER COMPETITION CODE	NILE		ZAMBESI		LIMPOPO		CONGO		NIGER		SENEGAL	
	1982	2025	1982	2025	1982	2025	1982	2025	1982	2025	1982	2025
1			Zambia Botswana Angola	Botswana	Zaire Congo Cameroon Ctri. Africa Zambia Angola	Congo Cameroon Ctri. Africa	Cameroon Guinea	Cameroon Guinea	Mauritania Guinea			Guinea
2	Egypt Sudan Ethiopia Uganda Kenya Tanzania	Sudan	Mozambique Zimbabwe Tanzania	Zambia Botswana Angola	Mozambique Zimbabwe	Botswana	Zaire Zambia Angola	Nigeria Niger Mali Benin Togo Burkina Faso	Niger Mali Senegal	Mali Senegal	Mauritania Mali Senegal	
3	Rwanda	Ethiopia Uganda	Malawi	Mozambique S. Africa	Mozambique			Algeria	Benin Burkina-Faso			
4	Burundi	Egypt Tanzania		Zimbabwe Tanzania	S. Africa Zimbabwe		Tanzania		Nigeria Algeria Togo			
5		Rwanda Burundi Kenya		Malawi								

Water stress levels associated with competition codes:

- 1 : limited water management problems (mainly in dry season)
- 2 : general water management problems
- 3 : water stress (absolute water scarcity in dry season)
- 4 : chronic water scarcity
- 5 : beyond manageable capability

Source: Falkenmark et al (1989). *Natural Resources Forum*, 13(4), pp. 258-267



century. Conflicts over access to freshwater sources and water drawing rights are occurring in several other areas of the globe, including Europe and North America (the Rhine and the Rio Grande, respectively). In Jordan and Syria, underground water is expected to be exhausted early in the next century.<sup>9</sup>

Falkenmark *et al.* (1989) posit that three decades from now, two-thirds of the African population are likely to face severe water shortages. As a general rule, countries in semi-arid Africa will not have access to the large quantities of water required to meet their needs, increasing the risk for international conflict.<sup>10</sup> Table 1.1 illustrates the macro-scale water stress predicament in countries sharing international river basins, taking into account population growth as presently predicted. The predicated scenario does not bode well for humankind. Drastic measures to ensure the correct and timely management of available water resources is of paramount importance.

## 1.2 Water and human health

Water exerts a major influence on human health. The World Health Organization estimates that 80% of ill-health in less developed countries stems from a lack of safe water and adequate sanitation. The number of children estimated to die each year from diarrhoeal diseases world-wide is well publicized. Nonetheless, it is a sobering figure, equivalent to the total number of children aged less than 19 years of age in Canada at the time of the most recent census (1976). Though much has been achieved since the start of the International Drinking Water Supply and Sanitation Decade in 1981, 1.7 billion people continue to lack access to clean water, and 1.2 billion to adequate sanitation. Many diseases can be controlled not just through therapeutic interventions, but require improvements in water supply and sanitation services, and a modification of health-related human behaviour.

Safe and adequate supplies of fresh water have a great bearing on human health. Most of the communicable diseases which characterize the morbidity profile of those living in developing countries are water and/or waste-linked. While some water and sanitation-related diseases can be treated and prevented with simple technical interventions, such as the use of a filter to interrupt the transmission cycle of guinea worm, many others are characterized by either complex or alternative transmission cycles.

Many faecal-oral diseases, particularly the diarrhoeas and some worm infections, can be transmitted in several ways. The possibilities for transmission of faecal infective material are many and varied: it may leach or drain into a water source; hands may not be properly washed after defecation or prior to handling food; flies or other insects may act as vectors; excreta may be used as a fertilizer on crops that are eaten raw. For communicable diseases, those caused by a living agent that passes by some specific pathway from one person to another, four basic water-disease associations are recognized: water-borne; water-washed; water-based; and, water-related.<sup>11</sup>

Water-borne diseases are those whose agent is transmitted in impure drinking water. They can be prevented through the availability of safe drinking sources. Water-washed diseases occur when people practice poor hygiene, including the inadequate washing of clothes and utensils, and insalubrious conditions in the domestic environment. These, including several of the soil-transmitted helminths, can be prevented through the provision of dependable, and adequate quantities of water. Water-based diseases are transmitted via human-water contact. A necessary part of the life cycle of the infecting agent takes place in an aquatic animal. Preventive measures include reducing contact with

known infected sources, and protecting uninfected sources. Water-related diseases occur when surface water bodies provide a medium for breeding or dwelling sites for the vectors of disease agents. These ill-health conditions can be avoided through behavioural changes in human water-handling practices, and the correct management of water courses (draining/maintenance of irrigation ditches, reservoirs, etc.).

Table 1.2 provides a summary estimate of the impact of several water-linked diseases on human health and survival. Table 1.3 illustrates the linkage between certain physical properties of water, human behaviour related to water handling and excreta disposal and the important water and waste-related infectious diseases. The diarrhoeal diseases, schistosomiasis, amoebiasis and ascariasis, all of which can be reduced by improved water supply and sanitation practices, dominate the mortality and morbidity statistics. Immunizations do not address these diseases. Oral rehydration therapy (ORT), although an efficient and low cost way of curing bouts of diarrhoea, is not a long-term nor permanent solution. The administration of ORT must be repeated over and over again if the water supply remains unsafe. Safe water and hygiene practices must accompany ORT programs if child health is to be enhanced.<sup>12</sup>

TABLE 1.2			
Data on selected water-linked diseases for all ages in LDCs*			
Infection	Annual Deaths (000)**	Total Cases (000)	Days Lost*PerCase
Diarrhoea**	4,300	2,800,000	3.5
Malaria**	1,500	150,000	3.5
Typhoid**	600	35,000	14-28
Schistosomiasis	250-50	10,000*	600-1000
Amoebiasis**	70	40,000	7-10
Hookworm	50	900,000*	100
Roundworm	10	1,000,000*	7-10
Guinea Worm	1	10,000*	100
Onchocerciasis	1	17,500*	3,000

Sources: \* WHO's most recent estimates of existing cases  
 \*\* Dr. Julia Walsh, Harvard Univ School of Public Health.  
 Total cases mean yearly occurrence of the disease.

Cited in "Water as a source of sickness: a short guide" in *Source*, December 1989, UNDP, p. 19.

Consensus exists about the need for improved water supply and sanitation facilities in most less developed countries and their potential influence on human health and well-being. However, there is disagreement about the relative merits of water and sanitation versus other health programs. One World Bank publication (1975) notes there are many studies that demonstrate no causal relationship between improvements in water supply systems and sanitation facilities and improvements in health. Several of these conclude that the source of water supply for a family matters less than might be expected. The central issue which accounted for significant improvements in health were behavioural, as well as the quality of the water in household containers.<sup>13</sup> Furthermore, Walsh and Warren (1979),

TABLE 1.3

IMPORTANCE OF WATER AND SANITATION-RELATED INTERVENTIONS  
FOR INFECTIOUS DISEASE CONTROL

Disease	Intervention					
	Water Quality	Water Quantity/ Convenience	Personal/ Domestic Hygiene	Wastewater Disposal/ Drainage	Excreta Disposal	Water Management/ Handling
<u>Diarrhoeas</u>						
viral diarrhoea	**	***	***	o	**	**
bacterial diarrhoea	***	***	***	o	**	**
protozoal diarrhoea	*	***	***	o	**	**
<u>Poliomyelitis &amp; Hepatitis A</u>						
	*	***	***	o	**	**
<u>Worm Infections</u>						
<i>Ascaris</i> , <i>Trichuris</i>	*	*	*	*	***	**
hookworm	*	*	*	o	***	*
pinworm, dwarf tapeworm	o	***	***	o	**	*
other tapeworms	o	*	*	o	***	*
schistosomiasis	*	*	o	*	***	***
guinea-worm	***	o	o	o	***	***
other worms with aquatic hosts	o	o	o	o	**	**
<u>Skin infections</u>						
	o	***	***	o	o	o
<u>Eye infections</u>						
	*	***	***	*	*	*
<u>Insect-transmitted diseases</u>						
malaria	o	o	o	*	o	***
urban yellow fever, dengue	o	o	*	**	o	***
bancroftian filariasis	o	o	o	***	***	***
onchocerciasis	o	o	o	o	o	***

Degree of importance of intervention: \*\*\* high \*\* medium \* low o negligible

\* Vectors breed in water storage containers.

Source: Ballance, R.C. and R.A. Gunn, 'Drinking-water and sanitation projects: criteria for resource allocation', *WHO Chronicle*, 38(6), 1984, p. 244.

in an article that laid the foundation for a major and protracted debate about the merits of the primary health care approach, posited that investment in the improvement of community water supply facilities would not result in a cost-effective intervention. They concluded that the provision of safe and adequate water supply through public standpipes would only reduce the incidence of diarrhoeal diseases by about 5%.<sup>14</sup>

Briscoe (1984, 1987)<sup>15,16</sup> and Okun (1987)<sup>17</sup> challenge the Walsh and Warren thesis. They identify weaknesses in data and analytic procedures as explanations for the inability of studies to provide conclusive evidence of the positive contribution of water and sanitation interventions, and advance the hypothesis that improved water supply and sanitation facilities are necessary, but not sufficient, conditions for improvements in health. Both experts also point out that the long-run effect on child survival resulting from improved water and sanitation facilities is probably substantially greater than would be expected, on the basis of an assessment of the immediate effects of diarrhoeal disease.

The results of 67 studies reviewed by WHO (1985) appear to support Briscoe's and Okun's statements, indicating that improvements in water quality and quantity have a reinforcing impact on decreased mortality rates (Table 1.4). However, serious methodological flaws and questionable data collection and analysis techniques call into question most estimates of the degree of impact of water and sanitation interventions on health. As Esrey and Habicht (1985) state:

*"When all of the published studies of water or sanitation improvements are subjected to scrutiny, it becomes apparent that the true effect of such interventions remains difficult to estimate. There are a few studies that: 1) support the hypothesis that excreta disposal is more important than water interventions, 2) support the hypothesized pathway between water and sanitation improvements and better health, and 3) do not have severe flaws."*

TABLE 1.4

PERCENTAGE REDUCTIONS IN DIARRHOEAL MORBIDITY RATES ATTRIBUTED TO WATER SUPPLY OR EXCRETA DISPOSAL IMPROVEMENTS

Type of Intervention	Number of Results	Percentage Median	Reduction Range
All Interventions	53	22	0-100
Improvements in Water Quality	9	16	0- 90
Improvements in water availability	17	25	0-100
Improvements in water quality and availability	8	37	0- 82
Improvements in excreta disposal	10	22	0- 48

Source: Esrey, S.A., Feachem, R.G. and Hughes, J.M., 'Interventions for the control of diarrhoeal diseases among young children: Improving water supply and excreta disposal facilities,' *Bulletin of the World Health Organization*, 1985, 63(4), pp. 757-772.

They conclude that in developing countries, the quality of drinking water plays an important role in outbreaks of diarrhoeal disease, where the level of faecal contamination from the environment is low. In the case of water quantity improvements, impact would likely be larger when exposure is high. Personal and domestic hygiene are important correlates. The propensity of studies to calculate valid estimates of the magnitude of improved health as a result of improvements in access and availability of safe water supplies and sanitation facilities would increase significantly with an improvement in the design and analysis methodologies for water and sanitation evaluation studies.<sup>19</sup>

Recent applications of the case-control method by Briscoe *et al.* (1988) have demonstrated its validity and utility. Their sample study, conducted in the Philippines, concludes that improved water quality, quantity and sanitation interventions were associated with a 20% reduction in all episodes of diarrhoea and 40% reduction in episodes of diarrhoea caused by enteric pathogens.<sup>20</sup>

Clearly, a good water system enhances significantly the propensity for improvements in personal and domestic hygiene, and increases the probability for health benefits at both the individual and community level.

### 1.3 Water and sustainable development

Besides direct benefits to health, there are many additional benefits that are a consequence of the availability of safe, adequate sources of fresh water. These include improved economic productivity through a reduction in incapacitation of those involved in the active work force, and a decrease in the time and effort required to obtain water. Social and political benefits also accrue. The provision of improved water supplies will result in the promotion of commercial activity and increased local food production. The introduction of water and sanitation systems can also be used as a means to develop and strengthen local community institutions, and their capacity to identify, implement, and maintain other community development programs.

The Brundtland Commission states the linkage between health, development and the environment implies that health and social policy cannot be conceived of purely in terms of curative or preventive interventions, or even in terms of greater attention to public health. Integrated approaches are needed that reflect key health and social issues, including water and sanitation. In this sense, they really require a developmental solution.

As the poor populations of the world increase at a rapid pace and our finite fresh water resources become less and less sufficient and of inferior quality, the challenge to human survival must be approached in new ways. Falkenmark *et al.* (1989) prompt our imagination with the following statement: "the relevant question to ask is not how much water do we need and from where do we get it, but rather: how much water is there and how can we best benefit from it?"<sup>21</sup> The overriding challenge is to strike a balance between the needs of people in terms of their productive utilization of water, the responsible disposal of wastes and the conservation of land and water resources, so as not to jeopardize future needs. Perhaps man has to revisit the past in order to identify the path for the future. In 1983, White identified water shortage as a major constraint to development and growth, and recognized the need to take into account the social, cultural, political and economic variables that influence water use. The knowledge, capacity and political will to manage water demand, to ensure continuity in management policy and practice, to manage water resources effectively, and to place values on environmental effects and the maintenance of the quality of water resources, are the factors that are most likely to influence the course of development.<sup>22</sup>

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## CHAPTER 2

### EVOLUTION AND ACHIEVEMENTS: THE INTERNATIONAL DRINKING WATER SUPPLY AND SANITATION DECADE 1981 - 1990

#### 2.1 Water and Development Prior to the IDWSS Decade

A review of available literature from the period 1950 through to 1975 indicates a recognition of the important role water plays in national development, and the fact that access to plentiful, safe supplies of fresh water for the majority of those living in less developed countries was lacking severely. The first instance of the central place of water in development thinking, at least at the international level, appears to have originated with the emergence of the World Health Organization (1948). Water, along with sanitation, were deemed to be integral components of the process and goals of development, as outlined in the organization's Charter. In 1953, a WHO Expert Committee on Environmental Sanitation was the first international meeting to highlight an adequate supply of safe drinking water and the safe disposal of human waste as basic to an improvement in the quality of life and in the promotion and maintenance of a safe environment.

Water was included as an agent and object of development in the plans of action elaborated for the UN First and Second Development Decades for the 1960s and 1970s. The focus, though, was on the exploitation and harnessing of water resources, as inputs into increased industrial and agricultural productivity. The provision of potable water, particularly to rural communities, was not perceived as a priority activity. The supporting rationale for such a strategy centred on the argument that investment of scarce resources in the water supply sector, and especially in rural and low income subsectors, was unattractive when compared to similar investments in other sectors of the economy. As Falkenmark (1982) states, there is often negligible political return from development projects that command little, if any, attention by the media.<sup>1</sup>

Perhaps the first concrete initiative at the international level to promote investment in water as a social infrastructure development activity was that taken by Latin American heads of state in 1961. At a meeting of the Pan American Health Organization, held in Punta del Este, Uruguay, targets for coverage of the population for water supply were established for 1970. While they can be criticized as being unrealistically high (70% coverage for urban areas; 50% coverage for rural areas), they served to highlight the need for an increase in investments by donor agencies in sector activities within the region. The Ministers of Health from the Latin American region met eleven years later, in Santiago, Chile, to review progress and set new goals for the 1970s.<sup>2</sup>

During the 1970s, concern by international experts about the consequences of the development and exploitation of water resources, particularly with respect to conservation and environmental protection was increasing. This led, in part, to the creation of the International Hydrological Decade (1970 - 1979), carried out under the auspices of UNESCO. This program, the precursor to UNESCO's Man and the Biosphere program, sought to stimulate the interest of member governments in the long range planning and utilization of their water resources.<sup>3</sup>

Prior to the 1960s, the World Bank was the principal international organization co-investing in water resource development and exploitation schemes. These related primarily to industrial and agricultural development activities. During the early 1960s, the focus of the Bank's lending program began to shift. In 1961, it made its first loan to underwrite the construction of an urban water and sewerage system construction project. By the end of 1979, the Bank had provided loans for 127 water supply and sewerage projects, worth approximately US\$ 3000 millions. The projects tended to emphasize the transfer of technologies that had been demonstrated effective in temperate climate countries. Most of the projects were urban-based.



According to a survey of 90 developing countries by the World Health Organization (WHO) in 1970, 77% of the population were estimated to lack adequate water supplies.<sup>4</sup> Burton et al (1973) summed up succinctly the situation that reigned during this period:

*This does not mean they [people] have no water. It is the case, however, that in varying degrees and in many different ways, people are forced to rely upon sources that are a constant threat to their health, or which yield insufficient quantities or which are so far removed that hours each day may be spent in obtaining water for household use. In some circumstances, all three of these limitations apply simultaneously, and there are few where none of these exists . . . Lack of adequate sanitation can lead to contamination of food and by the contamination of water supplies at their source, or in transport, or in household use . . . The stark and unpalatable fact becomes increasingly difficult to accept in an age of powerful science and effective technology . . .*<sup>5</sup>

In reaction to this situation, the Planning Group on Science, Technology and Development, established by the Organization of Economic Cooperation and Development (OECD), requested a report on the existing state-of-the-art in water supply and sanitation, and an assessment of how research and development might most effectively contribute to a substantial acceleration in the rate of improvement. The task was accepted by IDRC, which commissioned the study.<sup>6</sup>

The Burton Report was to have a profound effect on consolidating thinking and action at the donor agency level. Its main conclusions remarked on the wealth of existing knowledge and experience pertaining to water supply and sanitation technologies, but highlighted the lack of experience with the application and adaptation of these same technologies to developing country situations. The report also stressed the need to examine beyond technology and hardware, to include research on a wide range of factors, including economic, financial, social, political, behavioural, health, management and administration, education and human resources development.

Professor Burton and his colleagues also recommended the establishment of a '20-year program aimed at bringing improved water supply and sanitation to 95% of the population in rural areas by the end of the century'.<sup>7</sup> As a precursor, the report suggested the creation of a Task Force, the purpose of which would be to formulate an agenda for applied research and development. It would be comprised of representatives of the major donor agencies and experts in the field of water and sanitation. What was revolutionary was the call for a substantial representation from developing countries.

Following on the OECD meeting, and at the suggestion of several individuals, a meeting was convened by UNDP, IDRC and the OECD. It was held in Montreal in April 1974. Representatives from WHO, the IBRD, UNICEF and UNEP were invited to attend. The outcome of this meeting was a decision to strike an Ad Hoc Working Group on Rural Water Supply and Sanitation (AHWG), and to establish a trust fund to support financially the preparation of special studies by consultants, and future meetings. The trust fund was administered by WHO.

The first two meetings of the AHWG saw the establishment of two expert panels. The first, known as the Technical Panel, had as its objective to prepare a report on the technical problems to be met in the improvement of water supply and sanitation programs. The other, the Institutional Panel, was charged to examine the institutional arrangements that could be effective in implementing and supporting an expanded international effort to address pressing sector issues.

The Technology Panel supported the recommendations made by Professor Burton and his colleagues. It concluded that:

*The application of technology can only be achieved if the support systems are vastly improved. Support systems are the legal, economic and institutional backing that facilitate (needed to carry out national programs). Research is needed in relation to different methods of management of the operation and maintenance services, different rating and financing procedures, different systems of scheme selection, and local participation. The planning of water needs, from the outset, to integrate social, economic and legal aspects with the technological aspects.*<sup>8</sup>

The Institutional Panel recommended the establishment of a network of information centres at local, national and international levels, to promote and facilitate the exchange of information and dissemination of research and development activity results. These centres would also serve to train developing country project/programme designers and implementors, and to produce timely information and materials to promote new strategies to address pressing sector issues.

The AHWG, through its periodic deliberations, recommended the establishment of a more formal structure and process, to review progress in sector activities, and to promote coordination of activities among donor agencies. A proposal was also tabled for the creation of an independent interdisciplinary secretariat, to work on programme development. The secretariat would be responsible directly to the AHWG, appointed by it as well as funded by it. WHO would be responsible for its administrative and logistical support. However, reaction by several bilateral agency representatives to a request for additional financial support for the continuing activities and programme of the AHWG was cool. Additionally, there was resistance by WHO to agree to the establishment of a secretariat, if it were to have an independent status.<sup>9</sup> These events jeopardized seriously the continued effectiveness of the AHWG.

In terms of chronology, the next event to have a profound impact on thinking and action concerning the water sector was the United Nations Conference on Human Settlements (HABITAT). Two women, Barbara Ward (a member of IDRC's initial Board of Governors) and Margaret Mead, were responsible for crystallizing attention and pushing for a focus on drinking water (and sanitation) as integral to the development process.<sup>10</sup> This Conference produced five recommendations for action in this regard:

1. the establishment of realistic standards for water quantity and quality for urban and rural areas by 1990;
2. the promotion of the role of popular participation in sector planning and decision-making;
3. the integration of water supply and sanitation as part of the national planning process;
4. the need for improved harmonization/coordination of interest and efforts of local, regional and national governments; and,
5. a promotion of better consumption, recycling, reduction in waste, taking into account the environmental impact of development activities.

HABITAT would become known as a landmark activity. For the first time, the roles of popular participation and the role of women were accorded recognition; there was a call for increased and improved agency and institutional cooperation; and, drinking water supply and sanitation were perceived as having environmental impacts. Investment in the development of water resources for production-related exploitation needed to be tempered with a recognition of the externalities of such activities.

By 1977, and based partly on the recommendations emanating from HABITAT, donor agencies were becoming increasingly aware of the constraints to achieve an improvement in the coverage for water supply to disadvantaged populations. These included:

1. conventional engineering approaches to water supply system development that were too expensive and often inappropriate;
2. maintenance of existing systems was negligible, due to a lack of knowledge on the part of local agencies of repair procedures, lack of spare parts and the foreign exchange required to purchase and import them, and for institutional arrangements and procedures;
3. most of the investment by donor agencies was skewed towards the urban sector, despite the fact that the majority of people in less developed countries lived in rural areas;
4. the existing spatial distribution of water supply systems favoured significantly the higher-income groups; and,
5. while availability of water supply and sanitation facilities had been improving during the two previous decades, the proportion of the world's population with relative access to improved services was increasing slowly. However, the global population growth rate exceeded that for "population covered" by water supply facilities. The actual number of unserved people in developing countries continued to increase.

The conclusion drawn was an urgent need for an alternative and concerted strategy to meet the challenge of ensuring that all had reasonable access to clean fresh water sources.

The first UN-sponsored meeting devoted entirely to the subject of water supply was convened in Mar del Plata, Argentina, in 1977. More than 1500 representatives of 166 governments and many international organizations attended. The output was an action plan that called for the creation of an International Drinking Water Supply and Sanitation Decade, to extend over the period 1981 - 1990.<sup>11</sup> The Mar del Plata meeting drew attention to the need for a more rational and scientific approach to planning and project implementation for sector projects. It prompted governments to establish realistic goals for coverage in both rural and urban areas, and to concentrate investment and development efforts on the underserved.<sup>12</sup>

The Conference served also to identify several constraints, from the point of view of both major donor agencies and governments present, that impinge on their capacity to improve and increase

UN Conference on Human Settlements  
HABITAT  
Vancouver, 1976

Recommendation C12:

Safe water supply and hygienic waste disposal should receive priority with a view to achieving measurable qualitative and quantitative targets serving all the population by a certain date; targets should be established by all nations and should be considered by the forthcoming UN Conference on Water.

UN Conference on Water  
Mar del Plata, Argentina  
March 1977

All peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs. Similar considerations apply to all that concerns the disposal of waste water, including sewage, industrial and agricultural wastes and other harmful sources, which are the main task of the public sanitation systems in each country.

Source: *Yearbook of the United Nations 1977*,  
Volume 31 (New York: United Nations,  
1980), p. 555.

access to and the availability of potable water supplies. These included: promoting an increase in public awareness both in less developed and industrialized countries of the need for increased investment and activity in the sector; an increase in government commitment to funding and development activities; an increase in the quantity and quality of trained people for planning, building, operating and maintaining water supply systems; and, overcoming the lack of what was termed 'appropriate technology'.

It set out a series of nine recommendations, to guide international donor agencies and national governments alike in elaborating programmes designed to achieve the goal established at HABITAT. Primary among these was a call for increased collaboration and coordination of

activities among donor agencies, the need to promote and foster more actively technical cooperation among developing countries, and the development and use of a clearinghouse mechanism for information relating to all aspects of water supply and sanitation. There was also a recommendation that parties involved in water supply development/improvement activities, from the community through to the international levels, hold regular consultative meetings as a means of accelerating and coordinating initiatives and activities.

The conclusions and recommendations of the HABITAT and Mar del Plata meetings served to rekindle interest within the AHWG, to identify mechanisms for achieving the challenge of 'Water for All'. The report of the Task Force, established by the AHWG in 1976 to provide guidance as to possible mechanisms and strategies, proposed the creation of a steering committee, to be composed of the representatives of the five organizations that constituted the initial AHWG (WHO, UNDP, IBRD, UNICEF and IDRC). The primary purpose of this steering committee, which would replace the AHWG, and its ancillary support unit, would be to assist and support national task forces responsible for defining plans and strategies for achieving the goals of the proposed Decade. Due to a lack of support by a majority of the AHWG members, the Task Force recommendation was rejected. One of the principal arguments against it was that the structure proposed was unnecessary, as the same results could be achieved by building on existing collaborative mechanisms, such as the joint WHO/IBRD programme.<sup>13</sup> As a result, the AHWG was dissolved. This marked the beginning of a period of several years during which IDRC would either decline, or not be invited, to participate actively in meetings of multilateral and bilateral agencies that sought closer collaboration and development of a common strategy for the Decade.

Further support for the inclusion of drinking water supply as a specific element of community development, and in particular, as an essential component of primary health care, was provided at the International Conference on Primary Health Care, held in Alma Ata (USSR), in 1978. The Global Strategy for Health for All by the Year 2000 identified infectious and parasitic diseases as the primary cause of death in developing countries, highlighting limited access to safe water supplies as one of the most important constraints to achievement of good health.<sup>14</sup>

In 1980, several events occurred which set the stage for the creation of a special decade to highlight water supply and sanitation development activities. In the early part of the year, the Secretary-General of the UN set before the Economic and Social Commission two reports: one dealing with water

resources policy and planning; and the second, with the status of water supply and sanitation services in less developed countries.

The first report presented proposals to promote planning techniques and procedures and policy formulation for water resources development and management in developing countries. It envisaged interdisciplinary missions, which would assist governments in formulating water policies, in establishing legislative and administrative arrangements, and in elaborating national master plans and programs. The second report, based on the results of information supplied by the governments of 74 countries, contained details of current levels of investment in the sector, the degree of coverage for water supply and sanitation services in rural and urban areas, and expected targets for the forthcoming Decade.

In June 1980, the UNDP prepared a report that outlined the mechanisms to achieve Decade goals. At the national level, governments would establish national action committees to deal with water supply and sanitation development activities. The UNDP resident representatives were to coordinate these activities with technical support teams composed of UN experts. At the international level, a steering committee for co-operative action, composed of representatives of several UN organizations involved or interested in water and sanitation initiatives would be established.<sup>15</sup>

The role of women in the provision of water and management of water sources, and the particular burden inaccessible sources and adequate supplies of safe water present to this sector of society, was highlighted at the World Conference of the United Nations Decade for Women, held in Copenhagen in July 1980. This served to underline the need for urgent action to improve access to and the availability of safe fresh water, as a means of decreasing the social, economic and health burden placed on women.

On November 10, 1980, at the 35<sup>th</sup> Plenary Meeting of the UN General Assembly, by Resolution 35/18, the period 1981 - 1990 was proclaimed as the International Drinking Water Supply and Sanitation Decade. Member states would be expected to commit resources to bring about a substantial improvement in standards and levels of service to their respective populations by 1990. The Resolution called on governments "to develop policies and establish targets to this end, to take steps for their implementation, to set sufficiently high priorities for these activities and to mobilize adequate resources".<sup>16</sup> The focus for the next ten years rested squarely on drinking water supply. Water for all by the year 1990 was the challenge; it remained to be seen whether the goal was realistic and could be achieved.

## 2.2 International Mechanisms to Respond to the IDWSS Decade

The magnitude of the task defined for the Decade was enormous. Based on information supplied by 75 developing countries to the World Health Organization in 1980, the preliminary estimates indicated that:

- one out of every four urban residents was without adequate and safe water supply; and,
- two out of three rural dwellers were without adequate and safe water supply.

The goals set for the Decade at its outset were ambitious: 100% coverage for both urban and rural populations by 1990. The global plan envisaged that the majority of those living in urban centres would be served by household connections, the remainder with public standposts. Those living in rural

areas would be served by public standposts and improved point source systems. To achieve these goals, a massive human effort and financial investment would be required. An early estimate of the investment required per year over the course of the Decade equalled US\$ 30 billion (1978 dollars).<sup>17</sup>

As set out in the Report of the Secretary-General of the United Nations, the organization and implementation of Decade activities was to be coordinated by agencies within the UN system. A Steering Committee was formed, to be under the chairmanship of the UNDP. It would be composed of representatives from 11 UN organizations. WHO, through its Global Promotion and Cooperation for Water Supply and Sanitation Program (GWS) of the Environmental Health Division, was to act as the secretariat for the Committee.

UNDP was an important source of funds for development projects, having the advantage of in-field personnel in all developing countries. WHO's role paralleled that which it assumed as coordinator for developing strategies to attain the goal of HFA2000: the promotion of support for the goal of water for all by the year 1990 among policy makers at top government level, among professional groups in the health and related economic and social sectors, and among the general public; the coordination of the development of strategies and programmes at the operational level among countries and agencies; the development of an information bank to facilitate the exchange of data among countries and agencies concerning policies, strategies and programmes in the sector; the provision of technical advice on Decade activities and strategies; the encouragement of technical cooperation among developing countries; and, the coordination of agency activities through periodic meetings and other information exchange mechanisms.

The World Bank would play an important and dominant role during the course of the Decade. Not only was it a member of the Steering Committee, given its leading position as a lender to developing countries for water sector development activities, but many technical reports and feasibility studies relating to water supply and sanitation services in developing countries had already been carried out under its auspices and guidance. Two years prior to the start of the Decade, UNDP and the World Bank established a cooperative program, to develop the technologies and delivery systems needed to promote the extension of services to low-income groups. Its initial focus was on the development of handpump technologies for rural water supply, and on the acceptance of on-site sanitation through improved latrine designs.<sup>18</sup> The Bank would continue to play a primary role in establishing developmental priorities throughout the next ten years.

The Steering Committee was to meet bi-annually, to review progress in Decade activities and programmes, and to assign specific tasks to member agencies. Five task forces were convened to develop strategies and guidelines for subsector issues: human resource development; public information; technical information exchange; development of project preparation; and, women and the Decade.

By 1983, it was evident that progress in achieving Decade goals for coverage was slower than anticipated initially. Serious doubts were being raised regarding the capacity and ability at both the

UN Steering Committee for Cooperative Action  
IDWSSD

United Nations Development Programme (UNDP)  
World Health Organization (WHO)  
United Nations Children's Fund (UNICEF)  
International Labour Office (ILO)  
United Nations Environmental Programme (UNEP)  
Food and Agricultural Organization (FAO)  
The World Bank (IBRD)  
United Nations Educational and Scientific  
Organization (UNESCO)  
United Nations Department of Technical Cooperation  
for Development/United Nations Department of  
International Economic and Social Affairs  
(UNDTCD/DIESA)  
United Nations Centre for Human Settlements (UNCHS)  
International Research and Training Institute for the  
Advancement of Women (INSTRAW)

national and international levels to respond quickly and adequately to the needs of the decade, and to the achievement of its goals. Hence, in June 1984, WHO convened a meeting of representatives of the six regions of the world and from several UN organizations. Its purpose was to review the global situation, to identify constraints to progress, and to recommend adjustments to Decade goals and strategies. The results of an analysis of data compiled from the responses of 87 countries concerning the most pressing and urgent constraints to progress indicated that the highest ranking and most frequently cited were:

- scarcity of qualified personnel at all levels;
- limited funding available under the national budget and difficulty in obtaining soft loans and grants;
- lack of effective organization among the various ministries, agencies and other entities with sector responsibilities; and,
- lack of knowledge about groundwater resources. This leads to a preferential use of surface waters, and more costly and difficult water treatment requirements.

From the donor agency perspective, the primary constraints were: the importance of adequate institutional capacity; the lack of attention to operation and maintenance issues; the non-use of appropriate technologies; and the lack of adequately trained and sufficient sector personnel. The rank ordering of constraints identified differs between donor agencies and national governments. This may be a result of a difference in perception as to the primary objectives of the Decade, and the bottlenecks that impinge on progress towards their achievement.<sup>19</sup>

It was also becoming increasingly evident that a lack of cooperation and collaboration among donor agencies was another constraint to progress towards achieving Decade goals. There was a significant amount of duplication of effort, competition for projects, perceptions of 'territoriality' and 'ownership' of particular research and development agendas and initiatives, a reluctance to share information and to learn and build upon the experiences of other agencies, and, a reluctance to value equally the research and development efforts based at developing country institutions. The perception that the development of Decade strategies was dominated by and restricted to UN organizations was increasingly shared by several bilateral and research agencies, and non-governmental organizations.

The first formal meeting between the representatives of bilateral donor agencies and UN system organizations involved in Decade activities took place in 1984. This was followed by a second meeting in Paris the following year, sponsored by the OECD/DAC. These meetings were crucial in setting the stage for further meetings designed to promote closer collaboration among donor agencies concerning Decade activities.

In October 1987, the first of what were to become known as the Collaborative Council meetings took place at Interlaken (Switzerland). The meeting was attended by 56 delegates representing 30 multilateral, bilateral, and research agencies, and non-governmental organizations. Its primary objective was to identify strategies to strengthen collaboration and cooperation among donor agencies. The outcome of the meeting was threefold:

- the elaboration of a framework for global cooperation *Beyond the Decade*. The meeting proposed that a Collaborative Council of External Support Agencies be established. Its purpose would be to coordinate accelerated and expanded sector activities through to the year 2000. The secretariat for the IDWSS Decade Steering Committee would continue to serve to support the Council's needs. Membership would include representatives from multilateral and bilateral agencies, and would include research institutes and NGOs. Using the existing UNDP/World Bank programme as a focus, the Council's activities would expand beyond water supply,

sanitation, and hygiene education, to encompass other environmental issues (wastewater reuse, solid wastes management, drainage, hazardous wastes management). The aim would be to assist developing countries to formulate sector strategies, based on previous experiences gained through research and development project activities.<sup>20</sup>

2. the elaboration of an action plan for participating agencies. The meeting outlined a series of specific actions that could be taken by ESAs to ensure that concepts and strategies agreed as essential to success are implemented in developing country programs.
3. the amplification of global sector concepts: six issues were identified as central elements to be considered in the planning of developing country strategies and programs for IDWSSD and beyond: institutional and human resources development; cost recovery; balanced development; operation, maintenance and rehabilitation; community participation and hygiene education; and, coordination and cooperation.

Two follow-up meetings were held in 1988: the first in November, in The Hague (Netherlands), co-sponsored by the Dutch Directorate General of International Cooperation (DGIS) and WHO; and the second in December, hosted by the French Government in Paris. The Hague meeting was attended by 54 participants and 12 observers, between them representing 40 ESAs and including 2 representatives from developing countries (Tanzania and Ghana). It sought to formalize the outcome of Interlaken and subsequent discussions among ESAs, through the establishment of the Collaborative Council. The primary aims of the Council are:

- to raise international awareness of the need for intensified efforts to expand water and sanitation coverage during the 1990s;
- to achieve collaboration among ESAs within the countries in which they are active;
- to serve as a forum for exchange of information on achievements, sector strategies, projects and programs, and analysis of issues and needs, to alert members to opportunities for collaboration and support; and
- to mobilize support from members and others in the international community for development of the sector, including support for proposals emanating from Country-level, Intercountry and Global Consultations.

Membership of donor agencies was encouraged. Although not a decision-making body, the intent for the Council is that it serve in a guiding capacity for donor agencies, and as a means of increasing the visibility of the Decade and its associated activities.

The meeting participants identified as well three major components of a Work Programme for the Collaborative Council:

1. Country-level Sector Support: by matching ESA interest in providing support *with government priorities*, to assist developing country governments to coordinate sector support (emphasis placed on governments - very 'top-down').
2. Communication of Information: to help raise the profile of the water and sanitation sector, to assist developing countries to take maximum advantage of available experience, and to support improved collaboration among ESAs at national and international level.



3. Applied Research: to see that all outstanding research issues are addressed in a coordinated and efficient way, making best use of the resources already provided by various ESAs. Participants agreed to the establishment of a core membership in a Temporary Working Group on Applied Research. The terms of reference for this TWG were defined as well.<sup>21</sup>

To assist in the development of strategies for the sector in the 1990s, the Collaborative Council called on the Secretariat, provided by WHO, to organize periodic meetings of a temporary committee, to be known as the 1990 Committee. It would be comprised of a subset of members of the Collaborative Council, and invited representatives from other agencies and developing countries. This Committee was charged with three main functions:

- assistance to developing countries and ESAs in the organization of preparatory activities for a Global Consultation in 1990;
- preparations for maintaining the momentum of the water supply and sanitation sector beyond 1990; and,
- consideration of temporary working group reports on the Council's work program and transmission of the recommendations to Council members.

