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MANAGEMENT OF LARGE INTERNATIONAL RIVERS - PRACTICAL EXPERIENCE FROM A RESEARCH PERSPECTIVE

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ABSTRACT Experience gained from research conducted at the International Institute for Applied Systems Analysis is presented. Objectives and main directions of research are discussed. Water management issues for two case study rivers - the Danube and the Zambezi - are briefly presented, and then experiences in dealing with institutional and organizational aspects of the research are examined. Conclusions summarize both positive and negative experiences and recommendations are made concerning further activities in this field.

INTRODUCTION

This paper attempts to summarize the study that has been carried out since the fall of 1986 at the International Institute for Applied Systems Analysis in Laxenburg, Austria. However the views and opinion expressed herein do not represent those of the Institute or its National Member Organizations and the author is solely responsible for the opinions presented in the paper.

The study titled "Decision Support Systems for Managing Large International Rivers" has been initiated in the framework of the Large International Rivers Project, and was continued within the Water Resources Project. The research stemmed from the recognition that problems of water management and environmental protection, especially involving transboundary issues and disputes, are as much in need of improved institutions and processes as improved scientific understanding. By way of illustration, as of 1987 only 61 of the world's 215 international river basins (UN, 1978) were affected by any of the 286 transboundary water treaties then on record (UN, 1987). Almost 40 percent of the world's population lives in river basins shared by more than two nations and these basins comprise about 50 percent of the land of the Earth (Vlachos, 1986). At the same time there were only 25 cases of institutional arrangements in place for joint management or development in shared river basins.

The strategic objective of the research was to assess the extent to which institutional processes associated with the development planning and management of international rivers can be supported by the development and use of decision

support systems. The project approached the problems of transboundary river basin management with the viewpoint of those who are trained in applied systems analysis and who have direct experience using systems analysis methods to assist water resource management agencies. There were two basic lines of research:

(a) the first was dealing with specific case studies that have been considered;
(b) the second was focused on the development and initial application of a PC-AT microcomputer based, supported by color graphics and menu driven, called the Interactive River System Simulation Program (IRIS).

These two lines of work proceeded in parallel. Extensive discussion of all related activities can be found in three reports submitted to the Ford Foundation (Salewicz & Loucks, (1988), Salewicz, Loucks & McDonald (1989) and (1990)), the main sponsor of the study, and in some other publications (Salewicz & Loucks, (1989), or Salewicz, (1990)), while development of the IRIS program was presented and summarized separately (Salewicz & Loucks, (1990), Salewicz, Loucks & Gandolfi, (1990), or IIASA (1990a) and IIASA (1990b)). The intention of this paper is to give an overall evaluation of the experiences gathered during the study and shed some light on conditions and circumstances that one is confronted with while dealing with international river basins.

There have been two case studies: the first was the Danube River; the second river selected was the Zambezi River in southern Africa. In both cases the work was organized along two lines:

(a) Efforts to: (i) identify of organizations and institutions involved in water management in the particular river basin, (ii) establish of cooperation with some of these institutions, and (iii) identify of potential "clients" within these organizations in order to develop, apply and evaluate the use of decision support tools.
(b) Research to identify specific management problems or transboundary conflicts and to prepare data and applications relevant to these issues.

Very soon after initialization of the project, it became evident that political and institutional factors have had dominating influence on the course and substance of the research; and thus our attention will be focused on the links between the steps and attempt made to undertake and organize the research and political factors.

DANUBE CASE STUDY

The Danube is the most international river; it flows through eight countries, while its basin (see Fig. 1) is shared by twelve countries. Although the Danube is the subject of one of the oldest transboundary water agreements (the 1619 Treaty between Austria and Turkey) (Vlachos, 1986), there is no overall organization responsible for water resources management, development and utilization in the basin. The only existing international body for this river - the Danube Commission - is focused on navigation aspects only. Riparian countries have been involved in a number of bilateral agreements and treaties, but the first significant step involving all riparian countries was implemented in 1985, when after several years of negotiations Danubian countries signed a document called the Bucharest Declaration (see Hock & Kovacs, 1987). The Bucharest Declaration creates a political basis, but not an institutional basis, for cooperation. At its most concrete

sections, it "declares" that the Danube basin governments will strive to develop and implement a coordinated water quality monitoring program "in the framework of their biand multilateral cooperations", and establishes a timetable. But there is no description of an institutional mechanism for assuring that such a monitoring program is either developed or implemented. Perhaps for this reason, the timetable of the Bucharest Declaration has not been met, nor are there any clear expectations of wide, multilateral, operational cooperation getting underway in the near future since the Bucharest Declaration is even not mentioned in recent official governmental declarations (Pop, 1990).

