UNEP Collaborating Centre on Water and Environment

UCC-Water

Sustainable Management of Lake Basins in the Context of IWRM

Concepts & Issues Paper No. 2

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1 Background and purpose

Lakes are an essential part of the global water resource but has often been looked at in a purely lake context due to the many specialized problems and issues that lakes present to the planners, managers and scientists. Worldwide there is an increased and necessary focus on integration and holistic approaches to water management. This was for instance expressed by the agreements on preparation of Integrated Water Resources Management and Water Efficiency Plans by 2005 made at the World Summit on Sustainable Development in Johannesburg in 2002. These plans are under development worldwide and will promote management reforms necessary to overcome the essential water resources issues including those of the lake ecosystems. It is the purpose of this note to point out that Integrated Water Resources Management (IWRM) and Lake Management are intimately linked and that IWRM planners and lake managers need to establish and forge these links[1].

2 The importance of lakes for water resources management

At any given time, the lakes and reservoirs of the world hold approx. 90% of the liquid freshwater on the surface of the earth. Whereas rivers represent flowing water systems, lakes are primarily water storage bodies with considerably variation in size, shape and depth. Lakes are home to an enormous range of biodiversity, and for many indigenous lakeshore communities lakes provide the very foundation of people's livelihoods. Specific lifestyles based entirely on lakes and their resources have developed in some locations, an example being the indigenous cultures in the Lake Titicaca drainage basin in Bolivia and Peru. Lakes also have fundamental religious and spiritual significance for many cultures.

Artificial lakes or reservoirs are created around the world, often to address water demands in irrigated agriculture. Nearly all the world's major river systems have reservoirs in their drainage basins and 800,000 reservoirs are estimated to be in operation worldwide. Many more large reservoirs are under construction, particularly in developing countries.

Lakes and reservoirs are dynamic aquatic ecosystems and have very important functions vis-à-vis the aquatic ecology. Their main socioeconomic functions relate to their use as a source of freshwater for domestic, agricultural and industrial use, as a recipient for wastewater, for fishery and aquaculture, for hydropower generation, recreation and transport and as a natural flood deterrent. Not to be forgotten is the intrinsic values of lakes, many of which exhibit significant aesthetic features. Although important, such values are the most difficult to quantify, compared to other uses.

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[1] This note draws greatly on the following documents:
ILEC and UNEP (2003) *World Lake Vision: a call to action*. Prepared by the World Lake Vision Committee and presented at the 3rd World Water Forum in 2003.
ILEC (2005). *Managing lakes and their basins for sustainable use: a report for lake basin managers and stakeholders*. International Lake Environment Committee Foundation, Kusatsu, Japan.
ILEC Guidelines for Lake Management and ILEC's World Lake Database (www.ilec.or.jp)
GWP TEC documents (www.gwpforum.org)

Some examples of economic and social values of lake fisheries in Africa
• More than 60% of the fish consumed in Tanzania come from inland fisheries, and about 60% of the protein intake in Malawi is freshwater fish • The creation of Lake Kariba produced a viable regional fishery in an area in which freshwater fish were previously absent from the diet of Zimbabweans • Lake Victoria generates an annual GDP of US$ 3-4 billion, providing more than 25,000 people with an average annual income of US$ 90-270 per capita • In contrast, the eutrophication of Lake Chivero threatens the health and livelihoods of nearly three million inhabitants in the greater Harara/Norton urban areas, and caused the virtual collapse of a once-thriving fishery

3 The vulnerability of lakes

Lakes are generally sensitive to pollutants and with high water storage capacity and long retention times, chemical and organic pollutants can appear in rather high concentrations and accumulate in bottom sediments. A lake and its drainage basin are fundamentally linked, and interactions between humans, water and land resources are critical factors influencing a lake's health and its potential long-term uses. Most problems facing lakes are deeply rooted in socioeconomic issues. Among those, which originate from *within the drainage basins* are:

Excessive water withdrawals or diversions threatening water levels, water quality, human settlements and ecosystems. A dramatic example is the demise of the Aral Sea, a large lake in a closed drainage basin in South Central Asia. Because of the significant diversion of the lake's inflowing tributaries for irrigation purposes during the last half century, the Aral Sea has shrunk significantly in surface area and volume, experienced a major increase in salinity, and undergone fundamental changes to its biological communities. Water withdrawals for the purpose of land reclamation also can have profound impacts on lakes.