At the invitation of the French Government, the Secretariat called the first meeting of the 1990 Committee in Paris in December 1988. The meeting was attended by 28 participants, representing seven multilateral agencies, five bilaterals, and three NGOs, with two representatives from developing countries (Côte d'Ivoire and Morocco). The outcome of the Paris meeting was agreement on: the role of the Secretariat and the Collaborative Council Chairman, their resource requirements, and pledges by several ESAs to support financially their activities; the establishment of a timetable of events for the Collaborative Council's work; a broader perspective for post-Decade activities, taking into account the influences on and of the environment, with particular reference to the *Report of the World Commission on Environment and Development (The Brundtland Report - Our Common Future)*; support for periodic and regular regional Inter-Agency Round Tables on Water Supply and Sanitation, at which specific regional initiatives for action to improve the coordination and the effectiveness of sector support activities would be identified, discussed and approved; and, the establishment and definition of terms of reference and membership in the Temporary Working Group on Communication of Information.<sup>22</sup>

The next 1990 Committee meeting took place in Geneva in late May 1989. Participants had received prior to the meeting draft reports of the two TWGs, a report on the informal regional meeting on Water Supply and Sanitation Beyond the Decade, hosted by the Asian Development Bank in Manila in March 1989, and a proposal from the Secretariat for future administrative arrangements. Besides endorsing the content of and approving the TWG reports, the participants also undertook two landmark decisions:

1. there was agreement that developing countries were under-represented in Collaborative Council meetings, particularly if substantive issues relating to developing countries were to be discussed. ESAs were encouraged to finance the participation of developing country experts (government officials, academics, NGOs) to future collaborative meetings; and
2. agreement was also reached that the role of international and national NGOs was central to the success of WSS activities. NGOs had found it difficult to achieve adequate representation in 1990 Committee discussions, partly because of the quota of three NGO representatives set at the Hague meeting, and partly because there is not yet any established way of communicating

within the NGO community. The Chairman, in consultation with the British-based NGO WaterAid, is charged to determine the most appropriate means of encouraging and acknowledging NGO representation.<sup>23</sup>

The next meeting of the Collaborative Council was held in Nice, France in November, 1989. The meeting was attended by more than 100 participants. For the first time, representatives of developing country indigenous NGOs attended and participated actively at a meeting of the Collaborative Council. Its purpose was to present proposals for activities designed to lead to more effective expansion of water supply and sanitation services in developing countries in the 1990s. The consensus among meeting participants was that applied research is a prerequisite to large-scale service projects, and, that in the past, the level of cooperation and collaboration among the external support agencies was very low. The consequences of this lack of collaboration among ESAs are several: duplication of resources and activities, counter-productive competition and territoriality (ownership of research), a deficiency in building on experiences learned from previous research projects, more failures than successes, and confusion on the part of recipient governments and communities as to the technologies to be used and methods to promote and sustain the process of community development.

To mark the completion of the International Drinking Water Supply and Sanitation Decade, a 'global' Consultation on water and sanitation issues was held in September 1990. The venue was New Delhi, India. It served to review the Decade's achievements and failures, to identify remaining and new issues to be addressed, and to chart a course of action for the next ten year period. The meeting is of note, for the substance of its output, known as the New Delhi Statement, was debated and challenged by many representatives of developing country governments and non-governmental organizations. The changing role of government, from that of a provider, to that of a facilitator and promoter of change, was encouraged. The increasingly important role of non-governmental organizations in the planning, implementation and evaluation of water-related initiatives was recognized as well. Support was also registered for a broadening of issues that should receive attention over the next ten year period, to include integrated water resources management approaches and water quality issues.

One issue that remained unresolved was who controls the research and development activity agenda. Although there was general acceptance for more input by developing country activists in the planning and implementation of water related activities, external support agency representatives attending the meeting appeared reluctant to devolve control for such activities to their developing country peers. The deliberations of the Collaborative Council are an example of this situation, for while there was support for an expansion of the Council's membership, to include representatives of developing country governments and non-governmental organizations. But, despite good intentions, the perspectives of the multilateral and bilateral organizations will continue to predominate.

The aim of the New Delhi meeting, which marked the first dialogue on a large scale between ESAs and representatives of developing country governments and NGOs, was "to establish agreement on the basic principles for providing water supply and sanitation services in the wider context of community/national development and environmental sustainability".<sup>24</sup> In this regard, the meeting was a success. While concrete action emanating from the New Delhi meeting remains to be seen, there appears to have been a definite shift in understanding and political commitment to new and innovative administrative arrangements and mechanisms to meet the challenge that remains: that of providing clean, adequate and accessible water to the majority of the world's population by the year 2000.

### 2.3 Expectations and Achievements of the Decade

The original expectations of international organizations and national governments for the Decade were over optimistic and unrealistic. Donor agencies and LDC governments believed that the goals set for the Decade could be achieved, despite the burgeoning populations and lack of water supply systems/facilities at the start of the Decade, if only sufficient financial investments to the sector were committed. In retrospect, several factors can be identified as having a significant impact on the capacity of the Decade to achieve its predefined targets:

#### 2.3.1 The Impact of Demographics on Decade Activities

The targets established at the outset of the Decade for coverage of urban and rural populations were based on demographic information on developing countries and economic expansion indicators from the 1960s and early 1970s, and data concerning the status of water supply systems and facilities assembled by the World Bank and WHO in the early 1970s. Although revealing, the statistical data were less than complete, inaccurate, and based on information from questionable sources. The limited capacity of LDC governments to collect and analyze demographic census data at this time is a fact acknowledged by most experts and international bodies. The data provide estimates of dubious accuracy. Additionally, few governments had precise knowledge about the status of water supply systems. At best, they may have been in a position to provide data concerning the number and location of recent water supply facility construction projects. However, given the lack of water sector maintenance departments, it is doubtful governments would be able to determine which water systems/facilities were functional and providing safe and adequate supplies of fresh water.

As mentioned previously, the initial Decade target was to achieve 100% coverage for improved water facilities to both urban and rural populations by 1990. Taking the demographic information supplied by developing country governments as the base, and given the growth rates of urban and rural populations over the ten year period 1980 - 1990, the initial estimates made by experts at the World Bank indicated that the urban population to be served would more than double (from 320 to 710 million) and the rural population to be served would treble (from 140 to 413 million).<sup>25</sup>

By 1983, it was evident that the quantitative targets relating to the number of people to have reasonable access to improved water supply facilities were not to be achieved. A special WHO-supported analysis of the situation in LDCs during the first three years of the Decade indicated that the number of additional people to be served had been underestimated. The report indicated that in order to attain the targets set by national governments for coverage for water supply, the countries which responded to the WHO survey (55 reporting countries, excluding the People's Republic of China) would have to construct by 1990 new facilities to serve an additional 1 billion new beneficiaries. As a result, global Decade objectives were lowered to 95% coverage by improved water systems/facilities for urban areas and 85% for rural areas.

In 1985, WHO published the results of a second analysis of data supplied by member states, as a mid-Decade review. The report was based on data supplied by eighty-seven governments concerning the status of water services at the start of the Decade and the results of a subsequent survey carried out in 1983, to which ninety-four member states replied. These countries represented over 80% of the developing country population, excluding the People's Republic of China. This study concluded that:

- 77% of urban residents have access to safe water services as compared to 72% in 1980. Of these, approximately 80% are served by household connections; and,
- 36% of rural dwellers have access to safe and adequate water supply as compared to 31% at the start of the Decade.

The study was based on two assumptions: that the data supplied by member governments was accurate and complete; and, that the rate of implementation during the first three years of the Decade was sustained up to the end of 1985. As discussed previously, the validity of the first is open to serious debate. As to the second, it is an assumption of faith rather than fact.

The report hypothesized, based on the assumption of a constant rate of progress over the remainder of the Decade, that the anticipated coverage of urban and rural populations during the ten year period would benefit an additional 550 million people. However, this would be less than the targeted number of new beneficiaries, and meant that the number of unserved people at the end of the Decade would still be greater than the number of those without reasonable access to safe water supplies at the start of the Decade.<sup>26</sup> The report provided the following statement as a conclusion:

*... if means could be found to accelerate programmes to the extent that Decade targets are attained, the number of people with water supply and sanitation during the remaining five years should be 1,150 million and 635 million respectively; only about 350 million would be left without water supply and about 1,340 million without sanitation. The targets set by countries at the start of the Decade ... may [have to be reassessed and readjusted] in light of the current situation ...* <sup>27</sup>

The Report of the Economic and Social Council concerning the achievements of the IDWSS Decade, released in July 1990, indicates that, although progress was realized in terms of the number of people served in both the urban and rural sectors over the course of the Decade, the number of people unserved in 1990, based on the data supplied by developing country governments to UNDP in 1989, exceeds the number of people estimated as unserved ten years earlier (Table 2.1)<sup>28</sup>. Estimates through to the end of the century indicate that, although on a global basis the number of people unserved by water supply facilities in rural sectors can be expected to decrease significantly, the situation in Africa can be expected to deteriorate from the estimates for coverage for 1990 (Table 2.1). The situation in the urban centres of developing countries is expected also to worsen, with the number of people unserved by water supplies almost doubling between 1990 and 2000. In fact, on a global basis the proportion of the urban population expected to have reasonable access to water supply sources by the end of the century is estimated to be the same as that for 1980 (77% of the total urban population). The situation for the rural global population is considerably better. It is expected that the proportion of rural people who will have reasonable access to improved water sources will increase from 30% in 1980, to almost 90% by the year 2000. A formidable challenge remains for coverage in the urban centres and in Africa. Partly as a consequence of the recognition that the coverage targets set for 1990 have not been achieved, and may have been unrealistic, the goal of 'water for all' has been deferred to the year 2000. However, given the estimates for coverage by region for water supply facilities, even this may be an overoptimistic goal.

Perhaps the primary shortcoming of the Decade was the desire of donor agencies and politicians to see significant results quickly. The focus of attention for Decade activities was the rural sector. This, in reaction to the burgeoning rural populations, and the emphasis placed on the development of social service infrastructures in urban areas during the two previous decades. At the

TABLE 2.1

SERVICE COVERAGE IN 1980  
WITH ESTIMATES FOR 1990 AND 2000  
FOR WATER SUPPLY

	Served (in millions)			Unserved (in millions)		
	1980	1990	2000	1980	1990	2000
<u>GLOBAL</u>						
Urban	720.7	1088.5	1456.3	212.7	243.7	445.8
Rural	690.3	1669.8	2649.3	1612.7	998.7	321.5
<u>AFRICA</u>						
Urban	99.4	176.2	253.0	20.4	26.3	79.5
Rural	109.8	172.0	234.3	223.0	237.6	262.3

Source: United Nations, *Report of the Secretary-General: Achievements of the International Drinking Water Supply and Sanitation Decade 1981-1990*, Report of the Economic and Social Council to the 45<sup>th</sup> Session of the United Nations General Assembly, A/45/327, 13 July 1990, p. 20.

start of the Decade, the estimates used translated into an additional 1570 million rural dwellers having reasonable access to safe water supply in 1990 than in 1980. But, as Abel Wolman (1985) points out in a review of Decade activities, much of the industrial northern world's rural population still waits for reasonable access to safe and sufficient water supplies. The pursuit of a vast improvement of services for small, scattered populations demands a significant time frame and patience.<sup>29</sup> The goals of the Decade took neither into consideration.

### 2.3.2 Financial Investment in Decade Activities

The levels and rate of growth of financial investments in the sector were much less than expected. The estimated cost of achieving Decade targets for coverage varied, according to the source. One quotes a base financial investment requirement of US\$ 100 billion<sup>30</sup>, another US\$ 208 billion<sup>31</sup>. By 1983, the Bank had revised its estimate upwards to US\$ 800 billion<sup>32</sup>.

The total amount of external resources devoted to the sector rose dramatically during the 1970s. In 1978, total investment by national governments in LDCs and loans and grants by donor agencies for sector projects totalled US\$ 7 billion. By 1981, this had increased to US\$ 10 billion.<sup>33</sup> The UN agencies took the lead by dramatically increasing their allocation to sector activities from US\$ 7.7 million in 1973, to just over US\$ 104 million ten years later.

But the Decade started when the world economy was in one of the most serious recessions since the Great Depression. Data for the period indicate a reduction in investment in sector activities by several major donor agencies over the first three years of the Decade. The high investment levels recorded during the latter half of the 1970s levelled off quickly during the first few years of the Decade, to about US\$ 2.1 billion annually. For example, the UNDP reduced its allocations to the sector from \$14 million in 1980 to just over \$6.5 million in 1982. Between 1983 and 1987, UN allocations have declined to US\$ 80 million.<sup>34</sup>

At the World Bank, loans for water supply and sanitation activities during the latter part of the 1970s increased on a yearly basis, to a high of US\$ 894 million in 1979. Then, from 1980 through to 1982, the value of loans to LDCs for sector activities decreased to US\$440 million.<sup>35</sup> Although the Bank produced estimates showing an expectation of an increase in investments into sector activities over the next 5 year period (in fact, sector lending by the Bank reached a high of US\$ 970 million in 1987), information from it and other donor agencies indicated a serious shortfall in the expected investments available to the sector for the Decade. A survey of 11 of the 24 OECD countries illustrates that, although current dollar values of commitments to sector activities increased since the start of the Decade, the constant dollar value has in fact declined (Table 2.2).<sup>36</sup>

TABLE 2.2

FUNDING FOR WATER SUPPLY AND  
SANITATION ACTIVITIES  
1981 - 1988  
(millions)

Year	Dollars Committed	Constant Dollar Value (1981 base)
1981/82	1,250	1,250
1983/84	1,800	1,900
1985/86	1,800	1,825
1987/88	2,300	1,700

Source: 'Donor Dollars go further as agencies push cost effectiveness,' *Source*, September 1989, p. 21.

The amount of funding available from national governments for water supply projects has not been anywhere near sufficient to meet the needs. In many cases, funds have not been made available for spare parts and maintenance of systems already constructed, especially during times of economic difficulties. The result is that a large percentage of systems have gone out of service. Even when the systems operate, the experience is that water supplies alone have not lead to the expected improvements in health because hygiene and water use practices were not improved.<sup>37</sup>

### 2.3.3 Capacity of National Governments to Undertake and Achieve Decade Expectations

At the Mar del Plata meeting, governments had supported enthusiastically the need to elaborate national coverage targets and detailed strategies and action plans in the water sector. The WHO information system revealed that at the start of the Decade, only 9 countries had indicated that Decade plans had been developed. By 1983, 26 countries had established firm Decade targets and 39 others were 'thinking about it'.<sup>38</sup> This figure fell short of the expected number of governments to have established targets and plans.

The scale of the problem and the priority given by national governments to water supply facility development are significant factors. As previously illustrated, the number of additional people targeted to benefit from improvements in water supply facilities during the Decade was immense. The financial and human resources required to plan, implement, monitor and maintain these services were immense. However, water supply in many countries did not rank as high in priority as larger problems confronting national governments. Additionally, the scarcity of resources, both local and international, exacerbated the situation.

The reliance on governments to develop and implement solutions was ill-founded. The primary focus of the Decade was placed on national governments, to be the primary body responsible for the planning, implementation and maintenance of water supply facilities. Little or no regard was given to the constraints facing most governments to assume these responsibilities, nor the potential role of non-governmental organizations and the private sector.

As Kia (1984) remarks, from a review of eleven Decade plans and preplans, little of substance changed in the ways plans were developed and sector programs implemented over the first three years of the Decade:

*The plans generally serve to provide drinking water and do not look to the other components required to ensure a better health impact; decentralization is noted but the mechanisms are not spelled out; components (urban water supply, health, education) are usually the domain of customary government bodies, with superficial appeal for cooperation and integration; collected data and plans are partial to urban settlements. Plans are rarely prepared within the context of the countries' overall economic and social development; thus many governments give water supply and sanitation plans lower priority; funds are allocated on a piecemeal basis; and the plans seldom reflect any political commitment actually to allocate the necessary human and financial resources.*<sup>39</sup>

#### 2.3.4 Decade Achievements

Despite many shortcomings, the Decade served to accomplish several important achievements:

1. Increased awareness of the plight of millions living in Third World countries, particularly rural dwellers. There is no doubt the Decade served to channel attention, financial investment and program activities to improvements in the coverage of populations with technically superior water supply facilities. While the actual number of additional new beneficiaries since 1980 cannot be calculated accurately, access to better water supply facilities has been improved undoubtedly for millions of people over the course of the Decade;
2. Increased priority of the water and water supply issues in the thinking by politicians and bureaucrats in LDCs. Governments are placing stronger emphasis on sector activities, setting targets and creating national plans; strengthening sector institutions; and improving operations and maintenance systems. Despite the global economic recession during the first half of the decade and structural adjustment policies and strategies which are limiting the flexibility of governments to invest in social service infrastructure activities during the latter part of the Decade, indications are that government funding of sector activities has remained stable over the same period;<sup>40</sup>

3. Development and promotion of alternative and low-cost technologies; and a shift in emphasis from an engineering/technology solution to problems. A review of projects funded by the major multilateral and bilateral agencies during the first years of the Decade demonstrate a definite engineering and technical bias as relates to the identification of water supply problems and their solution. As the Decade progressed, a recognition that a more sociological approach was the more appropriate approach took hold. While not abandoning the need for research and development of technological solutions to pressing problems, this new approach did emphasize the need for increased attention to managerial and socio-cultural concerns of intended target populations if the strategies to increase coverage by improved water supply systems was to succeed;
4. Promotion of the role to be played by non-governmental organizations and implementation of sector activities. The perceived role of government in the development, operation and maintenance of water supply services, particularly in rural areas, has changed from that of provider, to promoter and facilitator. Should governments be ready and willing to divest themselves of their traditional responsibilities, this requires investigation and support for new forms of institutional arrangements and management processes to support the development, maintenance and funding of water supply and sanitation services. The role of nongovernmental organizations, particularly community-based committees, could take on increased importance;
5. Improved planning and coordination among donor agencies. One of the criticisms levelled by developing country governments and other interested parties involved in water-related development activities was the lack of coordination and collaboration among the external support agencies. The Decade witnessed the development of mechanisms, among them the Collaborative Council, that are designed to promote and facilitate discussion and collaboration among the external support agencies;
6. Strengthening of the link between water resources, water supply, health and environment issues. At the outset of the Decade, there was little coordination or collaboration among the discrete programs established that were involved in these issues. Water resources issues appear to have been the domain of agencies and organizations connected to the International Hydrological Decade and the Man and the Biosphere program; water supply issues were the responsibility of multilateral, bilateral and other interested organizations involved in IDWSS Decade activities; the WHO Special Program on Tropical Diseases took responsibility for overseeing developments in water-related vector-borne disease control projects, etc. By the end of the 1980s, there was increased support and recognition of the importance of a more integrated approach to water issues;
7. Increased recognition of indigenous knowledge and expertise in developing countries. The approach utilized for much of the 1970s and 1980s to identify and develop strategies and approaches to solve water-related problems was to engage experts from the industrialized countries as consultants. Conventional wisdom held that the experience of expatriate consultants, academics and donor agency and nongovernmental organization representatives was superior to that of developing country people, and was suitable to find answers to pressing problems. Few agencies supported the development of local and indigenous capacities to identify and carry out research. As a result, problem and attendant solution identification was biased towards perceptions based in the industrialized countries. While such expertise can be beneficial, there occurred a definite shift in recognition and support for the need and development of developing country-based human resources in the realm of research and development;



8. Recognition of the importance of the role of and increased need for applied research. Many projects were launched without prior investigation of the needs of intended target communities, nor the factors that would enable or inhibit the successful transfer or adaptation of technologies and approaches designed to improve the well-being of people through water-related development activities. Over the course of the Decade, the importance of research as a precursor to development activities, and as a means of contributing to the knowledge base of water-related issues, has been accepted. There has been a definite increase in the number of research activities being undertaken, particularly those originating from developing country sources;
9. Large numbers of developing country-based water engineers and technicians and village level handpump technicians have been trained and deployed over the past ten years;
10. Community participation in local water development activities has evolved from a popularly voiced goal and sentiment to a reality. There is a new recognition and increased support for the active and real role for community members in the planning, implementation, management, monitoring and evaluation of local water activities;
11. The role that non-governmental organizations, particularly indigenous ones, can and should play in the planning and execution of water development projects/programs is now accepted as a central tenet. Coordinated action among NGOs, communities and government agencies, to avoid duplication of effort and wasted resources is a reality in several countries, and a goal in many others; and,
12. The critical importance of accurate, reliable, timely and appropriate information for more effective and efficient policy-making, decision-making and management and evaluation of water-related activities has gained recognition.

In summary, the International Drinking Water Supply and Sanitation Decade was successful in focusing attention on several key issues. It served to increase public awareness of the central importance of water-related issues in the development process. It also served to highlight the need for and important role to be played by applied and experimental research in this same process.

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## CHAPTER 3

### AN ANALYSIS OF WATER-RELATED RESEARCH 1970 - 1990

#### 3.1 Major Research Trends During the 1970s and 1980s

Over the past two decades, considerable resources have been invested in water sector development activities, by both external support agencies and governments of developing countries. The World Health Organization estimates that government and external support agency investments to sector activities for the period 1981-85 totalled approximately US\$ 70 billion (1985 dollars). The World Bank estimates the investment level to the sector for the period 1985-1989 to average US\$ 9.3 billion (1985 dollars) per year.<sup>1</sup>

It is very difficult to identify with precision the volume of funds invested in developing country-based water-related research over the past twenty years. Few external support agencies define specifically the volume of funds allocated to support research activities. In many instances, research activities are components of technical or operational assistance, demonstration projects, and other development activities. The identification of water-related research activities is also made difficult when such activities are subsumed within undertakings from other sectors, such as housing, health or agriculture. A reading of agency reports indicates also the variation in the definition of the term research. What for one agency amounts to a research activity, another labels as a non-research activity. Whether a project evaluation constitutes a research activity is still debated. Additionally, the research carried out at developing country institutions is not well documented.

A rough calculation, gleaned from a variety of sources (primarily annual reports) indicates that the total investment in research activities by the major multilateral, bilateral and research-support agencies might be in the order of US\$ 700 million for the period 1981 - 1990. This figure represents only those activities that the major external support agencies class as research. It is doubtful that a more liberal estimate would increase significantly the value of total funds invested in sector research activities.

It is equally difficult to undertake a comprehensive analysis of the nature and substance of water-related research carried out in developing countries. The informational constraints are the same as those related to assembling data on funding. What information is available relates principally to the research activities supported and, for the most part, carried out by, or on behalf of, the major multilateral and bilateral funding agencies. Information on research activities carried out at developing country institutions, unless reported by the external support agencies or through institutional annual reports (a rare occurrence) is limited. Most of the literature on developing country-linked research is authored predominately by academics and professionals from North America and Europe. It is a challenge to determine the research needs and priorities from the developing country perspective. Much is either unpublished, or reported in what is termed 'fugitive literature', and hence, difficult to access.

The purpose of the present analysis is to provide an overview of the main themes of water-related research carried out in developing countries since the mid-1970s. A literature review was carried out using annual and other reports published by the major external support agencies, and the proceedings and reports emanating from several regional and global conferences dealing with water issues.<sup>2</sup> Unfortunately, the activities of all agencies and organizations involved in supporting and carrying out water-related research are not included in this review. For example, the annual reports filed by bilateral funding agencies rarely discuss specifics of research activities, as these are generally

conducted in collaboration with the UNDP/World Bank Joint Program for Water and Sanitation, and through support to WHO's activities. Additionally, and as mentioned previously, the results of many research initiatives are either unpublished, or are reported in 'grey literature'. Nevertheless, an attempt was made to obtain as complete an overview as possible from those agencies and organizations that, together, comprise the largest share of financial support to research activities in the sector. The findings are supplemented with information drawn from the report of the Temporary Working Group on Applied Research on Water Supply and Sanitation.

The following have been identified as some of the key outputs from the past 15 years, as pertains to research on water-related issues:

- the primary focus during the initial years of the Decade was the development and field-testing of low-cost water supply devices, particularly handpumps. During the latter part of the IDWSS Decade, there occurred a definite shift in emphasis towards what is known as the 'software' aspects of water supply. These relate, for example, to the socio-cultural and economic aspects of the introduction and adaptation of technologies into communities, existing knowledge and behaviour with respect to water handling and usage, and the process of management of water supply facilities at the village level.
- a related issue is the concentration of research activities on technologies in the laboratory and at the pilot-scale field testing levels. Little investment has been made to understand the linkages between development, manufacturing and commercialization of water-related technologies;
- reflection and problem-solving during the Decade was dominated, for the most part, by an engineering and technology perspective. As the Decade progressed, there occurred a realization that solutions and perspectives of a purely engineering nature were inappropriate. The need for a more holistic and multidisciplinary approach to research and development gained increased acceptance during the latter years of the Decade.
- up until the mid-1970s, the bulk of foreign aid invested in social infrastructure development projects (electricity/water supplies) was directed towards urban centres, in response to the fact that population growth rates experienced there exceeded that of the rural areas. One of the outcomes of the various pre-Decade conferences and reflection was the recognition that the standard of living in the rural areas was not improving. In fact, the development of social service infrastructures in the rural areas was very weak. One of the effects of the Decade was to highlight the plight of the rural poor, and cause a refocusing of attention away from the urban to the rural areas. Hence, research activities that focused on the problems of the rural poor and their solution, became more numerous after the commencement of the Decade;
- major research topics tended to be defined externally, at least in the early years of the Decade. With the exception of a few organizations, the influence of developing country individuals and institutions in the definition of research activities was quite limited. However, the number of sector-related people from developing countries employed by bilateral and multilateral agencies has increased significantly over the course of the Decade. There has occurred as well a concerted effort to improve the capacity of developing country people to identify and carry out research activities. While the directive nature of foreign aid-funded research and development projects still remains at a high level (as demonstrated by the continued reliance on expatriate consultants to carry out research activities), some agencies and organizations are promoting and supporting a more responsive mode for the planning and implementation of research activities;

- the emphasis of research activities supported during the Decade was related to strategies and means to improve access and use of clean water. But the emphasis placed on water supply for domestic purposes, although important, drew attention away from other water-related issues. Water resources management, the evacuation/treatment and use of wastewaters, the impact of water-related development schemes, and the competing demand for water among different productive sectors are several important issues that did not receive the attention accorded to water supply issues;
- the application and replicability of research results remains an issue that requires further attention. With the exception of a handful of water supply and treatment devices, knowledge about the impact of water and water-related development activities on health, social and economic well-being and productivity is limited. During the Decade, research activities tended to be related to singular instances and demonstration projects. The utility and appropriateness of these research experiences on a wider scale, or under different social, economic, political, and environmental conditions remains to be determined;
- there has been an increase in the concern expressed for the need for more research on the economics of water services and the mechanisms required to support financially their development, rehabilitation (where required), operation and maintenance. Also, increased attention to research dealing with the definition and measurement of the economic benefits of water development schemes and services is noted; and,
- during the Decade, most of the research on health impacts of water supply and sanitation interventions has emphasized diarrhoeal diseases and the resulting slower growth and mortality of young children. Diarrhoeal disease control programmes have been established since 1980 in over 100 countries. Evidence accumulated during the Decade supports the conclusion that water supply and sanitation improvements can result in better health status of children. However, this demands that facilities are functioning properly, are well utilized, and are used correctly.<sup>3</sup>

In summary, the research activities supported by external support agencies over the past twenty years contributed significantly to the development and implementation of water supply and treatment technologies that have resulted in an increase in access to clean domestic water sources (increase in coverage) for a significant number of people in developing countries. There has occurred as well an increase in the number of developing country researchers within government, academic institutions and NGOs, an improvement in their capacity to develop and implement applied research projects, and an improvement in the capabilities of developing country institutions with respect to the management and administration of research projects. Perhaps most important is the recognition, both nationally and internationally, of the need for applied research as an antecedent to sustainable and replicable development activities.

### 3.2 Future Research Needs

Based on an examination of available data and opinion, the following have been posited as some of the key issues for sector-related research over the next several years:

- the increase in the number of those unserved over the past ten years by improved water supply services, both rural and urban, demands further and expanded investigation into innovative technologies and service delivery modes;
- the increase in water scarcity and water stress situations, and the deterioration in the quality of available water resources as a result of human activity highlight the need for immediate research and action in the area of wastewater reclamation, recycling and reuse;
- the unprecedented and strong growth in urban populations, and the anticipated increase in the number of medium to large-scale cities over the next decade, coupled with the associated problems relating to settlement patterns, governance, and the operation and management of urban basic services, and the problems relating to water stress in urban settings, would seem to indicate that further study be given to the means of dealing with this impending situation;
- the move by many Third World national governments to divest themselves of the responsibility for the development, operation and maintenance/management of social infrastructure services, such as water supply, in the wake of the adoption of the 'structural adjustment' strategy requires research into new and innovative modes for the development and sustainability of such services;
- the perspective of water supply as a social welfare function rather than an investment in the productive capacity of mankind still prevails. It remains difficult to convince politicians and decision-makers to invest limited national resources in a sector that is not viewed as contributing to an increase in gross national product. A review of how water resources and their impacts are valued, and the role of water in the process of national economic development require further study;
- anticipated increases in industrialization and agricultural activities in response to structural adjustment and privatization in developing countries could have significant negative impacts on water resources, human well-being and the environment. Research on these issues, the means to measure their quantitative and qualitative impact, and alternative means of increasing national economic growth and productivity without sacrificing quality of life should receive increased attention.

The definition of an agenda for research on water-related issues is source dependent. Opinion varies widely and the choice of key agenda items depends on the nature, quality and quantity of the information that is readily accessible. The professional standing of the authors and editors of published materials exerts also a significant influence on what is considered as relevant input into the development of a research agenda. But the information published to date on this topic tends to originate from developed country-based organizations, institutions and individuals. Their focus tends to be defined from a centralized, professional point of view, related often to the corporate philosophies and mandates and perceived needs of development aid agencies and experts. While the topics identified as priority areas for research on water-related issues over the next several years may merit both attention and further investigation, the perspective that they represent is primarily that of developed country-based professionals. It is difficult to claim that its generation is 'demand-driven'. A prescription for a future research agenda requires input from both developing and developed country sources.

The analysis that follows is meant to supplement those that have been carried out already. Its purpose is to combine both a developed and developing country perspective. A 'systems' approach has been used in this analysis. That is, the aim of the exercise was to determine which courses of



action in research would be the most effective and optimal to achieve the goals set for the Decade and those of HFA2000, when compared to alternative possibilities.

The output of this analysis does not portend to represent a definitive list for a comprehensive research agenda for water-related issues. It is a distillation of information and opinion, drawn from a variety of sources, representing both developing and developed countries, and is a personal assessment. A review of reports dealing with research agenda-setting exercises from other sectors, such as the recently published report of the Commission on Health Research for Development<sup>4</sup>, were consulted, to assist in the definition of specific topics, and to learn about advances in reflection and opinion about research in these sectors. The criteria used to define the research issues are:

- equity: the availability of some clean water for all people;
- sustainability: the harnessing and use of water resources in a manner that does not compromise the needs of future generations; and,
- productivity: the availability of adequate and appropriate quantity and quality of water resources, to meet the needs of the various consuming sectors of a national economy;

What follows is the definition of a set of broad categories of issues, within which several specific research topics are addressed.

### 3.2.1 The impact of human activity on water: water resources management

Humankind's demands on water resources are many. It is a factor of production in agriculture and industry, and serves a multitude of purposes at the household level. Of the three, agriculture accounts for the greatest proportion of the total water resources put to productive use annually. While a significant proportion of water diverted for irrigation purposes reverts to a water resource (surface or ground water), the quantity of available water for other productive uses, and its quality, may be diminished significantly. For example, it is estimated that in the United States, 55% of agricultural withdrawals are consumed, which in turn accounts for 81% of all the water consumed annually nationwide.<sup>5</sup>

Industry (natural resource extraction, manufacturing, and hydroelectric power production) is the second largest consumer of global water resources. While the proportion of water resources consumed by the industrial sector in the Third World is significantly less than that in industrialized and the newly-industrialized countries, the demand for water resources and the impact of effluents from this sector can be expected to increase rapidly as the growth, trend towards greater privatization, and the liberalization of national economies continues.

The impact of domestic consumption and discharge of wastewater on the quality of water is a major concern. Rapid urbanization, the consequent increase in the populations of Third World metropolises, and the transformation of several hundred medium-sized cities to large urban centres over the next decade can serve only to exacerbate the strain on water resources. The plight of the urban poor, and the operational and maintenance problems attendant to urban water supply and sanitation systems received increased attention over the course of the Decade. However, the environmental situation in many urban centres in developing countries is appalling. The rapid expansion of urban populations over the past twenty years has resulted in a deterioration of water quantity and quality.

The lack of continuous and adequate supplies of clean water, water leakage and accumulation, and the uncontrolled discharge and accumulation of wastewater characterize many Third World metropolises. This situation has serious implications for environmental quality and human health.

An analysis of water-related research requires a study of the synergistic relationship between water resources and human activity, namely, the impact of human activities on water resources; and, the reciprocal impact of water resources on human well-being. As Falkenmark *et al.* (1989; 95) point out, the potential management options for industrialized temperate climate countries, and developing tropical and subtropical countries may be radically different. They posit that the water paradigm is a complex system, the study of which entails three successive steps: the identification of the specific characteristic features (physical, societal, economic, political, environmental) of the water resources system relevant to the different management problems that have to be faced; the prediction of the behaviour of the system (the system's response to human actions that disturb the original equilibrium); and, the management of the system, that is, the selection of the optimal alternatives to attain desired and specific objectives. This demands not only an assessment of actual and potential impacts, but also the steps required in order to manage their impact in an optimal fashion.<sup>6</sup>

Another factor relating to water resources management is the unprecedented rapid growth and spatial overconcentration of urban populations in developing countries. One of the major issues confronting their very survival and governability is the inadequacy of existing water supply treatment and delivery systems, and the counterparts for wastewater treatment and evacuation. In most Third World cities, the systems are old, and becoming obsolete. Many have not been maintained. Hence, their capacity to deliver adequate supplies of clean water effectively and efficiently is decreasing rapidly.

The responsibility of water scientists and engineers must be - within a full consideration of the changing environment - to develop and maintain information on the availability of water resources; to assess, monitor and predict the resulting quality of water bodies and the water-related environment; to develop a better scientific understanding of those effects of man's activities that influence hydraulic regimes; and, to provide decision-makers with the necessary information in succinct, properly constructed formats such that they will understand the problems, and the importance of the hydrological sciences as a basis for proper environmental management - especially the water resources - and be thus enabled to react appropriately.

- International Hydrological Programme Plan for 1990-1995 (1989)

During the latter part of the past decade, there was a decrease in the volume of financial resources invested in the development of water resources and water supply and sanitation systems in urban areas. As a result, the rehabilitation of obsolete and old systems has been postponed, and maintenance has been reduced significantly. The consequences include diminishing water supply per capita in the urban areas, and increased degradation of the environment due to the uncontrolled disposal of untreated

wastes. The conditions imposed on developing countries by the structural adjustment strategy will only serve to exacerbate the situation. While attempting to make governments at all levels fiscally more responsible, the impact of the strategy has been a disinvestment by governments in social service infrastructures, such as water and sanitation systems. The impact of this approach is that urban populations are obliged to pay more for water and sewerage services (where they exist, and if consumers are connected and metered), and simultaneously, the administrative capacity of agencies responsible for the operation and maintenance of these systems has diminished.

Simultaneously, concern is increasing about the capacity of traditional sources of water to provide for the needs of expanding populations, and for the requirements of industry and commerce. Their storage capacity is gradually reduced due to a variety of factors: silting, invasion of the watershed by urban spread, uncontrolled industrial activities. All cause harm and change to the hydrological

regime and water quality. New sources of water have to be found and tapped. However, new reservoirs will be much more expensive to develop than the old ones. New man-made lakes will have to be located further from population centres to avoid the impact of human settlement encroachment. The costs related to the construction and maintenance of distant reservoirs and distribution systems will be higher.

The hydrogeological environments in developing countries vary greatly. Aquifers have a very wide range of hydrogeological properties: they can be highly permeable or less permeable; may be porous and/or fractured; they can contain only a few thousand cubic metres of water, or many billions; the quality of water they contain can vary enormously. In brief, they are a very heterogeneous natural resource. However, when groundwater is considered as a potential or actual source of water supply, particularly for urban communities with high consumption demands, the potential utility of many groundwater resources is reduced considerably. The main limitations for groundwater utilization for urban purposes are of an economic nature. This is due to the costs associated to their exploitation, extraction, treatment, storage and distribution.<sup>7</sup>

The status of the systems for the collection, treatment and disposal of human and industrial wastes is even worse. A report prepared by WHO estimates that more than 90% of wastewaters generated in urban areas in developing countries are discharged directly into the environment without treatment.

Bulkley and MacKenzie (1989) identify several factors that should be taken into account with respect to the planning and management of water resources:

- in most hydrological systems, there are shared interests and jurisdictions;
- water resources planning and management should be a comprehensive and continuous process, not static or linear;
- there is no single prescribed model;
- increasingly, water resources planning and management is taking place in a policy arena and with high public interest;
- the nature, degree and direction of public interest is defined by the nature, degree and direction of interaction among the various interest groups and government agencies;
- future water resources planning and management activities will be devolved to regional and local governments, and to nongovernmental organizations, as central governments divest themselves of responsibility for social welfare functions.<sup>8</sup>

Comprehensive planning and management take place in a complex environment, one that is often multi-level, multi-interest, and multi-faceted. The process of water resources planning and management involves trade-offs, reflecting the values (economic, social, political) and capabilities of the various interest groups. Water resources planning and management requires collaboration among the scientific and political communities, and representatives of other (and particularly community-based) interest groups.<sup>9</sup>

In brief, some of the major issues relating to water resources management that should receive greater attention over the next several years are: changes in overall stream flow as a result of increased withdrawal of water and changes in land use in the catchment area; changes in the hydrological regime; changes in the physical and chemical properties of water (suspended sediments, microbiological and toxic contaminants; oxygen-demanding wastes; fertilizers); excessive drawdown of groundwater sources, leading to water scarcity and land subsidence; and, flooding. For urban water supply, the primary issues are: how to ensure to the entire population the availability of adequate and safe supplies of water for human consumption; how to ensure to other consumers (eg industry) the

availability of sufficient supplies of water for productive purposes; how to balance the needs of urban-based consumers with available supplies; how to address the issue of wastewater; and, the mechanisms that enable the effective and efficient (from the operational, financial, and benefit points of view) operation, maintenance and management of water supply and sanitation services. The challenge to the urban sector over the next several years is formidable.

