

SECTION 1

UTILIZATION OF WATER RESOURCES AND PROBLEMS OF LAKE MANAGEMENT

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INTRODUCTION

The lake, with its clear-cut boundary, is one of the best-defined natural ecosystems on earth. It is comparable with an island in that the natural system within its shoreline is fairly independent of related outside systems. That is why lakes and islands, if they are sufficiently old geologically, tend to have highly specialized biota containing a number of indigenous species.

In terms of the bio-geochemical flow of organic and inorganic matter, however, lakes are by no means independent of surrounding land systems. Water flows into lakes from their catchment areas and is drained by outflowing streams. Lake ecosystems cannot survive without the inflow of water and its associated supply of matter and energy. Therefore, the physiochemical and ecological attributes of the lake system depend largely upon the natural environment, human population and activity in the catchment area. A lake can only be environmentally stable as long as its catchment area maintains ecologically sound conditions.

Among inland water bodies, lakes are relatively stable in contrast to rivers. This has favoured local residents using the lakes to fulfill their needs for a number of resources and services. Lakes and reservoirs are an important source of drinking water. They are a source of water for washing, for agriculture and energy production. They provide a mode of transportation, an opportunity for recreation and sadly a site for waste disposal.

In the case of subsistence economies, the communities along the lake shores often adapt themselves to the lake environment so closely that very specialized lifestyles develop. Thus the Inders dwelling on Lake Inle in the Shan States of Burma live by fishing and vegetable farming on peculiar farms made of long strips of root mats cut from floating meadows of reed and other water plants. Their stilted houses stand in the coastal shallow waters, with pagodas rising above the lake surface at the village

center. The well-known floating life of the Uros on Lake Titicaca is another similar example from the Americas. Similar close bonds with lakes are common in many lake shore communities throughout the world. The stable existence of the lake provides a basis for the material and spiritual lives of the people in these communities who would not trade their lakeside life for any other lifestyle in spite of the invading modernization in recent years.

THE VULNERABILITY OF LAKE ENVIRONMENTS

The stability of lakes as water bodies is ironically responsible for the instability or vulnerability not only of lakeside communities but also of lake environments in general. Since inflowing water stagnates temporarily in the lake, all substances carried into the lake with the water, be it silt, nutrients or toxic substances, tend to be trapped in lake sediments or in the bodies of lake organisms, resulting in changes in water depth, water quality and other environmental conditions. The continuous inflow of nutrients and organic matter is known to cause gradual eutrophication of lakes. In artificial lakes the natural supply of organic matter alone may induce eutrophication, even where human activity in their catchments is negligible. Thus lakes are extremely sensitive to changes in terrestrial environments in their watersheds.

In the past, water resource planning has tended to treat fresh water as an unlimited resource that can be provided cheaply and in any quantity desired. Only recently has it been realized how fundamentally flawed this attitude is. Although adequate quantities of water are available to meet projected needs throughout the globe in the near future, poor management, lack of conservation, pollution and rapid increases in localized demand are endangering supply in many areas.

The availability of uncontaminated water is perhaps the single most important factor limiting the attainment of improved quality of life for almost two thirds of the world's population. As the rate of development in developing countries continues to accelerate, many lake basins have become susceptible to increased pressures which tend to give rise to a number of water resource management problems. These issues can no longer only be dealt with by specific water-related programmes and projects. There is now a clear need to address the issues on a basin-wide scale in a broader socio-economic context. Three problems deserve special attention. The first is the problem of environmental, economic and social effects of water resource development projects. In the past planning for water resource developments has tended to

concentrate on major construction projects such as dams and reservoirs, with little consideration given to the environmental, economic and social effects on the basin communities. Although benefits accruing from water resource projects are many and at times substantial, a whole series of negative secondary effects may occur, including involuntary resettlement and the consequent problems of adaptation to environmentally different sites on the part of the displaced population, the aggravation and spread of waterborne diseases, and changes in the aquatic environment resulting in the disruption of fisheries.

