A User's Guide to the GEF-LBMI Report, "Managing Lakes and their Basins for Sustainable Use"

How Can We Stop Degradation of the World's Lake Environments?

Integrated Lake Basin Management (ILBM): Towards Preservation and Sustainable Use of Lake Ecosystems

Ministry of the Environment

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ABOUT THE COVER

The cover base image is taken from NASA's Blue Marble. The highlighted region includes Lake Victoria and its drainage basin. The various arrows illustrate some of the connections between the lake and its basin, as well as with the world beyond, highlighting the necessity of an integrated approach to its management.

How Can We Stop Degradation of the World's Lake Environments?

Integrated Lake Basin Management (ILBM): Towards Preservation and Sustainable Use of Lake Ecosystems

Lakes and their Basins

Key Components of Global Water Resource Systems

Containing over 90% of the world's liquid surface freshwater, natural and artificial lakes provide many uses for sustainable human livelihoods and economic development, while serving as essential habitats for a great variety of flora and fauna. Resource development, use and conservation of lakes have been major undertakings across continents, particularly with regard to satisfying human needs within, and sometimes beyond, the lake basin. Lakes are vulnerable, however, and their overall condition is deteriorating. Lake basins are easily impacted by complex land and water relationships; they receive water, sediments, contaminants, nutrients and biota from rivers, surface runoff, groundwater, and the atmosphere. Because of their unique characteristics, lake systems are much more vulnerable to stresses, and more difficult to manage, compared to river systems.

Vast and Variety of Resource Values

Lakes and their basins possess many important values for humans *(Figure 1)*. Lakes are some of the most beautiful and accessible parts of the landscape. They supply water for domestic and other uses; and they serve as habitats for important food species comprising various forms of aquatic life and supporting the earth's biodiversity. They protect downstream areas against both floods and droughts, and they serve as sinks for sediments and contaminants to protect downstream areas. In developing countries, they are often centers of livelihoods for small-scale local fishers, as well as a base for much larger fishing operations. And whether located in developed or developing countries, most larger lakes are important transportation routes for both people

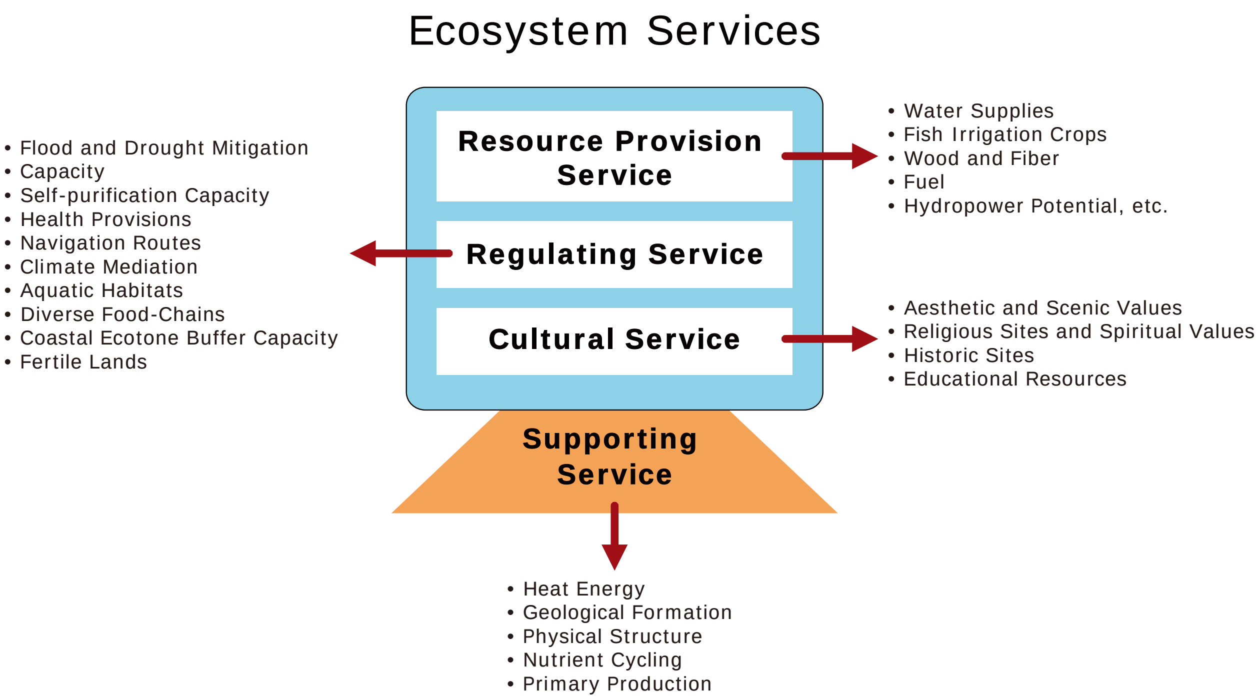


Figure 1. Ecosystem Services Provided by Lakes and Reservoirs
One proposed framework of ecosystem services is that of the Millennium Ecosystem Assessment. Resource Provision Services are valued monetarily, while other services (Regulating, Cultural and Supporting Services) are difficult to value in monetary terms and their degradation is often neglected.

and products. And although we can construct artificial lakes to create such values, the endowed values of natural lakes generally far exceed those of artificial lakes. It is these and many other uses of lakes through which they contribute to general human development and well-being from the shoreline, throughout the basin, and even beyond.