But, before attempts are made to identify and implement solutions, the limitations of the proposed approaches, particularly as regards their appropriateness and applicability, should be investigated and recognized. As Anton (1990) points out, many specific research problems that are normal in developing country contexts do not exist, or exist to a very limited degree, in the industrialized countries. This is particularly the case for urban-based issues (eg, contamination of groundwater in unsewered densely populated urban areas). But, to date, there is very little known about the appropriateness and applicability of solutions to address these issues. More research needs to be done in the developing countries, as it will probably not be carried out in the developed countries.<sup>10</sup>

In response to [a series] of constraints, they developed a plurality of supply, ensuring the security of the community by not relying on only one source for so crucial a resource as water. They knew how to conserve water for both public and private use, by storing it as close as possible to the point of use, covering channels, and diverting the excess from the ever-flowing fountains to the re-use [activities]. To complete the ecological loop, they learned to drain waste and storm waters away from the city for use in fertilizing and irrigating crops, whether food or trees. Re-use of waste waters . . . produced more food, and also replenished the water table so that wells and springs continued to flow for their children and grandchildren. The crux between supply and discharge was usage. This [was] resource management on a 50 to 100 year cycle . . .

- Crouch (1989)

Additionally, the relevance and applicability of solutions and technologies developed in the industrialized countries should also be taken into account. Research subjects or methods that have been, or are being, examined in developed country situations often require adaptations before they can be applied to less developed countries. The conventional approach of transferring technologies developed in and appropriate to temperate climate conditions has been shown repeatedly not to be the most effective nor appropriate means of addressing water-related issues in developing countries.

Perhaps a more historical perspective is required in the analysis and development of solutions to the major water resource management issues that exist currently in developing countries. As Crouch (1989) posits, the solution is often to be found in the study of ancient civilizations, particularly those whose very survival was dependent upon the effective and correct planning and management of water resources. In a study of ancient Greek civilization, he notes that the highly developed urban water system was based on careful examination of the behaviour of water integrated with equally knowledgeable manipulation of human, economic and political behaviour. The water management system - that complex of physical objects, technological development, and human behaviours which supplied, used, and discarded waters - was one of the subsystems that made up a Greek city, ranking with the food supply system, the defense system, the municipal government system, and so on. The food system and water system were the two basics that made urban life possible, and it is curious that until now the water management system has frequently been ignored completely, or at best has only been partially acknowledged.<sup>11</sup>

### 3.2.3 The Impact of water on human well-being and productivity

At the macro level, two key issues relating to the impact of water on human well-being and productivity are:

- the impact of water and its use/handling on human health and productivity; and,
- methods of forecasting the vector-borne implications in the development of different types of water resources projects.

As mentioned in the previous section, agriculture accounts for the largest proportion of water consumed by a productive sector. Within this sector, the activities that account for the greatest proportion of water usage are irrigation and flooding of fields for crop production. Irrigation schemes, in conjunction with improved crop varieties, have resulted in increased production of staple foods, and, concomitantly, an increase in general nutritional status. They have several secondary benefits also: the development of fish breeding grounds, and improved access to water for domestic livestock. Unfortunately, almost nothing is known about the general impact on nutrition and health of specific agricultural projects, which makes it difficult to determine the benefits of such schemes.<sup>12</sup>

The report of the workshop on *Research and Training Needs in the Field of Integrated Vector-borne Disease Control in Riceland Agroecosystems of Developing Countries* identifies several areas that require further research:

- an assessment of ricefield water-manipulation strategies to meet the twin goals of vector control and high rice yields;
- an assessment of the socioeconomic implications of adopting the most promising methods;
- an assessment of the relation between crop production practices and vector bionomics. This would include research on the development and implementation of a computer data base on vector-borne diseases in relation to rice production systems;
- an investigation into the relationship between agricultural management strategies and public health systems;
- a determination of the relationship between chemical treatments of ricefields and changes in the flora and fauna and the subsequent effect on pest and vector species;
- the study of the influence of elevation and distance of settlements from irrigation schemes on human health;
- an assessment of the role and impact of health education campaigns in promoting settlement-related interventions; and,
- an evaluation of the efficacy of personal protection strategies in reducing disease transmission in the community and on the farm.

The Report also identified a need for innovative survey methods. While surveillance systems may exist, they are not necessarily readily applicable. For example, recently developed techniques such as the immunosorbent assay (ELISA) procedure for sporozoite identification of malaria and for the

epidemiological surveys of Japanese encephalitis and schistosomiasis represent major breakthroughs. However, their application may be limited, given the high per unit costs involved, and the associated sophisticated equipment and supplies. Further study should be supported to identify alternative tools and techniques of diagnosis and surveillance, that complement the more sophisticated techniques, and that can revolutionize field-based approaches. However, existing techniques should not be neglected. Research on the improvement of technique sensitivity and specificity, as well as the means of making the techniques easier to use, should be supported.

Another weakness of the existing approach to determining the impact of agricultural practices on human health and productivity identified is the lack of a strong monitoring, evaluation and documentation process. Successful application of various approaches, and their corresponding integrated vector-control strategies, require research-generated information such as the physical components of vector habitat, vector-borne disease epidemiology, and response to specific control strategies. Models for disease prediction are the logical outcome of improved surveillance. Simulation is one tool for examining the impact of multiple variables on disease transmission and further development is required. The report suggests that primary importance should be assigned to vector surveillance, and the second to disease surveillance. Short-term investigation of agricultural surveillance methods may uncover useful overlaps. For example, identification of potential vector breeding sites by remote sensing could be applied to both agricultural pest and vector-borne disease control in the future.<sup>13</sup>

Concern about the effect of vector-borne diseases on human health and productivity is not recent, but quantitative data on the contribution of irrigation schemes and flood-plains to their transmission in different environments are very limited. Given the extensiveness of these diseases, the importance of irrigation and flooding on agricultural productivity in the tropics, the expectation that the amount of land under irrigation will increase substantially over the next several years in response to increased demand for produce and the transformation of land to agricultural use, a better understanding of the problem in the irrigated systems themselves and the vectors' relationships with various cropping practices is imperative. This is essential before any recommendations can be made on possible control measures in irrigation systems. It is also highly unlikely that farmers will adopt measures designed to control vectors only. To be attractive, vector control practices should be part of cultural practices that demonstrate tangible benefits in terms of yield increase or reductions in financial investment.<sup>14</sup>

Another agriculture-related issue that requires further investigation pertains to the use of wastewater for crop irrigation, especially in arid and semi-arid regions. The increasing use of wastewater is a result of several factors: increasing scarcity of alternative waters for irrigation; the high cost of artificial fertilizers and the recognition of the value of nutrients in wastewater and its impact on crop yield; and, the sociocultural acceptance of the practice. The use of wastewater, principally untreated, for irrigation is common practice in many countries. Research on its use and its potential impact on human health has been investigated in select situations.<sup>15</sup> Guidelines for the safe use of wastewater and excreta in agriculture and aquaculture have been developed.<sup>16</sup> However, research on the use of wastewater for irrigation, wastewater handling behaviour among farmers, the effect of this practice on different types of crops, soil and groundwater, the impact of effluent on the quality of farm produce, and, the impact on human health relating to the handling and consumption of produce irrigated with wastewater and excreta still require further investigation under the different environmental and ecological situations that characterize developing countries. Citing Strauss and Blumenthal (1990), while the use of wastewater, even when adequately treated, for the irrigation of vegetables is prohibited, the practice continues. The risks associated with this practice, and particularly the excess risk relating to the practice of mixing nightsoil with wastewater, have not been adequately assessed.<sup>17</sup> But, the actual public health importance of excreta or wastewater reuse can be assessed only by an epidemiological study of the particular practice to determine whether it results in measurably greater

incidence or prevalence of disease, or intensity of infection, than occurs in its absence. Such studies are methodologically difficult, and there have been only a few well designed epidemiological studies on human wastes reuse; more evidence is available about wastewater irrigation than about excreta use in agriculture or about aquaculture use. There is also a need for the economic appraisal of wastewater irrigation schemes (particularly with respect to the absence of such systems), and the financial aspects of cost-recovery and other schemes that could affect the operation and management of these systems.

Human behaviour, and the belief systems that define them, are key determinant to understanding the transmission of diseases, and useful inputs into the planning and evaluation of disease control and health maintenance programs. The feasibility of developing and implementing such programs without a comprehensive understanding of these variables, and the context in which the situation exists, could limit considerably the validity of the data collected. As a consequence, policy and program recommendations emanating from these studies will not be relevant, and quite misleading. While knowledge, attitude and practice (KAP) surveys can provide useful information, the significance of their findings are limited severely without an understanding of the proximate and contextual parameters that define them. Also, beliefs and behaviours vary widely across time and space that it is difficult, and dangerous, to make generalizations. The conventional approach has tended to append KAP and socio-economic studies to water supply improvement projects, with the motive of using changes in human water-related behaviour as proxy variables to demonstrate improvements in health and well-being. A new approach should be adopted, one in which greater attention is paid to the ecological, political, social and cultural variables that define the context of the situation, to generate a better and clearer understanding of the determinants of human behaviour and value systems. Such studies should be prerequisites to the design and implementation of water resource and water supply development projects.

As with research issues relating to water resources management, further research on the institutional arrangements that can support the operation and maintenance/management of agricultural systems that result in an improvement and sustainable level of human health, social well-being and productivity is also required. Comparative cost/effectiveness analyses of specific vector-control interventions and an integrated approach, and of alternative agricultural systems, with respect to these criteria, with particular reference to a decrease/minimization of health risk, also warrants serious study.<sup>18</sup>

There are several key research issues on the micro (community and household) level that merit further investigation also. One relates to the issue of the quality of water used for domestic purposes stored at the house, and the other, the impact of water on human health.

The physical, chemical and microbiological quality of water from rural supply sources is examined usually prior to and subsequent to a source improvement project. The purpose is to verify that the project in fact achieved the objective of improving water quality at the source. Usually, water quality tests are performed thereafter when the need arises. Most rural water source improvement projects are predicated on the assumption that the availability of clean water at the source will result in an improvement of health of consumers. There is little knowledge about and little attention paid to the micro-environment of the household with respect to the quality of water. The process involved in the transportation, handling and storage of water may have a deleterious effect on the quality of water drawn from protected sources, thereby contradicting the intended impact of the intervention.

Two studies carried out in Malawi demonstrated a significant difference in the quality of water sampled at the source and at the household level. Young and Briscoe (1985) showed that faecal streptococci levels for water samples drawn from gravity-fed water supply system taps and samples drawn from household water containers differed significantly.<sup>19</sup> Lindskog et al. (1987) found a similar relationship for faecal coliform and faecal streptococci in a study of comparative water quality between source and

household level in another region of Malawi.<sup>20</sup> On the other hand, Sutton and Mubiana (1989) concluded, based on a sample population drawn from a set of villages in western Zambia, that there was no evidence to support the assumption that the carrying of water, and its storage at the household prior to consumption, will result in a deterioration of its quality.<sup>21</sup>

The questions that spring up revolve around the tendency of people carrying water to their houses, and storing it in small easily accessible vessels, to contaminate initially coliform-free water, and turn it into a health hazard.

- S. Sutton and D. Mubiana (1989)

With little evidence from which to draw conclusions, it is difficult to determine whether an emphasis over the next several years should be placed on improving the conditions at the water source, at the household level, or at both. Further research into the quality of water consumed at the household level, and the cost-effectiveness of intervention programs at the source and household may be useful in the development of national water programs.

The causal link between an improvement in water supply and sanitation and its impact on health has been a cause for debate since the beginning of the Decade. Walsh and Warren (1979) set the tone for the debate, by suggesting that the health impact of water supply and sanitation projects is not significant, and that investments in sector activities would not be as cost-effective as those to other interventions.<sup>22</sup> The response was a number of studies that attempted to demonstrate the health benefits resulting from an improvement in water supply and sanitation interventions.<sup>23</sup> The evidence from published studies weighs in favour of positive impacts. However, as Briscoe *et al.* (1986), Briscoe (1987), Cairncross (1989) and Esrey (1990) indicate, methodological problems with health impact evaluation study designs remain problematic. Health impact evaluations are also expensive to conduct. While the epidemiological methods for health impact studies are well-defined and accepted, there are several design issues. As Cairncross states, the utility and value of conventional approaches to measure the impact of water supply and sanitation interventions on health may be limited:

*Their findings are frequently unpredictable and of little diagnostic power to programme managers. A more promising approach is to measure changes in hygiene behaviour. However, many studies have had difficulty in measuring behavioural factors, even through quite simple indicators such as household water consumption. However, the objective study of human behaviour is clearly not impossible, as a wealth of anthropological literature can testify. The problem is that the necessary techniques are not well known in the water and sanitation sector, and no coherent attempt has been made to adapt them to the sector's needs.*<sup>24</sup>

Several areas for further research on the subject of health impact evaluations of water supply and sanitation interventions have been suggested:<sup>25</sup>

- the development of guidelines for the study of hygiene practices, particularly the methodology of hygiene measurement;
- the examination of cost-effectiveness study methodologies that would be sensitive to the primary and secondary effects (the multiplier effect) of water supply and sanitation interventions;
- studies of the factors which determine the quantities of water used for domestic purposes, particularly for hygiene;



- the need for information relating to the impact of the level of service (water distributed through a piped system, through household connections, through handpumps) and the interactions between water supply, sanitation and hygiene education programs;
- an investigation of the conditions (including environmental, socio-cultural and levels of socio-economic development) under which installation of water and sanitation facilities are likely to produce the greatest health benefit; and,
- the identification of threshold indicator levels at which water quality considerations override quantity in health impact.
- a broadening of the scope of the indices for health benefits. The majority of health impact evaluations conducted to date focus on the impact of improved water supply and sanitation interventions on diarrhoeal disease. As Cairncross (1989; 311) points out, the prevalence of infection for other diseases such as trachoma and guinea worm may be much higher than is recognized by national health authorities. Much remains unclear about the transmission of several water-related diseases, particularly with regard to human behaviour.

The linkage between improvements in the state of water systems and the accrual of health benefits at the individual, community, and national levels is well grounded in theory and opinion. But there is little evidence to demonstrate a significant correlation and impact. It is interesting, and perhaps somewhat discouraging, to note that the issues which were identified as research priorities with respect to this topic identified over ten years ago remain the same today:

*We know that good domestic water supplies in every house are a vital part of the wide ranging environmental improvements which, together with wealth, have caused such a dramatic reduction in infectious disease in Europe and North America over the last 100 years.*

*We know that if it were possible to transform the socio-economic and environmental conditions (including water supply) of the poor in developing countries into those enjoyed in Europe and North America, a very dramatic reduction in infectious disease would follow.*

*We know that improvements in environmental conditions must include good water supplies if they are to have their full effect on community health.*

*We do not fully understand the role of partial and limited improvements in environmental quality as opposed to comprehensive improvements.*

*We do not know what is the potential role of water supplies constructed in the absence of other inputs or changes and designed to low-cost specifications.*

*We suspect that replacing dirty water by clean water in the absence of other inputs will often have little effect on health.*

*We know that it is difficult to induce changes in hygiene and water use practices but we suspect that such changes may be essential if improved water supplies are to improve health.*

*We suspect that bringing plentiful water close to, or into, houses and providing washing and laundry facilities may improve health in many cases.<sup>26</sup>*

Perhaps the most erudite rationale for investing in research on water supply and health is that provided by Richard Feachem (1978):

*The question "why?" is the most important question. To know that there was not a health impact in a given location is of little help to the policy maker. What he wants to know is how he may change the rural water programme in order to maximize the health benefit and for this it is necessary to know why a particular effect was observed.*

*We should not conduct research into the health impact of water supplies in order to know whether to build more water supplies. Water supplies will continue to be built, irrespective of evidence of health benefits, because they fulfil the legitimate political objectives of many governments. We should conduct research in order that water supplies may be built better and may have a greater impact on health.* <sup>27</sup>

### 3.2.4 Management Issues

One of the lessons being credited to the Decade is a realization that centrally managed water supply systems for low-income rural settlements may be neither suitable nor sustainable.<sup>28</sup> In response to this situation, the Decade witnessed a change in emphasis, to a strategy labelled community-based management schemes. But, as Sai (1986) has commented, management at times has been used as the catch-all for the failure of systems to live up to expectations. He continues:

*While one has to agree readily that in developing countries problems of management are likely to be very basic and underlie all or most of the failings in the health field, one has also to accept that it is not enough for anybody doing an analysis of health problems simply to state that the problems are managerial or due to poor management. It is a major responsibility of the expert to analyze which aspect of management is the problem, as management is so broad, so complex, and has so many meanings for different peoples and situations.* <sup>29</sup>

One of the lessons emanating from pilot studies using this approach indicates as well that the concept of community-based management is not a constant. Its definition depends on who is doing the defining, and it is very culture-sensitive. In many cases, community-based management (also referred in several studies as participatory management) appears to mean that community members are left to their own devices to deal with the maintenance of water supply and sanitation services, without the attendant infrastructure or support. In other cases, the use of the term veils the fact that responsibility for the maintenance and management of these systems does not rest with the community, but remains vested in a centralized, non-community-related administrative and/or technical group that has only a tenuous relationship to the community.

Perhaps the primary weakness with the approach, as it is currently defined, rests with several of its underlying assumptions:

- the agency or Ministry that holds absolute power and is the sole authority for the planning, implementation, and maintenance of water supply services will allow for a true devolution/decentralization of power and authority, particularly to communities;

- the community-based management approach is that it is more effective, in the functional sense, and less costly than conventional approaches. However, there is little information on the comparative cost-effectiveness of community-based management approaches with conventional or alternative management structures and processes. Also, the extra resources required to implement and maintain a decentralized system may not be available.

In several instances, the Ministry of Water, or its equivalent, is not be a priority ministry, a situation that may be problematic when resources are allocated among government ministries and departments. It is therefore difficult to state with certainty that the community-based approach is 'better' or 'more effective' than another. There is little information on the comparative 'manageability' of the various management processes. Additionally, information on the impact of the various management processes and structures on the health and social well-being of communities is also lacking, information that is requisite to resource allocation decisions;

- a decentralized approach for water supply can be implemented easily, based on the experience of decentralization with the political/administrative structure of government. But, the institutional arrangement of government may be such that, while district commissioners exist (who should have responsibility over the decentralized management structure and process) there is resistance at the central ministry level to devolve either decision-making and resource allocation power or authority to the district level;
- there is often confusion between what can be termed the 'functional issues' (those relating to the technical aspects of service delivery) and the 'administrative issues' (those relating to resource allocation and deployment, logistics, etc.). These have not always been addressed, or they have been melded, under the assumption that a body responsible for the management and maintenance of water supply systems would, on its own, be able to differentiate between and accommodate these functions;
- many community-based management schemes are related only to the maintenance and repair of water lifting devices, with villagers acting primarily as handpump technicians. They do not encompass a broader definition of community responsibilities, such as the planning, implementation and evaluation of water supply points. Additionally, there does not appear to be an integrated approach to the creation and implementation of community water committees with other village-level committees, such as those responsible for primary health care activities, agricultural development activities, etc. If the goal of development is to promote and implement a more global view of water resources planning and management, then a more holistic and integrated perspective of the role of the community in decision-making and management is required;
- community-based management of water systems is a better means of generating revenues for their support and maintenance. However, 'willingness to pay' does not equate 'ability to pay', nor does it address the issue of the capacity of communities to assume responsibility for the correct and sustained operation and maintenance (and expansion, where warranted) of such services. There exists little information about the comparative advantages of cost-recovery schemes and methods; and,
- a community-based management approach can be adopted/adapted to all situations, without recognition and research into the socio-cultural, economic and political context in which the community exists. Community-based management, in essence, involves democratization, a devolution of power and authority from central agencies, a shift in institutional arrangements

and governance with respect to planning, decision-making and management, and increased responsibility and, in some cases, an increased financial burden for communities. It can imply also major shifts in the politics and decision-making structure and process within communities themselves. Gender-related issues take on increased significance in such a strategy. Management models cannot be applied indiscriminately. They must be adapted to the context in which the communities exist.

The issue of ownership is still unresolved. While communities are told that they 'own' the service (eg, inherently responsible for its good function and upkeep), the requisite institutional arrangements and management process and structure to support such a schema are not in place. Community-based management will succeed only when the communities believe truly that they are the decision-makers;

The increasing scope of management considerations, together with increasing demands and impacts on the resource resulting from continuing socio-economic development, magnifies water management deficiencies and emphasizes the importance of efforts to enhance management capabilities.

- W.E. Cox (1989)

Additionally, the role of information in the management process has not been clear. The traditional approach is that the community informs an outside agency that a breakdown has occurred with the water lifting device. The repairs would be made. Water quality tests might be carried out, and information about the status of the water supply source collected. The same process holds true for the monitoring (if carried out) and evaluation of water supply schemes. The conventional approach has been for the evaluation to be carried out by 'experts',

external to the community. However, rarely is this information recycled to the community, for use in the planning and management of these services;

Finally, the approach is characterized by what appears to be an inherent naivete concerning the composition and dynamics within a community, as though it is a homogenous and singular entity. Often, reference is made to 'the community does this' or 'thinks that'. But communities are composed of individuals, and any plans to promote the concept of community-based management and decision-making must take full account of the internal conflicts, politics, and interrelationships that characterize a community. The designation of one person as responsible for the management of a committee to oversee the management of a water supply system, based on community hierarchy or power-politics may not mean that this individual will be successful in the task. It is far better to first assess the situation with the community, to understand as completely as possible the process and structure within a community, rather than to impose one that may be incompatible to the goal of community participation.

Given the paucity of experience with community-based/centred planning and management within the sector, and their small scale (and, hence, difficulties inherent with generalizing from them), there is a need for more investigation about comparative modes for promoting and implementing the strategy, evaluations about its comparative advantages and disadvantages to conventional or alternate approaches, and the policy and implementation implications of such an approach.

One of the priority issues emanating from the experience of the Decade and related international water resource development programs is the need for information for policy-making, planning, implementation, management, and monitoring and evaluation of water-related activities. But the reality is that accurate, reliable and user-appropriate information is not available. Nor is it apparent that what

is available is used, or used correctly. Decision-makers and managers at all levels of society tend to rely on faulty and incomplete information, and make decisions based on intuition. This is not unique to the water sector, and lessons can be learned from experiences elsewhere.

A 1987 report produced by the WHO to serve as a basic document of the 40th World Health Assembly remarked:

*The main constraint reported by practically all countries is inadequate information for the managerial process . . . to provide systematic and analytical information for continuous assessment of the situation, determination of priorities, improvement of management, and evaluation . . . The health-for-all strategy demands an integrated managerial approach . . . and also monitoring and evaluation with a view to modification or readjustment of the strategy as part of a continuous cycle.* <sup>30</sup>

The conventional approach relating to the collection, analysis and generation/dissemination of information about water supply and sanitation services/systems has several deficiencies:

- such exercises tend to be carried out on an *ad hoc* basis, generally within a framework developed by and for donor agencies;
- the focus is on the technical performance of devices and the extent of coverage, with little appreciation of the importance of qualitative factors, such as the process of community decision-making and the identification of factors that enable or inhibit this process;
- there is a lack of feedback of information to the beneficiaries of the development activities;
- the utilization of the information collected is unknown;
- there are serious deficiencies in data collection techniques. The quality of data collection instruments and survey techniques varies greatly;
- the quality of the data analysis tends to be superficial. There is an obvious need for an improvement in the capacity of people to analyze data, such that their prescriptions and recommendations are valid, relevant, and timely; and,
- the definition of goals, indicators, and the data collection techniques is usually carried out by persons external to the community. They usually have little understanding of the contextual framework in which the activities being reviewed exist. Also, the methods used can be complex and impractical. There is very little effort made to improve the capacity of indigenous people to undertake such exercises, nor to use the information collected for sustaining development/pilot activities.

If a truly community-centred management approach is to be promoted, then it follows that community members must have the capacity to understand the information that is collected, if not to have, in full, the capacity to design and implement a community management information system. Based on the experiences of several pilot scale projects that sought to establish and evaluate a community-centred management information system, the following represent some of the characteristics required to make such an approach work:

- the community is willing and able to implement a simple MIS;
  - the system is simple, inexpensive, and require very limited data collection and analysis;
  - the system should be manual, not computer-based;
- A community-based MIS would complement management information of a district health system; although, in some cases, the community and the health system would use the same data. The major distinction is in defining the user of the MIS. In a community MIS, the user is the community itself.

- Reynolds, Bryant and Bazmi (1988)
- technical assistance to the community is readily available and accessible, and is of a nature easily understood by those responsible in the community for the operation and maintenance of an MIS;
  - the information collected should serve a multitude of users, at different levels (eg. district level technical personnel, national level planners and policy-makers, donor agency representatives, etc.);
  - indicators should be flexible, as no standard set may be applicable or relevant to the needs of all communities;
  - the MIS should not replace, but rather complement existing national and other MIS;
  - it should not be expected to meet the needs of sophisticated applied research purposes. While some information collected within the framework of a community-centred MIS may be relevant and useful for such purposes, special data collection studies may have to be mounted in order to satisfy the information needed for scientific purposes.<sup>31</sup>

In light of the experiences with community-based MIS, particularly in the primary health care sector, several areas for applied research that merit increased attention emerge:

- the development of simple tools and techniques for the collection of information;
- the testing of different MIS modalities and institutional arrangements to support them;
- the identification and testing of essential indicators, record management systems, analytical process, and data presentation formats, to satisfy the needs of those intending to use the information;
- investigation into the relevance and validity of information collected at and by the community for the purposes of other users of information on water supply and sanitation services;
- comparative cost-effectiveness analysis of conventional and alternative approaches to MIS, particularly with reference to the goal of improving the capacity of communities to effectively and efficiently assume responsibility for the planning, operation and maintenance of water supply systems; and,

Participation in decision-making cannot be put on tap, to be turned on and off when desired.

- PROWESS/UNDP (1990)

- investigation into the type, quantity and quality of information required to make policies and decisions, plan and manage water resource development/enhancement activities effectively and efficiently.

Information is empowerment. If the goal of development is to improve the capacity of communities to be self-sufficient and to plan, implement and manage sustainable, useful and relevant activities to improve their social, economic and health well-being, then they must have the capacity to collect, manage and use information required for this purpose. There remains a wide scope of issues to be researched concerning MIS.

### 3.2.5 The development and dissemination of technology:

As the Report of the Temporary Working Group on Applied Research for Water Supply and Sanitation remarks, technology issues commanded a great deal of attention during the Decade, with water supply issues receiving much more attention than those relating to sanitation.<sup>32</sup> The focus of technology research and development activities was primarily handpumps and water supply treatment facilities. A perception that appears to be gaining in popularity with the completion of the IDWSS Decade is that all technology issues have been solved.

The need appears to have shifted toward greater emphasis on sanitation and waste management technologies relative to water supply and toward informational and institutional mechanisms to better promote and utilize existing technologies.

- Report of the Temporary Working Group on Applied Research for Water Supply and Sanitation (1989)

But not all the challenges of a technical nature have been resolved. Although the Decade served to highlight and promote research and development of water supply technologies for rural areas, the experience of the Decade has drawn attention to other technical issues that require further study. Examples include innovative, durable, and low-cost construction techniques for shallow and medium depth wells, new siting and borehole drilling techniques, and further research on small-scale water treatment and delivery systems.

Conventional water supply and wastewater collection and treatment systems may be inappropriate and too expensive for most developing country situations. The physical layout of most low-income and peripheral settlements and the increased demand for water supply and sanitation services in the major metropolitan areas in the Third World far outstrips the capacity of municipal governments to construct, operate and maintain conventional systems. Cairncross (1989) remarks on the validity of attitudes prevailing at the commencement of the Decade with respect to water-borne sewerage:

*Those who proclaimed its irrelevance in the 1970s were in a minority. Now, no-one can plead ignorance of its disadvantages as a sanitation system for low-income communities. Its excessive cost, its wasteful water consumption, its unreliability [sic] in conditions of intermittent water supply, and its technical impossibility in the narrow, winding alleys of the slums and shanty towns of the Third World are only the better known of the arguments against it.* <sup>33</sup>

... In three decades from now, two-thirds of the African population are likely to face severe water shortages.

- M. Falkenmark, J. Lundqvist and C. Widstrand (1989)

This situation demands further research and development of non-conventional systems. One example of technology development needs is, therefore, the optimization of infrastructure in peri-urban areas, including drainage, human wastes disposal and water supply and treatment.<sup>34</sup>

Another area identified as a key issue that remains to be addressed is the role of technology to deal with the depletion of water resources. Water

scarcity and increasing competition among productive sectors (agriculture, industry, productive sector infrastructure) and domestic consumers for available water resources are two increasingly pertinent issues. The subject of water saving devices is not restricted to arid regions. It is also a critical concern to municipal governments. Falkenmark, Lundqvist and Widstrand propose that the relevant question to be posed is not how much water do we need and from where is it obtained, but rather, how much water is there and how best can we benefit from it.<sup>35</sup> They continue:

*The overriding challenge is to strike a balance between the acute needs of people in terms of a productive utilization of their resource base and the equally demanding task of conserving the productivity of the resource base in order not to jeopardize future needs. A management strategy must thus be developed which allows the concurrent utilization and conservation of land and water resources.*<sup>36</sup>

The challenge remains twofold: to develop and test water saving devices that are appropriate to the socio-economic and cultural context in which they are intended to function; and, to identify the structure and processes of such management strategies. Many traditional communities in arid regions survive as a result of learning to cope with water scarcity, not water abundance. Yet few studies have been carried out to determine 'the secret of their success'. As Crouch (1989) notes, some ancient civilizations were able to deal with the complex issues of water resource management, water supply delivery and wastewater disposal in an effective and efficient manner.<sup>37</sup>

From a technology point of view, there remain three areas relating to water stress situations in developing countries that require further research: measures leading to a better use of available water resources, e.g. rainwater harvesting, water pollution control; measures leading to augmenting available water resources, e.g. desalination of brackish water; and, measures leading to a reduction of water consumption, e.g. water reuse and recycling, modification of productive processes, limitation of water wastage. Future research efforts may require identifying and applying lessons learned in the past to present situations in both rural and urban areas.<sup>38</sup>

An equally important issue relates to research and development of technologies that are sensitive to the environmental and ecological characteristics of the sites in which they are to be located. The conventional attitude was to transplant technologies designed to function in temperate climates to arid and tropical climates. But experience has demonstrated that such systems may not be effective nor appropriate. Research into and development of non-conventional and micro-scale (household and community level) technologies for increasing water supply and purifying water (eg. water supply technologies using passive energy, such as solar desalination and disinfection, and the use of natural coagulants) should receive increasing attention over the next few years. To date, much of the research on passive energy and traditional methods have been laboratory-based or at a pilot-scale. Despite the advances in knowledge about passive energy methods and the use of natural coagulants for water



purification<sup>39</sup>, more information is required about the effectiveness, efficiency and adaptation and utilization of these methods in real-life circumstances, and their replicability and applicability to larger-scale situations.

Important considerations in the development and maintenance of safe water supplies are the setting of realistic standards, the use of appropriate monitoring technology for assessing bacteriological water quality, and the availability and use of simplified, inexpensive and reliable microbiological water quality tests. However, ministries tend to allocate few resources to water quality monitoring. The expense and difficulty in obtaining sophisticated equipment and supplies, the need for highly trained personnel, the problems associated with the logistics of monitoring rural water sources, the long incubation period required for some tests before results can be obtained combine to create this situation. Additionally, there is a lack of simple and effective management systems for water quality data.<sup>40</sup>

During the Decade, developments in improved and simplified microbiological water quality testing procedures and techniques were developed, as well as simplified, computer-based water source classification schemes. What remains to be accomplished is the refinement and field-testing of such technologies.

One final note on technology issues: the need for research on the linkage between development, manufacturing and dissemination of water supply technologies. As stated in the Background Papers to the Global Consultation on Safe Water and Sanitation for the 1990s, knowledge about the links between these elements is very limited: most research and development resources continue to be invested at the 'upstream' end of technology development (in the laboratory and in pilot-tests). There exists little knowledge or research pertaining to the dissemination and commercialization of technologies, which relate directly to the sustainability of water supply improvement projects. There is also the additional issue relating to the mode of dissemination and commercialization. The options range from a centralized top-down approach, with the conventional commercial producer manufacturing and selling the devices, through to what can be termed a decentralized bottom-up approach, wherein critical components are manufactured centrally for strict quality control reasons, with other components manufactured at village-level workshops, or sub-contracted to cottage industries. Further research would be pertinent and useful relating to the relationship between these elements, and the process of technology development and dissemination.<sup>41</sup>

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## CHAPTER 4

### IDRC: RESEARCH ON WATER FOR DEVELOPMENT

#### 4.1 IDRC and Water: The First 20 Years

Since its inauguration 20 years ago, IDRC has approved funding for 214 projects<sup>1</sup> relating to various aspects of research on water for development. The projects were carried out by over 270 research teams<sup>2</sup> at institutions located in 52 developing countries, several in collaboration with researchers at Canadian-based institutions. The subject areas of the research cover a wide range of topics: the development of innovative water pumping and water treatment technologies, and the capacity of communities to operate and maintain them; the capacity of governments at different levels to support the construction and maintenance of water delivery and wastewater collection and disposal systems; the impact of water on agricultural production; the impact of water contact and handling behaviours on the incidence of water-related parasitic and infectious diseases; the potential utility and health aspects of treated wastewater for irrigation; water hydrology and hydrogeology; and, the development and evaluation of information data bases relating to water and water research. A list of the water-related projects supported by the Centre since 1974, the year in which the first water-related project was approved, is provided in Appendix A.

The Centre's contribution to achievement of the goals of the International Drinking Water Supply and Sanitation Decade has been significant, in both quantitative and qualitative terms. Although the Centre's financial contribution may appear significantly less in comparison to other external support agencies, IDRC has been and continues to be one of the lead agencies in terms of investments in applied and experimental research on water-related issues. From a qualitative point of view, the Centre's achievements can be summarized as:

- in several instances, the Centre supported research on innovative topics prior to investment by other agencies. An example is the support to basic and applied research and field testing of shallow and deep-well handpumps that incorporate below-ground components manufactured from polyvinyl chloride (PVC);
- research on water-related issues supported by the Centre have resulted in modifications to government policies and development activities. For example, the research supported on urban hydrogeology has prompted governments to review existing groundwater development and management schemes. The results of another project, one that assessed the water quality of a river basin, led to the modification of procedures concerning the disposal of untreated effluent from a government-owned agricultural complex;
- through its efforts, the Centre has supported many young professionals, scientists and technicians from developing countries to attend a wide variety of water-related training programs, to upgrade their level of expertise;

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<sup>1</sup> 'Projects' refers to grants made to recipient institutions, for which a unique project identification number has been assigned. For the purposes of this study, grants to multiple recipient institutions under the same project identification number are considered a single project.

<sup>2</sup> The number of research teams exceeds that for projects, as the monies available under one project identification number may have been awarded to research teams at more than one institution.

- the Centre has been one of the very few external support agencies to provide direct support to developing country institutions (including NGOs), to assist them in identifying problems and developing and implementing applied and experimental research projects.
- the Centre was among the first organizations to lend significant support to develop and strengthen developing country-based reference centres, through projects to create and sustain information collation and dissemination mechanisms in the sector.
- the Centre has highlighted and promoted the role of developing country researchers in the identification and implementation of research to find solutions to problems, and to support their active participation and involvement at international fora.
- IDRC has supported a wider spectrum of research issues than any other external support agency. Besides the subjects listed above, the major topics receiving IDRC support over the past 15 years include:
  - development and field-testing of water supply delivery technologies;
  - development and testing of passive energy water delivery technologies;
  - rainwater harvesting and storage technologies;
  - decision-making at the household and village level with respect to water supply and sanitation issues;
  - rapid and low-cost water quality assessment techniques;
  - development and field testing of household and village-level water purification and treatment technologies;
  - managerial/organizational aspects relating to the introduction and sustainment of village level water supply delivery and treatment systems;
  - water purification by natural coagulants and solar radiation;
  - surface and groundwater quality assessment;
  - hydrogeology and hydrodynamics of groundwater;
  - wastewater treatment/resource recovery and reuse;
  - health/environmental impact of improvements in water supply services.

The Centre prepared and published reports on the outcome and achievements of many IDRC-supported water-related projects, and on related themes. A list of publications is provided in Appendix B. The wealth of knowledge generated by IDRC-supported water-related research projects has made a major contribution to an understanding of situations and problems in developing countries, and the attendant solutions.

The purpose of the analysis contained in this chapter is to provide a foundation upon which recommendations upon which a future research agenda for water-related research for the Centre, and in particular for the Health Sciences Division, can be based. The present study is not the first review of research on water issues funded by IDRC. In 1988, the Centre published an overview of recently supported water-related projects.<sup>1</sup> Its purpose was to communicate to the general public the importance of research on these issues. While performing an important education and public relations role, it stopped short of a comprehensive and substantive analysis of trends and issues relating to research on water for development. The analysis will demonstrate that although all of the Centre's program divisions have funded research projects on water issues, their focus and substance differ substantially. Each Division has tended to define a unique research agenda, with interdivisional linkages being minimal. Hence, although the cumulative value of the knowledge gained may be impressive, the



approach adopted by the Centre over the past fifteen years leaves the impression that, to paraphrase John Stuart Mills, an 'invisible hand', to guide thinking and action at a corporate level on water-related issues, was absent.

