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Natural Resource Management: Training strategies for the optimal management of water resources

Contents

EXECUTIVE SUMMARY

Misuse and degradation of water resources can cause environmental emergencies in many parts of the world, which in the short run may be more severe than the possible effects of other global environmental threats (climate changes, the depletion of the ozone layer etc.). The growing demand for water, as a result of population pressures and increases in the standard of living is accentuating competition for the resource. Serious water scarcities already occur in a number of water short areas of the world. The steady rise in the cost of securing additional supplies have moved economic considerations into the foreground in the allocation process. Increasing competition for a limited resource will make most of the currently used methods of development planning, which are on a sector-by-sector or project-by-project basis, inadequate.

Water resource planning will have to become comprehensive, covering all water related sectors at the same time. In the future it will focus on the economic efficiency objective, using it as a benchmark against which the use of water for other 'social' objectives can be judged. The challenge will be to optimize economic performance, calculating the direct and secondary costs and benefits, and allowing for socio-political, institutional, environmental and technological constraints.

Remedial measures to stop mis-management of the water resources are time consuming, politically unpopular and usually costly. The World Bank, which is the largest multi-lateral financier in the development of water resources in the developing world, has a strong interest in supporting efforts of better resource management and should provide leadership in the dissemination of information.

Training needs fall into two major categories; (i) general and sub-sector specific technical subjects in irrigation, health, urban and rural water supply, sewage disposal, transportation, hydropower etc., and (ii) planning methodologies, data collection and evaluation, economic analysis, pricing of water, conservation measures and social, institutional and environmental aspects of water resource development. **EDI's training effort will focus on the non-technical subjects.** The objectives of the training program are:

(i) the development of awareness in the general public and with the policy makers in the developing World, that the water resource situation in their countries is rapidly deteriorating;

(ii) to train a cadre of professionals who will have the necessary understanding and analytical capacity to review **management alternatives** in a watershed, river basin, or groundwater source (aquifer), and assess the impact of the alternatives on the various water-dependant economic activities, on public health and on the well-being of the population and on the environment, and provide the politicians and decision makers with properly evaluated management alternatives;

(iii) to provide assistance to countries which want to experiment with management solutions developed in other parts of the world, and test their adaptability to resource allocation problems in their own socio-political and economic environment.

The training modules will be developed into manuals, audio-visual

presentations, and other seminar material and possibly computer simulation programs. The program will have an initial five year time horizon. In the first year (FY92), training material will be collated. Actual training will start from FY93. Over the five year period from FY92, some 500 senior officials and politicians will have participated in the one week, regional awareness seminars, and some 800-1,000 'trainers' will have graduated from the month-long management training courses in the regions.

The program will be supervised by a steering committee in EDI made up of representatives of the Infrastructure & Urban, Agriculture & Rural Development, Human Resources, and Finance, Industry and Energy divisions, with executive responsibilities for the program shared between the Infrastructure & Urban and the Agriculture & Rural Development divisions. The two divisions will agree on a task manager who will periodically report to the steering committee. He will closely coordinate his activities with the technical and country divisions in the Regions and with the divisions of the Sector Policy and Research, Vice Presidency. At the end of FY94 (after two years of operating regional awareness seminars and training courses) EDI will try to assess the accomplishments of the program and the performance of the trainees; if necessary changes will be introduced in the training modules.

The estimated cost of the five year program is US$6,6 million. The estimated cost for preparing the training material is US$350,000, including the cost of the computer simulation model; some 5% of the overall program cost.

Background

According to a recent estimate of the Worldwatch Institute (WRI), humanity is outstripping its limited freshwater resources, and in many places, is also seriously contaminating them. WRI estimates that over three-quarters of all water developed for beneficial use is lost to evaporation and seepage; that agriculture accounts for approx. 70% of global water use with overall irrigation efficiencies in some of the developing countries below 35%. Most of the water lost as run-off, or to seepage in irrigation is recovered as return flow to the rivers, or infiltrates to the groundwater; however, its quality is often degraded by agrochemicals and other contaminants which are carried along by the return flow. Some bodies of water are so polluted by human and industrial waste that they cannot safely be used.