Excessive nutrient loads (phosphorous and nitrogen) causing eutrophication (excessive growth of algae and aquatic plants causing degraded water quality*).* Lake Erie, one of the Great Lakes in North America was earlier increasingly loaded with nutrients from poorly treated industrial and urban wastewater. The high concentrations caused large growth of algae and oxygen depletion in the lake. Fish kills, foul smells and loss of recreational and aesthetic values were among the effects. Today, the problems of Lake Erie have been brought largely under control, but many other lakes suffer similar problems.

Contamination of water and sediments from toxic and hazardous substances endangering human and ecosystems health. These pollutants are of particular concern because of their long life and their ability to accumulate in lake sediments and in human, aquatic and terrestrial organisms. The presence of organic chemicals in Lake Ontario, also part of the Great Lakes system, reached peaks in the 1960s. Some 362 chemicals were present, with one third of these having toxic effects.

Increased erosion and sedimentation. Deforestation and other land and soil disturbances often produce large quantities of sediment that can degrade water quality and destroy lake habitats. Sedimentation can fill up lakes and interfere with flow control mechanisms, and reduce their flood control capacity. Lake Baringo in Kenya was very rich in biodiversity until the mid 1970s. Due to poor land use practices, river inflow has been seriously reduced and five million m3 of sediment is currently being deposited each year. The average depth has been reduced from 8.9 meters in the 1970s to 1.9 meters today. Depleted fish stocks have had serious effects on lakeshore human communities and fish eating bird species.

Unsustainable fishing practices and aquaculture. Adverse fishing practices can remove juvenile and breeding populations ultimately diminishing or destroying a fishery's capacity to be self-sustaining. Aquaculture can cause serious water quality problems, including nutrient pollution and increasing quantities of antibiotics and hormones. Also the introduction of exotic species can alter the fish population entirely. The Nile Perch was introduced in Lake Victoria in mid 1950s with the aim to boost the local fishery. However, with an insatiable appetite for other fish species, the Nile Perch has nearly destroyed the lake's 350 native species.

Not only is a lake fully dependent on processes in the drainage basin, but will also be threatened by factors originating outside the drainage basin. Among those, which originate from *outside the drainage basins* are:

Long range transport of airborne pollutants and nutrients. An example of this is lake acidification resulting from atmospheric transport of acid-forming compounds from distant industrial smokestacks and vehicular emissions.

Invasive species. Non-native animal and plant species intentionally or accidentally introduced in a lake can proliferate rapidly in the absence of their natural predators or other control mechanisms. A prominent example is the proliferation of the water hyacinth plant in many lakes in Africa, Southeast Asia and other parts of the world.

Climate change. The responses to climate change will among others take place as changes in precipitation patterns and drainage basin hydrology. Lakes are particularly vulnerable to changes in climatic parameters. Variations in such climate variables as air temperature and precipitation can directly cause changes in water evaporation, lake levels and volumes, water balances, and biological productivity.

4 Addressing the issues through IWRM approaches

Sound lake management is critical in a context of growing populations and economies and pollution problems. Sound lake management rests on the concept of Integrated Water Resources Management (IWRM), which the Global Water Partnership (GWP) defines as:

"...a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social

welfare in an equitable manner without compromising the sustainability of vital ecosystems"[2]

The general framework of the IWRM approach to water management is illustrated in figure 1.