## 4.2 Study Methodology

The methodology used for the study involved the collection and analysis of the project files for the 214 water-related projects identified for the purposes of this study, and the collection and analysis of information contained in the Centre's project databases for these projects. The first step involved a search of the project information system (PINS), to identify all projects supported by the Centre, between fiscal years 1971/72 and 1989/90 (up to the end of March 1990) that had the word water as a macrothesaurus descriptor. The PINS printout was then reviewed, to eliminate any projects that were not water-related, for the purposes of the definition of the present study (eg. water buffalo). The PINS data includes the project identification number; title; an abstract; the name and location of the recipient institution and the principal investigators; the original IDRC grant to the project; the commitment date; and, the estimated completion date for each project. This list was then compared to those for all projects supported by the program divisions, to identify any water-related projects that were not included on the PINS listing.

The Centre's project management information system (PROMIS) and financial management information system (FINMIS) were consulted, to obtain information about project commencement and completion dates, and updated financial information (eg. supplemental grants). The data used in this study represents information in the Centre's electronic information databases effective September 30, 1990. Individual project files were reviewed, to validate the financial data concerning grants to individual research teams. In the case of Health Sciences Division, individual files were consulted to obtain information on the status of water-related projects.

## 4.3 Evolution of the Centre's Involvement in Water-Related Research

IDRC's involvement in water-related development issues dates back to 1972, when Centre officers and Population and Health Sciences Division (the precursor to the present Health Sciences Division) personnel met with representatives from WHO, UNDP and the World Bank, to identify research needs in the field of environmental health. One of the outcomes was the creation, in 1973, of the Rural Water Supply and Sanitation sector, housed within the Population and Health Sciences Division. Its purpose was to guide the Division (and the Centre) in developing a programmatic framework for research on water for development.

This same year, the Population and Health Sciences Division provided a grant for the preparation of a landmark study of the state-of-the-art of water supply and sanitation technologies and research priorities for this sector in developing countries.<sup>2</sup> The report was commissioned by the Development Assistance Directorate and the Scientific Affairs Directorate of the OECD, and presented at the meeting of the OECD Planning Group on Science and Technology for Developing Countries (Paris, 1974).

Following this meeting, and at the suggestion of several independent and acknowledged individuals, a meeting was convened in early 1974 in Montreal by UNDP, IDRC and the OECD. Invitations were extended to the WHO, the World Bank, UNICEF and UNEP. The outcome of the meeting was the decision to establish an Ad Hoc Working Group on Rural Water Supply and Sanitation (AHWG), and the establishment of a trust fund to support its operation and research studies.

The conclusions emanating from the first meeting of the AHWG Technical Committee meeting in the fall of 1974 and a parallel meeting of the working group's Institutional Panel were:

1. the main improvement of drinking water supply and sanitation in rural areas would result primarily from applying and adapting known technologies;
2. the application of technology could only be achieved through marked improvement in the economic, institutional and legislative support systems requisite to national and local programs;
3. the need to develop appropriate mechanisms for managing and maintaining services, of evaluating [sic] their effectiveness, and methods of obtaining local participation in facility planning, operation and maintenance; and,
4. the need to promote and support technological investigations in adaptive research programs and strengthening of local capacities to carry out research and development projects.<sup>3</sup>

As a result of these deliberations, the Centre made a conscious decision to support applied and experimental research projects relating to water issues, primarily within the context of the declarations emanating from the various international conferences, that is, to improve access to potable water for the world's disadvantaged.

#### 4.4 Divisional Research Agendas on Water-related Research

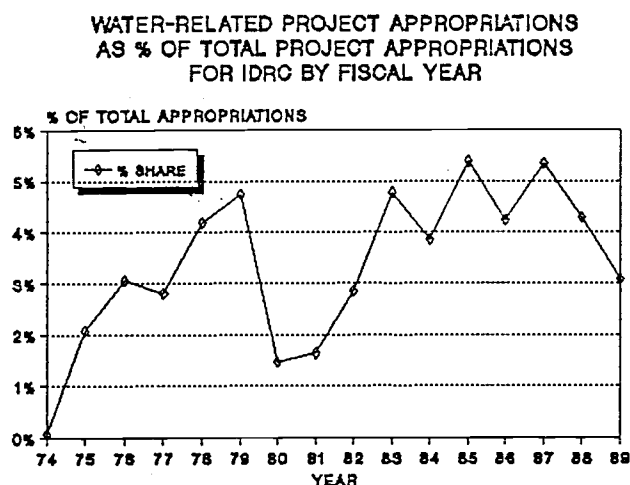
Despite periodic reductions in the volume of funds available to IDRC to support new project activities, the total appropriations for water-related research projects have tended to increase annually since fiscal year 1974/75 (Table 4.1). By the end of fiscal year 1989/90, the cumulative value of appropriations to water-related research projects exceeded \$32 million, representing almost 4% of total appropriations by the Centre to research projects. This figure does not include grants approved for small projects, consultancies, and other activities funded under Divisional Activity Projects (DAPs), or the costs associated with the preparation and publication of manuscript and technical reports dealing with water issues. However, neither the annual rate of growth, nor the proportion of water-

TABLE 4.1

APPROPRIATIONS FOR IDRC-SUPPORTED  
PROJECTS RELATING TO WATER  
1974 - 1989

Year	No. of Grants	Value of Appropriation
1974	1	14,700
1975	5	545,430
1976	8	826,983
1977	12	823,330
1978	12	1,301,041
1979	5	1,413,750
1980	8	537,370
1981	6	741,200
1982	8	1,576,724
1983	21	3,386,028
1984	24	2,890,452
1985	22	3,887,407
1986	19	3,025,471
1987	20	4,308,377
1988	25	4,422,227
1989	18	2,302,002
Total	214	32,378,260

FIGURE 4.1



• up to April 1990

of related project appropriations to total appropriations the Centre, have been constant (Figure 4.1). During the 1970s, appropriations to water-related research projects grew steadily. By fiscal year 1979/80, appropriations to water-related research projects accounted for 4.73% of total appropriations by the Centre to all research projects. However, due to reductions in monies available to the Health Sciences Division for project appropriations in the early 1980s (the Division up to this point in time having primary responsibility for water-related activities within IDRC), and the departure from the Centre of one of the professional staff members involved centrally in the identification and development of water-related projects, the annual level of appropriations to water-related projects fell

considerably. The annual growth of monies allocated to water-related research projects recommenced its upward trend after 1982, when the Centre again enjoyed an expansion of its annual appropriation from Parliament, and the Earth and Engineering Sciences Division (known then as the Cooperative Program Division) started to provide funds for projects on water-related issues.

The annual level of monies provided to support research projects dealing with water issues peaked in fiscal year 1987/88, as did the proportion of monies made available to water-related projects, as a share of total Centre appropriations to all research projects (5.7%). The total volume of funds appropriated in support of water-related projects decreased over the next two fiscal years. By fiscal year 1989/90, total appropriations to water-related projects had decreased by 47.9% over the previous fiscal year. As a share of total Centre support to all research projects for fiscal year 1989/90, the figure was 3%, approximately the same proportional share for fiscal year 1982/83. This reduction was a consequence of several factors, the most important being the restructuring of the Health Sciences Division (and the consequent dissolution of the former Water Supply and Sanitation sector), the departure from the Centre of two professional staff involved centrally in water supply research activities, and a general reduction in the appropriations level for new project initiatives for the Centre as a whole.

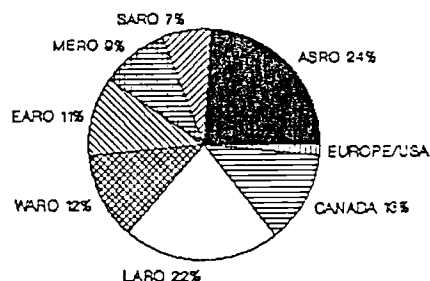
On a geographic basis, the largest number (50) and the greatest share of total appropriations awarded (24%) for water-related research projects approved by the Centre over the 15 year study period were located at institutions and organizations in South-east Asia (ASRO) (Table 4.2). In terms of the number of water-related projects supported, Canadian-based organizations and institutions, primarily

TABLE 4.2

**IDRC APPROPRIATIONS BY REGION  
WATER RELATED RESEARCH PROJECTS  
1974-1989\***

Region	No. of Grants	Value of Appropriation
ASRO	50	7,777,910
SARO	17	2,207,703
MERO	16	3,052,315
EARO	26	3,627,344
WARO	23	3,887,167
LARO	36	7,079,127
CANADA	41	4,177,595
EUROPE/USA	5	519,099
<b>TOTAL</b>	<b>214</b>	<b>32,378,260</b>

FIGURE 4.2

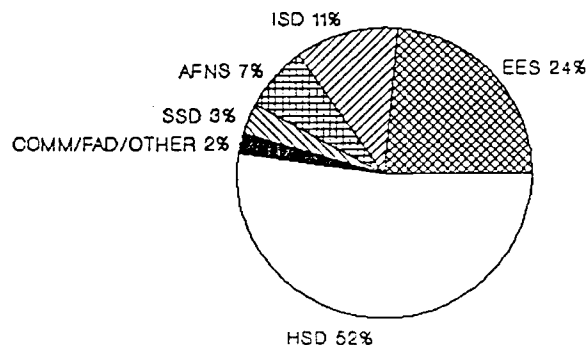
IDRC APPROPRIATIONS BY REGION  
WATER-RELATED RESEARCH PROJECTS

academic, ranked second (41 projects). However, as a percentage of the total appropriations made to water-related projects, Canadian-based institutions ranked third, with those in Latin America receiving a larger proportion of the total volume of appropriations (Figure 4.2). Institutions in sub-Saharan Africa (denoted by EARO and WARO), although receiving a greater total number of projects than those located in the LARO region (49 versus 36), received a smaller value of total appropriations (\$ 7,514,511 for WARO and EARO combined, as opposed to \$ 7,079,127 for the LARO region). Research institutions located in the Middle East and North Africa region (MERO) and in the south Asia region (SARO) received the fewest number of project grants, with SARO receiving the smallest share of appropriations for developing country-based institutions. The smallest portion of appropriations for water-related projects was awarded to organizations and agencies located

in the United States and Europe.

Investment in water-related research activities is not equal across the Centre's program divisions (Figure 4.3). By the end of fiscal year 1989/90, appropriations to water-related research activities represented approximately 52% of the total value of appropriations to water-related projects by the Centre's program divisions (\$16,923,441). As a proportion of total appropriations to Centre-supported research projects on water-related issues, the total value of grants made by the Health Sciences Division (HSD) accounts for the largest share. As this Division was the home of the Centre's Water Supply and Sanitation Program for several years, it became the focal point for such projects, and the liaison with other donor agencies.

FIGURE 4.3

IDRC APPROPRIATIONS 1974-1989\*  
FOR WATER-RELATED RESEARCH  
BY DIVISION

The Information Sciences Division (ISD) and the Earth and Engineering Sciences Division (EES) account as well for a significant portion of total Centre appropriations to water-related projects. ISD, which began support to water-related research activities in 1975, has provided over \$3.6 million in grants to research on water-related issues. EES, which ranks second in terms of total divisional appropriations to water-related research projects (\$ 7.6 million, or 24% of all Centre appropriations to water-related research projects), made its first grant to a sector-related project in its founding year (1981).

The Agriculture, Food and Nutrition Sciences Division (AFNS) has made grants to several water-related research projects. To date, grants approved by AFNS account for

\* up to April 1990

made by the Centre to water-related research. However, water, as a specific issue, was a secondary focus of these projects.

The Social Sciences Division (SSD) supported several water-related research projects, but the total volume of funds appropriated represents approximately 3% of the total appropriations to this sector. The Communications Division (COMM) and the Fellowships and Awards Division (FAD) tended to provide funds in support of other Divisions' water-related projects, rather than to develop and fund projects directly. Together, appropriations made by these two Divisions account for a fraction over 2% of the total value of project grants approved for this sector. The Office of Planning and Evaluation (OPE) and the Office of the Secretary and General Counsel also approved small grants in recent years, in support of three water-related projects developed and administered by HSD.

4.4.1	Fellowships and Awards Division	\$299,150	(2 projects; 4 interdivisional grants)
	Communications Division	\$404,586	(4 projects; 4 interdivisional grants)
	Office of Planning and Evaluation/ Office of the Secretary and General Counsel	\$ 57,820	(3 interdivisional grants)

Together, the total value of grants approved for water-related projects from these three Divisions account for approximately 2% of total appropriations to the sector to the end of fiscal year 1989/90. Although small in quantitative terms, the activities have been designed to support planned and on-going research activities in other divisions. The highest proportion of appropriations from these Divisions went to institutions located in the ASRO region.

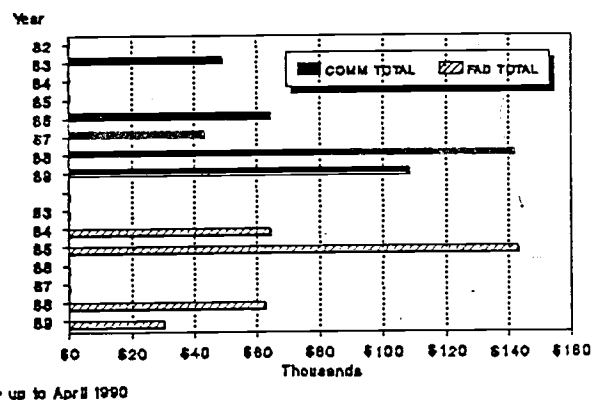
FAD provided two direct grants. One was to train scientists from Southeast Asia in farm irrigation and water management for increased production. The other provided support to train graduate students in hydrology at an academic institution in India. Both projects were related directly to larger-scale research projects supported by AFNS and EES Divisions respectively. These grants were approved in FY1984/85 and 1985/86. FAD provided as well monies to four interdivisional projects, to support further academic training of research team members. Proposals for specific training programs on water-related issues have not been developed and submitted for funding consideration since that period in time.

The Communications Division has supported financially and acted as the administrative division for four projects. These have generally been related to the preparation of audio-visual materials and the publications of manuscript and technical reports on water-related issues and IDRC-supported activities. Recently, the Division supported a small project on the dissemination and utilization of a rapid, inexpensive microbiological field testing procedure for water quality. The activities have tended to be in support of projects administered by other Divisions.

The grants provided by the Office of Planning and Evaluation and the Office of the Secretary and General Counsel were in support of water supply technology development and application projects developed and administered by HSD, and the dissemination of their results.

FIGURE 4.4

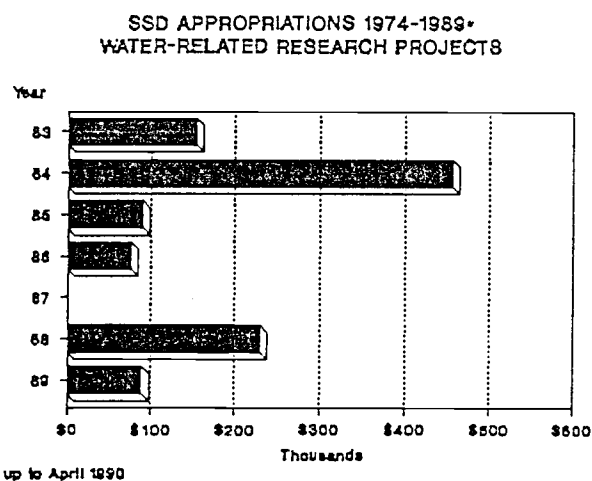
COMM/FAD APPROPRIATIONS 1974-1989\*  
WATER-RELATED RESEARCH PROJECTS



#### 4.4.2 Social Sciences Division \$ 1,095,350 (10 projects; 2 interdivisional grants)

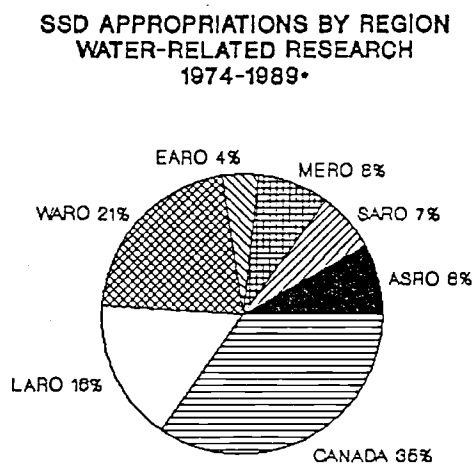
The Social Sciences Division's support to water-related projects accounts for 3.4% of total Centre appropriations to this topic since 1974. The primary focus has been urban-based infrastructure management. Smaller projects on the impact on health (particularly diarrhoeal disease) of an improvement in drinking water supply services, a water supply delivery system survey, and a project on water resources management have also been supported. The majority of the grants approved by this Division have been awarded to research teams located at institutions in sub-saharan Africa, although the value of appropriations is greater for Canadian-based institutions.

FIGURE 4.5



The conditions that characterize the majority of urban areas in developing countries are well documented. The issue at hand is to determine the most effective and efficient strategies and programs to address the two primary problems: that of a deteriorating situation in the provision of basic urban services due to nonexistent and nonfunctional physical infrastructures; and, a lack of administrative and management capabilities of those agencies charged with the responsibility to provide these services. The confounding factors are the rapid growth of urban populations and the consequences this holds for demand for and on basic urban services, the spatial expansion of cities through an expansion of municipal boundaries, the holding capacity and stress limits to urban growth, and the capacity of any one agency or government body to provide even a modicum of effective and cost-efficient service.

FIGURE 4.6



\* up to April 1990

The Social Sciences Division has supported 8 applied research projects that examine in detail a wide variety of aspects relating to water supply technologies and management systems in urban areas. These cover a wide range of topics: descriptive studies of environmental and ill-health conditions that characterize urban fringe areas and their populations; examinations of wastewater collection/transportation and disposal methods; and, a determination and examination of the factors which limit effective management of urban basic water supply and sanitation services. Many of these focus specifically on the status of urban basic services in the peri-urban and low-income areas. Several attempt to come to terms with the situation, elaborating recommendations for action.

For example, the results of several projects dealing with environmental surveys supported in collaboration with HSD, indicate that:

- a. despite claims of coverage and good access for water supply services in peri-urban areas, the evidence suggests that the majority of services are nonfunctional, or operate at less than expected capacity;
- b. even where they function, the quality of the water from the public water distribution system is unsatisfactory and health-threatening;
- c. while municipal by-laws may exist which regulate the quality and frequency of service to be provided, the theory does not match the reality; and
- d. while many peri-urban and squatter settlement inhabitants recognize that disease and ill-health conditions are a consequence of deleterious environmental conditions, they feel powerless to change the situation. At the same time, they have serious doubts regarding the capacity of municipal governments to address the situation.

The analysis of the projects dealing with applied research on the effectiveness of urban basic services demonstrates that:

- a. the spatial distribution of housing and roads in unplanned squatter settlements is perhaps the single most important factor which inhibits the effective and efficient provision of basic urban services;
- b. few metropolitan areas possess the data collection and analysis capabilities by which to critically assess the physical layout of urban basic services infrastructure, the personnel and financial resources required to construct, operate and maintain such services, or the economic data required to determine strategies to sustain them;
- c. priority has been placed on the development and testing of technologies;
- d. little attention has been paid to addressing other issues which affect the standard of living of peri-urban dwellers (factors such as employment, land tenure, housing);
- e. many peri-urban inhabitants pay exorbitant prices ( eg. water vending rates) for water on a per unit basis; and,
- f. a greater degree of rationalization of authority and responsibility for the provision of basic urban services and the collection of supporting revenues (whether through taxation or user-fees) should be sought, in order to address the recurring problem of overlapping authority and responsibility among several departments within a municipality, and among different levels of government.

The research supported to date under the urban policy program serves to highlight several important issues relating to the subject at hand. However, support for research projects on these topics has been sporadic. The most recent was approved in 1986. Given the prevailing and predicted situation for urban areas in developing countries, consideration should be given to increasing support to research projects which focus on urban water-related issues.

The Division's Population, Education and Society program has developed and approved financial support for one project which seeks to survey, analyze and improve rural mobilization and community participation methods relating to a Canadian NGO-funded water supply program in West Africa. The other water related project funded by the Social Sciences Division examines patterns of natural resource use in a rural community, with specific reference to water. Supported through the Division's Environment Program, it is an extension of an earlier project funded under the Centre's defunct Energy Program. The contribution of water-related research supported by this Division has been important, particularly as concerns the development, management and sustainability of public services to disadvantaged urban populations.

#### 4.4.3 Agriculture, Food and Nutrition Sciences Division \$ 2,303,844 (10 projects; 1 interdivisional grant)

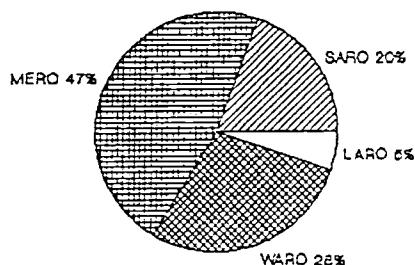
Although this Division did not possess until recently a water-related focus for project activities *per se*, its share of appropriations to sector projects accounts for approximately 7% of the total value of Centre project grants on this topic. This does not take into account projects on aquaculture and mariculture developed and funded under the auspices of the Division's Fisheries Program. Such research projects are not considered in this analysis. The majority of these projects are located in MERO and WARO.

Most of the research supported to date by the AFNS Division that relates to water has as its focus the impact of water on farming systems and crop production. These projects were developed and are administered through the Crops and Animal Production Program. The impact of limited water resources in irrigated forestry plantations has been

the subject of a small number of projects funded under the Forestry program.

FIGURE 4.8

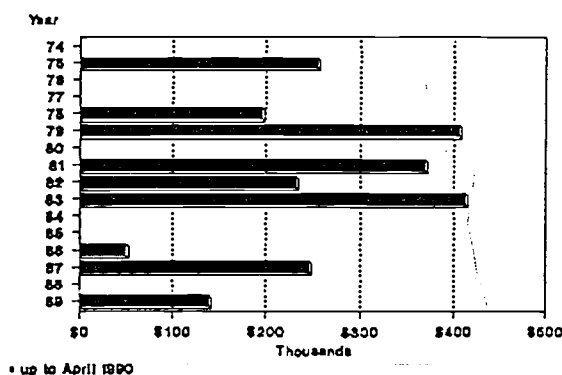
AFNS APPROPRIATIONS BY REGION  
WATER-RELATED RESEARCH  
1974-1989\*



\* up to April 1990

FIGURE 4.7

AFNS APPROPRIATIONS 1974-1989\*  
WATER-RELATED RESEARCH PROJECTS



The dynamics of irrigation, how water behaves in different soils, how much water different crops consume, and the development of irrigation technology was identified early on by the AFNS Division as a priority area of concern. This was particularly true for the semi-arid tropics. In 1975, the Centre provided a grant to establish the International Irrigation Information Centre (IIIC). Its aim: to collect and evaluate information about the use of water on farms; and to disseminate widely and popularize this information to those directly concerned: farmers, researchers and extension workers.<sup>4</sup>

According to a recent workplan for the Division, its Environment and Sustainable Management Program intends to give priority consideration to problems such



as the mismanagement of water resources, to include not only research on agricultural practices that have a deleterious impact on water resources but also to explore the environmental impacts of agricultural policies. The program will focus on analysis of water requirements for different cropping systems under various ecological situations (eg. desert reclamation), and its relationship to the potential for water supply, in terms of physical availability, the management of water exploitation and delivery schemes, and related costs.

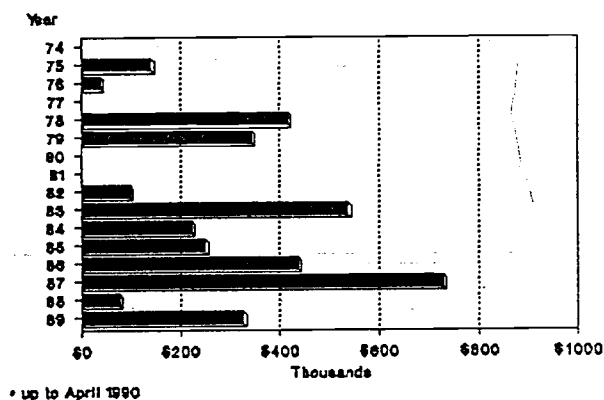
Only one water-related project was developed and financed in collaboration with another division. Through the Centre's former Energy Program, AFNS and the Health Sciences Division funded jointly a project on the development and technical evaluation of the performance of a solar powered deepwell pumping systems for irrigation.

#### 4.2.4 Information Sciences Division \$ 3,628,062 (20 projects; 4 interdivisional grants)

The Information Sciences Division has been involved in a wide variety of water-related research activities. To date, Divisional project funding accounts for 11.3% of total Centre appropriations to water-related research projects. Many of these were developed in close collaboration with the former Water Supply and Sanitation Sector of the Health Sciences Division, with several projects co-financed by the two divisions. The majority relate to the design, development and maintenance of regional information systems on water and wastewater activities. In many cases, these are related to the development of regional information and documentation centres, the purpose of which is to promote and facilitate the collection and exchange of information on water-related issues, and to stimulate the production of information by regional experts.

FIGURE 4.9

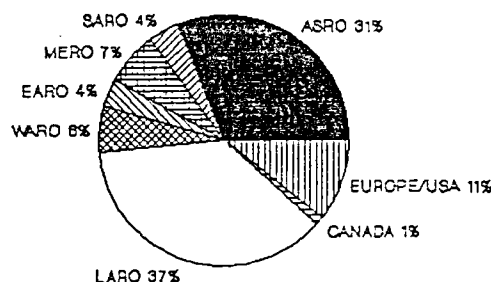
#### ISD APPROPRIATIONS 1974-1989\* WATER-RELATED RESEARCH PROJECTS



The Division's involvement in water-related research is a product of IDRC's role as one of the original, and arguably one of the most active, members of the Ad Hoc Working Group on Rural Drinking Water Supply and Sanitation in the early 1970s. One of the recommendations emanating from the AHWG was to establish a network of information centres at local, national and at the international level, to facilitate the exchange of information on activities and research initiatives in the sector. Based on the discussions of the AHWG, IDRC undertook to develop programs that it could support under its mandate to promote the strengthening of information exchange mechanisms. This resulted in the development and approval of funds for the first project designed to establish a regional information system at an institution located in a developing country. The project took place at the *Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente* (CEPIS) in Lima, Peru. Similar projects followed based at the Asia Institute of Technology (Bangkok). Recently, the Division supported the establishment of similar systems at regional institutions in West Africa and the Middle East.

FIGURE 4.10

ISD APPROPRIATIONS BY REGION  
WATER-RELATED RESEARCH  
1974-1989\*



\* up to April 1990

Through the Information Sciences Division, the Centre has launched and supported other landmark and innovative activities in the sector. One was the establishment of a low-cost journal on water-related activities, aimed at professional and technical people engaged in water projects at the field level. Waterlines was the first attempt to popularize information about developments and activities in the sector, and which helped to demystify water supply-related science and technology. For many in developing countries, it is the first experience of publishing the results of water related research and development projects.

The Division supported as well the first state-of-the-art review and annotated bibliography, relating to wastewater and the relationship between water supply and the disposal of

wastewater and excreta. The resulting publication<sup>5</sup>, now out of print, served to inform many in developing countries about the latest developments and learning on the subject. The Division was also instrumental in the production of a common multilingual thesaurus for water, a major contribution to the popularisation, dissemination and transfer of knowledge.<sup>6</sup>

Over the intervening years, the Division continued to develop and support proposals to expand, consolidate and strengthen the various regional and national information networks. Others relating to special fields of interest, such as the Agricultural Waste Management Information System in Malaysia, were also established.

One of the more innovative initiatives in recent years was the support to Approtech Asia (Asian Alliance of Appropriate Technology Practitioners), representing more than three dozen NGO member organizations in eight Asian countries, to collect, organize and disseminate information on water produced by its members. This is the first known formal information exchange mechanism among developing country NGOs. A subsequent phase project was approved recently, with the objective to strengthen and consolidate the program.<sup>7</sup>

According to the PWB for 1989/90, the Division is to continue to provide support to the identification and development of water information activities, and to assist national governments to identify and strengthen their information infrastructures.

#### 4.4.5 Earth and Engineering Sciences Division \$ 7,666,007 (30 projects; 1 interdivisional grant)

Since the creation of the Division's Earth Sciences program in 1983, research on water was identified as a priority area, specifically as it relates to hydrology and hydrogeology. By the end of fiscal year 1989/90, this program had developed and funded 30 water-related research projects. The total volume of grants appropriated accounts for approximately 24% of the total value of appropriations to water-related projects for all program Divisions over the period 1974/75 to 1989/90. This places the division second, in terms of its proportion of the total of appropriations by the Centre to water-related projects.

The projects have supported research teams located at 32 academic institutions in several developing countries, though primarily in Latin America. The majority of these were carried out in collaboration with researchers at Canadian-based institutions, most notably the University of Waterloo, the University of Québec at Montréal, and Laval University.

The first indication of an interest on the part of IDRC to fund projects relating to groundwater research is a study carried out in 1975/76, undertaken by Dr. A.S. Issar, Head of the Hydrogeological Project, Institute for Desert Research at Ben-Gurion University of the Negev, Israel. The study was commissioned by the Centre to determine the principal hydrogeological research activities in developing countries, the primary problems to be solved that require a research dimension, identification of the issues which constrain the potential for research conducted by developing countries researchers, and identification of existing centres of excellence in hydrogeology in developing countries.<sup>8</sup>

Dr. Issar's report recommended strongly the inclusion of the discipline of hydrogeology in its field of research support activities. His recommendations stemmed from what he perceived as a significant lack of attention to the role of hydrogeology as a priority research issue, with particular reference to:

- a. the potential of groundwater as a source of fresh water for human and agricultural use is neither appreciated nor utilized, due mainly to a lack of understanding of the nature of the resource in the conventional engineering mindset;
- b. the significant scientific and technological gap between developed countries, where this resource is overdeveloped and issues are concerned primarily with management problems, and the developing countries, where most of the preliminary research has still to be undertaken. The abundance of data and knowledge about hydrogeology and water resources development available at that time in the developed countries was not being transferred to developing country institutions nor individuals. The monopoly on knowledge remains with developed country experts;
- c. the lack of adequately trained people in developing countries in hydrogeology, and the predominance of expatriates and development agency personnel in groundwater-related activities;
- d. the need for centres of excellence in developing countries in the field of hydrogeology;
- e. the lack of a multidisciplinary approach to groundwater research, particularly as concerns water resources development and management; and,
- f. the failure of CIDA to include hydrogeological research as a precursor to CIDA-funded water resource development and exploitation projects, and the agency's lack of capacity to fund hydrogeology research.

FIGURE 4.11

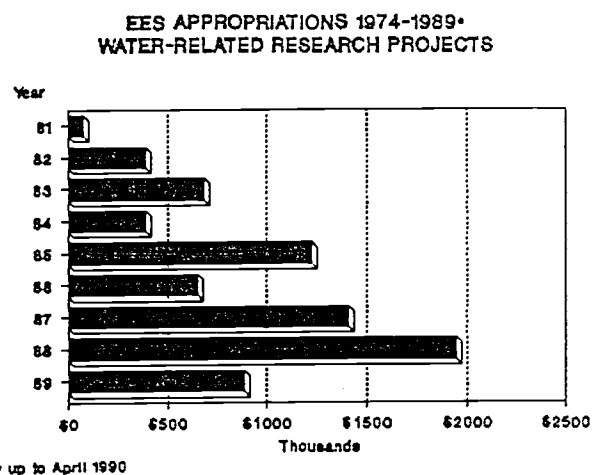
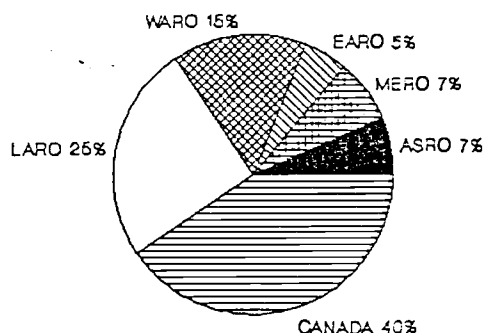


FIGURE 4.12

**EES APPROPRIATIONS BY REGION  
WATER-RELATED RESEARCH  
1974-1989\***



\* up to April 1990

Starting in 1982, the former Cooperative Programs Division commenced a series of consultations with scientists from Canada and the Third World, with a view of 'defining a special program in the earth sciences applied to issues of development'.<sup>9</sup> As a result of this activity, EES supported projects on groundwater geochemistry (eg. isotope studies of the effect of land use change on the ecology and climate of the Amazon Basin, and salinization of shallow ground waters in north-east Brazil).

EES also developed and supported several projects of primary importance to increasing knowledge about freshwater resources. One deals with the dynamics of glacial and snow melt. Its objective is to predict river flow as a result of this process, and the impact this will have on the operation of reservoirs and irrigation systems. Of equal importance are the projects which investigate the dynamics of contamination

for both surface and ground waters.

Perhaps the most significant of the Division's water-related projects is that pertaining to urban hydrogeology. To date, the network consists of ten projects, the earliest developed in 1985, the most recent in 1989. The foci of the research supported were:

- development of a computerized model of aquifers;
- isotopic analysis of the groundwater;
- range of hydrogeological tests to determine the origin, flow, and age of groundwater in the aquifer.

The purpose of these studies was to demonstrate to authorities how to exploit the aquifer without worsening the subsidence of urban areas.<sup>10</sup>

In 1989/90, the Division engaged an external consulting firm to evaluate the projects. Although the projects are in differing stages of advancement, with four being complete, the report highlights the significant contribution made by the network and the importance of the subject area:

*Opportunities for the urban hydrogeology projects to have a positive impact on urban development are very significant and unmistakable. Most projects are involved in one or several very serious problems of aquifer overexploitation, water supply shortages, groundwater contamination and land subsidence. Groundwater development for urban water supply has a direct impact on the living conditions of urban populations. At the same time, while hydrogeological studies can be beneficial to large urban areas, the development of high yielding wells for urban water supply may have a negative impact on existing rural water supplies.*<sup>11</sup>

In 1989, the hydrogeology/hydrology subprogram of the Earth Sciences program was renamed the "Water in the Environment" subprogram. The change of name is meant to reflect more accurately the intention to limit the scope of projects supported under this subprogram to the area of availability of water supplies. The subprogram is aimed at "developing good engineering solutions to problems caused by geologic conditions".<sup>12</sup> This subprogram is to deal with three main areas: groundwater resources and aquifer management; superficial and atmospheric water resources and basin management; and, soil erosion as it affects water supplies.

4.4.6 Health Sciences Division \$ 16,923,441 FIGURE 4.13  
(138 projects; 2 interdivisional grants)

Both historically, and in terms of the value of appropriations to research projects, the Health Sciences Division has been the most active within the Centre regarding the development and support of water and wastewater-related projects. It has also been the focal point for the Centre concerning International Drinking Water Supply and Sanitation Decade activities, such as IDRC representation on the Collaborative Council of External Support Agencies for Water Supply and Sanitation.

HSD APPROPRIATIONS 1974-1989\*  
WATER-RELATED RESEARCH PROJECTS

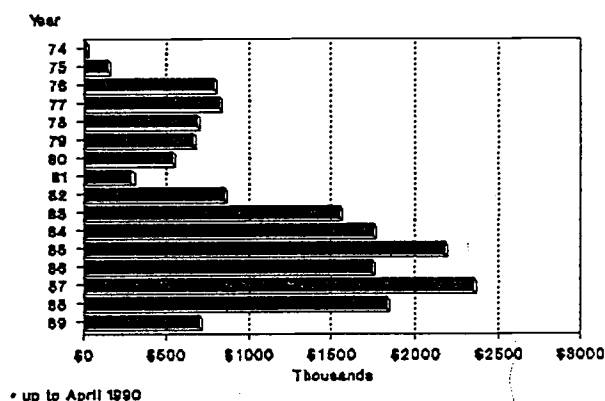


TABLE 4.3

WATER-RELATED RESEARCH PROJECTS  
HEALTH SCIENCES DIVISION  
NUMBER AND VALUE OF APPROPRIATIONS  
1974 - 1989\*

YEAR	NUMBER	VALUE OF APPROPRIATIONS
1974	1	14,700
1975	3	148,990
1976	7	787,833
1977	12	823,330
1978	9	688,880
1979	3	663,230
1980	8	537,370
1981	4	293,140
1982	5	854,629
1983	12	1,544,965
1984	15	1,753,912
1985	14	2,177,328
1986	11	1,747,008
1987	12	2,350,147
1988	14	1,831,699
1989	8	706,280
TOTAL	138	16,923,441

Over the past fifteen years, HSD has provided support to 138 water-related research projects. The value of monies appropriated to water-related research projects between April 1974 and March 1990 totals \$16,926,441. The first grant for a water-related project was made in 1974, to an international training and research centre located in Latin America. The value of the grant was \$14,700 (1974 dollars). Appropriation levels to water-related projects grew through the latter part of the 1970s. The considerable decline in both the absolute value of monies appropriated to water-related projects and the number of projects supported for fiscal year 1981/82 was a consequence of the departure from HSD of the professional staff member responsible for the identification and development of research projects on this topic.

Both the number and volume of appropriations to water-related projects increased significantly over the next six years. In 1983, three HSD professional staff were engaged in its Water Supply and Sanitation sector. In absolute terms, appropriations levels peaked in fiscal year 1987/88. Grants to water-related projects for that year totaled \$2.35 million. This

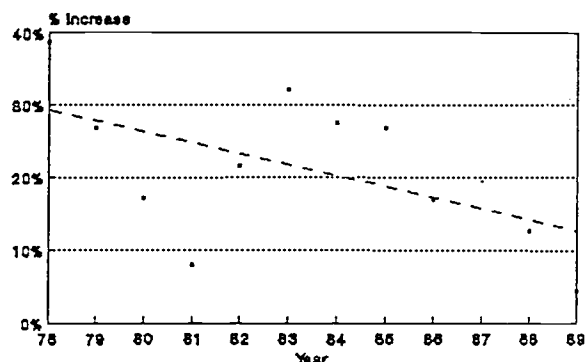
represented 18.4% of total HSD project appropriations for that year. There was also considerable variance in the value of grants made to projects over the study period. The smallest grant to a water-related project was made in 1974 (\$14,700), the largest to a single project in 1987 (\$1,129,040). The average value of a grant for a water-related project supported by HSD was approximately \$122,700.