The large irrigation and water supply systems of the past conveyed water by gravity, contained a number of key structures (dams, canal systems, reservoirs) with amortization periods of between 20 and 50 years, and were relatively easy to maintain. Inadequate funding for operation and maintenance of these projects had a serious cumulative effect only over a number of years. Many of today's systems tap smaller quantities of water and pump the water through pipes over large distances; plant and machinery have shorter amortization periods and are costly in operation. Inadequate funding for operation, maintenance, or replacement of faulty equipment has immediate consequences.

The growing demand for water, as a result of population pressures and increases in the standard of living is accentuating competition for the resource. Serious water scarcities already occur in a number of water short areas of the world. The steady rise in the cost of securing additional supplies have moved economic considerations into the foreground in the allocation process, sometimes overshadowing the socio-political objectives which have determined water allocation policies in the past. Eventually the opportunity cost of supplying additional water will become greater than its value for some economic activities (some irrigated crops and types of industrial production). Water allocations for these activities may have to be gradually cut back, causing serious economic dislocations and difficult socio-political problems (unemployment, migration to urban areas etc.). Increasing competition for a limited resource will make most of the currently used methods of development planning, which are on a sector-by-sector or project-by-project basis, inadequate. Water resource planning will have to become comprehensive, covering all water related sectors at the same time. The full range of links, interactions and hierarchial relationships,

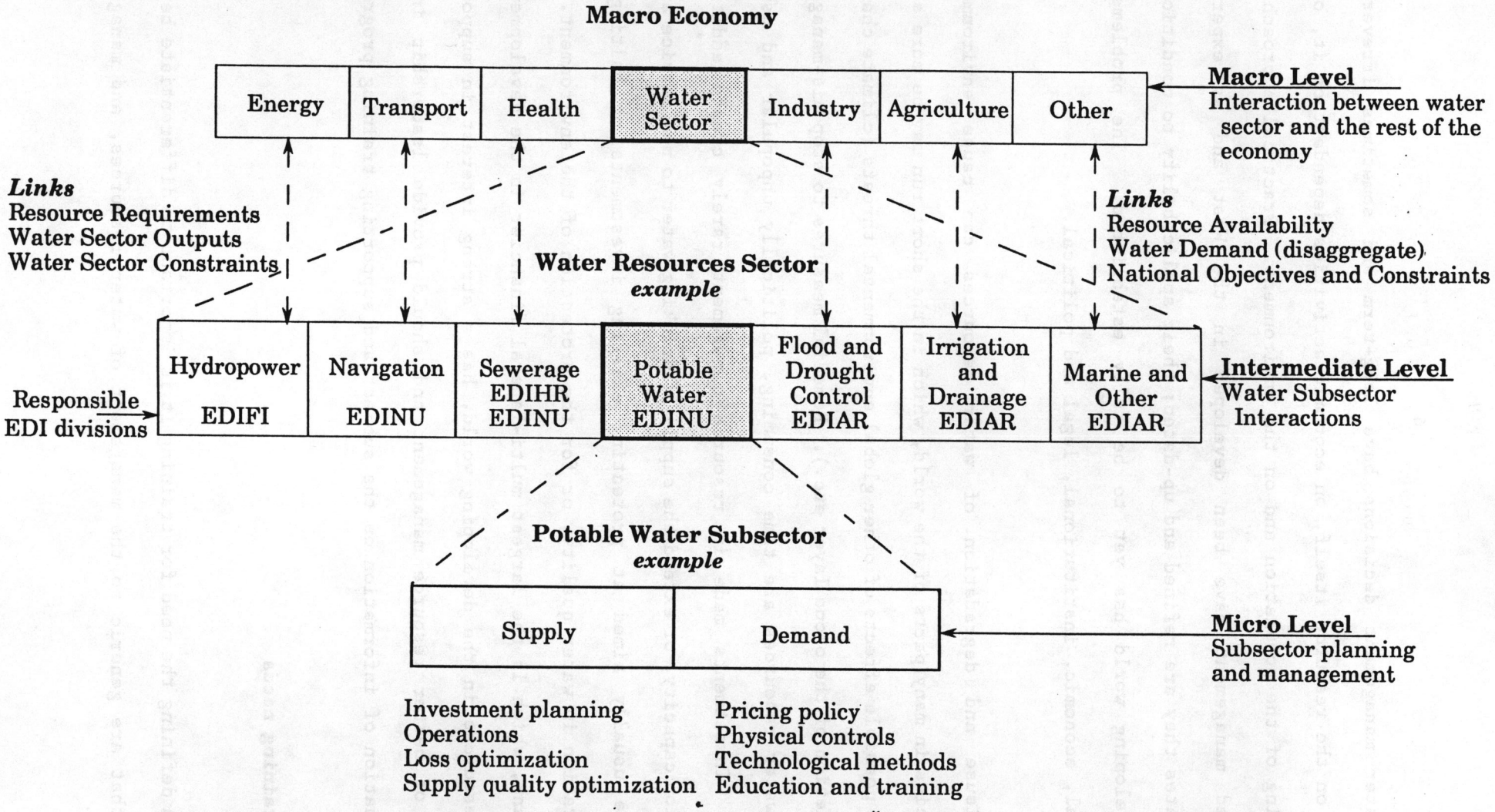
between the economy, the sectors and the water resource is demonstrated in the attached diagram (Fig.1). It also shows the administrative responsibilities in EDI, for water related activities.