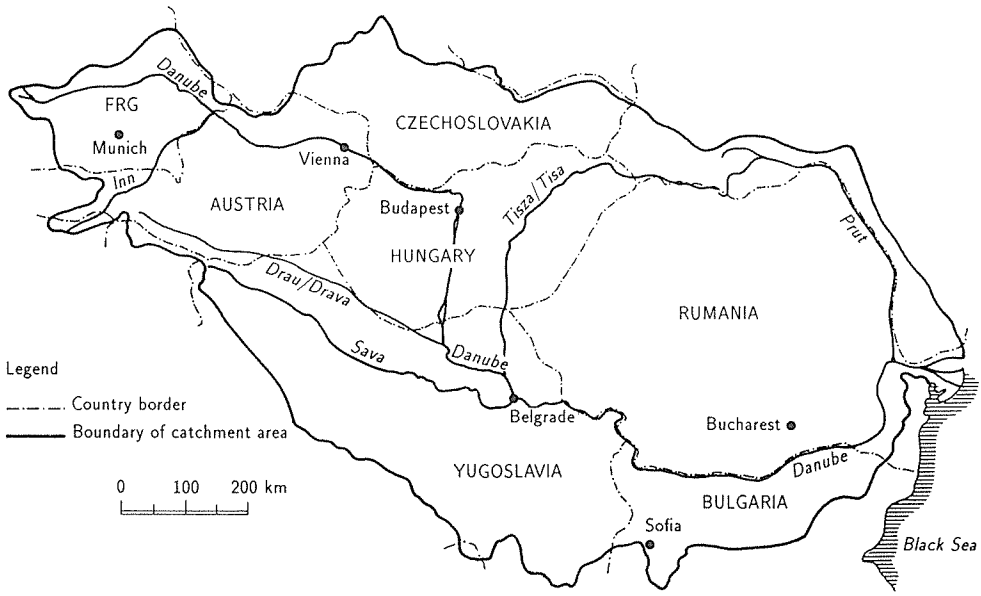

Fig. 1. The Danube Basin.

At the moment of the project initialization, attempts were made to approach problems of the Danube river water management from the multilateral perspective. In 1986, the World Health Organization prepared a proposal (WHO, 1986) for a project that would be conducted by the riparian countries in order to protect Danube water quality. IIASA responded to this initiative and hosted a meeting of WHO and the riparian Danubian countries. The objective of the meeting, which was held in April 1987, was to create a basis of cooperation among the relevant governmental bodies from the riparian countries in the framework of the WHO project.

Although some progress has been made at the meeting and some differences between riparian countries have been reduced, it was not enough to undertake and implement the proposed multilateral Danube water quality protection project. Ironically, representatives of the Danubian countries praised their commitment and desire to improve water quality in the river.

Some of the difficulties contributing to the lack of success in this and other efforts at multilateral cooperation on water quality issues are described in the

paper by Linnerooth (1988), e.g. differences in bargaining power between upstream and downstream countries, the scientifically complex and ill - defined nature of water quality problems; the political difficulties of establishing a basin-wide authority that infringes on national sovereignty; and the mismatches between bureaucracies and practices in different basin countries. Recognizing that the practical progress on the Danube would be largely through bilateral negotiations, our emphasis shifted from the multilateral WHO project to the bilateral Gabcikovo - Nagymaros Project (GNV) between Czechoslovakia and Hungary. The GNV Project (see Fig. 2) involves construction of a hydropower and barrage system along a 150 km stretch of the Danube on the border between Czechoslovakia and Hungary. The idea of building a series of dams and hydroelectric stations on this part of the river was originally raised in the early 1950s. In September 1977 a final treaty was signed between Czechoslovakia and Hungary to proceed with the project. Construction begun in 1978, and completion was scheduled for 1994. A detailed description of the proposed scheme is given by Lokvenc & Szanto (1986); the main purposes of the scheme are to improve navigation conditions along the Danube, generate electricity at two hydropower stations and increase flood protection. Almost from its beginning the GNV Project caused controversy and disputes among different professional and social groups.