However, the proportion of water-related project appropriations as a share of total HSD project appropriations varied considerably from year to year. The average for the study period (fiscal year 1974/75 to 1989/90) of the proportion of monies appropriated by HSD to water-related projects in relation to total project appropriations is 14.6%. In fiscal year 1974/75, the first year that the Division made a grant to a water-related project, the proportional share for water-related research represented only 0.4% of total HSD project appropriations. The proportional share increased quickly, accounting for 23.5% of total Divisional project appropriations in fiscal year 1977/78. This decreased to 5.0% for 1981/82, then increased again, to 23.4% in fiscal year 1984/85. From fiscal year 1986/87 through to the present, the percentage of total HSD project appropriations made to water-related projects has declined steadily. For fiscal year 1989/90, it stood at 6.9% of total Divisional monies appropriated to research projects.

The trend in the comparative net change between succeeding fiscal years of appropriation levels for water-related projects and for all projects in HSD is also of note (Figure 4.15). In fact, for the study period, it is negative. In other words, the proportional share of appropriations to water-related projects to total HSD project appropriations tended to be greater during the 1970s than during the 1980s, despite an increase in the total value of appropriations to water-related projects. Even factoring out the exceptionally high net rates of growth in appropriations to water-related research projects experienced immediately following the creation of the HSD water sector (1,016% net growth rate in appropriations between fiscal year 1974/75 and 1975/76), the trend in the net rate of growth in appropriations to water-related research projects remains constant. Significant variation in annual net growth rates in appropriations made to water-related projects did occur. In several instances, the annual rate of growth of the appropriations level for water-related projects exceeded that for total Division appropriations (1976 - 1978; 1982 - 1985; 1986 - 1987). For the remainder, it was less.

FIGURE 4.14

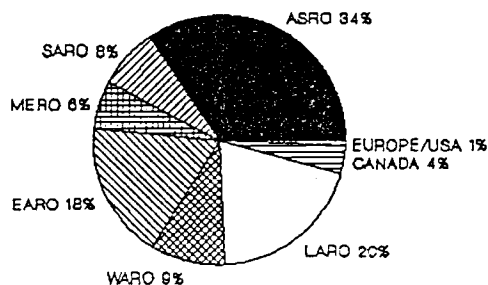
#### HSD % INCREASE IN ANNUAL APPROPRIATIONS WATER-RELATED RESEARCH PROJECTS 1978-1989



• up to April 1990

FIGURE 4.15

#### HSD APPROPRIATIONS BY REGION WATER-RELATED RESEARCH 1974-1989\*



• up to April 1990

The largest proportion of sector-related appropriations were made to support research projects in south-east Asia (\$5,828,632, or 34% of total appropriations to water-related research

projects). Institutions in Latin America received the second largest proportion of appropriations (\$3,361,971, or 20% of total sector appropriations). Institutions located in east and southern Africa accounted for the next largest proportion of total grants made for water-related research projects by the Division (\$3,022,397, or 18% of total appropriations for water-related projects). WARO, SARO and MERO ranked respectively fourth, fifth and sixth, in terms of their proportional share of total appropriations made by HSD for water-related research projects. Canadian-based research projects accounted for only 4% of total sector appropriations.

A review of the quantitative aspects of the water-related projects approved by the Division over the past 16 years indicates that:

- a total of 155 research teams received grants from the Health Sciences Division for water-related research. Of these, 139 were located in 45 developing countries. The remainder were located in North American (13) and European-based (3) agencies/institutions.
- the Division provided monies to only 2 projects developed and administered by other Divisions. These are: a joint AFNS/HSD financed project examining the technical efficiency of deep well solar pumps in West Africa; and, a joint ISD/HSD financed project, to support the further development and evaluation of an information exchange network system among Asia-based NGOs. By contrast, the Division has received funds from other Divisions for a total of 11 projects administered by the HSD.
- a shift in emphasis occurred in terms of the range of projects supported from a concentration for support of investigations on the development and assessment of the technical qualities of water pumping technologies to a more broad-based approach, covering management and human behaviour issues relating to water supply delivery, collection and storage, water purification and wastewater disposal/treatment and reuse, and water quality assessment techniques;
- of the 45 countries in which HSD supported water-related projects, 17 (or 35%) received support for only one project between 1974/75 and 1989/90. Institutions in 20 countries received grants for more than 1 but less than 5 water-related projects over the same period. Only 8 countries registered more than 5 approved projects in this field of study (Table 4.4).
- In rank order, the countries which were the most frequent recipients of grants for water-related projects from the Health Sciences Division over the 16-year study period were:

Thailand	- 17 projects
Malaysia	- 10 projects
Philippines	- 7 projects

TABLE 4.4

FREQUENCY DISTRIBUTION OF WATER-RELATED  
PROJECTS/COUNTRY  
SUPPORTED BY HSD 1974 - 1989  
BY GEOGRAPHIC REGION

Region	Number of projects approved/country			
	1	2-4	5+	Total
M-East/N. Africa	5	1	-	6
Asia	2	4	5	11
LA/Caribbean	3	8	1	12
Sub-sahara Africa	7	7	2	16
Total	17	20	8	45

LOCATION OF RESEARCH PROJECTS RELATING TO WATER (excluding DAPs)  
SUPPORTED BY HSD 1974 - 1989

[illegible]



TABLE 4.5 (CON'T)

LOCATION OF RESEARCH PROJECTS RELATING TO WATER (excluding DAPs)  
SUPPORTED BY HSD 1974 - 1989

YEAR	74/75	75/76	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	TOTAL
<u>LATIN AMERICA</u>	1	1	-	2	-	1	4	1	-	1	1	11	4	-	5	1	33
Peru	1	1									1	3 <sup>3,8</sup>					6
Brazil				1								1 <sup>3</sup>			1		3
Panama				1		1							1				3
Guatemala							1	1									2
Bolivia												1 <sup>8</sup>	1				2
Ecuador							3					1 <sup>8</sup>					4
Honduras													1				1
Colombia										1		2 <sup>8</sup>			1	1	5
Chile												2 <sup>3,8</sup>			1		3
Costa Rica													1		1		2
Mexico															1		1
Venezuela												1 <sup>8</sup>					1
<u>ASIA</u>	-	-	2	3	7	1	1	2	2	10	9	5	4	6	4	3	59
Singapore			1			1				1 <sup>3</sup>		1					4
Thailand				1	3 <sup>2</sup>		1	1		3 <sup>3</sup>	1	2	1	1	1	2	17
S. Korea				1						1	2						4
Bangladesh				1							1					1	3
Malaysia			1 <sup>4</sup>						1	2 <sup>3</sup>	1		1 <sup>2</sup>	1	1		10
Philippines					2					2	1	1		1	1		7
Sri Lanka					1 <sup>2</sup>					1							3
India					1						1	1	2 <sup>2</sup>				4
Indonesia								1	1	1				1	1		5
Nepal											1						1
PR China														1			1
<u>CANADA/OTHER</u>	-	1	4 <sup>4</sup>	3	-	-	1	-	1	-	-	2 <sup>8</sup>	2 <sup>2</sup>	1	-	1	16
TOTAL	1	3	9	12	9	4	8	4	5	14	15	24	13	12	14	8	155

<sup>2,3,4</sup> REFERS TO THE NUMBER OF COMPONENTS IN A PARTICULAR PROJECT. HENCE, 2<sup>3</sup> INDICATES THAT ONE OF THE TWO PROJECTS FUNDED IN A PARTICULAR COUNTRY/YEAR IS A COMPONENT OF A THREE-COUNTRY PROJECT.

- Kenya/Peru - 6 projects each
- Colombia/Indonesia/Ethiopia - 5 projects each
- the largest number of water-related research projects were approved for institutions in Asia (59, or 42%); in sub-Saharan Africa, 36 institutions carried out HSD funded water-related projects; in Latin America/Caribbean region, 33 institutions; and for the Middle East/North Africa, 11 institutions (Table 4.5).
- almost 50% (76) of the water-related research projects supported by the HSD were carried out by research teams located at academic institutions, 64 of these located in developing countries. The Division provided grants to 38 research teams located in government ministries and research centres; to 27 NGO-affiliated research teams; and, to 5 research teams located at international research and training centres. WHO received one water-related research project grant from HSD. The remaining 7 research grants were awarded to proprietary companies, publishing houses, and to IDRC itself for special research initiatives on water-related research issues during the early 1970s.

The Health Sciences Division took the lead in the early 1970s in matters relating to water issues. Based on the recommendations of the Burton Report and literature reviews by Divisional professional staff, there was a recognition within the Centre that one of the primary weaknesses in programs designed to deliver safe drinking water to rural populations was the lack of suitable pumps, specifically as relates to their durability, ease of maintenance, and related costs. In response to this situation the Division hired, in 1974, two professionals specialized in water supply technologies, specifically handpumps. The Rural Water Supply and Sanitation program decided to focus its attention to support research on the development and technical evaluation of handpumps with the following properties:

1. their fabrication, as far as possible, should be in developing countries; and,
2. they must be reliable, have a reasonable cost, and should be maintained by the villagers.<sup>13</sup>

By 1975, the program had embarked on developing a framework for a strategy for improving water pumping technology.

Following closely on the deliberations and recommendations coming from the Water Conference in Mar del Plata, Argentina in 1977, the focus of the Rural Water Supply and Sanitation Program expanded. A review of the distribution of water-related projects indicates a definite concentration of effort on the development of innovative water pumping devices over the next five year period (Table 4.6). At the same time, the Division also identified and provided support for several projects relating to the development of strategies for use by rural populations in maintaining improved water supply facilities. The program would also continue to support research relating to the safe disposal and treatment of wastewater, with particular emphasis on the technical efficiency of waste stabilization ponds. The program would also seek to support research to demonstrate the potential of making sewage disposal profitable by using treated wastes as a food for fish production.

Over the period 1979/80 to 1983/84, a shift in emphasis occurred in the substance of water-related projects. A greater emphasis was placed on the evaluation of technologies already in existence rather than on the development and experimentation with new technologies. More support was also given to research on the impact of water interventions on the health and well-being of the intended beneficiaries of improved water supply facilities, and water system-related management issues (capacity of communities to install and maintain water supply facilities). As noted in the Program of Work and Budget for 1981/82:

*This (shift in emphasis) has largely come about from experience gained over the past five years; it became obvious that technology by itself was not the bottleneck. Rather, cost, implementation, acceptance and maintenance at field level were and continue to be the crucial factors in the success of the method chosen.*<sup>14</sup>

By 1983/84, the sector had supported the establishment of networks of researchers, specifically related to the handpump research initiatives. The sector also embarked on research to identify a low cost and rapid means of assessing water quality, in response to a recognition of the expense and highly sophisticated process involved using conventional techniques. Environmental health issues also received increased attention and financial support. A topic that received an increase in support was the impact on water quality of industrial effluent discharged into rivers, and the implications for health.

By 1985/86, the breadth of subject areas supported under the Water Supply and Sanitation Sector (the Rural designation was dropped in 1983) had increased. Research on water quality issues (the development and technical appraisal of innovative water quality analysis techniques and surveys of water quality in freshwater resources) received increased attention, as did investigations into alternatives to groundwater for drinking water (rainwater harvesting), and the evaluation of intervention strategies. The sector also gave support to research on community-based strategies to control the impact of tropical diseases (specifically schistosomiasis and dracunculosis). This latter activity was a departure from the research agenda pursued by the WHO and IDRC Tropical Disease Research program, both of which concentrated on the epidemiological and clinical aspects of these diseases, and on the development of new, simpler diagnostic and therapeutic methods.

When the Division was restructured in 1988, the annual total appropriations to water-related research projects was approximately \$2 million. A review of the distribution of water-related projects for the two years preceding the dissolution of the Water Supply and Sanitation program indicates that no particular topic predominated. The number of water-related projects was distributed equally among three areas of interest: water supply retrieval technology development and appraisal; water quality surveys and the appraisal of water quality analysis techniques; and impact studies and managerial issues.

With the restructuring of the Division, responsibility for the identification, development, approval and administration of water-related research activities within the division were reallocated among the new program designations. The defined areas of interest for the Health Systems and Health and the Community programs do not explicitly list water as a central theme. However, the issues that comprise the focus of these programs are common to the current and emerging priority water issues. For example, the Health and the Community program's emphasis on support to research on the development and testing of health education materials, and the process and impact of health and hygiene education strategies, investigation into the effectiveness and impact of community-centred interventions to improve health, the introduction, dissemination, and use of technologies, and the study of the contextual and behavioral aspects of the transmission of communicable diseases lends itself to support of water-related research projects on these issues.

The definition of the interest of the Health Systems program, with its emphasis on the policy, planning and managerial aspects of services, and its support to research on the development of measures to determine health status and surveillance systems for health-care needs assessment, monitoring, and evaluation is consistent also with many of the issues that are priorities for the water sector. As described in the previous chapter, increasing emphasis is being placed on the capacity of communities to manage water delivery systems.

One of the principal themes of the Health and the Environment program relates to water and water use. Many of the projects being supported by the Division at the moment of the restructuring were transferred to this program. The primary water-related subject areas supported within this program relate to issues of water accessibility through technical improvements to water retrieval, storage and delivery systems, water quality monitoring issues, environmental surveys of water resources, wastewater disposal/treatment and reuse, and the technical assessment of village-level water treatment technologies and household level water purification techniques. This program provides support as well to research relating to the control of water-based vectors of parasitic and infectious diseases at the community level, through the investigation of water management approaches and systems for domestic and agricultural uses designed to control the ecology of infectious and parasitic disease vectors. Consideration is also given to the impact of water resource development and exploitation schemes upon the physical, social and health ecology of communities and regions.<sup>15</sup>

A retrospective analysis of the distribution of HSD-supported water related research projects for the fifteen year period under study reveals that they can be categorized along six major themes: water supply retrieval and delivery systems; water quality assessment techniques; water purification/treatment technologies; surface and groundwater quality assessments; wastewater treatment/resource recovery and reuse; and, health/environmental impact of improvements in water supply facilities. The outcomes and achievements of the projects related to these themes have not been fully documented. The following provides an overview of the primary achievements of the projects, the research framework elaborated by the Division to guide its funding decisions, and an indication of some of the priority research issues that remain to be addressed, for each theme.

#### *Water Supply Retrieval and Delivery Systems:*

- handpump technology development and technical assessment (15 projects - \$2,857,914)
- managerial/organizational aspects (12 projects - \$2,051,870)
- passive energy water retrieval and delivery systems (9 projects - \$978,485)
- rainwater harvesting and storage systems (9 projects - \$610,460)

When the Division embarked on this important area of research in the mid-1970s, it did so based on a narrowly-defined, but none the less timely and relevant research question: would the use of polyvinyl chloride (PVC) in a handpump's below-ground components serve to produce a more robust, less expensive, and easy-to-install and maintain water retrieval device? The research began in 1976 at the University of Waterloo. Handpumps of the day had many flaws, including tendency to corrode, difficult maintenance and unavailability and expense of spare parts. The research effort aimed at addressing these problems by developing a new, simple, low-cost PVC piston and foot-valve assembly for a manual shallow-well handpump. The design offered many new features, including the use of plastics and making the piston and footvalve interchangeable, thus saving costs related to their manufacture, simplifying maintenance procedures, and keeping the required number of spare parts to a minimum.

At the time, Centre documents indicate that those involved in the development of this research initiative had no knowledge of the substantive issues that would arise as a result of the lessons learned from the Centre's experience in support of this research effort. The responsive and open-ended approach that characterizes the Centre's strategy to project identification and development permitted

it to capitalize on the wealth of information emanating from the projects, and to broaden the scope of the handpump-related research over the years.

The result was a comprehensive and wide-ranging assortment of research projects relating to handpumps. A retrospective review of these projects indicates three distinct stages in the conceptualization and implementation of the 'handpump' projects, following upon the results of the Waterloo-based research. A series of Phase I projects (1977 - 1982) took place in Ethiopia, Malawi, Thailand, the Philippines, Sri Lanka and Malaysia. Their objective was to investigate the technical viability of using plastic materials for the manufacture of below-ground components for a shallow-depth handpump. When this was found to be viable, Phase II (1982 - present) was initiated to study the technical performance of the handpumps under field conditions, and to investigate the social, economic and other factors related to their local manufacture, and their installation and maintenance by villagers. The Phase II projects took place in several countries in Asia, Africa and Latin America.

The encouraging results of the Phase I and II projects in Malaysia led IDRC to provide further funding for a Phase III project (1988 - 1991). This project aimed at promoting the widespread commercialization of the UNIMADE handpump technology as well as the establishment of a Regional Research & Training Centre at the University of Malaya. It is expected that at the end of the project, self-sustaining indigenous manufacturing units will have been established in several LDCs. The R&T Centre in Malaysia is expected to continue to conduct research to develop new materials and designs not only for handpumps, but also for other water supply technologies. It will also provide training to LDC people in the manufacture, installation and maintenance of the handpumps. The Centre should be self-sustaining.

From the very beginning, a handpump was considered by the Division and the Centre to be more than just a scientifically sound device. It represented the techniques, methods and know-how which together with the handpumps, had to be acceptable to users and decision-makers alike. Additionally, handpumps were not perceived solely as a means of improving access to and decreasing the effort of drawing water from subterranean sources. They represented as well an important element in public-health, when combined with correct health and hygiene behaviours.<sup>16</sup>

Fostering the development of indigenous expertise has been an important element common to all handpump projects. This perhaps remains today as the most unique characteristic of the Centre's contribution to the development of improved water pumping devices. It includes giving the opportunity to national groups to improve their knowledge and practical experience on the technology, on research and development, as well as about the social and administrative aspects of a technology introduction process. Technology transfer cannot be reduced to the transfer of information necessary to reproduce, operate and maintain handpumps. The path to self-reliance can only begin by allowing recipients of a technology the freedom to rely on their own experience, know-how, initiative and creativity. The expertise created through HSD support to handpump-related applied research projects in developing countries is an important resource for the future.

Another unique characteristic of the Centre's slate of handpump projects is their focus on development, with the emphasis placed on people, not on hardware.<sup>17</sup> The elusive search for a 'perfect' handpump is a dead-end in itself. The original objective for this piece of hardware was, and remains, to improve the living conditions of the poor and disadvantaged by decreasing the burden of transporting water long distances, and by offering protection against water-borne diseases.

As mentioned earlier, at the outset of HSD support for research on handpump technology, no one envisaged where this initiative would lead. It was only in 1986, and based on ten years'

experience, that a framework for a comprehensive strategy on handpump research, inclusive of issues pertaining to the commercialization and dissemination of the technology, was elaborated.<sup>18</sup>

Many of the handpump projects remain active, or have only recently been completed. It is not possible at this juncture to discuss the findings specific to each project, as an assessment of their technical reports must still be undertaken. However, there are several general conclusions that can be drawn from the experience to date. These include:

- a demonstration of the utility of plastics in the manufacture of handpumps;
- transferring a technology to different social, economic and technical settings requires the concomitant transfer of information to community members necessary to adapt, operate and maintain the handpump in its new environment. This includes the transfer of knowledge about the principles of a handpump's design;
- strategies to promote the successful introduction, use and maintenance of a new technology are culture-specific. There is no singular approach to the technology transfer process;
- social, economic and managerial issues related to the acceptance and use of the handpump, as well as the active participation of community members in decisions concerning issues such as the siting of the handpump and operating and maintenance schemes, were found to be critical factors that influence the success or failure of the technology transfer/introduction process;
- there exist a variety of institutional arrangements for the manufacture of handpumps in developing countries; and,
- at the community level, handpumps evoke a powerful image as a source of clean water and good health. This offers NGOs an ideal vehicle upon which to base community organization and development strategies, and to promote the concept of community-centred development.

The experience to date gained from the HSD-supported handpump projects, together with that from projects supported by other donor agencies, indicates the existence of several important issues related to research on handpump technology development and transfer that remain to be addressed. Among the more important are:

- there remains much to be learned about community-based management of water supply facilities and services. Many assumptions have been made concerning the expected roles and responsibilities of communities, and of specific sectors within communities, regarding repair and maintenance schemes for handpumps. However, there are few scientifically documented studies that demonstrate the cost-effectiveness and socio-economic impact of such strategies;
- in a related vein, hygiene and health education have tended to be treated as 'black boxes'. While many different approaches, tools and materials have been produced and used, there is little information about their effectiveness in causing a change in water-related behaviours; and,
- there is a lack of knowledge about the feasibility, effectiveness, or impact of different institutional arrangements for the manufacture and commercialization of handpumps in developing countries.

Several evaluation studies are to be conducted during the Phase III project. These include an evaluation of the achievement of project objectives with respect to technology dissemination and utilization; and evaluation of the commercialization strategy, the telematics network and R&T Centre activities; and an evaluation of the communications strategy used to disseminate the handpump technology. The evaluative studies relate only to the Phase III Malaysia project. None are directed at the Phase II studies taking place in other LDCs. To date, no evaluation of the handpump projects has been carried out, other than the review of the technical reports submitted by the research teams, but an in-depth review is proposed. Following the restructuring of the Division in 1988, a decision was made not to invest further in the development, field-testing and promotion of handpumps.

The Division has provided support also to projects relating to three other issues concerning water retrieval systems: the development and testing of passive energy water retrieval systems; the development, technical assessment, and application of rainwater harvesting (collection and storage) technologies; and, the technical assessment intermediate-level technologies for the improvement of water supply sources, such as bailer wells, and ferro-cement well construction techniques.

The results and achievements to date of these projects is mixed. For example, although the potential for the use of solar-powered pumps for irrigation and community water supplies exists, the lessons from the two research projects funded to date on this topic are not encouraging. The systems tend to require sophisticated equipment and supplies, some elements of which are not easily found in developing countries, or if available locally, are extremely expensive and not always procurable. The research on the solar distillation of brackish water yielded very interesting technical data on locally-produced solar stills and information on the factors that affect their effective management by community members. However, other than this experience, the Centre has not received any further requests for research support on this topic. The Division also provided support to three research projects on wind-powered pumps. The results of two of these studies provided the basis for the development of windmill-powered pumping systems in southern Africa. The results of the third project on this topic were inconclusive, and are not expected to have a significant impact on the further development of wind-powered pumps.

Very little attention has been paid by donor agencies to support of research on the development and assessment of what are termed intermediate technologies for water supply. The focus of research on water supply technologies over the past decade has been on handpumps. There is now recognition that the coverage targets for the IDWSS Decade cannot be achieved. What is required is research into models and construction techniques to improve wells, approaches that do not require significant financial input and that can be easily managed by the communities. What is required are research projects relating to the comparative advantages of various intermediate water supply improvement technologies, in terms of their construction techniques, costs (both capital and recurrent), maintenance and management approaches, and their impact on health.

The Division gave support as well to several projects investigating the design and technical performance of various rainwater harvesting and storage technologies, most notably the use of ferrocement construction techniques for storage tank construction through community-based initiatives. Studies relating to other aspects of the use of rainwater for domestic purposes have also received support. These include investigations into the quality of rainwater collected from roof catchment systems, and the attitudes, practices and knowledge of people about the use and handling of rainwater for domestic purposes.

Several of the projects specifically related to the development of water retrieval technologies have included components to study various modes of community-based approaches to manage water supply facilities. The results of the individual projects vary, but the general conclusion that can be

drawn from them is the higher degree of community support for water supply improvement schemes when community members are enabled to assume authority and responsibility for their repair and maintenance. The Division anticipates the development of several projects to carry out a comparative evaluation of the effectiveness and impact of participatory schemes for village-centred maintenance schemes with conventional management approaches. These are a product of a joint UNDP/IDRC/World Bank-supported initiative on the development and testing of participatory tools and techniques for monitoring and evaluating water supply and sanitation facilities and systems, launched in 1990.

*Water Quality Assessment and Management:*

- development and application of water quality assessment techniques (5 projects - \$656,663)
- development of software for analysis/management of water quality data (1 project - \$98,980)

Water quality monitoring is a necessary component for the efficient and sustainable development of drinking water resources. Without appropriate and continuous monitoring, water supply programs (source selection and protection; treatment; distribution; operation; maintenance; and, upgrading) cannot be implemented effectively. Unfortunately, most rural drinking water sources in developing countries are seldom evaluated on a consistent basis, if at all.

Conventional standard microbiological tests for water quality have several inherent disadvantages for routine use in developing countries: they are based on procedures that require specialized personnel; requisite equipment and supplies are expensive, difficult to transport into areas that are not easily accessible, and may not be readily available; and, they may require expensive support systems. Consequently, only the more developed countries can afford to implement them. And even then, their use is usually restricted to communities that are easily accessible by road.

Other fundamental problems with current water quality control programs include the lack of practical and clearly defined strategies for monitoring, and the lack of appropriate means for utilizing the limited amount of data collected. Very often, much of this information is recorded on laboratory forms and stored in files. Little attempt is made to collate and analyze the data. Consequently, most ministries responsible for water resource management and the monitoring of water quality have little knowledge about the current status of their rural water supplies. Where this information exists, it is rarely used in the planning and management of drinking water resources.

The Health Sciences Division began to support research on water quality assessment procedures in 1983. By the end of fiscal year 1989/90, HSD appropriations to the five projects and three DAPs relating to this research effort totalled \$718,598. The research activities have so far focused on three distinct aspects of water quality assessment:

- the development and testing of rapid, inexpensive and technically simple and reliable microbiological water quality tests for use in the monitoring and classification of drinking water sources;
- their application, and investigation into a community-based management system for water quality assessment and monitoring; and,



- the development and testing of a computer software package for the management and analysis of drinking water quality data.

The projects related to the first objective evaluated, modified and adapted existing tests to the particular conditions and needs of Asia (Malaysia, Thailand, and Singapore), Latin America (Brazil, Chile and Peru), and north Africa (Morocco and Egypt). Researchers from the National Water Research Institute (NWRI) of Canada assisted the research team in the statistical analysis of the research data.

The tests investigated include: Presence/Absence (P/A); the H<sub>2</sub>S paper strip; A-1 broth; and the use of coliphage as indicators. Comparative evaluations with standard coliform tests were carried out. The results of the experiments indicate that the H<sub>2</sub>S and coliphage tests were the most promising for the assessment of remote water sources and their classification. They also determined that both tests should be modified and refined, to improve their validity, reliability, and utility. For example, the researchers determined that the H<sub>2</sub>S test, which is a qualitative test (ie. it indicates only the presence or absence of microbiological contamination) could be improved by modifying it to become a quantitative test. There was also a need for further study of the effect of non-coliform bacteria on its sensitivity. For the coliphage test, the researchers recommended further study of the effects of water quality and the selectivity of bacterial host strain(s). Additionally, its applicability to assess water treatment efficiency (such as disinfection) merited further study.

The research also served to establish guidelines for water quality sampling strategies and tests, and to link them with the goals of the water quality monitoring exercise. The results of the research projects demonstrated that the testing of untreated drinking water sources and treated or disinfected drinking water sources require different strategies. The former must first be classified in relation to their microbiological quality (degree of faecal contamination and ensuing potential presence of pathogens). Once found suitable to be drinking water sources, they must be reevaluated on a regular basis. The initial classification and the ensuing surveillance require quantitative tests. On the other hand, treated or disinfected water sources must be tested to assess the efficacy of treatment in the removal of pathogens and/or to indicate whether recontamination by faecal material has occurred. This requires highly sensitive tests, which can be either quantitative or qualitative (presence or absence detection).

The Malaysia-based project resulted as well in the development of a prototype coliphage field test kit.

It should be noted that the intent of this research initiative is not to replace the internationally accepted indicator organisms for bacteriological water control (coliforms and faecal coliforms), nor their related standard procedures. Although these may possess several inherent shortcomings that limit their utility for developing countries, they are the accepted standards, based on the large amount of experience accumulated over the forty years that they have been in use. This situation is unlikely to change over the short-term, and most rural drinking water sources in developing countries will remain unevaluated unless more appropriate tests are developed and applied.

The application of the water quality tests, and the study of appropriate strategies to support community-based management of water quality assessment exercise is currently being carried out in a small, isolated community in northern Manitoba. The research team consists of members of the Split Lake Band of First Nations. Researchers from NWRI are assisting the research team, to train them in water quality testing procedures, and to develop a prototype, basic laboratory to be run by community members. The project will also develop a water quality monitoring protocol, and evaluate the suitability and effectiveness of the four tests under prevailing environmental and social conditions. No conclusions can yet be drawn from this experience, as the project is still active.

The microcomputer software package for the analysis and management of water quality data was developed through a collaborative project between the Department of the Environment (Malaysia), the University of Malaya, and researchers at NWRI. This project resulted in the development of uRAISON, a user-friendly software package with enhanced graphics presentation. It is an adaptation of an existing software package known as RAISON, developed by researchers at NWRI and the University of Guelph for the regional analysis of acid rain data in Canada. The Malaysian research team, with the assistance of NWRI personnel, successfully modified and adapted RAISON to handle the information management needs of the Malaysian Ministry of Health for its rural water supply, sanitation and drinking water quality surveillance programmes. The software utilizes data from a variety of sources, such as: demographic information; epidemiological data for water-borne diseases; results of water supply and sanitation service surveys; water resources data; and, climatic information. The information can be analyzed both spatially and across time. The salient features are the ease and rapid access to the relevant information data bases and the multimode graphical presentation capability in relation to the geographical locations of drinking water sources.

Since April 1990, two projects, representing subsequent phases to the research investigating the water quality assessment tests, have been approved for funding by HSD. The projects include both laboratory and field-based research activities. The Latin American-based projects will seek to improve the H<sub>2</sub>S and coliphage tests, and to examine their suitability for field use through comparative trials using standard procedures. A second prototype field kit, suitable for production and dissemination, is to be developed by the Malaysian research team. This project also seeks to study the relationship between coliphage counts and the presence of specific bacterial and viral pathogens, and to assess the versatility and robustness of the field kit.

The Division supported a workshop, held in Thailand in December 1989, to disseminate information about the development and application of uRAISON, and to determine the utility of uRAISON and future research and development activities. Participants included the directors of departments and agencies that are responsible for water quality surveillance programs from 4 Asian countries (Thailand, Philippines, Malaysia and Indonesia). Representatives from Thailand and the Philippines expressed an interest in the training of administrators and planners in their respective countries on uRAISON, adapting the software package to local needs (eg translation into Thai; incorporation of specific database and data analysis techniques); and, evaluating its effectiveness in policy and planning with respect to water resources management.

The Ministry of Health (Philippines) has submitted a proposal to this effect. A companion proposal from the Ministry of Health (Thailand) is expected to be submitted shortly. Discussions with NWRI have also taken place, to determine their role in any future research activities, and expectations concerning the potential to enhance uRAISON. Researchers at the Office national d'eau potable in Morocco and at CEPIS in Peru have indicated an interest in developing similar proposals. HSD and ISD are studying together the potential for funding for these projects.

*Water Purification and Treatment:*

- filtration systems (13 projects - \$821,045)
- solar radiation/natural coagulants and filters (5 projects - \$436,135)
- other techniques (2 projects - \$141,600)

The first water-related project supported by the Division, in 1974, evaluated the performance of an existing water treatment plant located in Lima, Peru, to determine the type of modifications needed to improve its operational cost-effectiveness. The majority of the projects supported by HSD on this topic related to the assessment of the performance and design criteria for various types of water treatment systems. It was not until 1988 that a project on the management aspects of water treatment systems was financed. Although it is still technology-linked, the emphasis of the research is the capacity and strategies for the community management of water treatment systems. To date, no comprehensive review has been conducted concerning the eight projects relating to this topic.

The purification of drinking water is essential to ensure that its consumption does not lead to infection, ill-health and incapacitation. The pretreatment of drinking water in most developing countries is beyond the capabilities of most individuals and households for a variety of reasons, among these: the time required to disinfect water; costs related to obtaining materials required to disinfect water (wood; chemical reagents) and their availability; and, lack of knowledge regarding the relationship between quality of water and health (or lack thereof).

Solar radiation (or solar water disinfection - SWD) to purify drinking water is another technique to purify drinking water. The Centre supported several activities related to research on the subject of the disinfection of drinking water by solar radiation. The use of solar radiation to disinfect water is not a new idea, although its application is limited. Some research was carried out in the late 1970s on the effect of solar radiation on the quality of water used to prepare oral rehydration solution. IDRC became involved in research on this issue through support to two projects. The first sought to determine the relationship between socio-economic status of community members and the quality of water consumed, and the development of design criteria, construction, and laboratory-based evaluation of the performance (including effect on bacteriological properties of water) of small-scale disinfection units. The second, examined the effectiveness of a continuous-flow solar disinfection unit to eliminate pathogenic organisms, and studied its feasibility for domestic use.

Other research on the application and utility of solar radiation was carried out in several developing countries, with financial support primarily from the Integrated Rural Energy Systems Association (co-sponsored by the United Nations University and the Brace Research Institute (Canada)). HSD, in collaboration with INRESA, co-sponsored the first international workshop on solar disinfection of water in August 1988. The purpose of the meeting was to review the state-of-the-art in solar disinfection of water research; to develop guidelines on testing procedures; to develop field testing protocols for the introduction of solar radiation of water at village level; and, to identify current research priorities and emerging issues. The meeting identified several constraints related to the successful application and utility of solar radiation disinfection techniques as popular methods for improving the quality of drinking water. Among the more important are:

- the specificity of conditions that must be met in order for solar radiation techniques to be effective: non-turbid water; low to intermediate bacterial load; continuous solar intensity of at least 500 W/m<sup>2</sup> for at least five hours; the use of non-coloured containers; and, the restricted volume of water that can be disinfected at one time (dependent on container size);
- there are indications of a certain bacterial resistance to inactivation and of a quick recovery after sublethal injuries by UV radiation;
- the presence of suspended solids, solutes, turbidity and/or colour in the water, and other microbial populations may enhance bacterial survival; and,
- the lack of information of the practicality and acceptability of the process at the community level, and of its comparative cost-effectiveness with other methods of water purification.

Meeting participants identified several current and emerging research issues that merit further study. These include further laboratory-based investigations about the inactivation of pathogenic bacteria, viruses, protozoa and helminths by solar radiation; the development of criteria regarding the effectiveness of solar radiation in improving water quality in relation to the suspended solids, turbidity, etc.; and, research into the development of prototype solar water disinfection units for use at the village and household levels, and the evaluation of their performance and acceptability under field conditions; and, to develop materials to disseminate information about the effectiveness of a solar radiation techniques to disinfect water, to a wider audience.

After careful deliberation and consideration of the achievements of HSD-supported research and research supported by other agencies, and the recommendations of the solar water disinfection meeting, the Health and the Environment program decided not to provide further support at this time, believing it not to be an issue of high priority for continued Divisional support. The reduction in funds available to the program to support research projects, the shifting emphasis within the Division away from a 'technology-fix' philosophy, the issue of the practicality of the application of solar disinfection techniques at the village and household levels, and the attendant systems management issues, as well as the emphasis on laboratory-based research over the short-term were the factors that influenced this decision.

An area that has received support from the Division, and that is a subject that the Health and the Environment program perceives as an issue meriting further study and support for research relates to the use of natural materials and traditional methods for water purification. HSD has provided support to two research teams studying the use of natural materials (ash from rice-husks; coal-based materials) for water purification at the household level. The projects are investigating as well design criteria for and the performance of simple, low-cost water filters for domestic use. The preliminary conclusions from the projects are promising.

Many traditional societies have developed and use a wide variety of methods to improve the quality of drinking water. Dr. Samia Al Azhara Jahn, with financial support from GTZ, carried out in the late 1970s a pioneering study on the nature and effectiveness of various traditional water purification techniques.<sup>19</sup> She demonstrated that natural substances, such as seeds from the tree *Moringa sp.* are effective natural coagulants for treating turbid water. Rapid, effective destabilization of the colloidal material, with its associated bacteria, followed by the subsequent removal of precipitated floc (the loosely aggregated mass of suspended fine particles) is an effective means of improving water quality. A large number and variety of natural substances, such as plant species, bark resins, ashes, shells, clays, and other materials have been examined for their coagulating properties.

The advantage of the use of natural coagulants is their ready and local availability, low cost, ease of use, effectiveness, and their apparent non-deleterious effect on human health. This is not to say that there are no negative side effects of the use of natural coagulants to improve the quality of drinking water. Dr. Jahn observed in experiments in the Sudan the propensity of an increase in the bacterial load in water under treatment with natural materials. This is attributed to the organic material present in the coagulant, which is thought to provide additional substrate for the growth of bacteria. However, proper additional disinfection of the water should be effective in killing the bacteria.

There has been little research since Dr. Jahn's work on the use of natural materials for water treatment at the rural village and household level, nor studies on traditional water treatment methods. The Health and the Environment program has determined this to be an area that merits further research, not only as regards the technical aspects, but also the knowledge and behaviours associated with the practice. The Division has not, as yet, supported research on this topic. The use of traditional methods, in combination with other water purification techniques, whether using household filters made of natural materials, or larger-scale filtration techniques, both in terms of their technical effectiveness to improve water quality, and the associated management and socio-cultural aspects of the application of these techniques, merits further study.

*Surface and Groundwater Quality Assessment (11 projects - \$1,627,833):*

The focus of the projects assigned to this theme vary widely. The majority relate to the assessment of water quality in surface water sources. The rapid industrial expansion characterizing many developing countries, combined with the growth in the use of chemical-based fertilizers and the failure of municipal and national governments to maintain existing and construct new waste/wastewater collection and treatment systems to keep pace of the growth of urban populations and the territorial expansion of cities, increase the probability of severe and chronic contamination of surface and groundwater resources. The uncontrolled discharge of raw effluent into surface watercourses, and the propensity of many riverine residents to draw water for domestic use directly from the river has serious implications for human health.