The second is the problem of access to, and allocation of, water resources among competing users. Water resources are unevenly distributed in space and time and by social group, leading to both over-abundance and shortages. Water resource planning almost always involves some form of allocation process of which the main criterion has so far been economical efficiency. There is a clear tendency to divert water resources to those areas and sectors where the maximum return can be obtained with the minimum investment.

The third is the issue of environmental and social problems arising from water and land use interactions. Although a lake basin forms a convenient unit for water resource development and management, the increasing use of land and water resources in the basins can lead to potential conflicts between upstream and downstream areas, and between different sectors such as agriculture and fisheries. In most cases these conflicts occur because development in the lake basin proceeds haphazardly with little or no regard for the impact on the lake environment.

THE NEED FOR EFFECTIVE LAKE MANAGEMENT

The lake environment is extremely sensitive to environmental changes in its watershed and when phenomena like eutrophication and pollution occur, though they may proceed slowly, the damage caused is correspondingly difficult, if not impossible to reverse. Changes in land use patterns, alterations to the natural vegetation, increases in population, industrial development and other human impacts on the lake/reservoir catchment conditions may lead to a deterioration of lake/reservoir environments. In addition, water development projects such as dams, canals, and river/stream channelization programs may lead to a serious degradation of water quality, displacement of population, destruction of farmland, the ruination of wetlands and fisheries downstream, and may also contribute to species extinction through

habitat destruction. Different human activities have varying degrees of impact on the lake and its environment. Changes in activity have their own cause-effect function. Many such functions have already been identified, but many more remain unknown. Little is yet understood regarding the interactions between the different functions and how to assess their relative impact. Hence, there has been a growing awareness of the need for a comprehensive strategy of sustainable development of lake resources and catchment areas.

It is now commonly accepted that the concept of sustainable development of lake resources and catchment areas requires a delicate balancing between human activity and the environment. This can be attained only by integrated management of the whole catchment area and the lake ecosystem, based on sound evaluation of many relevant cause-effect functions and their interactions. Increased emphasis should be placed on preventive planning based on environmental impact assessment. These policy approaches have been fairly successful when applied effectively. Other policy issues, however, remain as yet unresolved. These include the problem of forced resettlement and the question of whether a large scale water resource project is more beneficial to society as a whole than say a series of well-linked smallscale schemes. These are hard political decisions and policy-makers would benefit greatly if more information were to be available to help improve the decision-making process. This, in part, explains the need for the production of a series of guidelines on the environmentally-sound management of lake resources.

Environmentally-sound management encompasses the management of human influences on the lake environment and the corresponding feedback effects that can occur in terms of health, economic effects and the general quality of life of local inhabitants. A great deal of research has been carried out on the limnology of lakes, the ecological management of terrestrial environment and socio-economic aspects of regional development, but the existing knowledge has not yet been synthesized into environmentally sound principles for the use of resources in lake/catchment areas. There is a clear need for the development of a management system for integrated land/water ecosystems of the lake/reservoir environment in the context of social, cultural and economic aspects and for easily understandable guidelines for management strategies.

THE SECOND GUIDELINE ON LAKE MANAGEMENT

The papers presented in this guideline bring together the most important socio-economic aspects of lake environment management. Topics covered range from the development of an analytical framework for water resource management through to description of the environmental and social problems related to particular developments. There are four sections in addition to this introductory section.

The second section of this guideline deals with the problems of lake management from the perspective of local residents and interest groups with case studies from Japan and the United States. The third provides an analytical framework for water resource management with papers on planning, implementation and management of water resource projects, lake water monitoring, integrated land-water systems, and also economic and other analytical appraisals of the impact of such activities. The fourth discusses the environmental and social impacts of water resource development projects with particular reference to reservoir and dam construction in developing countries, resettlement and compensation issues, and water resource developments in brackish lakes. The final section summarizes the main points discussed in the guideline and outlines a number of recommendations. Throughout this guideline two-page summaries are provided to give the reader details on the situation at various lakes and reservoirs in the world. The profiles also provide case studies for the arguments presented in the main papers.

No excuses are made for the wide range of information and any possible inconsistencies that may occur. These inconsistencies are thought to be a strength rather than a weakness in that they reflect the complex reality where relatively simple concepts are open to a wide range of interpretations influenced by cultural and societal circumstances.