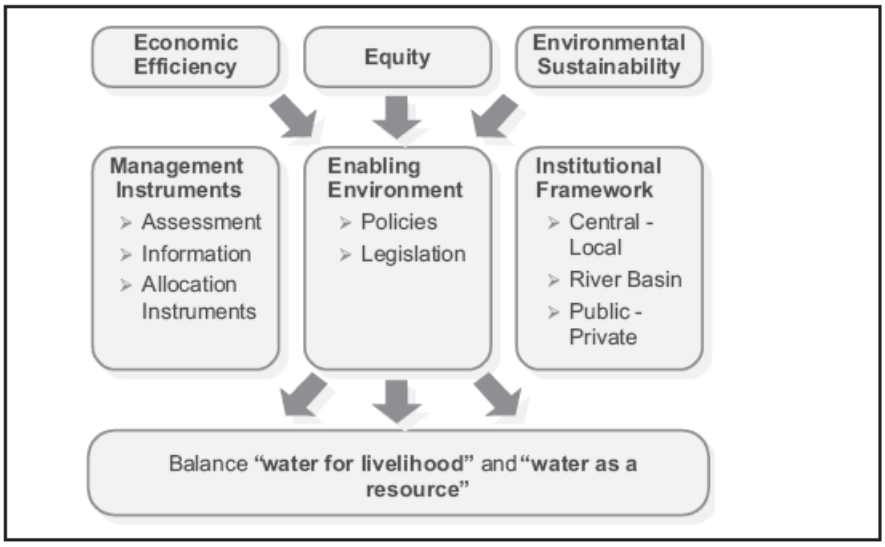

Fig. 1: The general framework of IWRM.

To implement this vision, there is a need to ensure coherence and appropriate linkages between the main national and local ***development objectives*** with respect to:

- *Economic development objectives* relating to monetary resources, such as economic growth, management of monetary assets, and economic sector development.
- *Social development objectives* relating to human resources, such as poverty alleviation, health, education, and job creation.
- *Environmental development objectives* relating to natural resources, such as water policies, pollution control policies, nature conservation policies, agricultural land policies, forest policies, and fisheries policies.

The "Three Es" in the general IWRM definition – **E**conomic efficiency, social **E**quity and **E**cological sustainability have to be achieved through a comprehensive development of "The Three Pillars" in water management:

1. The enabling environment in the form of policies, strategies, legislation, etc.
2. The institutional roles of the various stakeholders in the water sector.
3. The management instruments such planning tools, monitoring, regulation and economic incentives.

[2] For more information about the general IWRM framework, please refer to GWP (2000). TEC Background paper No. 4 (and other GWP publications at www.gwpforum.org).

IWRM places emphasis on achievement of cross-sectoral integration via coordination and collaboration, as illustrated by the "IWRM Comb" in figure 2 below.

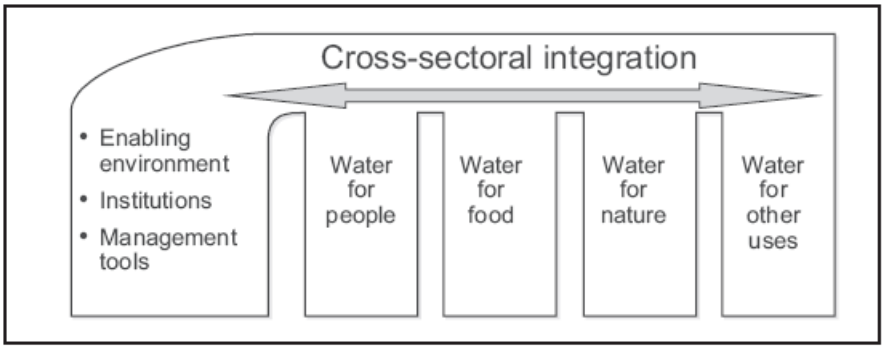

Fig. 2: IWRM comb – cross-sectoral integration.