The majority of the surface water quality assessment projects had as their objectives to identify and classify the sources of pollution; to develop a water quality assessment protocol; to collect and analyze water samples for their physical, chemical and bacteriological quality; and, to investigate the status and functional effectiveness of existing wastewater treatment systems. Some have also examined existing water quality legislation, to determine its application. One large project in Latin America seeks to determine the relationship between exposure to water contaminated by heavy metals, and the health of riverine populations. No comprehensive overview of the achievements, lessons learned, or the remaining and emerging research issues related to the projects has been carried out.

The Division has also provided support to two projects that investigate the contamination of groundwater by on-site sanitation facilities. On-site sanitation facilities, particularly pit latrines, are being widely promoted and introduced as an initial step in improving human waste disposal. This is particularly true for the low-income areas of many African and Latin American cities. They present, however, two potentially serious disadvantages: the risk of groundwater contamination from pathogenic microorganisms; and, the health risks associated with handling excreta either while emptying the pits, or in using the untreated excreta as a fertilizer. There are also environmental and health concerns relating to the flooding of latrine pits during rainy season. The projects are investigating several issues:

the survival of human pathogens in latrine pit contents and the surrounding subsoil; the relationship between latrine pit volume, retention time and emptying frequency; the collection of hydrogeological data on contaminant movement in shallow, unconfined aquifers; and, the development of guidelines for the siting, design and construction of on-site latrine facilities and on-site water supply systems (dug wells and boreholes). No conclusions can yet be drawn from these research efforts, as field activities for both projects are on-going.

Other projects assigned to this theme included studies of the sources and levels of fluoride in drinking water, its relationship to fluorosis, and defluoridation methods for water; the development of a biological monitoring scheme to assess water quality using macroinvertebrates; and, to determine the content of arsenic in drinking water, and to develop and test the efficiency of a small-scale arsenic removal system.

*Wastewater treatment/resource recovery and reuse (16 projects - \$2,992,042):*

As with research about water treatment/filtration systems, much of the support provided by the Division to research on wastewater treatment and resource recovery has focused on studies of the technical performance of the various systems, and their design criteria. In recent years, the Division provided support to several projects that are also investigating the implications of the reuse of wastewaters for agricultural purposes, specifically the irrigation of market crops. The potential health hazards associated with wastewater irrigation are not fully understood. These projects are assessing the sanitary and toxicological acceptability of raw and treated wastewaters for irrigation, identify and compare the risks associated with the presence of parasites, bacterial organisms and synthetic organic chemicals in river water and wastewater used to irrigate market crops, and to establish guidelines for monitoring and controlling the reuse of wastewater for agricultural purposes. To date, no comprehensive review of the projects relating to this topic have been carried out.

*Health/environmental impact of improvements in water supply facilities (15 projects - \$2,230,133)*

The Division has provided support to very important research on this topic. Many have studied the relationship in the incidence and prevalence of parasitic and infectious diseases as a result of the installation, correct use and maintenance of improved water supply facilities. Several of the projects have also investigated the impact of innovative water-related health and hygiene education strategies, particularly as they influence human behaviour relating to water handling and use, and the incidence and prevalence of water-borne diseases. However, many of the projects relating to this subject have tended to follow what can be described as a conventional and conservative approach: that of investigating knowledge, attitudes and practices of people, without an understanding of the contextual and proximate variables that account for the perceived behaviours. Also, several of the socio-economic studies have been adjuncts to technology-oriented projects. Little attention was paid to linking the findings of the socio-economic studies to the technology introduction and assessment activities.

The Centre has supported the publication of a landmark report that reviews experiences of field-level investigations concerning methods to measure health impact accruing to improvements in water supply and sanitation facilities and changes in human behaviour.<sup>20</sup> The Division has also provided monies to research teams that are studying the decision-making process in rural villages as concerns

water supply and sanitation behaviours, and the capacity of villagers to undertake action to improve the status of the existing water supply facilities.

While the Division has provided support to a large number of projects relating to this topic, it has not carried out an overview of the lessons learned to date from such a wide experience.

#### *Non-project related activities*

Besides support to water-related research projects, the Division has been involved in several non-project activities within the sector. Divisional personnel have represented the Centre at a variety of international fora on water issues, as well as on committees and working groups studying water issues. Since 1987, HSD has assumed responsibility as the focal point for Centre participation on the Collaborative Council of External Support Agencies for Water Supply and Sanitation.

The Division and the Centre have been recognized and acknowledged by the Collaborative Council for their contribution to the promotion of and support to applied research on important water issues, and for the support provided to developing country institutions and individuals. In this context, the Council chairperson approached the HSD Director in early 1990, to determine the Division's and IDRC's interest and willingness to assume responsibility as the coordinating agency for a new initiative, known as the Global Applied Research Network on Water and Sanitation Issues (GARNET). The Temporary Working Group on Applied Research, commissioned by the Council in 1988 to examine the state of the art on water-related research issues, and to identify current and emerging issues that should receive attention during the 1990s, identified a lack of exchange of information on conceptualization of research issues and activities as a major constraint to progress to achieve the goals of the International Drinking Water Supply and Sanitation Decade. One of its recommendations proposed the development and implementation of an informal and decentralized clearinghouse on sector information, and the establishment of a decentralized system of networks on applied research on water issues. The goal of the initiative would be to strengthen the linkages between developed and developing country institutions and organizations involved in applied research efforts, and to encourage the timely exchange of information on experiences and lessons learned from research projects. GARNET was conceived as a means of achieving this goal. The activities envisaged for IDRC within this initiative include:

- the establishment and maintenance of a directory of current and emerging research topics on water issues;
- the dissemination of information about GARNET to institutions and organizations involved in applied research on water issues;
- the identification of agencies, institutions, and organizations that would be willing and be capable of assuming the role of coordinating agencies (TCAs) for networks relating to specific applied research issues and efforts;
- the development and maintenance of an inventory of the TCAs; and,
- the fielding of enquiries about research activities and opinion to the appropriate TCA.

The Division can be proud of the contributions it has made in increasing knowledge about sector issues, its support to applied research projects in developing countries, and the role played in improving the capacity of developing country individuals and their respective institutions to identify, develop, carry out and administer applied research activities. As noted previously, HSD has provided support to groundbreaking research on several issues. Some of the more noteworthy achievements of the research on water issues supported by the Division are:

- the development, technical assessment, dissemination and commercialization of handpumps that utilize below-ground components made of polyvinyl chloride (PVC);
- the development, technical assessment and application of passive energy water retrieval technologies, such as solar-powered pumps, hydraulic ram pumps, solar desalination devices, and rainwater harvesting and storage systems, and on intermediate-level technologies for the improvement of water supply sources, such as improvements in the design of traditional water supply sources and innovative well construction techniques;
- investigations into the issues relating to community-based management of water facilities and services;
- the development, field assessment and application of innovative, rapid, simple, and inexpensive water quality test procedures, and the development of an ancillary microcomputer software package for the management and analysis of data relating to drinking water quality;
- investigation into the relationship between the siting of on-site sanitation facilities and groundwater contamination;
- investigation into the health impact of community-based water supply improvement strategies, as an alternative to mass chemotherapy, to control water-borne parasitic and infectious diseases;
- the environmental assessments of water resources, particularly river basins;
- research on the health implications of the reuse of wastewater for the production of agricultural produce, and the factors that influence related water handling behaviour; and,
- investigations into the socio-cultural aspects of water, with particular reference to water transportation, storage and handling behaviours at the domestic level, and their effect on water quality and human health, and process documentation of decision-making on water issues and activities at the village level.

There are also several shortcomings that characterize both the Division's program relating to water-related issues, the decision-making process concerning Divisional support for water-related projects, and the project identification, development, and administration process. Principal among these are:

- the identification of water-related issues with one particular program within the Division: in the mid-1980s, the Division employed three professional staff involved directly in its Water Supply and Sanitation program. Their focus was the identification and development of water-related projects. Research on water-related issues was also an interest within the Division's other sectors, particularly the former Tropical and Infectious Disease and Occupational Health and



Environmental Toxicology sectors. However, in the interim, the Division has changed both its guiding philosophy about the nature of research that it will consider for support, and its program structure. The emphasis placed on water as a distinct and highly visible theme has diminished. Water issues are seen presently within the context of their implications for human health, and responding to the defined areas of interest and concentration of the Division's program, and not defined according to conventional criteria;

- a related issue is the technical expertise on water issues within the Division. The technical and scientific expertise of HSD professional staff has also changed. The program officers responsible centrally for water supply and sanitation activities have left the Division. While it still maintains an expertise on many water-related issues, it no longer possesses an expertise in sanitary engineering. This affects the capacity of the Division to monitor on-going projects that have an engineering focus. This situation exists also in regions where HSD regional representatives claim a lack of technical expertise on sector issues. As a consequence, several projects have gone unmonitored for over two years;
- the existence of a distinct theme within the Health and the Environment program tends to perpetuate the perception both within and outside HSD that this represents the focus of the Division's interest in water-related health issues. But many of the current priority and emerging water-related research issues transcend the defined HSD programs. They cannot be easily compartmentalized within any one program. This requires of HSD a more 'corporate' means for the review and development of research projects on water issues within the Division;
- the analysis of the foci of water-related projects supported by the Division indicates a wide range of issues. The current resources available to the Division, both in terms of personnel and funds, constrain the capacity of the Division to continue to entertain such a diverse range of research topics.

The relationship between water and health is irrefutable. The question facing the Division is not whether or not it should continue to support research on water-related issues. Rather, the issue at hand relates to how these issues should be viewed in the context of the current prevailing philosophy about research support within HSD, and how water-related proposals should be processed and administered, given the resources, both human and financial, that are available. The legacy of the Division, and particularly that of its former Water Supply and Sanitation sector, should not be taken lightly. The efforts of the Division's professional staff involved in the identification, development and administration of the HSD slate of water-related projects are responsible, in large part, for the reputation that the Centre has enjoyed for several years concerning its contribution to development efforts in general, and to the achievements in developing countries during the International Drinking Water Supply and Sanitation Decade.

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## CHAPTER 5

### RECOMMENDATIONS FOR A WATER-RELATED RESEARCH AGENDA FOR IDRC

#### 5.1 The Framework for a research agenda

Over the past twenty years, and particularly during the International Drinking Water Supply and Sanitation Decade, efforts were made and energies expended to extend access to water for disadvantaged populations, to improve the quality of the water drawn at source, and to increase the quantity of water available. However, as the end of the 20<sup>th</sup> Century draws near, the situation in many Third World countries continues to deteriorate. A future of increased water scarcity generated by rapid population growth but finite water availability, decreased land fertility, continued environmental degradation, and massive debt burdens hinder the efforts of governments to achieve the goal of improved accessibility of adequate clean water for all, particularly in poverty-prone rural and peri-urban areas. A new approach to development is required, one in which the priorities for strategies designed to better the lives of the poor are established according to the existing situation of local communities and the needs and wishes of people, rather than through the desires of and needs as perceived by professionals.<sup>1</sup> If a holistic view of community development in harmony with its local environment is accepted as a viable course of action, it is useful then to explore possible ways and means that support this approach.

As mentioned in Chapter Three, although accounting for a small share of total investments in water supply activities, applied research projects have served to increase considerably knowledge on several fronts. They have contributed also to an improvement in the capabilities of developing country researchers to identify, develop and undertake practical and relevant applied research activities that respond to priority local and national issues, as well as the capacity of institutions (governmental and academic) and NGOs in developing countries to administer research projects and programs. Applied research activities have contributed also to finding practical solutions for several major issues identified as priorities at the beginning of the Decade. However, there is consensus within the international development community that more research is required on a broader set of water-related issues, that a multidisciplinary approach is the most appropriate strategy to address them, and that the definition of priority research topics and the means of problem-solving must increasingly be linked to the aspirations, knowledge-base and capabilities of the intended beneficiaries.

In the medium-term perspective, the socio-economic development of poor communities will have to depend on finding alternatives to master locally available resources. For these alternatives to be sustainable, they would have to be integrated with a long-term perspective of water and land conservation. The concurrent utilization and conservation of land and water resources calls, in turn, for the decentralization of decision making and action to local people, with decisions reflecting local realities. This micro-scale approach could be implemented on a community-level basis for peri-urban areas, or on a small watershed basis<sup>2</sup> for rural areas. A small watershed (or sub-drainage basin) is a natural unit for water and soil resources evaluation. Care is needed to follow water through its availability in the environment, allocations among competing users, appropriations, transformations and uses, including linkages between the physical aspects and the human behavioral aspects that aim at ensuring a more equitable distribution and more efficient productive use. The development of these methods would assist considerably in increasing knowledge about the information needed for a particular location, the rationale for its need, what can be learned from it, and how it can be used by the local people for their own benefit.

The success of this approach depends largely on the level of real decentralization that can be achieved, on the political commitment of those holding power currently to pursue and promote a devolution of authority and power-sharing, and the degree of co-operation possible between the various government and non-government organizations involved. This strategy is dependent equally on the absorptive capacity of local authorities and communities vested with the devolved responsibilities and obligations to assume the burden of their administration and sustenance. It also requires a new attitude for external support agencies. Based on the experience of a SIDA-funded water supply and sanitation project in Tanzania, Andersson (1990) remarks how donors and central governments must come to terms with a completely new role: that of a catalyst, providing required incentives and back-up support, rather than being the prime movers in planning and implementation.<sup>3</sup>

The construction of a framework for a research agenda for IDRC on water-related issues is dependent on several factors. Among these are the external and internal variables that may affect both its focus and substance. For the purposes of developing a framework for a future research agenda as concerns water-related issues for IDRC, and more specifically, for the Centre's Health Sciences Division, several assumptions are made that relate to the external and internal research environments.

#### 5.1.1 Assumptions relating to the external environment

Perhaps the most important of the constraints relating to the environment external to IDRC concern the future availability of funds from the Canadian government for the support of applied research in developing countries. Although the federal government decreased considerably the funds available to overseas development assistance in fiscal year 1989/90, it is expected that ODA will increase over the next several years, although at a slower pace than anticipated originally. Given the reputation of IDRC both nationally and internationally, it is assumed, for the purposes of the present exercise, that the Centre will continue to enjoy a modest and constant increase in its financial resource base over the next several years.

The second assumption relates to the research environment external to IDRC. To date, the definition of a global set of research priorities has tended to be determined from a professional, developed country perspective. The influence of developing country individuals and institutions in the definition of research agendas has been quite limited. But, over the past few years, recognition of the important role developing country sources can play in defining research issues, and in designing and implementing applied research projects has increased. Support for a more participatory approach to defining a future research agenda, one that incorporates input from both developing and developed country sources, is also gaining support. It is assumed that this attitude will continue to gain support and be promoted actively by funding agencies.

As the UN Decade for water and sanitation ends, the Third World faces a future of increasing uncertainty as concerns the availability of sufficient supplies of clean water. As stated in an earlier chapter, clean water is a finite resource. The situation is exacerbated by rapid population growth rates, particularly in the urban centres, increasing numbers of migrants and displaced peoples (including economic, social, political and other refugees), accelerating environmental degradation of watersheds and water resource catchment areas, and continuing depletion of fresh, clean groundwater resources. Simultaneously, the massive and growing debt burdens of developing countries, the escalation of competition among users of water resources, and between nations for water rights, only serve to hinder the capacities of both the public and private sectors to meet the quantitative targets for coverage set for the Decade. It is assumed that these factors will continue to represent, unfortunately, the major

influences on the definition of emerging and central issues in the water sector for the next several years, at least.

The resolution adopted by the UN General Assembly in December 1990 recognized the constraints that limited the capacity of national governments and donor agencies to achieve in full the goals established for the International Drinking Water Supply and Sanitation Decade. It called for a redoubling of efforts to achieve the goal of 'water for all by the end of the century', and encouraged national governments, donor agencies, and organizations involved in the planning and implementation of water projects to increase investments in such activities. The resolution noted the move towards a greater degree of collaboration among interested parties for the planning, implementation and evaluation of water and development activities, and advocated continued support to this approach. IDRC's contribution to knowledge on water issues, and its support to the development of the capacity of developing country-based individuals and institutions to identify and carry out applied research projects has not gone unnoticed. Based on the groundswell of increased interest in water-related issues, particularly with respect to their direct relation to global environmental concerns, the assumption is made in this study that water will remain a major focus both nationally and internationally. Given the reputation within the sector that IDRC has established over the past 15 years, and the increased attention to water issues on international fora, it is assumed also that, should the Centre be willing and able, it will have an important role to play over the next 10 years.

#### 5.1.2 Assumptions relating to the internal environment

The framework within which an agenda for water-related applied research issues for IDRC is based must take into account as well the internal forces that could influence the focus and substance of Centre policy and its supporting mechanisms. The Centre has matured and grown considerably over the past 20 years. It is timely that a critical review of its mandate, *modus operandi*, and its structure be undertaken. For the purposes of the present study, several assumptions are made in reaction to the present state of affairs at IDRC.

First, the Strategic Framework exercise currently being undertaken at IDRC may result in fundamental changes in both the Centre's programs and structure. However, although this major strategic review of its mandate and *modus operandi* is underway, it is assumed that no radical changes to either the Centre's structure or programs will occur over the next few years. The analysis posits as well that the structure and program of the Health Sciences Division will also remain fairly constant over the short term.

As mentioned previously, it is anticipated that the Centre's program budget will continue to increase over the next several years, although at a slow rate of growth. This does not provide the Centre with a large degree of freedom to launch new or radically different applied research initiatives, nor to create additional organizational structures and mechanisms for their support. Hence, it is expected that the current attitude of fiscal restraint at IDRC will be maintained. Consequently, any recommendations for a new research agenda must take into account the realities of the constraints placed on the Centre's financial and personnel resources.

Another assumption upon which this study is grounded relates to the perceived desire of the Centre to maintain its reputation and its desire to support research that is on the leading edge of development. This requires that the Centre possesses appropriate, timely and comprehensive information about current and emerging issues, and that it also evaluates on a regular basis the

achievements of the projects it supports. The critical issue for the Centre, and its program divisions, is to remain 'ahead of the pack'. The challenge is to ensure that the research supported by IDRC influences and guides thinking and action on research issues, both within the Centre and, of greater importance, internationally.

There is a need to recognize, and perhaps recapture, the essence of IDRC. The Act of Parliament that created the Centre states clearly its mandate:

*to initiate, encourage, support and conduct research into the problems of the developing regions of the world and into the means for applying and adapting scientific, technical and other knowledge to the economic and social advancement of those regions, and, in carrying out those objects*

- (a) *to enlist the talents of natural and social scientists and technologists of Canada and other countries;*
- (b) *to assist the developing regions to build up the research capabilities, the innovative skills and the institutions required to solve their problems;*
- (c) *to encourage generally the coordination of international development research; and,*
- (d) *to foster cooperation in research on development problems between the developed and developing regions for their mutual benefit.* <sup>4</sup>

The Centre's fundamental mission is to provide the means to improve and maintain the capacity of developing country individuals, through support to the institutions to which they are affiliated, to identify, develop, apply relevant, appropriate and effective solutions to problems that limit or diminish the capacity of disadvantaged populations to lead full and productive lives. The means to achieve this goal was, and remains, by providing support to innovative and scientifically sound applied research activities. The Centre did not set out, nor ever pretend to be, a donor agency in the conventional sense. Its *modus operandi* was unique, in that it provided venture capital for research, an original and daring concept, even today. Support for the replication on a larger scale, and the further evolution of ideas research products developed through IDRC sponsorship would be taken up by other agencies and organizations, international and national.

There are few like-minded institutions, and fewer still that encourage considerable freedom to developing country individuals to identify problems and issues, to define the potential solutions, and to develop the means of putting them into operation. Despite the current limitations to funding and resource constraints at IDRC, and the on-going re-examination of its structure and internal administrative and research support processes, the recommendations made in this report are based on the assumption that the fundamental guiding philosophy of IDRC is immutable.

Finally, it is assumed, for the purposes of this exercise, that the Centre perceives water, and its attendant issues, as topics that merit further, if not increasing, attention and support over the next several years. This is not based simply on the Centre's legacy, its modest though considerable investment in support of developing country researchers to address water-related issues, but as well a recognition of the impending critical situation with regard to humankind's very survival, and its correlation to the resolution of many current and emerging water issues. As stated clearly in a recent IDRC publication, water is, and will continue to be, a major concern for the Centre.<sup>5</sup>

## 5.2 A New Approach to Water-related Research for IDRC

Discussions with IDRC professional staff indicate very strong support for a continuing role for the Centre in water-related research. Opinion varies, though, regarding the visibility and specificity that water, as a theme, should be accorded. Some hold that a Centre-wide program on water should be established. Others believe that water should not be granted special programmatic status, but be subsumed as a subject for research support within existing divisional programs.

Many professional staff outside of the Health Sciences Division expressed concern about the dissolution of the former water supply and sanitation program, believing it indicates to those outside the Centre a decision to abandon support for research on this topic. This perception appears to have been further strengthened by the publication and wide dissemination by the Centre, simultaneous to the disappearance of the program, of a special edition of *Searching*, devoted entirely to research supported by IDRC on water-related issues. This concern is exemplified by expressions of confusion on the part of the representatives of several major donor agencies, who have questioned and speculated at international meetings about the interest, willingness and capacity of IDRC to support water-related research, as well as the nature and direction of the Centre's research agenda on this topic. The majority of those interviewed in the course of this study point to the need for a better definition of Centre support for water-related research, and a more corporate policy on the subject.

### 5.2.1 Rationale for a continued role for IDRC in support of water-related applied research

The projects funded by the Centre over the past 15 years have made a significant contribution to the creation of new knowledge about water-related issues. Several have been responsible for establishing new directions for and approaches to applied research on specific topics. IDRC support to developing country institutions has assisted as well to increase the research capabilities of developing country-based people, and the research administration capacities of the institutions with which they are affiliated.

The Centre has also made an important contribution to the advancement of cooperation among external support agencies, and has been a strong and consistent advocate for the promotion and active involvement of developing country scientists and technicians in the process of conceptualization about and action on research issues within the sector. Its input and involvement on various committees, temporary working groups, at international conferences and workshops, and with the Collaborative Council of External Support Agencies for Water Supply and Sanitation, have been acknowledged on several occasions. The Centre continues to be approached to contribute in a variety of ways to efforts to strengthen and sustain the role of applied research on water-related issues.



**RECOMMENDATION #1:**

**Centre support to water-related research, and its active involvement in international activities relating to water issues, should continue.**

Centre support for water-related research should continue. Not only is there recognition on the international scene as to the Centre's contribution in addressing the major issues that were identified as central to water and human development over the past 15 years, but the very nature of the Centre is amenable to increasing knowledge on such issues, particularly at a point in time when the issues facing the very survival of many people living in the Third World is directly linked to water. The Centre also possess several characteristics that allow it to respond very effectively to requests for research support from developing country sources (one element of the Centre's 'comparative advantage' over other funding and development agencies). These include:

- its relative flexibility and quick response time in comparison to other external support agencies, to direct support to developing country research institutions
- its endeavour to improve the capacity of developing country people to identify and carry out applied research projects
- its excellent reputation for quality research
- the active involvement and collaboration of non-governmental organizations in applied research projects, thereby promoting and supporting innovative grass-roots approaches to addressing priority water-related issues
- the rich diversity of issues and topics supported
- the sustained support provided to several topics, and the promotion of strong and sustained linkages between developing country research institutions and researchers, for the exchange of information about research experiences and mutual support.

Hence, based not only on the heritage of Centre involvement in water-related activities and its support to important and innovative research projects, but also on its guiding philosophy and *modus operandi*, IDRC should continue to support applied research on priority water-related issues, within the limits of the funds made available to it.

### 5.2.2 The traditional framework for water-related research

Having established that the Centre should continue to be involved in the identification and support to applied research activities relating to water issues, the next issue to be dealt with concerns the definition of the research agenda itself. The criteria that defined the framework for the research agenda on water issues at the Centre during the period 1974 - 1990 is the product of the wisdom and experience of the pre-Decade period. At the risk of oversimplification, the primary hypothesis which

appears to have driven the research agenda was that the primary constraints to progress and achievement of the Decade's goals were technology-linked. The review of the direction and focus of applied research on water-related issues supported by IDRC over the past fifteen years demonstrates a bias towards the development and application of technologies designed to increase access to and improve the quantity and quality of water available to beneficiary populations, and investigation of their technical performance, the examination of community-based management processes relating to their installation, repair and maintenance, and engineering studies of both surface and ground water resources. Although improvements in health and social well-being have been the ultimate goals of the water-related projects supported by the Centre, in many respects, water in itself became the primary focal point, with technology perceived as the means of achieving the goals of improved access and availability. Issues such as equity, social justice, and democratic participation, all central to the process of national development, factors that have a fundamental impact on the capacity of people to improve their social and physical well-being, appear to have been assigned secondary importance. While this model may have been suitable and appropriate to that period, current and emerging developmental issues demand a revision of this research agenda and its framework.

Another factor that may have had a considerable influence on the focus and substance of the Centre's agenda for applied research on water issues is the absence of a corporate policy to guide Centre thinking and action on water issues, and a multidisciplinary approach for the identification and development of research projects. The limitations of the conventional problem-solving approach, that of investigating issues from a singular professional perspective with little recognition or understanding of the context within which they exist, have been amply documented. Robert Chambers (1978), in a treatise prepared prior to the IDWSS Decade about factors influencing priorities in water-related research, identified the lack of an active multidisciplinary approach as a major compromising factor to the capacity of 'development projects' to affect real and sustained change:

*It is no surprise, then, to find many disciplines engaged on water-related research, including climatology, geology, hydrology, soil science, geography, engineering, agronomy, botany, zoology, medicine, sociology, social anthropology, economics, and most recently political economy, to name but some of those that are prominent in the tropical rural context. With so many specialized points of entry, the danger is that no one will take a balanced view because no one is competent to do so. In these circumstances, multi-disciplinary approaches are called for, but may be merely assemblies of narrow searchlights which illuminate some faces of the subject but leave others in the darkness. Interdisciplinary research may similarly involve the exchange of insights and methods between disciplines, but may still leave gaps between them. The solution, it will be argued, lies in a different approach to identifying concerns and priorities and in a bold readiness to explore gaps.*<sup>6</sup>

Twelve years later, including a decade of special attention to water issues worldwide, a cohesive, multidisciplinary approach remains a challenge, even within IDRC. The traditional approach within the Centre, as exemplified by the low number of interdivisional projects to date, has been for each Division to develop its own unique and distinct research agenda on water-related issues. This is not to say that projects were developed without taking under advisement the comments from colleagues in other Divisions. However, few water-related proposals were developed through a truly multidisciplinary and interdivisional approach. This shortcoming in the Centre's operational process was highlighted in *PPR VII*:

*Although IDRC's attention has always been largely devoted to development problems, it has been directly [sic] mainly through the medium of subject areas relevant to those problems, rather than holistically on the problems themselves. Supporting Third World scientists in various subject areas through relatively small projects and at the same time remaining sensitive to indigenous capabilities and aspirations, has resulted in a diversity in the Centre's programming that to a large degree merely mirrors the diversity in social, economic and research conditions. This responsive mode has been widely appreciated and generally effective. However, the separate actions of individual divisions have resulted in a very wide scatter of initiatives, with the concomitant risk of being insufficiently 'responsive' to those occasions when the coordinated application of several disciplines could be more effective.*<sup>7</sup>

The absence of a corporate approach that promoted a multidivisional and interdisciplinary review of all water-related projects, to ensure that a wide variety of experience and expertise would be called upon to assist in the development of the research proposal, and to reach consensus on the relevance of the issues at hand and the means of resolving them may have served to limit the effectiveness of the Centre in addressing water-related issues. In the few occasions where interdivisional collaboration has occurred, the richness of diverse perspectives and expertise has had a major impact on the capacity of the Centre to assist developing country researchers in the development, implementation and application of their research ideas. A distinction must be made between a semblance of interdivisional cooperation and collaboration, and a true multidisciplinary and coherent approach to problem solving.

This does not exclude the identification of new and innovative research issues and activities from a singular disciplinary perspective. Rather, it entails an expansion within the knowledge base of the topic at hand. It requires a consolidation of knowledge gained over the past decade and a half, from a wide variety of sources, to assist in the exercise of determining the relevance and scientific and technical merit and validity of the proposal.

**RECOMMENDATION #2:**

**The Centre should adopt and pursue a more holistic, cohesive and corporate approach to the review of water-related research issues, and to the development and support of sector-related activities.**

The second factor relates to the responsive mode the Centre has adopted as the means of defining its research agenda. Through this approach, the Centre tends to react to, as opposed to defining itself, the research issues identified by proponents. There is considerable merit in this approach. It provides a window on the perception of developing country experts as to the priorities of their respective countries, a perspective that may not receive sufficient recognition and support by the professional views that tend to dominate within the current international research community. As Hall (1978) states, the monopoly on knowledge held by those in power and authority serves to subvert the aspirations of the disadvantaged.<sup>8</sup> Development demands the demystification and popularization of information and knowledge. The responsive mode assists in achieving this goal. However, the wide range of research topics supported over the past fifteen years, although allowing for a flexible approach

to project development and research topic identification, resulted in a scattered approach to research support. A small amount of funds were allocated to a wide variety of disparate research initiatives. With the exception of a few notable research efforts, a logical framework for the definition of research strategies and programs was never developed.

The lack of a coherent corporate approach to such an important issue appears to have contributed to, in part, the hiatus that occurred in the conceptualization and support to water-related research projects over the past few years. It also accounts for the interruption of IDRC involvement and participation on several international bodies and working groups involved in water-related issues. Representation on international committees and working groups has tended to be centred on an individual, or within a specific sector. The departure from the Centre of professional staff identified with water-related activities left a void in Centre representation on several international bodies.

This situation has not gone unnoticed. Several external support agencies have questioned the Centre's commitment to water-related development issues, and remarked on what is perceived externally as apparent confusion within the Centre concerning the definition of a corporate perspective and policy about its involvement in sector activities. This does not mean that the definition of Centre support for water-related issues should be sector-driven. The framework for support to water-related activities at IDRC should be founded within the established definitions of the workplans for each of its program divisions, in recognition of and in response to priority current and emerging issues.

**RECOMMENDATION #3:**

**The Centre should evolve as quickly as possible a corporate policy concerning applied research on water and development issues.**

To date, there is no mechanism that promotes or fosters a sustainable corporate, coherent, inter-divisional approach to water-related issues and applied research activities at IDRC. The process has tended to be *ad hoc*, based largely on the personal decisions and attitudes of professional staff to share information and proposals. The result, as demonstrated in the analysis of the divisional activities on water-related research, has been a scattered approach to the definition of research priorities within the Centre. There was little, if any, coordination among the Divisions as concerns the development and distribution of responsibilities for water-related issues and subjects in the preparation of Division workplans. This is not to advance the view that the definition of Divisional workplans for water-related issues was without purpose. In fact, the programs for sector issues, past and present, are very well documented. There is a need for better coordination and relation among the Divisions to develop a strategy to address priority research issues. The intent should be to develop a complimentary and coordinated approach to water-related research issues. This would not only assist the Centre to elaborate a corporate policy, but should also promote and support a more effective project development and administrative approach.

### 5.3 The Elements of a Renewed Research Agenda for the Centre

Over the past few years, the Centre has had to contend with a decrease in funds available for the support of new applied research projects. One of the effects of this situation is a consolidation of Divisional programs, with some being eliminated, others being absorbed into higher profile programs. In order to use its available human and financial resources more effectively and efficiently, an approach that promotes and supports greater inter-program and inter-divisional collaboration for the development, funding and administration of projects will have to be adopted.

Given its mandate and experience, the Centre can be proud of the contribution it has made in increasing the knowledge about sector-related issues. But, at least in the short term, it appears that the growth in financial resources the Centre enjoyed through the 1980s is unlikely to continue. The analyses illustrate the very wide range of research topics on water issues supported by the Centre over the past 15 years. In several instances, the original initiatives have led to the evolution of research networks and quasi-programs (eg. handpumps; urban hydrogeology; water quality testing and source classification technology; information centres). However, the probability that growth in the Centre's programme budget will continue to be limited over the next few years may preclude the possibility of continuing to support existing research projects, and, simultaneously, of developing and supporting new research initiatives. Over the next few years, perhaps the most prudent course of action would be to build upon the existing initiatives and networks, limiting support to new research initiatives to topics that stand out as priority areas of research, that receive no financial support from other sources.

#### **RECOMMENDATION #4:**

**Given the current ODA environment under which IDRC exists, and the implications this may have for the funding of new research initiatives, the Centre should consolidate its approach to water-related research activities, building upon the efforts and experiences gained over the past several years.**

This approach would permit the Centre to consolidate its experiences, and draw on lessons learned in order to develop a continually updated research agenda. It is increasingly evident that the Centre cannot provide resources to the broad range of topics, and to all peripheral, yet pertinent, research questions emanating from central research issues. The task is to stay at the 'cutting edge' of research, to ensure that the Centre responds to the priorities as perceived by the developing countries and supported by scientific evidence. The Centre's aim should be to attempt to steer thinking and action on development issues through the research it supports.

Based on the analysis of both current and emerging issues relating to applied research on water issues, the heritage of water-related research at IDRC, the achievements of and lessons learned from the applied research activities it has supported, and the available in-house expertise relating to the wide variety of water-related issues, several themes are proposed that could define the principal elements for a Centre policy and program for water-related research. They do not represent a definitive list. Nor are they meant to limit the definition of a research agenda for the Centre, by unnecessarily

**RECOMMENDATION #5:**

The Centre should consider the following as the principle elements of a program framework for the corporate water policy:

1. Water Resources Management
2. The Planning and Management of Urban-based Water Services, with particular reference to Peri-urban Populations
3. Structural Adjustment and Water Resources
4. Community-based Planning, Management and Evaluation of Water Resources and Supply Systems
5. The Impact of Water on Human Health
6. The Socio-cultural Dimension of Human Interaction with Water
7. Institutional Capacity Building/Human Resources Development

restricting the scope of the issues considered for support. The Centre's responsive mode of operation must continue to be supported, for it is what permits the Centre to stay abreast of progress and change in current issues, and the development of emerging ones. The intent is not to prescribe to Divisions the direction and substance of their individual research agendas. Rather, assuming there exists within the Centre support for a corporate policy on water-related issues, and a desire to implement a mechanism for multidisciplinary and interdivisional cooperation, the topics presented should be viewed as reference points for the evolution of a Centre program on water issues. The experience of the Health Sciences Division has demonstrated that many of the important water issues transcend the research agenda, interests and professional in-house expertise of any specific Division. To succeed in achieving the mandate, the Centre must be willing to adopt a more corporate approach. The issue at hand is to modify the perspective that has come to define the criteria for support of water-related projects, from one that is water-centred, to one that is people-centred.

### 5.3.1 Water resources management:

Rapid urbanization, the consequent increase in the populations of Third World metropolises, and the transformation of several hundred medium-sized cities to large urban centres over the next decade have major implications for the capacity of governments at all levels in developing countries to satisfy the needs for domestic water supply, and to address the issues of wastewater discharge and its attendant impacts on human health and well-being.

As noted previously, the already great strain placed on the carrying capacity and quality of water resources can be expected to increase. In many areas, competition for water by different user groups (industry, agriculture and domestic sectors) is increasing, as accessible sources of sufficient quantity and quality become more scarce. Solutions are very site-specific. To repeat what was noted in a previous chapter, some of the major issues relating to water resources management that should receive greater attention over the next several years are: changes in overall stream flow as a result of increased withdrawal of water and changes in land use in the catchment area; changes in the

hydrological regime; changes in the physical and chemical properties of water (suspended sediments, microbiological and toxic contaminants; oxygen-demanding wastes; fertilizers); excessive drawdown of groundwater sources, leading to water scarcity and land subsidence; and, flooding.

The Centre, principally through the Earth and Engineering Sciences Division, has supported several applied research projects relating to water resources assessment and management studies. There are two areas of particular importance that merit particular attention: watershed basin management, and groundwater studies. The recent evaluation of the network of urban groundwater projects demonstrates the important and unique contribution made to the generation of new knowledge on this topic. Much remains to be completed, and there are many regions in the world where similar studies would contribute to improving access to and the use and management of available groundwater resources.

To date, there appear to be few agencies actively supporting watershed basin management studies in developing countries. Information about the sustainability of existing watersheds under various demand scenarios is critical to the planning needs of developing countries. The relative importance of research on these issues, and the role of Centre program Divisions in this regard, are highlighted in a report on urban environments and water supply in Latin America prepared recently by one of the Division's professional staff members.<sup>9</sup>

The Centre also possess the capacity to support research relating to the impact of current development-related activities on water resources management, and the capacity of national governments to implement and manage their national water resource and utilization policies. All countries were requested to develop and implement such policies as a means of achieving the goals of the International Drinking Water Supply and Sanitation Decade. While most have developed national policies for drinking water supply, there are few, if any, studies on their implementation and impact, nor of their linkage to actual water development activities. For example, many countries have established guidelines for the discharge of industrial effluent into water courses. Yet there exist few studies that assess critically the application of these policies and regulations, nor their relevancy, practicality or impact. If the control of harmful discharges into water courses is deemed to be one of the elements of the global effort over the next decade to protect the environment, then the Centre can serve an important role in improving the capacity of both public and private sector bodies in developing countries to monitor and assess water quality, and to find practical and cost-effective alternatives to current practices for the disposal of industrial and agricultural byproducts.

Table 5.1

## Information for Watershed Planning and Development

## Geographic Information System

## Management Information System

stream & watershed map  
topographic map  
stream networks and orders  
rainfall and stream flow characteristics  
existing and potential land use map  
crop suitability soil map  
map of local administration and village locations  
location of existing water resources facilities

Community-based information  
existing water resources facilities  
existing water utilization  
potential water utilization for existing water facilities  
potential for water resources development  
classification of sources and determination of water quality boundaries  
environmental sanitation information

Adapted from: P. Wirojanagud & K. Smith, "Small Watershed Management in Thailand", *Waterlines*, Vol. 8, No. 3, January 1990.