The main concerns raised were associated with the construction of the Gabcikovo diversion canal and its impact on ground water level and on the ecosystems around the natural river bed. Also of concern were the water supplies of the people in much of the Hungarian section of the river basin and the quality of the underground water reservoir on the Slovak side.

Lack of public involvement in the decision process concerning such major investment and engineering structures as GNV, in both Czechoslovakia and Hungary, caused very strong political discontent, which was much more visible in Hungary because of the relatively permissive approach of the government to opposition. In Czechoslovakia, where political pressure did not allow the opposition to get well organized, there were no open protests.

In the fall of 1987, when we began efforts to establish collaboration with Hungary and Czechoslovakia, pressure and protests against GNV project were already voiced quite strongly and openly in Hungary and the government was getting ready for more open discussion about possible negative consequences of the project and ways to reduce adverse effects. An IIASA initiative to undertake joint study of selected water management and environmental issues associated with the GNV project got a positive response. In early 1988 the Hungarian representative to the Joint Hungarian - Czechoslovak Transboundary Water Commission, who was also Head of the Hungarian National Water Authority, accepted an invitation to visit IIASA with his top technical advisor. Unfortunately, his Czechoslovak counterpart, the Minister of the Slovak Ministry of Forestry and Water Management, did not accept an invitation despite several promises made by his aide. We were told that an internal reorganization in the Ministry did not allow him to accept the invitation. It was a pattern that would be repeated.

The Hungarian visit led to a proposal for joint research drafted by the Hungarian Centre for Water Resources Development (VITUKI) in collaboration