The IWRM approach strives to ensure coordination of *all* sector uses, so that the impacts of one particular user are taken into account for all other affected users. Consequently, planners for water supply and sanitation (Water for People), for irrigation and fisheries (Water for Food) and for nature conservation (Water for Nature) and so on must take other needs into consideration, particularly in terms of water allocations and impacts.

Principles for sustainable lake management

A lake is an important part of the drainage basin and must be managed in an integrated manner. A lake, its functions, its water quality and volume are all dependent on land use and other human activities in the drainage basin. The examples mentioned earlier clearly illustrate this point. The IWRM approach strive to find the delicate balance between water for livelihoods and water for maintaining the resource base, and to ensure coordination of all sector uses so that impacts from one particular use is taken into account when looking at other uses.

The World Lake Vision presents seven key principles in the context of IWRM for sustainable lake management. They are presented in table 1 (below) including summarized supporting statements:

Principle 1. **A harmonious relationship between humans and nature is essential for the sustainable use of lakes** ...it is necessary that humans respect the natural capacity of lake ecosystems to meet their various needs...
Principle 2. **A lake drainage basin is the logical starting point for planning and management actions for sustainable lake use** ...a lake and its drainage basin, including its inflowing and out flowing tributaries, comprise an inseparable system... ...lake management should focus on the scale of the drainage basin, effectively integrating hydrological and ecological processes, as well as socioeconomic realities...
Principle 3. A long term preventative approach directed to preventing the causes of lake degradation is essential ...a proactive approach that identify and address problems before they happen, including the need for continuing monitoring, assessment and corrective actions, is a key element in managing lakes...
Principle 4. Policy development and decision-making for lake management should be based on sound science and the best available information ...the study and management of lakes requires a multidisciplinary approach... ...the knowledge of people directly linked to a lake is important... ...it is essential that systematic, continuous and up-to-date monitoring and evaluation of environmental and socioeconomic conditions be undertaken...
Principle 5. **The management of lakes for their sustainable use requires the resolution of conflicts among competing users of lake resources, taking into account the needs of present and future generations** ...lake management requires the identification, analysis and reconciliation of competing uses, as well as avoidance of water related conflicts...
Principle 6. Citizens and other stakeholders should be encouraged to participate meaningfully in identifying and resolving critical lake problems ...in addition to government agencies, involving citizens and other stakeholders is essential for managing lakes... ...cooperative and collaborative arrangements for multiple stakeholders are fundamental...
Principle 7. Good governance, based on fairness, transparency and empowerment of all stakeholders, is essential for sustainable lake use ...lake management activities must be subject to principles of fairness... ...citizens and other stakeholders must be empowered to play their significant roles...

Table 1: Principles for sustainable lake management

Based on studies of 28 lake basins, the project called "Towards a Lake Basin Management Initiative"[3] provides new knowledge on lake management and valuable lessons learnt. Key issues are summarized in Annex 1 under the following six lake management components:

- Adequate **institutions** for implementation change;
- Efficient, effective and equitable **policies**;

[3] ILEC (2005)

- Meaningful **participation** of all stakeholders involved;
- **Technical** measures to ameliorate certain problems;
- Appropriate **information** about current and future conditions; and
- Sufficient **financing** to allow all the above to take place.

One of the strongest messages emerging from the study is the need for coordinated action between sectors, levels of governance and upstream/downstream. In case of transboundary lake basins coordination is also needed between countries. See below for more information about transboundary features of lake management.

The 28 lake briefs provide a rich diversity of experiences from lake basins in very different physical settings, with different social and economic conditions, and different levels of resources. Nevertheless, there are some *common lessons* that emerge from these examples including the following:

Focus on lake basins
There need to be a fundamental shift in approach from a focus on lake management to one based on lake basins. A significant number of problems associated with lakes originate in the lake basin, but these problems often come from a diversity of areas and so these are difficult to manage without the involvement of all groups in the lake basins.