The assessment of land and water resources is a basic component of small watershed planning and requires the compilation of best existing data, tapping both conventional and non-conventional sources of information. The specific information requirements will vary according to the local environment and community development. Planning may begin with limited information and could be updated and improved regularly through continuous monitoring and data collection. Table 5.1 presents an outline of the information needs. From the technical perspective, much of the information needs relate to the hydrogeological characteristics of water resources, as well as to their physical, chemical and microbiological properties. The research needs pertain not only to the compilation of this data, but relate also to the development of appropriate computer-based software, the institutional arrangements to support the collection, management and analysis of this information, and, the translation of the data into practical policies and programs that address the major water resources sustainability and use issues. Not only is there a need for relevant software, but there is also the need to investigate its applications, and how it could be useful to a wider range of users.

### 5.3.2 The planning and management of urban-based water services with particular reference to peri-urban populations

There is general agreement that the situation facing many cities in developing countries has reached a critical stage. Environmental conditions in urban areas are deteriorating quickly, and put at peril the health and well-being of millions of people. The source of the problem appears to be related to the incapacity of municipal agencies to plan, implement, operate and manage effectively and efficiently urban-based water supply and sanitation/wastewater disposal systems. The situation is exacerbated by a realization that many people living in squatter settlements and low-income areas, whether located on the urban periphery or within municipal boundaries remain without any sort of reliable and safe source of clean water for domestic use. Increasing population pressures, the rampant and often uncontrolled expansion of unorganized settlements, and the increase in the number of large urban centres can serve only to exacerbate the situation.

The response on the part of many experts is the need for a broader range of technologies, and an improvement in the capacity of municipal services and agencies to plan, operate and manage the services. However, based on the analysis of the situation, and the current and emerging issues, it would seem that a different focus for applied research on urban water issues may be required. This is one that seeks to address issues such as alternative institutional arrangements for the planning, operation and management of urban basic services.

The Centre, primarily through the leadership of the Social Sciences and Health Sciences Divisions, has considerable experience in supporting innovative applied research on the management of basic urban services, with particular reference to domestic water supply. The projects have served to identify several important issues that characterize the operation of urban basic services, and which inhibit the capacity of municipal governments to provide adequate, continuous and affordable water supply and sewage services to their constituent populations. The analysis of the situation demonstrates that there continues to be a need for research on mechanisms that would assist and strengthen the capacity of municipal governments to develop and implement realistic, practical, and relevant regional and community-specific approaches for the planning, operation and management of water supply and sewage services.

A related area that would complement research on new institutional arrangements is research on information data bases for the planning, operation and management of urban basic services. This is referred to as community-based information in Table 5.1, and includes: process of local government,



authority structure in communities, division of labour, traditional water law and water rights, behaviour and cleanliness culture, existing indigenous knowledge and practices related to the management of natural resources, priorities and needs. Methods to collect, manage and update this information are needed, as well as ways and means by which the information may be conveyed back to agency staff and to the communities that rely on the services.

### 5.3.3 Structural adjustment and water resources

To date, the economics of water has not been an element of the traditional research agenda on water issues within the Centre. What 'economics' have been investigated have dealt primarily with the costs associated with the installation, operation and maintenance of water supply devices. However, in light of the implementation of structural adjustment programs in many developing countries, and the debate about their impact on human health and well-being, it may be timely for the Centre to embark on developing a set of projects that focus on the impact of structural adjustment strategies on the goals of the IDWSS Decade.

For example, the impact of structural adjustment policies on water resources development and water supply and wastewater disposal services, from the national and local (community) perspectives, is unknown. Structural adjustment programs advocate the implementation of cost recovery schemes, to cover the costs related to the operation and maintenance of public services. This includes water treatment and delivery systems, and waste/wastewater collection, treatment and disposal systems. The strategy calls for a decrease in government spending on public sector activities, and advocates as well the devolution of responsibility for their operation and maintenance to lower levels of government. There is also support for the privatization of many public services. Structural adjustment programs have serious consequences for the principle of equal access for all to adequate and accessible clean water (one of the central tenets of the Decade). Research on the impact of structural adjustment policies and programs on the availability and access to water supply services merit serious consideration.

A related emerging issue is the impact on human health and social well-being of cost-recovery schemes, with particular reference to the utilization of improved water supply facilities. Several donor agencies are incorporating cost recovery schemes for improved water supply facilities as components of the water supply development activities that they fund. The rationale is based on the assumption promoted by, among others, the World Bank, that people are willing to pay for such services. But, as other studies have demonstrated, a willingness to pay does not equate necessarily to an ability to pay. The option for disadvantaged people may be to draw water from traditional and unimproved water sources. The implications for their health and social well-being are serious.

### 5.3.4 Community-based planning, management and evaluation of water resources and supply systems

The failure of conventional approaches to the planning, implementation and administration/management of improved drinking water services, coupled with the devolution of responsibility for the operation and maintenance of water supply systems, has led to a greater focus on the development of practical and effective community-based strategies to complement, and in some cases, replace government involvement in these activities. However, to date, there is a paucity of research on experiences with community-based/centred planning and management within the sector.

Most of the studies that have been carried out on alternative strategies are limited to small-scale demonstration projects. The applicability of their results is very limited. As the analysis of current and emerging issues in the previous chapters have demonstrated, there is a need for more investigation about comparative modes for promoting and implementing the strategy, evaluations about its comparative advantages and disadvantages to conventional or alternate approaches, and the policy and implementation implications of such an approach.

In light of the experiences with community-based management strategies, particularly in the primary health care sector, and the Centre's experience on this issue, there is a continuing need for comparative cost-effectiveness analysis of conventional and alternative approaches and institutional arrangements for planning and management, particularly with reference to the goal of improving the capacity of communities to effectively and efficiently assume responsibility for the planning, operation and maintenance of water supply systems. The collaborative initiative on innovative approaches to community-based monitoring and evaluation of water supply and sanitation facilities, supported jointly by PROWESS/UNDP and the Health Sciences Division is a case in point.

Additionally, there is also a need for continued support to research that investigates the capacity of communities, and the appropriate institutional arrangements and management processes, to operate and manage water supply technologies. For example, the Centre has supported several projects that investigate community-based strategies for the management of simple water treatment devices. It has also provided considerable support to research on community-based approaches for the upkeep and maintenance of handpumps, and simple water quality assessment technologies that can be used by community members. The focus, though, should not necessarily be on the development of such technologies, nor an assessment of their technical performance. Rather, the emphasis should be placed on their application and use at the community level, by community members themselves, for the benefit of the community.

The development, evaluation and application of innovative community-centred information systems for the management of water supply and sanitation services, and the research on the linking and uploading of information collected at the community level to higher level (regional and national government) databases on water-linked development activities is another area that could benefit from interdivisional cooperation. Research on this topic could include the testing of different management information systems (MIS) modalities and institutional arrangements to support these community-centred arrangements, the identification and testing of indicators to measure the impact and effectiveness of community-centred approaches to the planning and management of water supply sources, the investigation into the relevance and validity of information collected at and by the community for the purposes of other users of information on water supply and sanitation services, and, investigation into the type, quantity and quality of information required to make policies and decisions, plan and manage water resource development/enhancement activities effectively and efficiently. The development and assessment of information systems for groundwater resources assessment and management could be a cooperative effort among EES, ISD and HSD.

### 5.3.5 The impact of water on human health

The rationale for most of the health-related water projects supported to date is quite simple: access to sufficient and reliable sources of clean water is an essential precondition to acceptable and sustained levels of public health and welfare. This followed directly from the primary goal of the IDWSS Decade. In light of the experience gained during the course of the Decade through research and development activities funded by IDRC and other sources, it is now apparent that access, though an important consideration, constitutes only one of many important variables that affect health.

As reported in Chapter 3, there are a plethora of water and health related issues, both at the macro and micro levels, that have not received the attention they deserve, and which merit support and investigation. However, given the resource constraints within the Centre, it is impossible for it to support and manage a research agenda that incorporates all of them. In keeping with the spirit of the proposed framework, the current guiding philosophy within the Centre as pertains to applied research on health issues, and the experience and expertise available within the Centre, with particular reference to its Health Sciences Division, there are a large number of health-related water issues that deserve serious consideration by IDRC. A more detailed discussion of the substance of these are provided in the next section of the chapter, as a component of the in-depth discussion of the water-related research agenda for the Health Sciences Division.

### 5.3.6 Social and cultural context of human interaction with water

The Centre has supported a large number of research projects relating to human behaviour *vis-à-vis* water. However, as is becoming increasingly evident, attempting to 'change' human behaviour without a firm grounding in knowledge about belief systems and the social, cultural and political context within which a community exists, will not lead necessarily result in the desired outcome. This relates directly to the previous discussion about the need to open up and explore the 'black box' of proximate variables. Such investigations are important components of many of the elements of the research agenda proposed above. Without a thorough understanding of the contextual variables, and their impact on human beliefs and behaviour, it will be difficult to develop relevant and valid intervention programs. For this reason, and given the expertise available within both the health Sciences and Social Sciences Divisions, it is proposed that this be one of the essential elements of the Centre's research agenda for water issues. A more detailed discussion of the particular research issues that merit further study and consideration by the Centre is presented in the in-depth presentation about the research agenda proposed for the Health Sciences Division.

### 5.3.7 Institutional capacity building/ human resources development

Although improving the capacity of developing country researchers to identify and develop applied research projects is a principle element of the means of carrying out the Centre's mandate, the number of training awards made by the Centre to support either the creation and maintenance of institutional-based water-related training programs, or grants to individuals to attend water-related training courses remains small. There was reticence to support developing country individuals to attend water-related courses located at developed-country-based institutions, as many were not applicable to their needs, and contextually they were far from the realities that characterize the situations in which both the individuals and their projects exist. Funding for core support for the creation and maintenance of centres of excellence on water-related issues was also very limited. One notable example is the creation of the Research and Training Centre on Innovative Handpump Technologies, established as a component of the cooperative HSD/ISD/Communications Division-funded project Water Pumping Technology - Phase III (Malaysia) 3-P-87-0084. The scarcity of distinct institutional capacity building initiatives within the water sector may have been due, in part, to the shortage of developing country institutions during the 1980s that were capable of assuming responsibility for training programs, the lack of a framework and the requisite attendant human and financial resources within the Centre required

to embark on planning and supporting such an initiative, and the need for a long-term commitment to institutional capacity building activities.

But the need to improve and strengthen the capacity of individuals and institutions in developing countries to address local, national and regional water-related issues remains a challenge. It is evident that the prevailing financial and human resources environment in which the Centre finds itself limits considerably its capacity to undertake singularly large-scale institutional capacity building initiatives. The decrease in the visibility of water as a specific theme within the Centre also adds to the degree of doubt about the extent to which the Centre would embark on such an initiative. As an alternative, the Centre might consider complementing an on-going initiative to strengthen the capacity of developing country institutions to identify, develop and implement relevant and timely water-related applied research projects.

The International Training Network for Water and Waste Management (ITN) was created in 1984 through the UNDP-World Bank Water and Sanitation Program, "to promote the establishment of a 'network' of collaborating local, regional and international institutions in order to strengthen and enhance internal capacity for training, education, information dissemination and research activities on appropriate low-cost water supply and sanitation issues."<sup>10</sup> The focus of the ITN initiative is technology-linked. Its stated purpose is to identify and implement appropriate technology projects utilizing multidisciplinary approaches to address water-related issues. To date, nine network centres have been established: two each in Asia and India; two in West Africa; and, three in sub-Saharan east and southern Africa. Plans call for the establishment of similar centres to serve the Middle East/North Africa region, and in Latin America. Financial support for the operation of the centres is provided through the UNDP-World Bank program by several donor agencies, including CIDA.

To date, IDRC has had no formal linkage with the ITN system. However, the Centre has provided support to particular projects at several of the institutions that presently act as ITN centres. These include, among others, the *Centre régional pour l'eau potable et l'assainissement à faible coût* (CREPA), an ITN centre hosted by the CIEH (*Comité interafricain d'études hydrauliques*), the University of Zimbabwe, the All-India Institute of Public Health and Hygiene, the Africa Medical and Research Foundation (AMREF), and the Bangladesh University of Engineering Technology.

IDRC could make a contribution to this activity in two important ways. One of the inadequacies of the ITN system presently is the shortage of funds to support small applied research projects identified and carried out by the trainees. The central focus of the present agenda for the ITN centres relates to training. There are few funds available for research. A small-grants program, on an experimental basis, could prove to have a considerable impact on the potential utility of the ITN system. The second shortcoming of the ITN system is the technology focus. As previously mentioned, the ITN approach identifies and implements **appropriate technology** projects utilizing **multidisciplinary approaches** to address water-related issues. Given the multidisciplinary approach advocated by the Centre, and the need to adopt more formally such an approach within the water sector, the Centre could serve to affect the guiding philosophy concerning the identification and resolution of water issues at the ITN centres. This would be an important and worthwhile contribution to strengthen and expand local capacity to identify and undertake appropriate applied research projects, and to assist in affecting the substance and direction of national development policies.

#### 5.4 Recommendations for a Renewed Water-related Research Agenda for the Health Sciences Division

The achievements of projects supported by the Health Sciences Division on water issues have been significant, as noted in the previous chapter. In fact, several research projects have resulted in the creation of innovative and groundbreaking technologies and approaches designed to improve the plight of disadvantaged populations, and served as well to generate a seachange in the conceptualization and action on several water-related and development issues. Nevertheless, over the intervening sixteen years since the first grant by the Centre to a water-related project was approved, an evolution in both the focus of applied research supported by the Division, and the scope of issues within the water sector have undergone considerable change.

The evolution at IDRC of both the philosophy that guided the definition of a research agenda for water-related issues, and the supporting operational structures and mechanisms must also be taken into account. When the Centre embarked over fifteen years ago to support applied research projects on water-related issues in developing countries, the primary concern rested with the need to improve access to water, and increase the availability of clean water at the source. The decision to focus on the development and assessment of the design and technical performance of technologies was based on the in-house expertise that existed within IDRC at the time, and on the advice and counsel of recognized experts in the field. As this in-house expertise was available within the Health Sciences Division, a logical consequence was the fact that many of the water-related projects supported by the Division in the initial years were heavily biased towards a technology-linked focus. In fact, a review of the slate of projects supported by the Division over the past fifteen years indicates that many had little direct relationship to health issues. As a result, a paradox arose, as the Division gave support to projects for which the health research issues were minimal or ancillary.

Another shortcoming of the framework for research on water issues that characterized the Division throughout the 1980s was its principal hypothesis, which held that the development, assessment and application of water-related technologies, examples being the PVC handpump and low-cost dynamic water treatment systems, would lead, through an increase in access to and an improvement in the quality of water for domestic use, to an improvement in health and well-being. While valid for particular water-linked diseases, such as guinea worm, where the introduction and use of a simple screen to filter water for human consumption serves to interrupt the transmission cycle of the causal agent, the inherent weakness of the hypothesis was its tendency to oversimplify the relationship among the variables that characterize the reality and context in which the problem or situation exists. In other words, this model failed to take into account the multidimensionality of the relationship between determinants of ill-health and social deprivation, and actual manifestations of these variables (eg. disease and poverty). Little recognition was accorded and few investigations supported that examined the impact of ecological, social, economic and political factors that constitute the fundamental determinants of human well-being. The prevailing paradigm tended to define problem-solving according to a single causation relationship, rather than as a 'web of causation'<sup>11</sup>, in which the perceived chains of causation represent only a fraction of the reality, and in which the events that characterize the causal linkage are in themselves the result of a complex genealogy of antecedents.

The impact of the lack of consideration of contextual factors is highlighted in a study of the criteria used in planning health services in a region of northern Québec:

*La perspective proposée consiste à radicaliser et à prendre au sérieux l'idée d'une adaptation socioculturelle des services de santé. La méthode actuelle privilégiée au Québec pour dresser le tableau de la distribution et de l'importance des problèmes dans un territoire déterminé est l'enquête épidémiologique. Compte tenu du fait que les études épidémiologiques donnent accès à une évaluation objective et standardisée des problèmes de santé dans une population, les planificateurs et tout l'appareil administratif supposent qu'il existe une correspondance entre problèmes et besoins de services, et que les connaissances objectives fournies par l'épidémiologie sont suffisantes pour fonder l'adaptation des services de santé réalités locales et régionales.*

*Bien qu'elles soient indispensables, nous considérons que les connaissances sur la prévalence des problèmes ne sauraient suffire pour garantir l'adéquation socioculturelle des services dans un milieu particulier. L'approche que nous proposons est complémentaire à celle de l'épidémiologie; elle vise à reconstruire le champ des perceptions et des pratiques en santé, du point de vue des communautés elles-mêmes, et à mettre en évidence leur ancrage dans un contexte social et culturel spécifique. L'hypothèse à la base de cette démarche est que l'ensemble des perceptions et des représentations relatifs aux problèmes de santé se reflète directement dans les réactions et dans les actions qu'ils suscitent et influence notamment la place accordée aux ressources professionnelles dans un univers plus large de recherche de solutions. Faute d'en tenir compte, on risque de mettre en place des programmes et services ne rejoignant pas vraiment les populations visées et demeurant en porte-à-faux par rapport à leurs attentes.* <sup>12</sup>

There is nothing startling innovative about what is stated. Rather, the innovativeness is found in the fact that the analytic framework prescribed and used in this study was based on a much broader theoretical footing than the conventional model, one that grounds the relationship between cause and effect within the sociocultural, political and economic context of the society for which the services are being planned. In the conventional paradigm, factors which explain the 'why' and 'how' a given context determines the nature and degree of social and health well-being of a population are not analyzed, but are treated as a 'black box'. In essence, although the 'black box' is known to exist, it is opened rarely and explored. The challenge for the Division is to do so.

#### 5.4.1 Principal elements for a divisional water-related research agenda

Since the restructuring of the Health Sciences Division in 1988, the focus and substance of its research agenda has evolved and shifted considerably. It no longer coincides with or include the types of water-related projects considered formerly for funding. Simultaneously, the scope of definition for many water-related research projects supported by the Centre has expanded beyond both the research interests and focus of the Health Sciences Division, and as well, beyond its scientific and technical assessment and administrative capabilities. In essence, it can be said that the Division has shifted away from the traditional research agenda defined for water-related projects, while the substance and focus of water-related research projects previously considered for financial support by the Centre have outgrown both the interests and in-house expertise of the Health Sciences Division.

The decision to reorient HSD's guiding philosophy and attendant program structure resulted in a decreased visibility for 'discipline'-specific topics (eg. water supply and sanitation, mother and child health, tropical and infectious diseases), and highlights in its stead a more holistic and health ecology-related research agenda. Research supported within the Division is to focus on people, and their capacity to improve their health and well-being through self-action and through a closer, interactive relationship with experts from outside the community on health issues. The current approach places water among a number of factors that may affect health. The research focus shifts from water as an end, to water (its availability, quality, quantity, use and management) as a means to achieve the goal of health for all.

**RECOMMENDATION #6:**

The Health Sciences Division should continue to identify and provide support to applied research projects that focus on the relationship between water-related issues and health.

The first order of business with which the Division must deal is whether or not it should continue to identify and provide support to applied research projects on water issues. Such a decision should not be based solely on the fact that the Division has accumulated considerable experience in the sector, nor that it has a heritage and reputation to maintain in this regard. Rather, the criteria for such a decision should be based on the need for new knowledge on water and health issues, the potential impact this will have on improvements to human health and well-being, and the comparative advantage of the Division as a contributor to this objective.

As mentioned previously, there remain numerous and considerable gaps in knowledge about the relationship between many aspects of water at both the micro and macro levels, and human health and well-being. There is also evidence that many of the prevailing conditions in many developing countries that have an impact on human health and well-being are water-related. Finally, as discussed in a previous chapter, there is evidence as well that many studies that seek to demonstrate a causal relationship between particular water improvement schemes and human health are fraught with methodological problems. As Cairncross (1990) notes in a recent article:

*Attempts to measure the health impact of water supplies and sanitation have a long and chequered history. Many of them have been made by amateur epidemiologists at the behest of the agencies financing the construction of facilities, and with insufficient planning and rigour.*<sup>13</sup>

Finally, the holistic approach to health-related research adopted by the Health Sciences Division supports a research agenda that would identify and critically analyze the contextual and proximate variables that explain the 'why' and the 'how' of the relationship between water and health. This fresh

approach to research on water and health issues, one not encumbered by the conventional technology-focused approach, could serve to generate new and innovative knowledge about water-related issues, which in turn could serve to influence thinking and action about development issues on a wider scale.

**RECOMMENDATION #7:**

Working within current funding limits, and given the wide range of expertise available within the Health Sciences Division, the experience and knowledge gained over fifteen years of support to research on water-related issues, existing gaps in knowledge about current water and health issues, and the substance of emerging priority issues, the following are proposed as the primary elements of a water/health-related research agenda for the Division:

1. the development and investigation of the effectiveness of alternative approaches for the control of water-related vector-borne diseases;
2. the assessment of the health implications of water resources development activities;
3. investigations into the relationship between current agricultural production management practices, such as rice irrigation, and health;
4. investigations on the use of wastewater for crop irrigation and the implications for human health;
5. investigations into the relationship between the siting of latrines and water sources, and human health;
6. the development and testing of surrogate measures to 'health impact' for water supply interventions, for the purposes of public health policy formulation;
7. studies into the cost-effectiveness of alternative approaches to the protection of the quality of drinking water at the household level;
8. the development of guidelines for the study of hygiene practices, their impact on health, and innovative methodologies; and,
9. the examination of the cost-effectiveness of alternative institutional arrangements (community-based; government-centred) for the planning, implementation, monitoring and evaluation of water supply systems.

Another issue that faces the Division is the substance of a water-related research agenda. As mentioned in this and previous chapters, there are a host of 'water and health' issues that merit further study. However, the Division must have realistic expectations, and work within the limits of its budget and in-house expertise. Given the primary interests of HSD's program divisions, the need to consolidate on past experiences, the expertise of both HSD's professional staff, and that of colleagues in other program Divisions, and some of the emerging research issues that relate directly to the Division's established mandate and areas of concern, the following are presented as broad elements that could serve to define a Divisional research agenda for water-related health issues:



## 1. at the macro level:

- alternative approaches for the control of water-related vector borne diseases: the Centre, and particularly the Health Sciences Division, has considerable experience in supporting applied research projects that investigate the influence on disease transmission of community-based vector-control strategies that focus on the actions of humans to change both the vector habitat and behaviours that influence disease transmission. It may be timely for the Centre to consider supporting a review of the lessons learned from these projects about the effectiveness of these strategies to control vector borne disease incidence and prevalence, and their comparative cost-effectiveness to other vector control strategies, both traditional and new approaches.
- assessment of the health implications of water resources development schemes: a related area is the impact of water resource development activities on human health. The rationale for many activities of this nature is the expected accrued economic benefits. There are few studies that delve in-depth into their impact on human health, from either a primary or secondary consequence. Given the problems that now face many developing countries as concerns accessibility to secure, reliable and sufficient quantities of water for domestic, industrial and agricultural purposes, in addition to the influence of structural adjustment policies on national strategies for water resources development and management, it is perhaps timely for the Centre to embark on increased support for research on this issue.
- investigations into the relationship between current agricultural production management practices, such as rice irrigation, and health: over the past few years, the Centre has received, and considered positively for financial support, several research projects that are investigating the relationship between agricultural cropping practices, with particular reference to irrigation schemes, and human health. As mentioned in Chapter 3, quantitative and qualitative data on the contribution of irrigation schemes on the transmission of vector-borne diseases are very limited. Given the importance of irrigation on agricultural productivity in many developing countries, and the expectation that the amount of land under irrigation will increase considerably over the next decade, a better understanding of the issues relating to the vectors' relationship with various cropping practices, knowledge and practices about water-handling behaviours, and their relationship and impact on human health, are required before policy recommendations regarding control measures in irrigated systems can be made.
- investigations on the use of wastewater for crop irrigation, and the implications for human health: again, this is an area to which IDRC has provided some support. It remains, and will continue to be, an important public health issue in many developing countries. However, referring back to the discussion in Chapter 3, the risks associated with this practice remain to be assessed comprehensively. Well designed epidemiological studies to assess whether particular practices result in measurably greater incidence or prevalence of disease than occurs in the absence of the use of untreated wastewaters are required. There is a need as well for comparative cost-effectiveness appraisals of wastewater irrigation schemes with alternative agricultural production schemes.
- investigations into the relationship between the siting of latrines and water sources, and human health: little research on this topic has yet been carried out. It remains an important area of public health concern, in particular given the situations that exist with respect to the siting of water sources and excreta disposal facilities in many urban centres. Given the experience that the Centre, through the collaborative efforts of its Health Sciences and Earth and Engineering

Sciences Divisions, it is proposed that this remain one of the essential elements of a water/health theme for the Centre.

- the development and testing of surrogate measures to 'health impact' for water supply interventions, for the purposes of public health policy formulation: experience from the Decade has demonstrated the problems relating to measuring the health impact of water supply interventions. But demonstrable health impact remains a major consideration in the formulation of national policies for the development of water supply services. What is required is support for continuing research into the identification and assessment of the validity, and reliability of surrogate and proximate measures of health impact.
2. at the micro level:
- the cost-effectiveness of alternative approaches to the protection of the quality of drinking water at the household level: the Decade emphasized the improvement of access and availability of water at the source, predicated on the assumption that the availability of clean water at the source would result in an improvement of health, through a decrease in water-borne diseases. Few studies on the impact of the transportation, handling and storage of water on its quality, and on human health, were carried out. As the Decade progressed, so did the debate as to whether governments allocate resources to the improvement of water sources, or concentrate their efforts on ensuring that water quality standards are attained at the household. However, the results of the research carried out and available to date about the differences in water quality between water drawn from protected sources and water at the household level are inconclusive as pertains to whether water transportation, handling and storage practices result in a deterioration of its quality. Whether an emphasis should be placed over the next several years on improving conditions at the water source, or shifting the emphasis to the protection of water at the household level, or a combination of both strategies, remains to be determined. Hence, the Centre should continue to support research that not only investigates the impact of human behaviour on water quality as relates to its transportation and storage, but should also support studies on the cost-effectiveness of water supply intervention programs at both the water source and household levels.
  - the development of guidelines for the study of hygiene practices, particularly the methodology of hygiene measurement: many of the research projects supported by the Health Sciences Division relating to water have included a health/hygiene education program, as a means of influencing the water-related behaviours. Educational materials have been developed, various strategies for delivering 'health messages' and promoting changes in human behaviour and practices instituted, and assessments made of the impact of the programs. However, what is lacking is an assessment of the lessons learned from these experiences. Nor has there been a critical assessment of the methodologies used. It may be timely for the Centre to step back, and carry out a comparative and comprehensive review of the variety of hygiene promotion campaigns and strategies, to determine guidelines for future related activities.

Taking these as a base, research agendas specific to each of the Division's programs can be defined. The following scenario emerges from a preliminary correlation between the defined research agendas of the Division's programs and the principal issues that could define broadly a water and health research agenda for the Division:

**Health Systems:**

- projects for which the primary focus is the investigation of the process and structure relating to the management of water supply services, and their integration into primary health care plans and programs;
- investigations into different institutional arrangements for the management of water supply services, their impact, and their comparative cost-effectiveness with other arrangements or schemes;
- the development, assessment, application, and evaluation of management information systems for water supply services and water resources management;
- decision-making concerning the delivery of water services at the household and village level, and the interrelationship of this process with decision-making at the political and bureaucratic levels;
- the development and testing of innovative and participatory methods for monitoring and evaluating the impact and sustainability of water supply schemes; and,
- in collaboration with the Division's two other programs, evaluations of the impact of water development and water supply improvement activities on human health.

**Health and the Community:**

- investigation of transportation, handling, storage and use of water for human consumption and domestic use, and their impact on water quality and human health;
- investigation into water handling and use practices and their impact on human health, as relates to industrial and agricultural uses, in collaboration with the Health and the Environment program;
- the investigation into the relationship between access to water sources, their quality and status, and human health;
- investigation into the socio-economic aspects of traditional and household level water purification techniques, and their impact on health;
- investigations into the measurement of benefits and the impact of health and hygiene education activities, as they relate to human interaction with water;
- the investigation of the social impact and cultural acceptability of water resource and water supply development activities; and,
- the impact of human activity on water resource and water supply issues, and their relationship to human health.

**Health and the environment:**

- in collaboration with the Earth and Engineering Sciences Division, continue to support investigations into the actual and potential for contamination of groundwater resources by human and domestic waste, and industrial and agricultural effluent. EES should concentrate on the dynamics and hydrogeology aspects, with HSD responsible for the investigation concerning the relationship between water quality and its impact (actual and potential) on human health;

- the health-related aspects of the contamination of agricultural produce and fish of heavy metal uptake, pesticide residues and other contaminants from untreated and partially treated wastewater and runoff from agricultural land.
- investigations into water management approaches and systems for domestic and agricultural uses designed to control the ecology of infectious and parasitic disease vectors;
- the comparative analysis of community-based management approaches for the control of infectious and parasitic diseases;
- from the health impact perspective, the environmental assessment of the impact of domestic, industrial and agricultural activities on water resources, particularly surface waters. Investigations on this subject should be developed and co-administered with the Social Sciences Division's Environmental Policy program, to take account of the relevancy, practicality, and impact of existing policies and regulations governing the management of water resources.

The present list is meant to assist the Division to define, in broad terms, the essence of a research agenda by identifying a series of issues that transcend the defined areas of interest and concentration of research activities for the Division's three programs. They are not meant to represent a definitive list of elements for a Divisional research agenda on water and health issues. In keeping with the spirit of its guiding philosophy and the holistic approach to the definition of research issues, the Division should retain some degree of flexibility, so as not to restrict its capacity to respond to emerging issues that are defined as priority area for applied research by developing country scientists.

#### 5.4.2 The future for a distinct divisional water subprogram

A related key question is whether, or to what degree, water should be accorded visibility within the Division. Presently, only the description of the workplan for the Health and the Environment program makes specific mention of a water subprogram. There is also the question of how this subprogram, if one is to be maintained, is defined. However, assigning a special designation to 'water' within any one program carries with it both positive and negative implications.

The present research agenda defined for the water subprogram incorporates a wide range of water issues, the primary ones being:

- issues of water accessibility through technical improvements to water retrieval, storage and delivery systems;
- water quality monitoring issues;
- environmental surveys of water resources;
- wastewater disposal/treatment and reuse; and,
- the technical assessment of village-level water treatment technologies and household level water purification techniques.

This program provides support as well to research relating to the control of water-based vectors of parasitic and infectious diseases at the community level, through the investigation of water management approaches and systems for domestic and agricultural uses designed to control the ecology of infectious and parasitic disease vectors. Consideration is also given to the impact of water resource development and exploitation schemes upon the physical, social and health ecology of communities and regions.

**RECOMMENDATION #8:**

**The Health Sciences Division should retain the Water and Water Use subprogram within the Health and the Environment Program, but give serious consideration to redefining its substantive research agenda to specific environmental issues. The Division should also give serious consideration making specific mention of water as one element considered for support within the defined agendas for the Health and the Community and the Health Systems programs.**

One of the strongest arguments in favour of retaining a subprogram within the Health and the Environment program specific to water relates to the validity and relevance of such a program in the absence of a water-related research agenda. Additionally, this program possesses some of the world's recognized experts in water-based vector diseases and water-related environmental toxicological issues. Those in support of retaining a distinct subprogram on water issues within the Health and the Environment program point to the lack of water-related projects supported by the Division's other programs. Concern has been expressed that the elimination of a distinct and visible water-related subprogram will result in a disappearance of research on water-related issues within the Division. Finally, although a shift in focus has occurred with respect to the nature of the substance of the issues considered for support within the Division, from a technology-linked orientation to a people-centred model, such that several of the on-going research projects no longer relate to the present research agenda for the Division, the Water and Water Use subprogram has been instrumental in identifying and supporting several water-related projects which relate directly to the Division's more holistic approach to health research. In essence, this subprogram has been an important mechanism for bridging the former research agenda and slate of projects developed under the former Water Supply and Sanitation Program with the current Divisional program for research support.

On the other hand, the continued existence of a separate water theme within the Health and the Environment program may not serve the best interests of the Division, nor of the developing country researchers it is designed to encourage and support. Several of the elements of the research agenda for the water subprogram within the Health and the Environment program transcend the research agendas of the Division's other programs. Additionally, the expertise required to identify and assist developing country researchers to develop applied research projects on water and health issues is not exclusive to this program. Several Divisional staff outside of the Health and the Environment program possess expertise and experience pertinent to water and health issues, although their primary area of expertise does not relate directly to the water sector.

While it would serve to alert researchers to the need for, and possibility of funds being made available by HSD to support research on important health and water issues, the retention of a Water and Water Use subprogram unique to the Health and the Environment program might limit the scope of definition of applied research on health and water issues that are not explicitly described within the description of the Water and Water Use subprogram. This may not complement the Division's strategy to project an image that encourages the submission of research projects that relate to a broad spectrum of water and health issues.

An option the Division may wish to consider would be to retain the Water and Water Use subprogram within the Health and the Environment program, but redefine its research agenda to issues specific to environmental issues. Simultaneously, the Division might consider making explicit mention of its interest to support applied research on water-related health issues within the research agendas of its other two programs, just as is presently done for nutrition and health services. This would indicate to researchers in developing countries the Division's continuing interest in water and health issues, and at the same time, to publicize that the holistic approach that has been adopted by the Division extends to water-related issues.

For many in developing countries, the distinction between water and health is not as clearly defined as it may be for Divisional professional staff. They do not necessarily perceive water in a health context, nor would they understand inherently that water, as a health issue, is a component of the stated research agendas of the Division's programs. Their primary concerns relate to the scarcity of accessible sources which provide water in sufficient quantities and of acceptable quality. The Division has invested considerable resources, both human and financial, to a development issue that continues to be of a high priority to most developing countries, especially as concerns the most disadvantaged populations. It would be most unfortunate if researchers who are seeking to resolve water-related problems that have a health linkage do not seek assistance from the Division, because water is not explicitly mentioned in its research agenda, or the definition of the issues are restricted to only one subprogram. Hopefully, specific mention of water as an area of interest for the Division could serve to not only encourage researchers to submit proposals to the Division, but it may serve also to promote a different approach to the definition and study of water-related health issues, shifting the emphasis from a technology-linked problem-solving approach to a more contextual and people-centred orientation.

#### 5.4.3 Mechanisms for the review of water-related research within the Health Sciences Division

The issue of an absence of a corporate policy and operational process for the review and development of applied research projects, and its consequences, is one which can be applied to a degree to the Health Sciences Division as concerns water-related projects. Proposals were, and still tend to be, developed within the framework of a particular program. Although professional staff from the other programs may be requested to comment on applied research proposals, there is no mechanism that permits or encourages a comprehensive roundtable dissection and discussion of the relevancy of the proposed research hypothesis or the scientific merit of the research methodology. The Division has at its disposal a wide spectrum of in-house expertise. It should utilize it to its fullest advantage. As so many water-related issues incorporate elements of the Division's three programs, then it would seem logical that a more coherent and corporate approach must be adopted for the review of proposals on water and health issues.

**RECOMMENDATION #9:**

Given the multidimensionality of many water/health issues, a more corporate and multidisciplinary approach to the review of applied research proposals on water issues, such as roundtable discussions, should be adopted.

#### 5.4.4 The administration of active water-related research activities

The Health Sciences Division has supported a rich diversity of issues and topics relating to water over the course of fifteen years. It has provided support to the creation and expansion of several viable research networks on water issues. Some have evolved into important mechanisms for the exchange of information on research experiences, and as means of identifying emerging issues, and innovative approaches and research methodologies. It has nurtured as well formidable multidisciplinary research teams that transcend national boundaries. Exciting opportunities have arisen in which solid research products have been produced. Considerable momentum has been generated.

However, before the Health Sciences Division takes a decision about future financial support for projects, networks and activities supported presently, it should undertake, or commission to be carried out, in-depth reviews of their achievements, priority research issues on the topic that remain to be addressed, emerging issues, and the nature and status of research being carried out on the same topic, supported by other funding sources. To discontinue support at a point in time that might be critical to the potential viability and sustainability of a research initiative without a clear and thorough understanding of the ramifications of this decision would neither be a good or acceptable business strategy. Although not accepted as an argument by some professional staff of the Health Sciences Division, the fact remains that it has a moral responsibility to the researchers that it has supported. Support from the Division has been used to create programs, and to improve the capacity of researchers to identify, develop and implement relevant and practical applied research proposals and the administrative capacity of their respective institutions. Whether planned or not, expectations have been raised. Several research initiatives are reaching a critical threshold level for which additional support would provide the impetus required to launch them into large-scale application. As is so often the case, the application of research results is the most critical part of the entire development process.

The assessment could serve as well as input into the development and evolution of Centre thinking about the direction and substance of research on innovative strategies for development. In its attempt to disseminate useful information on research experiences and results, the Centre has promoted the preparation and publication of the analysis of substantive research issues, based on the lessons learned about particular topics from a variety of related research projects. To date, with the exception of reports on research results pertaining to the networks established on water quality testing and PVC handpumps, the Division has not had the opportunity to take stock and draw conclusions and lessons from its experiences from support to other water-related issues. It may be timely to undertake such studies.

**RECOMMENDATION #10:**

The Health Sciences Division should undertake, as a precursor for decisions on future support to on-going research Initiatives, a comprehensive review of the status of research and development Initiatives, lessons learned from these experiences, and strategies for the support of the wide-scale application of their products for the following topics:

- PVC handpump technology
- groundwater pollution from on-site sanitation facilities
- rainwater catchment systems
- wastewater treatment/resource recovery and reuse
- health/environmental impact of improvements in water supply facilities
- community-based strategies for the planning, implementation and management of water supply improvement activities.