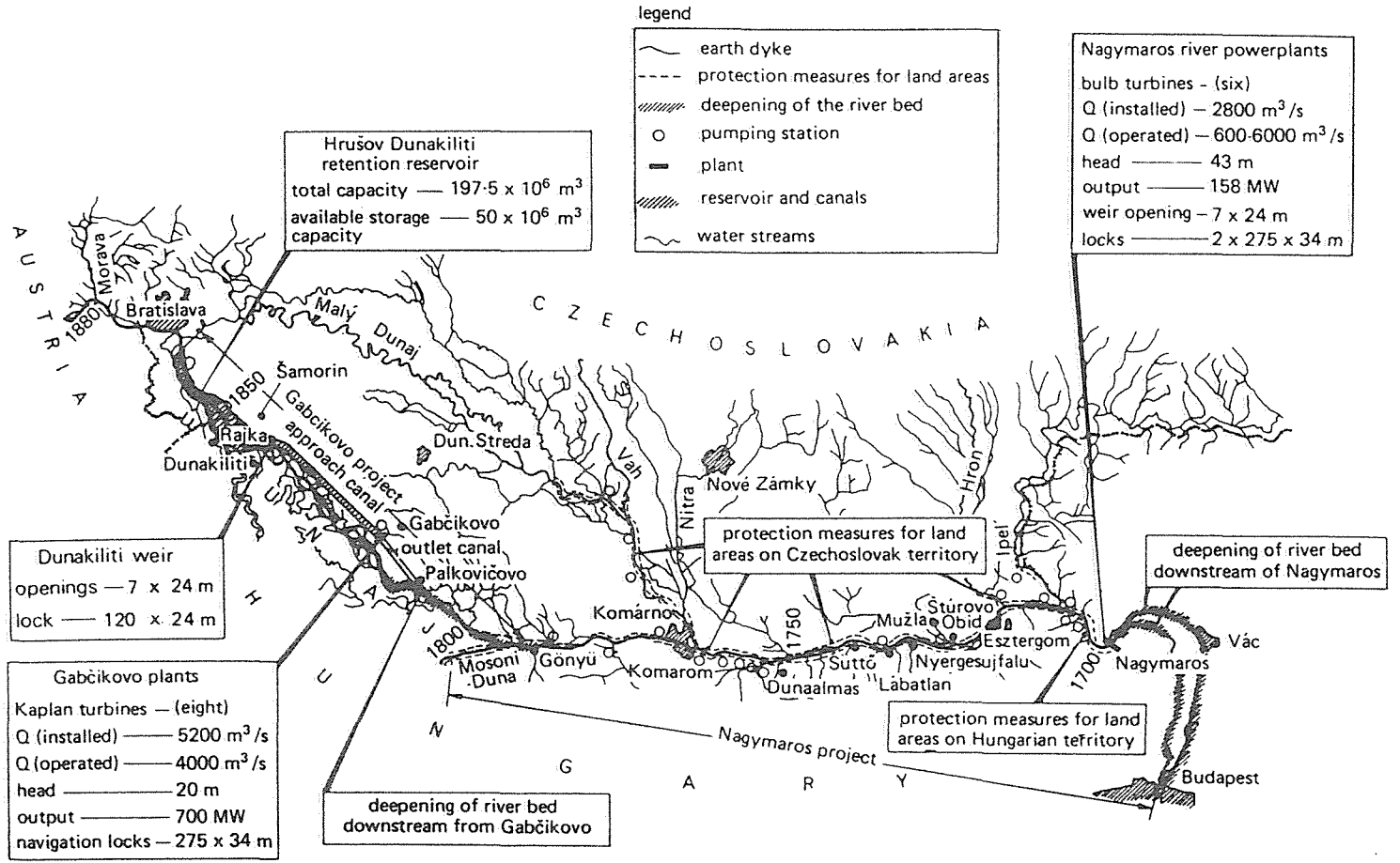

Fig. 2. *Scheme of the Gabcikovo - Nagymaros Project.*

with other Hungarian research institutes. The Hungarian government was ready to fund the research.

The problems associated with a strictly international project such as the GNV could not be studied unilaterally by the Hungarian side only. Moreover, IIASA as an international institution with both Czechoslovakia and Hungary as member countries, was not in a position to undertake the study on such a delicate issue without having approval from the both parties involved. Therefore parallel efforts were made to establish contacts with the Czechoslovak side. Researchers in Bratislava, the capital of Slovakia, were very interested in launching a joint study and beginning collaboration. However they could not make any commitments without approval of the republican government in Bratislava and federal government in Prague, and those were not forthcoming. Attempts were also made to involve the Czechoslovak member organization to IIASA in creating a joint working group, but initial reaction to this effort in June 1988 was not clear and not encouraging. The Czechoslovak tendency continued to be one of delay and vagueness. In the meantime political pressure and opposition against the project was growing in Hungary, but after some discussion, the Hungarian Parliament in October 1988 voted explicitly to continue construction.

In order to focus the dispute and arguments on facts we proposed that both parties prepare documents summarizing up-to-date research studies conducted in both countries in connection with the design and construction of GNV. The Hungarian side responded positively and the draft of such a document has been prepared, with condition, however, that " ... due to the both scientifically and politically delicate subject of the paper, the presently available parts of the material shall not be made public, copied or even referred to without the permission of the author (meaning also the permission and approval of the home authorities of the author) ..." (Jolankai, 1988). Due to further political developments, this document never has been published.

The Czechoslovak side did not respond to this initiative. Finally at the end of 1988 the Czechoslovak Committee for IIASA expressed the opinion that, although a study on environmental impacts of the GNV project was very interesting and necessary, it was too early to begin such a study; the scheme should be completed first and then investigations could be initiated. It was also noted that there was no need to initiate research that would repeat studies already completed at the preparatory stage for construction, and that these new studies could yield results contradicting previous studies. At the end of 1988 and at the beginning of 1989 the Czechoslovak side was strongly pushing for the completion of the GNV project despite growing political discontent in Hungary and ignoring any initiatives to analyze controversial issues; the Hungarian government was trying to proceed with construction and calm down the opposition by proposing additional measures and studies aimed at reduction of adverse effects caused in Hungary by the scheme, while the Hungarian opposition was not interested in studies and demanded immediate cancellation of the project. IIASA made an attempt to organize an even broader study on GNV related issues involving possible funding from international institutions and participation of independent international experts, but this initiative also did not get enough support from the two countries involved. The last initiative undertaken by IIASA in this area was an experts meeting organized in June 1989 and attended by high ranking officials and

experts from these two countries. The meeting did not bring concrete results: participants were not able to answer questions concerning the nature of key environmental problems caused by the Gabcikovo - Nagymaros hydropower scheme and to propose any concrete steps for further action.

Inadequate progress led IIASA in the fall of 1989 to cease its active involvement in the Danube study and act rather as an observer of the events.