The years since World War II have witnessed the intensive development of most of the major watersheds in the World. Large investments were made in irrigation, hydropower, domestic water supplies, industrial development, sewage and waste water disposal etc. Water was first drawn from the rivers for domestic use and the same river was then used for the uncontrolled disposal of industrial wastes and sewage effluent. Through the haphazard development of groundwater, the situation in many parts of the world is even more critical; coastal aquifers are over-pumped and have become saline, and water levels of inland aquifers have dropped and wells have dried out.

In the river basins and watersheds of western Europe, Japan, Australia and North America concerted efforts are being made to manage water resources, clean-up the rivers and waterways and allocate water between competing uses. In eastern Europe and the USSR water pollution is a leading cause of the deterioration of the environment. In growing numbers of watersheds and aquifers in the developing world the situation has become critical during the last decade, both as far as water quantities for use and their quality is concerned. In the coming years this trend will accelerate. Except for a few exceptions, the problem of comprehensive water resource management and the allocation of increasingly limited resources between competing uses in watersheds, or from groundwater has yet to be addressed effectively in most of these countries.

Figure 1.

Conceptual framework for integrated water resources planning and policy analysis



Based on Figure 1 from "Water Supply Policies and Issues in Developing Countries," by Mohan Munasinghe, Natural Resources Forum, February, 1990, pp. 33-48.

Water management decisions have long-term and sometimes irreversible effects on the resource itself, on economic activities dependant on it, on the well-being of the population and on the environment. Practical approaches to watershed management have been developed in the West and as experience accumulates they are refined and up-dated; their applicability to conditions in the developing world has yet to be fully established. The problems are technical, economic, institutional, legal and political.

Misuse and degradation of water resources can cause environmental emergencies in many parts of the world, which in the short run may be more severe than the possible effects of other global environmental threats (climate changes, the depletion of the ozone layer etc.). Remedial measures to stop mis-management of the water resources are time consuming, politically unpopular and usually costly. Investments made in resource management rarely create additional production capacity, or extend the supply of drinking water to new service areas; they are usually aimed at protecting existing investments or halting the deterioration in water quality, or for the protection of the environment. The World Bank, which is the largest multi-lateral financier in the development of water resources in the developing world, has a strong interest in supporting efforts of better resource management and should provide leadership in the dissemination of information on the subject and supporting training programs.