Promote a long-term, adaptive approach
Development of effective institutions, promotion of meaningful stakeholder involvement, and acquisition and acceptance of knowledge all require a long-term commitment by local institutions and national governments. This long-term approach should include support for national scientific research and training institutions so that the next generation of managers and scientists are developed. However, a long-term commitment does not imply a rigid approach; it needs to be responsive to new knowledge, changing objectives, and shifts in external circumstances.

Mainstream lake basin management
While lake basin management institutions can coordinate, the reality is that sectoral institutions will continue to take the lead in infrastructure investments and in management of the resources in the lake basins. Lake basin management institutions need raise the awareness of institutions about the importance and the vulnerability of lakes, so that these concerns are fully incorporated into their policies, programs, plans, and strategies.

Coordinate across sectors and jurisdictions
While the forms and legal mandates of management institutions vary, the most important role played by successful management institutions, is to coordinate the activities of sectoral institutions, including coordination across jurisdictions.

Encourage both governance and investments
Good governance and sustainable investments are needed to improve the environmental status of lakes. In some cases, technological solutions can lead to rapid improvements in the environmental status of lakes – most notably with sewage treatment plants. However, these technological solutions are not sustainable if the elements of good governance are not in place.

Involve stakeholders

It is important to involve communities in decisions that will affect them. The benefits include more ownership, better decisions, improved enforcement, sometimes reduced cost, and support for increased community participation in governance. Lakes where there has been an improvement in environmental status are characterized by strong stakeholder involvement.

Transboundary features of lake management

In the case of transboundary lake basins, the differences in political environments, economic development, social norms, and administrative settings can readily lead to different approaches to lake basin management, with detrimental effects on the environmental and development status of lake basins. Such circumstances make it necessary to establish joint management bodies, collaborative mechanisms or other means to ensure that land use and other human activities take place with environmental sustainability as the common goal.

The project "Towards a Lake Basin Management Initiative"[4] suggests that there are specific factors that affect the success of transboundary lake basin management, including the perception of common problems faced by the lake basin countries; the kind of nature of cooperative agreement among the countries; and their political will, commitment, and fulfilment of obligations. The institutional arrangements between countries are affected by the evolution of such arrangements, the relationship between the sector agencies and the coordinating body, the coordination and collaboration mechanisms, and participatory mechanisms and experiences of stakeholders.

It is often not possible nor practical to develop a powerful supranational agency to form management policies and implement programs for a transboundary lake basin. Therefore, the lake basin nations may rely on the facilitating functions of coordinating institutions. Such joint bodies should have a wide representation from many governmental and nongovernmental stakeholder organizations, including ministries and local authorities, so that the results produced by international/national projects would be broadly sustained.

To develop the essential confidence to enable transboundary water resource management and collaboration, parties need to build and accept common data sets and knowledge about the water resource issues and share visions about the future of the resource. Indeed, mechanisms for conflict resolution are often fundamental to building effective institutions. The national management frameworks (described in the IWRM 2005 Plans) will have to be harmonized in order to allow a cooperation regarding international lakes and other transboundary water resources to proceed.

Once established, transboundary water management needs to move beyond visions, and develop specific regulatory mechanisms, data and information sharing protocols and financing mechanisms to put transboundary water management firmly on the ground. Experience with transboundary rivers shows that technical secretariats are essential in this respect.

[4] ILEC (2005)

5 The connection between IWRM 2005 plans and lakes – An opportunity for bringing lakes into the current national planning processes

At the World Summit for Sustainable Development (WSSD) held in Johannesburg in 2002, the international community took important steps towards more sustainable water management. See Annex 2 for more details. Since then, the Global Water Partnership (GWP) has issued guidelines to support the achievement of the IWRM 2005 plans[5] and Cap-Net has established training materials[6]. To accelerate the achievements towards IWRM 2005 plans supported by many global actors (e.g. Global Water Partnership, UNDP, development banks and bilateral donors), UNEP launched in 2005 the "2005 IWRM programme" with the objective to provide assistance to governments to plan and implement water management reforms incorporating environmental aspects. These activities bring an opportunity for lakes to become an essential part of water resources planning.