Although in 1989 Hungary decided to stop construction at a moment when the Czechoslovak part of the project was almost completed, it did not change the facts: what was constructed so far is at its place; hydropower plant at Gabcikovo will not be able to operate with a full peak capacity due to lack of the dam at Nagymaros; financial commitments and burdens that both countries have to carry haven't been settled; proposed studies to analyze negative effects of the project and to propose measures for mitigating these effects have not been conducted; and mutual animosities between various social groups both in Czechoslovakia and Hungary have grown, similarly as tensions between these two countries on the issues concerning the fate of the GNV project. It is interesting to note that recently the political tendency surrounding GNV has changed entirely: now the Slovak and Czechoslovak sides (Petrovic and Holy, both personal communication) are interested in undertaking joint research project sponsored also by European Community, while there is no response from the Hungarian side.

There is no reason to claim that the research and joint problems analysis proposed by IIASA would have a decisive effect on the positive development of the situation in this region, but at least it offered a mechanism and capabilities to separate issues, concentrate on facts and analyze them in an objective way. Domination of political factors caused that there were no chances for scientific analysis since at all times one side or another was not interested in an objective evaluation of the problems.

ZAMBEZI RIVER CASE STUDY

In the case of the Zambezi River (Fig. 3) there are no pressing joint projects for immediate political concern. Moreover, the river is in a developing region of the world, and so far development of the riparian countries has taken place in areas relatively distant from the river. The basin countries have nonetheless taken a substantial first step in creating an international basin management mechanism through the adoption of the Zambezi River Action Plan (ZACPLAN) in 1987 by five of the eight riparian countries (UNEP, 1987). Implementing ZACPLAN is the responsibility of the Southern African Development Coordination Conference (SADCC), Soil and Water Conservation and Land Utilization (SWCLU) Unit located in Maseru, Lesotho. For various reasons implementation of ZACPLAN is proceeding quite slowly. The immediate objectives of its managers seem to be:

(a) maintain and enhance political will for cooperation among basin states;
(b) improve on existing data and understanding of basin processes, and
(c) build analytic tools to evaluate joint development projects and management arrangements.

All efforts of the IIASA project were focused on support of this third objective.

At the initial stage of involvement in the Zambezi study, an extensive

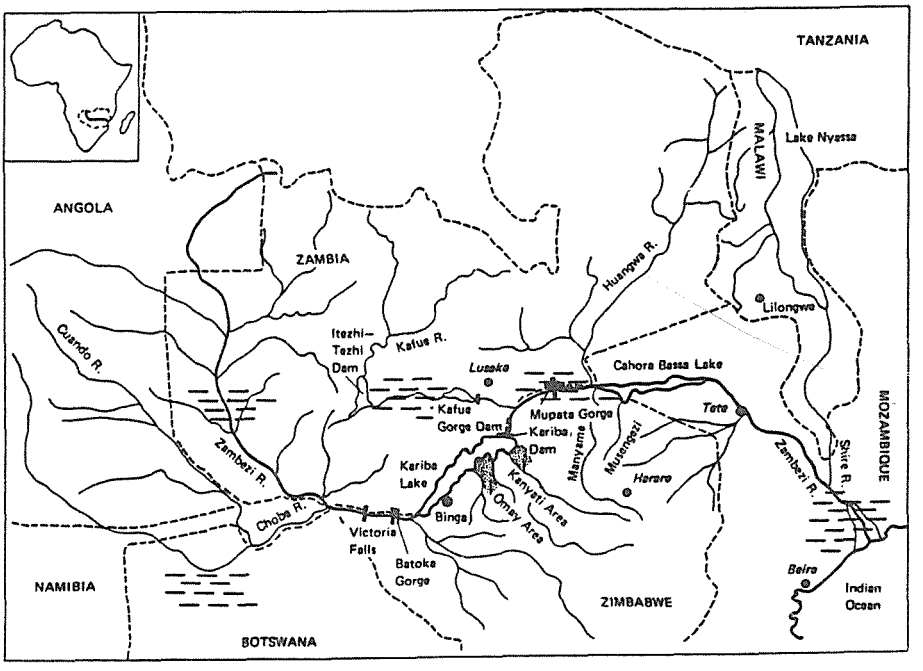

Fig. 3. *Zambezi River Basin.*

review of data and studies addressing Zambezi basin hydrology, ecology, land use and development was conducted by Pinay, 1988. This was supplemented by initial research on social, political and economic factors likely to affect basin management efforts (Campos, 1989), and by a study visit to the basin (Salewicz & McDonald, 1988). This background information allowed us to list and rank the most important issues in the basin, as a basis for shaping the functions of an appropriate decision support tool. These issues are (Salewicz, Loucks & McDonald, 1990):

(a) Hydropower generation;
(b) Land degradation;
(c) Water diversion;
(d) Fisheries management.