Training needs

In defining the need for training it is important to differentiate between issues that are generic to the management of water resources, and management

problems which are sector and location specific to a region, to a country or even to a watershed. Training programs, which address the more general issues of resource management can usually draw on existing training material and experience from the developed world; programs for dealing with location specific problems will have to be developed individually in discussions with local experts and interest groups and from experimentation and pilot operations.

Training needs fall into two major categories; (i) general and sub-sector specific technical subjects in irrigation, health, urban and rural water supply, sewage disposal, transportation, hydropower etc., and (ii) planning methodologies, data collection and evaluation, economic analysis, pricing of water, conservation measures and social, institutional and environmental aspects of water resource development. The present training effort will focus on the non-technical subjects.

Both Regional Offices and the departments of the Sector Policy and Research Vice Presidency in PRE are presently involved in water resource management studies. The EMENA and Asia regions are studying regional management problems and AGR has launched a 'Comprehensive Water Resources Management Policy Review' which should provide the conceptual framework for future Bank lending in the water sector. EDI's proposed training program will be fully complementary to these efforts and will draw on location specific experience in the Regions.

Objectives of the training program are:

(i) the development of awareness in the general public and with the

policy makers in the developing World, that the water resource situation in their countries is rapidly deteriorating, and that it requires top national priority to deal with it effectively;

(ii) to train a cadre of professionals who will have the necessary understanding and analytical capacity to review management alternatives in a watershed, river basin, or groundwater source (aquifer), and assess the impact of the alternatives on the various water-dependant economic activities, on public health and on the well-being of the population and on the environment, and provide the politicians and decision makers with properly evaluated management alternatives and,

(iii) to provide assistance to countries which want to experiment with management solutions developed in other parts of the world, and test their adaptability to resource allocation problems in their own socio-political and economic environment. The feedback from these activities will be used to amend and up-date the EDI training programs.

Training topics

The management of a water resource (surface or groundwater) impacts on a number of economic activities (drinking water supply and health, agricultural and irrigation, industry, sewage and other waste disposal, power generation, transport, recreation etc.) It requires close coordination among the concerned sectors and their policies. National and even international conflicts of interest are already occurring in many watersheds and will cause growing friction among the various interest groups; they are not only about water quantities, but

also about quality and the timing of the supply.

Until recently the nature of water as an economic good and the need to consider its cross-sectoral opportunity cost has not generally been recognized. Also, the entire hydrological cycle has rarely been considered as a single planning unit. Actions taken in one part of the system often impact upon other parts; these quantity and quality 'linkages' are important in estimating the cost and benefits of management interventions. For example, a reduction in water allocation for agriculture in a certain area may create serious unemployment, an effort to reduce seepage and leakage from surface water irrigation systems may effect the groundwater balance in the area and the quality of the return flow.

Also, the physical interdependence among water uses may create externalities, which complicate the task of managing the resource. For example the use of a common water source, - which can be a river, an aquifer, or the return flow from an upstream economic activity,- by a number of users with different water quality requirements, may create such externalities.

Water resource management will focus on the economic efficiency objective, using it as a benchmark against which the use of water for other 'social' objectives can be judged. The challenge will be to optimize economic performance, calculating the direct and secondary costs and benefits, and allowing for socio-political, institutional, environmental and technological constraints. Ranking of priorities among different sectors and objectives, some of which cannot be assigned unambiguous economic values, is one of the more difficult tasks in resource management.

Solutions to a typical water management 'situation' requires knowledge in

(i) civil, sanitary, mechanical and hydraulic engineering, in hydrology and meteorology and in earth sciences,

(ii) in institutional subjects, such as organizations, administrative procedures, legal issues etc.; and

(iii) in macro and micro economics.

Training program

The proposed program is made up of three components; (i) seminars for senior government officials, where regional water management problems will be discussed; the seminars will try to motivate the participants to consider their countries' water management problems as a matter of high national priority; (ii) training courses for 'trainers' in national and regional training institutions (training intermediaries), who will then train government professionals dealing with water management; and (iii) assistance to governments in studying resource management alternatives in typical watersheds.