The primary objective of the assessments would be to determine the benefit and impact of the investment made to projects, or sets of projects, and other research activities related to these areas of study. The central issues for the assessments should be:

- what impact and contribution to improve the standard of living and well-being of disadvantaged populations in developing countries have the projects under study made?
- what has been the comparative advantage of the Centre's approach and the impact of its investment, in comparison to that of other funding agencies?
- what lessons can be drawn, to assist to strengthen the Division's and the Centre's role in supporting research for development? and,
- what are the central and ancillary research questions related to the subject at hand that remain to be addressed, what should the Division's and the Centre's strategy be in this regard, and what mechanisms are available to either provide support directly, or to assist researchers to find alternative sources of financing, for the wide-scale application of research results?

As discussed in the previous chapter, the Division has supported research on several topics that have produced important outputs and which have made considerable contributions to knowledge on the topic. Resources permitting, comprehensive assessments based on the aforementioned criteria should be considered for the following:



- PVC handpump technology
- groundwater pollution from on-site sanitation facilities
- rainwater catchment systems
- wastewater treatment/resource recovery and reuse
- health/environmental impact of improvements in water supply facilities
- community-based strategies for the planning, implementation and management of water supply improvement activities.

Preliminary reviews of the objectives, achievements and the identification and discussion of some of the more important related research issues that remain to be addressed have been carried out on three topics: handpumps; water quality assessment; and, solar disinfection of drinking water and the use of traditional methods for water purification. cursory overviews were undertaken for the purposes of the present study on other topics that have received financial support from the Health Sciences Division, namely rainwater harvesting and storage systems; surface and groundwater quality assessment; wastewater treatment/resource recovery and reuse; and, health/environmental impact of improvements in water supply facilities. However, none of these reviews covers the criteria mentioned previously, that are believed essential elements of a comprehensive analysis to provide a rationale to the Division and to the Centre upon which to base a decision concerning future support.

For example, the framework for a strategy for the Centre on handpump-related research was elaborated only in 1986, after ten years experience. However, the Division, and to a certain extent the Centre, appear to be hesitant, or incapable of responding to certain elements of this strategy. This is particularly true as concerns the commercialization and local manufacture of handpumps in developing countries. Despite its best intentions, neither the Division nor the Centre has made a decision as to what role it should play as concerns such proposals: should it provide direct financing of such ventures as studies relating to the various institutional arrangements for the manufacture and commercialization of handpumps in developing countries; should it assume the role of broker, acting

as an intermediary between institutions and organizations that submit proposals on handpump manufacture and commercialization, and other donor agencies; or, should it divest itself entirely of any further involvement in handpump research and development? These are important questions that merit forthright responses. A comprehensive assessment of the handpump-related projects would assist in this process.

On the subject of groundwater contamination by on-site sanitation facilities, there are four reasons to justify a thorough review of research on this topic:

- the Health Sciences Division provided a substantial amount of support to research on the development of low-cost, on-site sanitation facilities;
- to date, there are few research projects supported by either IDRC or other funding agencies on the subject of the relationship between the siting of on-site sanitation facilities, groundwater contamination, and the implications for human health and public health policy;
- no comprehensive review of the findings of these research projects has as yet been carried out;
- the health issues relating to the subject are very important.

The review would be useful to both EES and HSD. It would assist them to determine the direction and the substance of future research initiatives on this subject, and the potential for Centre support to this issue. It would also serve to strengthen the collaboration between these two Divisions, by pooling their

expertise, with the Earth and Engineering Sciences Division taking the lead for research support to the dynamics of groundwater contamination, and the Health Sciences Division concentrating its expertise on water quality and health issues.

Support by the Health Sciences Division to research projects on rainwater harvesting have covered a broad spectrum of issues. Much of it relates to the development and technical appraisal of water harvesting and storage devices, and some to water quality issues. Few studies on the socio-economic and behavioural aspects of rainwater harvesting, storage, utilization and consumption, nor its impact on human health, have been carried out with Centre support. Nor has the Division developed a framework to guide decision-making for support to research initiatives on this topic. As mentioned in the previous chapter, WASH/USAID has created and maintains a large information exchange network on research and development activities relating to rainwater catchment. A review of the slate of projects relating to the development and technical assessment of water supply technologies supported by the Centre would serve to indicate whether any research issues remain that should be supported by the Centre.

The Division has provided substantial support to research on wastewater treatment/resource recovery and reuse, particularly as concerns the technical assessment of technologies, and the human health implications relating to the use of untreated and treated wastewater for irrigation. As noted in Chapter 3, this is an area that has been identified at international fora and by several recognized experts on water issues as a priority area deserving increased support for research activities over the next several years. Substantial funds are scheduled to be invested by the World Bank and other donor agencies into research and development activities on this topic. It would serve the Centre's interests to carry out an assessment of the contribution it has made, and its potential and comparative advantage to continue to do so under existing resource constraints and in light of the intentions of other donor agencies, before taking a decision to support further applied research on this topic.

The Division, as part of the support provided to the projects on the development and testing of PVC handpumps, has provided considerable support to research on community-based strategies for the planning, implementation, and management of water supply improvement interventions. Many of these projects have recently, or will shortly be nearing completion. While the technical aspects of the handpumps have been documented and disseminated through IDRC publications, a review and analysis of the achievements and lessons learned of the attendant research on community-based strategies for the support of the technology has not been undertaken. This remains a very important aspect of water-related development activities. The experiences of these projects may be applicable to other sectors, such as primary health care services.

**RECOMMENDATION #11:**

Given the slate of water-related projects that remain active, the fact that several appear not to be assigned to the most appropriate program, and changes that have occurred within the Division's complement of professional staff over the past few years, it is recommended that the Division review the status of each project, to ensure that it is assigned to the most appropriately qualified member of the Division.

On other issue that merits attention by the Health Sciences Division relates to the administration of water-related projects for which field activities are on-going. Projects active at the time of the restructuring of the Division were redistributed among the Division's new programs. However, in several instances, the original reassignment of projects did not take into account the research focus of the pertinent program, such that the research objectives of the project did not coincide necessarily with the defined program workplan. In these cases, the projects 'followed' the professional staff member to whom they had been originally designated to the program to which they were assigned.

Over the intervening period, several changes in the Division have occurred, such as the departure of professional staff who were involved directly in the administration of the water-related projects. As a consequence, active projects were again redistributed among professional staff. With the recent arrival in the Division of several new professional staff, and the approach of an annual Divisional staff meeting, it may be timely to review the status and focus of the water-related projects that remain active, in order to determine the most appropriate program affiliation and professional staff assignment.

#### 5.7 Mechanism for Promoting a Corporate Policy for Water-related Research Activities

If the Centre is to adopt a more holistic and corporate approach to the definition and implementation of a water-related policy, and given the resource constraints under which it functions presently, the Centre should utilize as effectively as possible all of the resources it possesses to its advantage. One of the comparative advantages enjoyed by the Centre is the wealth of professional qualifications and experience possessed by its program staff. To overcome the often fragmented approach that tends to characterize the approach within the Centre as relates to the development of water-related research projects, a mechanism should be adopted and implemented that draws upon the wide range of expertise found within the Centre.

The Centre has experience in such mechanisms already, some more formally structured than others. For example, the more formal approach is represented by the Centre's Gender and Development Unit. While providing greater visibility for a special program thrust, it entails administrative requirements that may not be replicable within the Centre, given the existing restrictive resource

environment. As this mechanism is defined, each program Division invests a set amount of funds annually to support the development and funding of new projects on women's issues. It requires also the secondment of an existing professional staff position.

The Centre's Nutrition Unit, although similar administratively to the Gender and Development Unit in several respects, does not receive financial support from other Divisions. Nutrition-related issues and applied research proposals are reviewed by members of a technical advisory group, composed of professional staff from other Divisions and development of research activities. However, support to applied research projects that relate to nutrition receive support directly from the program Division in which they are developed and approved for funding.

#### **RECOMMENDATION #12:**

Given the continuing importance of water issues in development thinking and action programs, the history of the Centre in its support of research on this topic, the proposal that the Centre elaborate a corporate policy on applied research for water issues, and the need for a more holistic approach and broad-based expertise to identify, review and administer water-related research activities, it is proposed that the Centre give serious consideration to the creation of a Technical Advisory Group on Water Issues.

Given the resource constraints and internal environment at the Centre, the creation of a formal Water and Development may not be practical, nor financially or politically possible. An option would be to establish an *ad hoc* working group on water issues. Similar to several other committees within the Centre, its role would be to provide guidance to the Centre on matter pertaining to water issues. It would meet on a regular basis, and would promote active participation by Divisional representatives. Its mandate would be quite limited, as would its time frame of existence, in keeping with its *ad hoc* nature. The purpose of the TAG would be:

- to provide guidance to Centre management and professional staff about current and emerging research and development issues;
- to review research proposals that have a multidisciplinary focus, or those that may have implications or future research potential for support from more than one program Division over the life of support for research on a specific topic;
- to recommend Centre strategy as pertains to research proposals submitted to IDRC that fall outside of defined Divisional programs, and for which in-house expertise to review and assist in the development of proposals does not exist;
- to coordinate Centre representation at international conferences and meetings, on international, regional and topical committees, and responses to enquiries concerning Centre activities and opinions relating to water issues; and,

The TAG concept builds upon the informal nature of contact among program staff already existent in the Centre. It also has the advantage of a greater degree of flexibility than a more formal 'unit' structure, and allows for maximum input from interested representatives. It would, in essence, reflect and provide a corporate perspective on water-related research issues and activities. The TAG would serve as a forum, to review research proposals for which the Centre does not have a policy, or for which there is no in-house expertise. It could make recommendations to the program Divisions as to whether the Centre should consider supporting the research, and the most effective means to review, develop and administer the resultant project. The TAG could also serve as the focal point for regional input on sector-related issues and activities.

Optimally, each program Division would nominate a divisional representative to the TAG. Regional representation would also be sought, with consistent communication between the TAG and regional offices. Meetings of the TAG would be held on a regular basis. Responsibility for the chair would rotate among TAG members on a fixed term. Although it has no authority or formal status, the TAG can be useful to both Divisional and Centre management, to assist them in determining the direction and scope of research funded on water-related issues. The TAG could be charged to report to senior management and the Board every two or three years on the role of IDRC in supporting research on this topic, the status of on-going initiatives, and emerging issues.

#### 5.8 Centre Representation on Water-related Committees and at International Fora

Centre representation on sector-related international councils and committees, and working groups and specialized committees, appears at present to be dependent on the availability of professional staff, the interest of their home division, and their personal professional interests. Rarely is information emanating from regional and international fora shared with professional staff from other Divisions. This may be due to a perception within the Centre that other program divisions do not share an interest in the topic. It may also reflect the premium placed on time by professional staff: the current workload may not permit sufficient time to prepare and present to other Centre personnel information about current and emerging thought on research and development issues. Nor do staff from other Divisions necessarily have the time or inclination to attend.

##### **RECOMMENDATION #13:**

**The TAG should meet quickly, to identify who represents the Centre on water-related international councils and committees, and who should retain the responsibility to maintain correspondence with these and other international agencies and organizations concerning water-related issues and activities at IDRC.**

The need to have a more corporate policy and action as concerns Centre representation on international councils and committees is illustrated by the experiences with Centre representation on the Collaborative Council of External Support Agencies on Water Supply and Sanitation Issues.<sup>1</sup> The Collaborative Council was established in 1988, following a series of meetings of donor agency representatives. Among its purposes are the promotion of an improvement in cooperation and collaboration among donor agencies on sector-related research and development activities. IDRC played a key role in its creation. It represents a very important step in the development of a coherent and rational approach to development activities within the sector. At the recent annual Council meeting, the representatives of several donor agencies, including the Council chair, remarked with pleasure the apparent decision of the Centre to continue its membership within the Council. For many, this indicated a renewed interest on the part of IDRC to fund applied research projects on sector issues.

Centre representation on the Council has not been consistent or regular. First, representation on the Council was interrupted in mid-1989, following the departure from the Division of the two professional staff who had served in this capacity. It was not until the following year that the Centre was again represented on the Council. Also, the decision to have a representative from the Centre on the Council was not taken by the Centre as a whole. Rather, it was a divisional decision, based on the traditional role played by the Health Sciences Division in water supply issues, and the interests of professional staff related to the former water supply and sanitation program. The lack of a corporate strategy for representation on the Council could affect the capacity of the Centre to influence thinking and action by the Council on sector-related issues.

The TAG could serve to reinforce the Centre's intention to continue to support water-related research activities, and to communicate this message to other donor agencies. It could serve as well as a focal point for inquiries about Centre sector-related activities and opinion. The TAG could serve also to coordinate Centre representation on international councils and committees, and promote a sharing of information emanating from them to other Centre personnel, and to the regional offices. It would also serve to ensure continuity of representation, and to promote a more corporate representation of IDRC at international fora. Most importantly, through the development of a corporate policy on water-related issues, and continued active involvement by Centre personnel on international committees and at international fora, on a coordinated basis, the Centre could use its influence and reputation to guide thinking and action on issues.

The Centre, and the Health Sciences Division, have developed a very important heritage in water-related research. The emerging trends and issues indicate that water will continue to be a major issue in many developing countries through to the end of the century. The Centre plays a unique role in the international development process, and has much to contribute. The recommendations presented in this study are designed to assist IDRC, and in particular the Health Sciences Division, to fulfil their mandates, to assist in the process of improving the standard of living and wellbeing of disadvantaged populations, in an effective manner.

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<sup>1</sup> A detailed description of the Centre's involvement in the creation of the Collaborative Council, its mandate, composition and activities, is provided in Chapter 3.

## ENDNOTES

1. R. Chambers, 'Identifying Research Priorities in Water Development,' *Water Supply and Management*, Vol. 2, 1978, pp. 389-396.
2. See for example: P. Wirojanagud & Kevin Smith, 'Small Watershed Management in Thailand,' *Waterlines*, Vol. 8, No. 3, January 1990.
3. I. Andersson, *Waterlines*, 8(3), January 1990, pp. 20-23.
4. IDRC Act of Parliament, paragraph 4.
5. International Development Research Centre, *Searching - Fresh Water: the Human Imperative*. (Ottawa: IDRC, 1989), p. 7.
6. Chambers, *op cit.*
7. PPR VII, pp. 25-26.
8. B. Hall, 'Breaking the monopoly on knowledge: research methods, participation and development,' in B. Hall and J.R. Kidd (eds.) *Adult Learning: A design for action* (United Kingdom: Pergamon Press, 1978) pp 156-159.
9. D. Anton, *Urban Environments and Water Supply in Latin America: with particular emphasis on groundwater*, (Montevideo: IDRC, November 1990).
10. UNDP-World Bank Water and Sanitation Program, *The International Training Network for Water and Waste Management* (INT/86/027), Progress Report as of January 1990. Mimeo.
11. B. MacMahon and T.F. Pugh, *Epidemiology: Principles and Methods* (Boston: Little, Brown and Company, 1970), pp. 23/24.
12. Corin, E.E., Bibeau, G., Martin, J-C., et R. Laplante *Comprendre pour soigner autrement* (Montreal: Les Presses de l'Université de Montréal, 1990), pp. 18/19.
13. A.M. Cairncross, 'Health Impacts in Developing Countries: New Evidence and New Prospects,' *Journal of the IWEM*, 4, December 1990, p. 571.

APPENDIX A

LIST OF WATER-RELATED PROJECTS  
SUPPORTED BY IDRC  
1974-1989

Health Sciences Division

3-P-74-0033	WATER TREATMENT PLANT (PERU)
3-P-75-0007	STABILIZATION PONDS (PERU)
3-P-75-0039	TRUST FUND RURAL WATER SUPPLY/SANITATION (WHO)
3-P-75-0128	GROUNDWATER IRON REMOVAL (GHANA)
3-P-76-0035	LITERATURE REVIEW: INNOVATIVE HANDPUMP TECHNOLOGY (CANADA)
3-P-76-0085	WATER MANAGEMENT (NIGERIA)
3-P-76-0109	MANUALLY OPERATED LOWLIFT PUMP PROTOTYPES (CANADA)
3-P-76-0140	WASTEWATER RECLAMATION (MALAYSIA/ISRAEL/KENYA)
3-P-76-0141	PIGGERY WASTE TREATMENT (SINGAPORE)
3-P-76-0158	WATER PUMP SYSTEMS (CANADA)
3-P-76-0187	RURAL WATER TECHNOLOGY RESEARCH (CANADA)
3-P-77-0002	MAASAI WATER IMPACT (KENYA)
3-P-77-0019	WATER SUPPLY AND SANITATION (USA)
3-P-77-0020	PUMP-WINDMILL SYSTEMS (CANADA)
3-P-77-0022	PUMPING TECHNOLOGY RESEARCH (ETHIOPIA)
3-P-77-0029	WINDPOWER (ETHIOPIA)
3-P-77-0053	WATER TREATMENT (BRAZIL)
3-P-77-0059	WASTE RECLAMATION (THAILAND)
3-P-77-0069	INFILTRATION GALLERIES (PANAMA)
3-P-77-0080	RURAL WATER SUPPLY (KOREA)
3-P-77-0095	SANITATION IMPACT (BANGLADESH)
3-P-77-0107	SHALLOW WELL PUMP RESEARCH (MALAWI)
3-P-77-0122	HANDPUMP LABORATORY TESTING (UK)
3-P-78-0014	PALM OIL WASTES (MALAYSIA)
3-P-78-0016	WATER PUMPING TECHNOLOGY (PHILIPPINES)
3-P-78-0018	WIND POWER PUMPING (BOTSWANA)
3-P-78-0019	WATER MANAGEMENT (SUDAN)
3-P-78-0037	ENVIRONMENTAL HEALTH (THAILAND)
3-P-78-0082	WATER PUMPING TECHNOLOGY (MALAYSIA)
3-P-78-0097	WASTES MANAGEMENT (THAILAND)
3-P-78-0105	HANDPUMP TESTING (SRI LANKA)
3-P-78-0134	RURAL WATER FLUORIDES (KENYA)
3-P-79-0071	PIGGERY WASTE TREATMENT (SINGAPORE) PHASE II
3-P-79-0072	PATHOGEN TRANSFER/WASTEWATER (ISRAEL)
3-P-79-0074	INFILTRATION GALLERIES (PANAMA) PHASE II
3-P-80-0023	MANPOWER TRAINING PROJECT (AFRICA)
3-P-80-0044	WATER DEMAND AND DESIGN CRITERIA (GUATEMALA)
3-P-80-0088	WATER MANAGEMENT (ETHIOPIA)
3-P-80-0091	RAINWATER COLLECTION (SIERRA LEONE)
3-P-80-0119	WATER LOSS (ECUADOR)
3-P-80-0158	ROOF CATCHMENT (THAILAND)
3-P-80-0179	LOW-COST SANITATION (ECUADOR)
3-P-80-0197	DYNAMIC FILTERS (ECUADOR)
3-P-81-0065	TRAINING EVALUATION (GUATEMALA)
3-P-81-0100	ENVIRONMENTAL SANITATION (GAMBIA)



Health Sciences Division (con't)

3-P-81-0103	WATER SUPPLY SURVEY (THAILAND)
3-P-81-0181	WATER PROJECT TRAINING (INDONESIA)
3-P-82-0039	SOIL-TRANSMITTED HELMINTHS (INDONESIA)
3-P-82-0054	RURAL SANITATION (SIERRA LEONE)
3-P-82-0058	WATER AND SANITATION FILM (CANADA)
3-P-82-0150	SCHISTOSOMIASIS (KENYA)
3-P-82-0162	WATER PUMPING TECHNOLOGY (MALAYSIA) PHASE II
3-P-83-0007	RURAL WATER FLUORIDES (KENYA) PHASE II
3-P-83-0019	WATER SYSTEMS EVALUATION (COLOMBIA)
3-P-83-0026	INTRODUCING PVC HANDPUMPS (THAILAND)
3-P-83-0031	HOSPITAL WASTEWATER (THAILAND)
3-P-83-0066	HANDPUMP MANUAL (ASIA)
3-P-83-0156	PIGGERY WASTES TREATMENT (MALAYSIA)
3-P-83-0193	WOMEN IN HANDPUMP TECHNOLOGY (SRI LANKA)
3-P-83-0205	VILLAGE HANDPUMPS (PHILIPPINES)
3-P-83-0244	PUMPING TECHNOLOGY RESEARCH (ETHIOPIA) PHASE II
3-P-83-0310	WATER SUPPLY AND SANITATION (KOREA)
3-P-83-0311	SMALL-SCALE DESALINATORS (BOTSWANA)
3-P-83-0317	WATER QUALITY CONTROL (MALAYSIA/SINGAPORE/THAILAND)
3-P-84-0013	SOLAR DISINFECTION (THAILAND)
3-P-84-0022	RAINWATER CATCHMENT (PHILIPPINES)
3-P-84-0080	WATER POLLUTION (TUNISIA)
3-P-84-0111	MACROINVERTEBRATE SURVEY (KOREA)
3-P-84-0159	SCHISTOMIASIS CONTROL: A COMMUNITY-BASED APPROACH (ZIMBABWE)
3-P-84-0185	LIVESTOCK WASTES (KOREA)
3-P-84-0187	SANITARY CONDITIONS (NEPAL)
3-P-84-0208	THEYTHANCOTTAI WATER TREATMENT (INDIA)
3-P-84-0245	BLISS WASTE TREATMENT (PHILIPPINES)
3-P-84-0254	SANITATION SYSTEMS (BANGLADESH)
3-P-84-0258	HYDRAULIC RAM PUMP (UGANDA)
3-P-84-0274	HANDPUMP MANUFACTURE (INDONESIA)
3-P-84-0283	RURAL SANITATION RESEARCH (SIERRA LEONE) PHASE II
3-P-84-0336	DRACUNCULOSIS (TOGO)
3-P-85-0006	WATER QUALITY CONTROL (BRAZIL/CHILE/PERU)
3-P-85-0031	RAINWATER COLLECTION (PHILIPPINES)
3-P-85-0034	SOLAR DISINFECTION (LEBANON)
3-P-85-0048	WASTE MANAGEMENT TRAINING (SINGAPORE)
3-P-85-0080	HYDRAM POTENTIAL (TANZANIA)
3-P-85-0084	HORIZONTAL SAND FILTRATION (THAILAND)
3-P-85-0183	WATER QUALITY CONTROL (MOROCCO)
3-P-85-0185	WOMEN WATER AND SANITATION (EGYPT)
3-P-85-0203	WASTEWATER REUSE (PERU)
3-P-85-0208	SOLAR LIQUID PISTON PUMP (GHANA)
3-P-85-0244	WATER QUALITY CONTROL (EGYPT)
3-P-85-0252	RICE HUSK FILTERS (INDIA)
3-P-85-0270	RAINWATER CONTAMINATION (THAILAND)
3-P-85-1030	HEAVY METAL RIVER POLLUTION (LATIN AMERICA/CANADA)
3-P-86-0018	HANDPUMP TECHNOLOGY (COSTA RICA)
3-P-86-0119	PVC HANDPUMPS (CAMEROON)
3-P-86-0132	WINDPUMP/COMPOSTING LATRINE TECHNOLOGY (PANAMA)
3-P-86-0133	DEEP WELL PUMPS (INDIA)
3-P-86-0136	ENVIRONMENTAL SLUM IMPROVEMENT (THAILAND)

Health Sciences Division (con't)

3-P-86-0198 DISSEMINATION OF PVC HANDPUMP IN RURAL AREAS (MALI)  
3-P-86-0255 CHILDREN AS CHANGE AGENTS (HONDURAS)  
3-P-86-0226 WATER QUALITY SURVEY (ZIMBABWE)  
3-P-86-0322 WATER DISINFECTION (BOLIVIA)  
3-P-86-1002 COAL-BASED SORBENTS (INDIA/CANADA)  
3-P-86-1051 WATER QUALITY DATA MANAGEMENT (MALAYSIA/CANADA)  
3-P-87-0004 PVC HANDPUMPS (CHINA)  
3-P-87-0060 FRCS MANUAL (PHILIPPINES)  
3-P-87-0081 WATERLINES (ENGLAND)  
3-P-87-0084 WATER PUMPING TECHNOLOGY (MALAYSIA) PHASE III  
3-P-87-0085 WELLS AND HANDPUMPS (KENYA)  
3-P-87-0086 HUMAN PATHOGEN SURVIVAL (ZAIRE)  
3-P-87-0091 SOCIOECONOMIC STUDY OF EWWCA HANDPUMP PROJECT (ETHIOPIA)  
3-P-87-0092 WOMEN IN HANDPUMP TECHNOLOGY (SRI LANKA) PHASE II  
3-P-87-0105 SOIL TRANSMITTED HELMINTHS (INDONESIA) PHASE II  
3-P-87-0153 COMMUNITY SELF-RELIANCE (THAILAND)  
3-P-87-0173 POLLUTION LOAD MSIMBAZI STREAM (TANZANIA)  
3-P-87-1039 GROUNDWATER POLLUTION (TANZANIA)  
3-P-88-0001 WOMEN WATER AND SANITATION (EGYPT) PHASE II  
3-P-88-0071 EVALUATION OF ENVIRONMENTAL SANITATION (BRAZIL)  
3-P-88-0072 WATER QUALITY (MALAWI)  
3-P-88-0104 INTEGRAL SYSTEM FOR RECYCLING ORGANIC WASTES (MEXICO)  
3-P-88-0181 EVALUATION OF RURAL WATER SUPPLY PROJECTS (SIERRA LEONE)  
3-P-88-0221 DRACUNCULOSIS (MALI)  
3-P-88-0243 PARTICIPATORY STRATEGIES IN WATER SUPPLY (COSTA RICA)  
3-P-88-0257 ARSENIC CONTAMINATION (CHILE)  
3-P-88-0258 DISSEMINATION OF FERROCEMENT RAINWATER CATCHMENT SYSTEMS (PHILIPPINES)  
3-P-88-0273 HYDRAMS (MALAYSIA)  
3-P-88-0275 AGRO-BASED WASTEWATER (THAILAND)  
3-P-88-0323 SLUM IMPROVEMENT (THAILAND)  
3-P-88-0340 COMMUNITY WATER TREATMENT SYSTEMS (COLOMBIA)  
3-P-88-0397 SCHISTOSOMIASIS CONTROL: A COMMUNITY-BASED APPROACH (ZIMBABWE) PHASE II  
3-P-89-0031 INTEGRATED HEALTH INTERVENTION FOR CHILDHOOD DIARRHOEA (THAILAND)  
3-P-89-0061 HOUSEHOLD WATER DISINFECTION (THAILAND)  
3-P-89-0169 SLOW SAND FILTRATION (EGYPT)  
3-P-89-0180 ROUGHING FILTERS (COLOMBIA)  
3-P-89-0209 RAINWATER CATCHMENT (BANGLADESH)  
3-P-89-0211 GRAVEL WATER FILTRATION SYSTEMS (JORDAN)  
3-P-89-0320 MICROBIOLOGICAL WATER QUALITY TESTING CAPABILITY (CANADA)  
3-P-89-0330 RAINWATER CATCHMENT (TANZANIA)

Information Sciences Division

3-P-75-0022 CEPIS INFORMATION SYSTEM DESIGN (LATIN AMERICA)  
3-P-76-0156 WASTEWATER DISPOSAL: STATE-OF-THE-ART REVIEW (CANADA)  
3-P-78-0010 INFORMATION CENTRE ON SANITATION (ASIA)  
3-P-78-0083 POTABLE WATER SUPPLIES AND SANITATION JOURNAL (ENGLAND)  
3-P-79-0117 PANAMERICAN SANITARY ENGINEERING INFORMATION SYSTEM (REPDISCA)  
(LATIN AMERICA) PHASE II  
3-P-82-0072 ENVIRONMENTAL SANITATION INFORMATION CENTRES (ENSIC) (ASIA)  
PHASE II  
3-P-83-0152 REPDISCA - CONSOLIDATION PHASE (LATIN AMERICA) PHASE III  
3-P-84-0322 REPDISCA (PERU)  
3-P-84-0323 INTERWATER THESAURUS (NETHERLANDS)  
3-P-84-0067 WATER SUPPLY AND SANITATION RESEARCH INFORMATION SYSTEM  
(LATIN AMERICA)  
3-P-85-0239 AGRICULTURAL WASTE MANAGEMENT INFORMATION (MALAYSIA)  
3-P-85-0297 REPDISCA (ARGENTINA)  
3-P-86-0106 APPROTECH ASIA INFORMATION SYSTEM ON WATER AND SANITATION  
(ASIA)  
3-P-86-0108 WASSDOC (SRI LANKA)  
3-P-86-0109 AFRICAN WATER AND SANITATION INFORMATION SYSTEM (BURKINA FASO)  
3-P-86-0321 REPDISCA (GUATEMALA)  
3-P-87-0047 REPDISCA (NICARAGUA)  
3-P-87-0096 WATER AND SANITATION INFORMATION NETWORK (INDONESIA)  
3-P-87-0108 CEHANET (JORDAN)  
3-P-89-0080 WATER AND SANITATION INFORMATION NETWORK (TANZANIA)  
3-P-89-0212 APPROTECH ASIA INFORMATION SYSTEM ON WATER AND SANITATION  
(ASIA) PHASE II

#### Fellowships and Awards Division

- 3-P-84-0255 POSTGRADUATE HYDROLOGIC EDUCATION/RESEARCH (INDIA)
- 3-P-85-0067 REGIONAL TRAINING: IRRIGATION AND WATER MANAGEMENT IN RICE IRRIGATION (BANGLADESH)

#### Communications Division

- 3-P-83-0072 INFORMATION EXCHANGE WITH CHILDREN (KENYA)
- 3-P-83-0250 WATER AND SANITATION IMPACT VIDEO PRODUCTION (CANADA)
- 3-P-89-0004 TRAINING MODULES IN COMMUNITY PARTICIPATION (COSTA RICA)
- 3-P-89-0283 COMMUNITY-BASED EVALUATION OF WATER QUALITY: MEP IN KIBWEZI (KENYA)

#### Social Sciences Division

- 3-P-83-0028 URBAN SERVICES IN MONTERIA (COLOMBIA)
- 3-P-83-0183 URBAN SERVICES MANAGEMENT (NIGERIA)
- 3-P-83-0255 URBAN SERVICES MANAGEMENT (TANZANIA)
- 3-P-84-0006 URBAN GROWTH MANAGEMENT (IVORY COAST)
- 3-P-84-0009 URBAN GROWTH MANAGEMENT (ZAIRE)
- 3-P-84-0011 URBAN FACILITIES IN DAKAR (SENEGAL)
- 3-P-84-1005 URBAN GROWTH MANAGEMENT (CANADA/AFRICA)
- 3-P-86-0261 FINANCIAL MANGEMENT OF URBAN SERVICES: WATER AND SANITATION (INDIA)
- 3-P-88-0067 NATURAL RESOURCE USE AND TECHNOLOGY DIFFUSION (MEXICO)
- 3-P-88-1023 VILLAGE HYDRAULICS EXTENSION AND COMMUNITY PARTICIPATION (TOGO/CANADA)

#### Agriculture Food and Nutrition Sciences Division

- 3-P-75-0107 CROPPING SYSTEMS (SRI LANKA)
- 3-P-78-0050 CROPPING SYSTEMS (SRI LANKA) PHASE II
- 3-P-79-0120 DESERT FARMING SYSTEMS (EGYPT)
- 3-P-81-0141 FARMING SYSTEMS (MALI) PHASE II
- 3-P-82-0251 SHELTERBELTS (NIGERIA) PHASE II
- 3-P-83-0097 DESERT FARMING SYSTEMS (EGYPT) PHASE II
- 3-P-87-0263 IRRIGATED FORESTRY (PAKISTAN)
- 3-P-86-0152 DEEP WELL SOLAR PUMPS (SENEGAL)
- 3-P-89-0094 NEW LANDS WATER SURVEY (EGYPT)
- 3-P-89-0021 WATERSHED MANAGEMENT (COLOMBIA)

Earth and Engineering Sciences Division

3-P-81-1014 AQUATIC POLLUTION IN THE CARONI RIVER (TRINIDAD)  
3-P-82-1016 STUDY OF JAMAICAN BAUXITE WASTE (JAMAICA)  
3-P-83-1020 SNOW AND ICE IN THE UPPER INDUS BASIN (PAKISTAN)  
3-P-83-1027 AQUATIC POLLUTION IN THE CARONI RIVER (TRINIDAD) PHASE II  
3-P-84-1044 URBAN GEOLOGY (THAILAND)  
3-P-84-1056 QUATERNARY HYDROGEOLOGY (BENIN)  
3-P-85-1005 AQUIFER DEVELOPMENT (MEXICO)  
3-P-85-1023 AQUIFERS (SANTA LUCIA/URUGUAY)  
3-P-85-1032 CONTAMINANT TRACING (BRAZIL)  
3-P-85-1039 HYDROLOGY/HYDROGEOLOGY OF DONGAS (SWAZILAND)  
3-P-85-1041 HYDROGEOLOGY (UGANDA)  
3-P-86-1014 SALT WATER INTRUSION IN AQUIFERS (SENEGAL)  
3-P-86-1026 CAMANCHACAS (CHILE)  
3-P-87-1016 ALTIPLANO HYDROLOGICAL SYSTEM (BOLIVIA)  
3-P-87-1017 PRODUCTIVITY OF AQUIFERS IN FOUNDATION ROCK (BURKINA FASO)  
3-P-87-1018 DISCONTINUOUS AQUIFERS (NIGER)  
3-P-87-1046 SLURRY POND RECLAMATION (MALAYSIA)  
3-P-88-0016 SILTING-UP OF WELLS (BURKINA FASO)  
3-P-88-1012 GEOTECHNOLOGY CONAKRY (GUINEA)  
3-P-88-1017 HYDROGEOLOGY BAMAKO (MALI)  
3-P-88-1029 LATIN AMERICAN URBAN HYDROGEOLOGY NETWORK (LATIN AMERICA)  
3-P-88-1033 GROUNDWATER CONTAMINATION (BRAZIL) PHASE II  
3-P-88-1035 MARAHOUE RIVER HYDROGRAPHICAL BASIN (IVORY COAST)  
3-P-88-1054 AQUIFER MANAGUA (NICARAGUA)  
3-P-88-1056 GROUNDWATER MANAGEMENT - LA PLATA (ARGENTINA)  
3-P-88-1059 GROUNDWATER COCHABAMBA VALLEY (BOLIVIA)  
3-P-89-0074 ESTUARIAN WATERS (SENEGAL)  
3-P-89-1017 QUATERNARY HYDROGEOLOGY (BENIN) PHASE II  
3-P-89-1025 WATER RESOURCES MANAGEMENT MODEL METRO MANILA (PHILIPPINES)  
3-P-89-1029 AQUIFER DEVELOPMENT (MEXICO)

## APPENDIX B

### LIST OF WATER-RELATED PUBLICATIONS IDRC 1974-1989

#### MANUSCRIPT REPORTS

- MR102e PROCEEDINGS OF A WORKSHOP ON HYDRAULIC RAM PUMP (HYDRAM) TECHNOLOGY (1986)
- MR127e RAINWATER CATCHMENT: STATUS AND RESEARCH PRIORITIES IN THE SOUTHEASTERN ASIAN REGION. PROCEEDINGS OF THE REGIONAL SEMINAR AND WORKSHOP HELD IN KHON KAEN, THAILAND, 29 NOVEMBER - 3 DECEMBER, 1983 (1986)
- MR150e SEMINAR ON THE PARTICIPATION OF WOMEN IN WATER SUPPLY AND SANITATION PROGRAMS (1987)
- MR159e IDRC HANDPUMP NETWORK: PROCEEDINGS OF A MEETING HELD IN BANGKOK, THAILAND, 1-3 OCTOBER 1986 (1987)
- MR193s CONTAMINACION DE AGUAS SUBTERRANEAS EN AREAS URBANOS EN AMERICA LATINA. ESTUDIOS E INVESTIGACIONES PRESENTADAS EN LA PRIMERA CONFERENCIA LATINOAMERICANO SOBRE HIDROLOGIE URBANA REALIZADA EN 1987 EN COCHABAMBA, BOLIVIA (1988)
- MR211e CARIBBEAN ENVIRONMENTAL HEALTH RESEARCH: NEEDS AND PROPOSALS. PAHO-IDRC CONSULTATIONS HELD IN HASTINGS, BARBADOS, 23-25 MARCH 1988. (1989)
- MR231e SOLAR WATER DISINFECTION: PROCEEDINGS OF A WORKSHOP HELD AT THE BRACE RESEARCH INSTITUTE, MONTREAL, QUÉBEC, 15-17 AUGUST, 1988 (1989)
- MR247e USE OF SIMPLE INEXPENSIVE MICROBIAL WATER QUALITY TESTS: RESULTS OF A THREE-CONTINENT, EIGHT-COUNTRY RESEARCH PROJECT (1989)
- MR248e WATER QUALITY CONTROL NETWORK: PROCEEDINGS OF A MEETING HELD IN OTTAWA, 20-24 FEBRUARY, 1989 (1989)

#### MONOGRAPH SERIES REPORTS

- 028e RURAL WATER SUPPLY AND SANITATION IN LESS-DEVELOPED COUNTRIES: A SELECTED ANNOTATED BIBLIOGRAPHY (WHITE, SEVIOUR: 1974)
- 057e HIDDEN WATERS IN ARID LANDS: REPORT OF A WORKSHOP ON GROUNDWATER RESEARCH NEEDS IN ARID AND SEMI-ARID ZONES, HELD IN PARIS, FRANCE 25 NOVEMBER 1974 (HEINDL: 1975)
- 102e LOW-COST TECHNOLOGY OPTIONS FOR SANITATION (RYBCZYNSKI, POLPRASERT, MCGARRY: 1978)
- 154e WASTEWATER TREATMENT AND RESOURCE RECOVERY: REPORT OF A WORKSHOP ON HIGH-RATE ALGAE PONDS, SINGAPORE, 27-29 FEBRUARY 1980 (IDRC: 1980)