A water resources management framework must be designed to cater for the particular issues and conditions that lakes present to the 'water resources manager'. Lakes are natural elements of the drainage basins in which they are located. As such they should be integrated in the water resources management and planning in the same way as other features like rivers and streams, groundwater reservoirs, irrigated areas, urban areas and hydropower reservoirs. Due to their vulnerability and high values for the society they need special attention in the approaches as well as in the management framework. Policies and legislation may make special allowance for lakes, separate institutions or cooperative arrangements may have to be created and lake management tools may have to be readily available to the water resources management agencies. Lakes are then included in the national water resources management framework, which is described and explored during the preparation of the IWRM 2005 Plans.

For addressing major threats facing lakes, the World Lake Vision recommends three longer term strategies, which could be incorporated in preparations of the IWRM 2005 Plans. They are summarised below:

- Monitoring and assessing the health of lakes and their drainage basins
- Developing the capacity of individuals and organisations to manage lakes for their sustainable use
- Identifying lake stakeholders in the drainage basin and facilitating their active involvement

6 Concluding remarks

Lakes are an essential part of the global water resource but has often been looked at in a purely lake context due to the many specialized problems and issues that lakes present to the planners, managers and scientists. But as other basins lakes and reservoirs can benefit from an IWRM approach, reflecting social, environmental and economic factors.

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[5] Torkil Jønch-Clausen (2004). ...Integrated water resources management (IWRM) and efficiency plans by 2005: why, what and how? Global Water Partnership, TEC Background Papers No. 10. Global Water Partnership (2004). Catalyzing change: a handbook for developing integrated water resources management (IWRM) and water efficiency strategies. Technical Committee (TEC) (www.gwpforum.org)

[6] Cap-Net (2005): Integrated water resources management plans: Training manual and operational guide (www.gwpforum.org)

Worldwide there is an increased and necessary focus on integration and holistic approaches to water management. A lake, its functions, its water quality and volume are all dependent on land use and other human activities in the drainage basin. This is also the key message from the World Lake Vision, which strongly advocates lake management as part of the IWRM framework.

The IWRM approach strive to find the delicate balance between water for livelihoods and water for maintaining the resource base, and to ensure coordination of all sector uses so that impacts from one particular use is taken into account when looking at other uses.

With the message from the World Lake Vision, the principles of lake management and IWRM are identical. Only its focus and its scale may be different. The IWRM framework comprises all management levels from the regional to the local level. Lake management usually focuses on the lake basin.

Hence, IWRM and lake management are intimately linked, and IWRM planners and lake managers need to establish and forge these links. Therefore, lakes should be taken into account in IWRM plans as the prominent features they are.

Annex 1: Key lessons learnt: Towards a lake basin management initiative

(Adopted from: ILEC (2005). *Managing lakes and their basins for sustainable use: a report for lake basin managers and stakeholders*. International Lake Environment Committee Foundation, Kusatsu, Japan.)

Key lessons learnt about institutions

- Development of strong institutional links promoting effective participation, and development of strong local government capacity are among the important institutional issues for lake basin management.
- Lake basin management institutions are most effective when they build on existing structures. Sectoral institutional arrangements may be improved and facilitated through coordination mechanisms without establishing a new lake basin management organization.
- Links to other institutions, particularly sectoral agencies, are vital to success. Formal links should be supplemented by informal links.
- Decentralisation can help improve management if there is adequate administrative and technical capacity at the local level.
- NGOs and CBOs often play critical catalytic roles in facilitating institutional linkages, particularly with regard to enhancement of community participation in collaboration with government.
- The success of transboundary lake basin management depends on the member states' political will, commitment, and fulfillment of obligations, rather than on the particular form of institution or its legal status.
- Transboundary collaboration is likely to be more successful when guided by an agreed plan of action.
- Lake basin institutions need to adapt to emerging problems and the development needs of the lake basin communities.