The training material for activity (i) will be based on information on specific water resource management problems in the respective regions and countries of the participants. The training module will be prepared from data generated by the Bank's regional offices; the participation in the 'awareness seminars' of senior regional staff, who are familiar with the resource management problems of the countries in the region, may help convince the politicians and senior government officials of the urgency of dealing with the management of their water resources, and for setting the required national priorities.

The training modules for activity (ii) will deal with planning methodologies and procedures, the project preparation sequence, economic project analysis, macro and micro-economics, with the economic implications of water management decisions, and with institutional issues.

Training scope

The proposed EDI training program will address only economic and institutional subjects connected with the management of water resources. The rational for initially limiting the training subjects to institutional and economic issues, is that engineering and earth science subjects are well defined and the necessary know-how is usually available in the professional community of the country; also the regional technical staff of the Bank is active, on a more or less permanent basis, in providing technical assistance to the counterpart staff in their countries' of operation.

Problems like how to improve the management of irrigation schemes, or the training strategies to be used for that purpose, or how to treat sewage and industrial effluent to avoid pollution of rivers and lakes,- are well documented in the professional literature and in recent Bank publications; an example is EDI's, 'Irrigation Training in the Public Sector', which deals with training assessment and strategy. The publication dated 1989, was jointly prepared with USAID. If necessary, additional training material can readily be produced from existing publications by the national and regional training bodies.

On the other hand, experience with location specific institutional problems

in the developing countries is very limited. Locally based training material is practically non-existent; any training program must largely be based on approaches and procedures developed, and experience accumulated, from water resource development situations in the West, Japan, Australia, and other parts of the World.

Content and themes

The proposed economic and institutional training program will demonstrate how to optimize, under various conditions of water availability, the economic and social goals of the country (economic growth, poverty alleviation, food security, protection of the environment etc.); it will explain the influence of pricing on water use ('economic demand' concept), discuss financing of investments and cost recovery, and the institutional arrangements necessary for the implementation of a resource management program. It will analyze the legal issues which affect the management of the resource, such as temporary, customary and permanent water rights, international conflicts over water etc. It will focus on water allocation procedures between different sub-sectors and for various economic activities in the sub-sectors; on the intervention of institutional bodies in the allocation process; explain how these bodies promote social objectives, use administrative measures and provide direct and indirect incentives to advance the use of water saving technologies; also their efforts to control pollution of water resources to ensure acceptable water qualities for the various uses.

The program will discuss the financing of water projects from public and private funds, the importance of cost recovery to insure a reasonable

amortization of the investment and the funding for operation and maintenance. Easily exploitable water resources are reaching their limit, construction of more expensive and more sophisticated water systems will be required. Effective cost recovery will become essential.

The training modules will be developed into manuals, audio-visual presentations, and other seminar material and possibly computer simulation programs (Annex 1).

Material development and source

1. The main themes of the regional awareness modules will be:

(i) A global overview of water resource management problems (sources: available publications such as Worldwatch Institute, World Bank and other International Agencies dealing with the environment, NGO's etc.);

(ii) Regional and OED overviews of water management problems (sources: information collected from OED, the technical departments and country divisions of the Bank, analyzed and edited for presentation by EDI);

(iii) A simulated demonstration of water management situations on economic performance, on public health and on the environment, on the achievement of social objectives, and on future development plans etc. The presentation will be based on one or several examples of regional watersheds which suffer from mismanagement of the water resource. (source: EDI, with the help of the regional divisions, possibly using the computer simulation model).

(iv) Seminar discussions on constraints to water resource management:

legal (water rights), administrative and institutional shortcomings (diffusion of management authority among a number of organizations in different 'competing' sectors, conflicting regulations etc.), vested interests of consumer groups and conflicting sectoral objectives, government indifference to the menacing environmental problems etc. To make the theme convincing the presentation will be based on real life situations for the different regional seminars; (source: EDI, with the help of regional offices and possibly assisted by the authorities in the countries of the 'selected' watersheds);

(v) Professional manpower requirements for the preparation and management of water resource management programs, in watersheds, river basins, country's etc.