Studies on Selected Zambezi Basin Issues

The first issue studied was the operation of the Zambezi River reservoirs. So far the main water use in the basin has been limited to the construction of three large hydroelectric schemes: Kariba and Cahora Bassa on the Zambezi itself, and Itezhi-tezhi-Kafue Gorge on the Kafue River, one of its main tributaries. Zambia and Zimbabwe rely for more than 70 per cent of the generating capacity of their interconnected electricity supply system on Kariba and Itezhi-tezhi-Kafue Gorge schemes (ZESA, 1986). The creation of large manmade lakes has changed environmental conditions in the Zambezi Valley and endangered the ecological

equilibrium in some areas (Obrdlik et al, 1989). In the study undertaken at IIASA an attempt has been made to incorporate environmental considerations directly into the formulation of the reservoir's management problems. The study was divided into two steps:

(a) a multi-objective optimization analysis of the management of Kariba and Itezhi-tezhi-Kafue Gorge hydropower schemes ; and then

(b) on the basis of solutions obtained at the first stage, a simulation analysis of the system operation using Interactive River System Simulation Program IRIS.

Operation of the Kariba and Itezhi-tezhi-Kafue Gorge schemes was analyzed separately (Gandolfi & Salewicz, 1990) based on the heuristic approach proposed by Guariso et al (1986). Objective functions for Kariba included minimization of the maximum energy deficit and minimization of the maximum flood release from the reservoir, while the objective functions for Itezhi-tezhi-Kafue Gorge scheme included minimization of the expected value of the monthly energy deficit, maximization of the expected value of the monthly energy surplus and minimization of the differences between the release regime from Itezhi-tezhi reservoir and the flooding cycle necessary for ecological reasons.

The optimization and simulation experiments revealed ways to improve overall performance of the system in comparison with the operating policies used traditionally.

Estimating the Impact of Land Use Change on Soil Erosion Hazard in the Zambezi Basin

Soil erosion and land degradation are major problems in many areas of the African continent. Pinay, 1988, concluded that the erosion process may entail silt deposition in reservoirs diminishing their real storage capacity, which is especially important in the case of relatively small reservoirs used for water supply. It has been recently observed in Zimbabwe that due to siltation live storage of many reservoirs will be depleted in less than 20 years (Khatso, personal communication). It is therefore necessary for planning purposes to delineate areas susceptible to soil erosion in order to predict the consequences of land use changes both in terms of erosion hazard and reservoir sedimentation.

A model for the estimation of soil erosion hazard in southern Africa (SLEMSA) has been developed and validated under field conditions in Zimbabwe by Elwell, 1978. The study that has been conducted at IIASA (Leenaers, 1990), combined computer implementation of the SLEMSA model with its linkage to a PC - based Geographical Information System. As a result of this study soil erosion hazard maps of the Zambezi River basin were produced for different land use scenarios.

Toward Methodology and Knowledge Transfer to Zambezi Basin Countries

Parallel to in-house studies on the selected issues (Leenaers, 1990, Gandolfi & Salewicz, 1990, Varis & Kuikka, 1990), IIASA made efforts to transfer metho-

dology and technology to the basin countries. Our efforts were supported by the SADCC branch responsible for the ZACPLAN implementation (SWCLU Unit in Maseru). The major joint initiatives were: (a) a week long training workshop for the representatives of SADCC countries held in Kariba, Zimbabwe in June 1989, and (b) two months long, extensive training course conducted at IIASA for selected participants from the basin countries from January 15 till March 14, 1990. Both initiatives were very well received by the participants and were significant events in the slow implementation of ZACPLAN. They allowed for the transfer of new methods and knowledge to the Zambezi basin countries and created welcomed opportunities for joint discussion and analysis of common management problems that basin countries are facing. They also created big expectations and hopes among African professionals for further contacts and knowledge transfer; expectations that unfortunately couldn't be satisfied by IIASA due to its limited resources.