Key lessons learnt about policy

Simply raising awareness among resource users is one of the most effective and easiest policies to implement. People will often modify a behavior if they learn it has a negative effect on others.

- National level policies are essential for establishing the foundation of good lake basin governance;
- Policies affecting lake basins need to support poverty reduction and development policies, because poverty itself contributes to lake basin degradation and also because affected stakeholder groups are more likely to become involved in lake basin management if they benefit,
- National policies are implemented at the local level through either command-and-control (CAC) policies, incentives/disincentives (economic instruments), or public awareness. Each has advantages and disadvantages. These instruments are often used together.
- CAC policies are effective when there is a clear outcome being sought; there are relatively few affected stakeholders; and there is social acceptance of government decisions.
- Economic instruments have their advantages of being flexible; relatively cheap to implement; and able to include the cost of externalities. However, they can be difficult to introduce, especially when they involve charging for use of a resource previously accepted as being free.
- Overall, successful local policies build political will; involve the stakeholders; ensure administrative sustainability; are equitable; and actively work toward policy integration

Key lessons learnt about involving people

People are central to lake basin management. They are the ones who use a lake's resources; the ones who create and suffer from problems; the one who work in institutions; and the ones who are affected by any management decisions.

- Public participation and active involvement is essential to managing lakes. There are numerous benefits, including a greater acceptance of rules for allocating lake basin resources if stakeholders are involved in their formation and implementation.
- All affected stakeholders, both powerful and marginalized, need to be included in the decision making process. Historically disenfranchised stakeholders, including indigenous peoples, must be included if they and the lake basin are to benefit.
- Creating linkages to the improvement of livelihoods of the local communities is a key to promoting participation in lake basin management.
- Without proper understanding and appreciation of the local cultural beliefs, values and norms, a lake basin management plan will not be accepted and properly implemented by the community.
- Women play a central role in the provision, management and safeguarding of water. Their participation in a full civil society, using a participatory approach and using culturally sensitive methods, will enhance efforts to achieve effective lake basin management.
- NGOs and CBOs play key roles in agenda-setting and the policy development process. Their roles include operational functions, networking, collaboration, and mediation among government agencies and local communities, and transferring skills to local institutions and community groups.
- Any effort that depends upon a change in behavior or compliance with new legislation must rely on CEPA (Communication, Education and Public Awareness) if change is to occur.

Key lessons learnt about technology

Changing people's behavior through rules, incentives/disincentives or awareness raising to achieve management goals is not always easy. For some problems and under certain circumstances, a technological solution can be an effective response.

- Exploration of lower-cost technological options, combined with source control of pollutants, should be a priority consideration for lake basin management. A long-term objective should be to reduce, reuse, and recycle land-based sources of possible pollution through on-site control technologies with involvement of representatives from the polluting facilities and local communities.
- Nonpoint-source problems, particularly sediments, nutrients and agro-chemicals from agriculture and forestry land uses, can be tackled through community based reforestation and afforestation, and catchment protection activities.
- Wetlands act as efficient traps for contaminants as well as providing other valuable services. Rehabilitating degraded wetlands, and even constructing artificial wetlands, is seen as a cost-effective method of protecting lake environments because removing contaminants after they have entered lakes is very expensive. Protection of existing wetlands should be a priority.
- There is a need for concerted scientific research into technology development and application for better lake basin management.
- A shift to a long-term view of sustainable lake basin resources use requires new conceptual approaches and innovative technological designs for lake basin management. For example, making appropriate provision for environmental flows to maintain the ecological health and resource uses of lakes is a growing concern as more dams and weirs are constructed for water storage and regulation.