(vi) Seminar discussions on economic and institutional approaches for an optimal management of the resource; the need for a clear definition of national economic and social objectives (as inputs to the required planning exercise), definition of responsibilities of the decision making level, discussions of the required institutional reforms, temporary and permanent water rights, administrative procedures for the allocation and control of water quantities and qualities etc. (source: EDI, regions, consultants).

2. The training programs, to create a cadre of professionals in the individual countries will have 'core' chapters, similar for all regions of the Bank, and location specific additions to reflect the ecological and socio-political conditions in the regions.

The main themes for the training modules will be:

Water resource development planning

(i) water a multi-sectoral resource, economic aspects and methodology of multi-objective planning, data collection and evaluation, computer modelling;

(ii) social and environmental objectives of planning;

(iii) macro - and micro economic benefits generated by water in the various economic sectors;

(iv) economic demand for water;

(v) value of water, (opportunity cost, marginal cost);

(vi) valuation of negative benefits from environmental damage, the role of water in the sustainability of the eco-system;

(vii) the project preparation sequence.

Economic analysis

(viii) unit of analysis;

(ix) sector and project analysis;

(x) externalities when appraising investments;

Operation of systems, cost recovery, property rights

(xi) importance of adequate cost recovery;

(xii) water legislation, right to use water (customary, temporary and permanent), ownership of a national resource, right to compensation, user groups, water trading;

Institutions, policies and procedures

(xiii) institutions in the water resource sector;

(xiv) water allocation policies and procedures;

(xv) water quality control procedures;

(xvi) water quality standards, pricing of pollutants;

(xvii) sub-sector specific issues

Source: The training manual, audio-visual presentations and seminar material will be prepared with the assistance of the sector policy and research departments of PRE, OED and by EDI staff, and outside contractors (universities and consultants). The computer model will be prepared by contractors. The sub-sector specific issues will be prepared by the appropriate divisions in PRE.

3. Assistance (to interested countries), for testing the adaptability of water resource management procedures (developed in Europe, North America, Australia etc.) under local conditions, is the third component of the proposed training strategy. The need for such experimentation will be emphasized in the awareness seminars, where the cooperation of politicians and senior government officials will be sought. A typical watershed will be selected for detailed testing.

The main themes for the adaptability studies will be:

(i) review of existing data on water availability and quality in the 'pilot watershed', definition of additional data collection and evaluation requirements;

(ii) evaluation of the economic and social benefits from present water use in the different sectors, assessment of water related environmental problems and calculation of 'negative benefits' of certain water uses;.

(iii) review of water use and water rights in the watershed and

presentation of legal and institutional changes which could enable better resource management, including changes in present water allocation and control practices;

(iv) review existing administrative procedures; drawing attention to possible changes which would facilitate the management of the water resource;

(v) assessment of the political implications of the recommended institutional and administrative suggestions; recommendations on ways to reduce local and/or national opposition to measures which were identified as essential for a better management of the water resource in the watershed, and by implication in the country as a whole.

(vi) presentation of alternative water resource management plans, which would satisfy social and national objectives;

The recommended pilot studies would be iterative; experience from one study in a region could provide inputs to studies in other countries in a similar ecological and socio-political environment.

Implementation: The pilot studies could be financed from Bank Group lending operations; included in the budget would be a TA component, under which the country could engage a consultant who would assist in the implementation of the pilot study. EDI and/or the Regions would have supervisory responsibilities.