LESSONS FROM CASE STUDIES

The strategic objective of the study, as we have already mentioned, was to assess the extent to which institutional processes associated with the use and management of international rivers can be supported by the use of computer-based decision support tools. Although results of the work conducted in the study were not directly applied in the decision-making processes associated with the management of international river basins, the fact that such a tool is being developed and can be applied to address specific issues of river management caused visible reactions of political and institutional structures involved in the development planning and management of the Danube and Zambezi rivers.

The experience gained from these two case studies is to some extent contradictory, but very well illustrates possible reactions, depending on the political situation in the basin.

In the case of the Danube River very soon it became evident that there was no will for collaboration involving many countries or for a joint approach to problem solving. Proposed, as the alternative solution, the study involving two countries and focused on the controversial Gabcikovo - Nagymaros project demonstrated to decision makers the possibility that the controversial issues could be analyzed, discussed and eventually negotiated using the methods and tools developed in the research process. In the past the Hungarian side of the controversy, prompted by political developments in the country and trying to find a way out of the difficulties, readily accepted the idea of study, hoping that open discussion on the issues and ways of reducing adverse effects of the hydropower scheme may help to reduce political tensions and find acceptable solutions. The Czechoslovak side, which was not interested in opening any discussion on that subject, was afraid that the study and joint analysis of controversies could open politically inconvenient discussions. Currently this tendency has reversed, but the fact that the set of computer tools could be developed to address conflicting issues of water management alerted respective institutions in riparian countries. It demonstrates how significant the role is of such investigations and resulting methodological and software tools in addressing problems of shared river

management. The same conclusion can be drawn based on the experiences gathered in the Zambezi River study, even though some of these experiences were opposite to the case of Danube. Institutions representing countries involved in the implementation of Zambezi River Action Plan began to consider IIASA activities, tools and methodology as a positive, unifying factor contributing to achieving objectives of the ZACPLAN. Although ZACPLAN objectives seem to be oriented more toward long term benefits, riparian countries want, through the ZACPLAN implementation, to achieve short term objectives, that is to improve their analytic capabilities and solve more acute problems of development planning and water management, including international disputes (such as between Mozambique and South Africa or between Zimbabwe and Mozambique) using methodology and tools developed in the framework of the study.

CENTRAL QUESTIONS AND CONCLUSIONS

The intention of this paper was to discuss the following questions, based on first-hand experience with the Danube and Zambezi river basins:

(a) What are the unique or different problems caused by large scale or the international character of such river basins?
(b) How were these problems tackled?
(c) How did hydrological knowledge relate to water management aspects?

Hydrologic phenomena are not influenced by the fact that a river is international. The international dimension of the river basin means, however, that utilization of its resources is influenced and governed by the policies, needs and capabilities of riparian countries. It also means that information characterizing river resources usually is collected and used according to interests and objectives of the riparian countries. Consequently, when dealing with international river, the scope of scientific investigations may be significantly limited by political factors and by lack of access to proper information. In extreme cases it may be impossible to undertake studies since political implications of the expected results can be unacceptable to decision makers. Hydrologic knowledge is therefore absolutely necessary to separate objective facts and problems from their political context.

Even very sound and objective studies may have political overtones. If the issue is complex and controversial it is possible that none of the parties involved would be happy with the results of analysis and implications of the expected results. One plausible way of tackling controversial problems would be through creation of the institutional basis for a joint analysis of the problems, and consequently joint approach to problem solving, involving very close cooperation between hydrologists, political scientists, social scientists, decision makers and even public opinion. The role of hydrologists and other representatives of natural sciences would be to create a true and objective image of the reality and predict impacts of possible actions.

Growing water demands and the scarcity of water resources of acceptable quality may cause more frequent and deeper controversies concerning the use of water resources and development planning in shared river basins. The international community, and especially specialized UN agencies, are making efforts to promote approaches and instruments for a cooperative approach to transboundary

water problems (UN, 1988a) 1988b, 1989a, 1989b, 1990). But unfortunately practical implementation of proposed measures proceeds very slowly. Hydrologists and specialists in water management seem to be quite distant from these problems.

It is not realistic to expect a rapid break-through in this area. Progress will be stimulated by growing needs and pressures, but the costs and speed of the progress may be significantly improved by a conscious and constructive attempt on the part of the scientific community to understand and address challenges.

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