Key lessons learnt about information

Accurate, impartial and accessible information is central to lake basin management. Without it, institutions can be inefficient, rules can be ineffective, people can be disempowered, and technologies can be misapplied.

- Both natural science information and social science information are needed for lake basin management. The latter includes socioeconomic and cultural information pertaining to and held by local communities and indigenous peoples. Sometimes the information on locally generated management approaches can be very useful when there are no long-term monitoring studies available to provide scientific data.
- Scientific information has been successfully used in the study lakes to show the limits of lake basin resources, enlighten hard-to-see connections, and provide innovative solutions to problems. However, the benefits from use of information have not been fully realized. Scientific information needs to be disseminated to relevant parties and translated into the language of decision makers and stakeholders if it is to be fully applied in management.
- More directed research with application in mind, having managers define the research needs, possible through a formal needs analysis, was recognized as an effective way to have research results taken up and applied in management. There is a need for a collective, widely shared knowledge base of experiences.
- Two of the characteristics of lakes (long retention times and complex response dynamics) make long-term scientific commitment particularly valuable. Resident research institutions in developing countries can be assisted by international collaborators through training and technology transfer programs.
- Monitoring has been used to both develop a baseline for the lake basin and to assess the effectiveness of management interventions.
- Scientific models had been used to help managers at a number of study lakes. However, the complexity of the models needs to be matched to the capacities of the users, the available data and the demands of the task.

Key lessons learnt about financing

A common observation is that sufficient funding is not available to meet all the management goals at a given lake. It is clear that, like all resources, money is scarce and available funds must be put to the best possible use.

- Locally generated funds, such as water user fees, fish levies and pollution charges, can often provide a stable and important part of the financial base for lake basin management.
- It is important that locally generated funds are largely retained locally and that there is involvement of resources users in establishing and administrating the fees.
- Most funding for lake basin management comes from national and/or local sources. External funds should play a catalytic, rather than a primary role for implementing lake basin management activities and investments.
- Financing for capital infrastructure investments usually comes from national level or from international resources; local-level funding is an important source of money to help meet routine recurrent expenditures.
- To ensure global benefits from lake projects, particularly in the case of international lake basins, a programmatic approach from donors, would be better than a project-by-project approach. This approach would also require a longer-term commitment from lake basin countries to sustainable management.

Annex 2: The target to develop IWRM plans by 2005

In the WSSD Plan of Implementation[1] it is stated that: "*Human activities are having an increasing impact on the integrity of ecosystems that provide essential resources and services for human well-being and economic activities. Managing the natural resources base in a sustainable and integrated manner is essential for sustainable development. In this regard, to reverse the current trend in natural resource degradation as soon as possible, it is necessary to implement strategies which should include targets adopted at the national and, where appropriate, regional levels to protect ecosystems and to achieve integrated management of land, water and living resources, while strengthening regional, national and local capacities. This would include actions at all levels as set out below[2]":*

Develop integrated water resources management and water efficiency plans by 2005*, with support to developing countries**, through actions at all levels to:*

(a) ***Develop and implement national/regional strategies, plans and programmes*** *with regard to* ***integrated river basin, watershed and groundwater management*** *and* ***introduce measures to improve the efficiency of water infrastructure*** *to reduce losses and increase recycling of water;*

(b) ***Employ the full range of policy instruments****, including regulation, monitoring, voluntary measures, market and information-based tools, land-use management and cost recovery of water services, without cost recovery objectives becoming a barrier to access to safe water by poor people, and* ***adopt an integrated water basin approach****;*

(c) ***Improve the efficient use of water resources*** *and promote their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirement of preserving or restoring ecosystems and their functions, in particular in fragile environments, with human domestic, industrial and agriculture needs, including safeguarding drinking water quality;*

[1] Section IV, Para 24. (www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf)

[2] Section IV, Para 26 defines some actions.