Organization and coordination of the EDI program

The training program will have an initial five year time horizon. In the first year (FY92), training material will be collated, training modules

designed and the existing computer simulation models adapted to the training needs of the program. Starting from the second year, regional 'awareness' seminars will be organized and training courses for trainers started. From FY93, and until the end of the five year program, four, week long awareness seminars will be organized each year, one for each Region (or sub-region), with an average of 30 participants. Also a number of regional training institutions will be selected from National and International Institutions with experience in water resource management training. A partial list of such institutions is available in Annex A, of EDI's 'Irrigation Training in the Public Sector' publication of 1989. Each year, two, month-long training courses will be organized in each institution. The last week of the course will be dedicated to sub-sector specific issues in parallel training sessions. Each training course will be for 20-30 participants. Over the five year period from FY92, some 500 senior officials and politicians will have participated in the one week, regional awareness seminars, and some 800-1,000 'trainers' will have graduated from the month-long management training courses in the regions.

The program will be supervised by a steering committee in EDI made up of representatives of the Infrastructure & Urban, Agriculture & Rural Development, Human Resources, and Finance, Industry and Energy divisions, with executive responsibilities for the program shared between the Infrastructure & Urban and the Agriculture & Rural Development divisions. The two divisions will agree on a task manager who will periodically report to the steering committee. He will closely coordinate his activities with the technical and country divisions in the Regions and with the divisions of the Sector Policy and Research, Vice Presidency. At the end of FY94 (after two years of operating regional awareness

seminars and training courses) EDI will try to assess the accomplishments of the program and the performance of the trainees; if necessary changes will be introduced in the training modules.

Time table and budget needs

Water resources management training, proposed activities and budgets for FY92;

Activity	Responsibility	man/weeks	Estimated cost in $'000
1.Prep. of 'awareness' modules (core)	EDI, consultants	12	36.0
2.Prep. of regional additions	Regions, cons.	8	24.0
3.Prep. of training modules (core)	EDI, consultants	20	60.0

4.Prep. of regional additions	Regions, cons.	10	30.0
5.Royalty payment for use of computer programs	EDI	optional	(100.0)
6.Changes to computer programs	contractor	optional	(100.0)
Total, preparation of training material			150.0
without, and with simulation model			(350.0)

Water resources management training, proposed activities and budgets for FY93, 94, 95, and 96

Activity	Responsible	Total number and cost/participant	Estimated Cost in $'000
1.Four regional one week awareness seminars per year, for four years	Regions and EDI	500 & $4,500	2,250.0

2.Eight training courses of one month per year, for four years	Regions and EDI	1,000 & $4,000	4,000.0
Total, seminars			6,250.0
Total for program			6,600.0

Note: The cost per participant, both in the awareness seminars and in the month long training courses varies very considerably, with the geographical location of the meeting. Therefore, average cost per trainee was used for the estimate. An average cost of US$4,500 per participant was taken for the week-long seminar for senior officials and US$4,000 for the one month courses for trainers.

The estimated cost of the five year program is US$6,6 million. This does not include the cost of assisting interested countries in studying and adapting to local conditions, water resource management experience from other regions and countries. Funding for this component of the training program, including consultancy support, could be from future Bank Group lending, or from co-financed operations in the water and environmental sectors.

The cost (EDI and the regions) for preparing the training material, including the cost of the computer simulation model is about 5% of the overall program cost.

Annex 1

Computer simulation of water resource management problems in a watershed

The computer programs would simulate conditions in a watershed in a developing country, which has reached a stage in its economic development where water resource management problems are threatening the existing and prospective development in irrigation, in industry and other uses, and where both water quantity and quality problems exist. It would present water allocation alternatives and their impact on the efficient use of the resource, on the economic and social priorities set by the model, on the environment (degradation of water quality etc.) and on other selected parameters. In the program, the spacial and temporal availability of water and its opportunity and marginal costs will be provided as a planning input; the value of present and future uses in the various competing sectors will be the planning variables; also the various types of property right to the resource and their constraining influence on the allocation of the resource will be variables.

Computer models for simulations of watersheds and river basins have been developed among other places, in the Institute of Irrigation Studies at the University of Southampton, UK and in CADI, Computer Assisted Development Inc. Fort Collins Colorado, USA. These models could be adapted to fit the training purposes of the EDI program.