Changes in Resource Values Over Time

While some natural lakes have been around for millions of years, others have only been in existence less than a hundred years. Although artificial lakes may have been a part of human history in many regions of the world since the earliest times, most of the world's reservoirs were constructed only over the past century. All lakes, natural or artificial, undergo various transformations through time due to natural processes of aging caused by climatic, hydrologic and ecosystem changes. However, the greatest degradation impacts to lakes and reservoirs are caused by human interventions. The growing population and industrialization in a lake basin can lead to mounting pressures for development of lake resources, such as water withdrawals and fish landings. Polluting wastewater discharged back into lakes can cause deteriorating water quality and ecosystem integrity. Thus, the transition in values over time, and changes in the state of the lake environment, must be understood in relation to each other.

Development interventions of resource values typically take place in phases. In early stages of resource development, they may be limited only to construction of lakeshore facilities for fisheries, navigation and small scale water supplies. As the population increases, the need for water for domestic, industrial and agricultural uses increases, generally leading to construction of large scale flow control facilities. Ports and harbors for fisheries and navigation will also have to be upgraded to accommodate more fish landings and more passenger and cargo traffic. The commercial interest development of tourism and recreational facilities may then grow, perhaps sufficiently to exploit the lake's cultural and natural heritage assets. Overall, the resource development activities are inevitably associated with infrastructure development and landscape alterations in and around the lake basins which, together with wastewater discharges, gradually accelerate degradation of water quality and ecological integrity, usually without being noticed when they began.

The progression of degradation inside a lake often takes place on a wider and deeper scale than is apparent. If the seriousness of a lake problem is realized in time by scientific means, resource conservation and restoration measures may produce some promising results. Often, however, the symptoms of degradation remain unnoticed for a long period of time because of their incremental nature, and the introduced conservation and remedial measures may be too little too late. The level of ecological and water quality degradation may have already reached crisis proportions, suddenly leading to instant loss of ecosystem sustainability *(Figure 2)*.

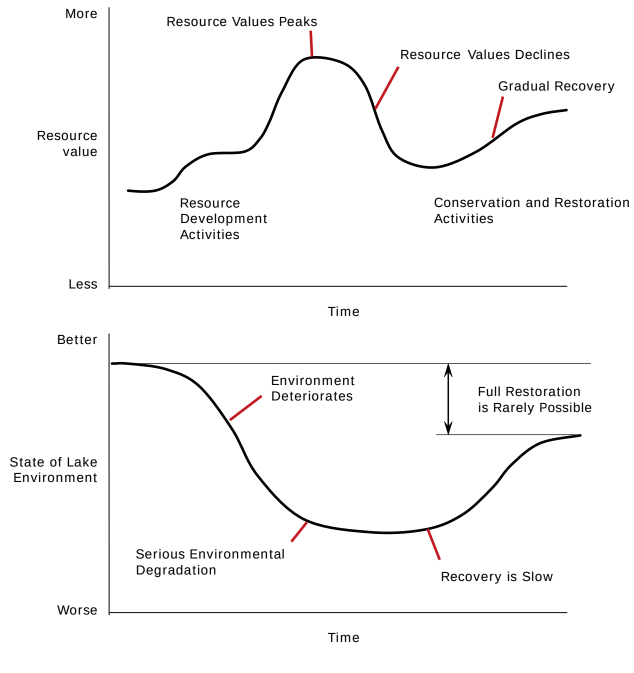


Figure 2. Changing Resource Values and Resulting Environmental State of a Hypothetical Lake

The Story of a Lake

People settled around the lakeshore many millennia ago. While the population was low, the lake's resources were abundant, and there was little conflict between different settlements over use of these resources. The fish caught by one community did not seriously impair the ability of another community to obtain fish, and the water withdrawn for domestic use did not noticeably lower the lake level. But, as the lake's population increased, some of these resources came under pressure. This happened first with the fish. Following some years of low rainfall, fish catches began to decline and the fish that were caught were smaller than before. The more experienced fishermen realized that this was occurring because the wetlands were not being flooded and the fish could not breed successfully. Conflicts started to break out between different communities about access to the best fishing grounds. Fortunately, the rains returned before these conflicts became unmanageable, the breeding grounds became available again, and the fish populations recovered.

Nevertheless, the incident caused the leaders of the fishing communities to agree on some rules of access to fishing grounds that would reduce tensions. Each community had the right to send only a specific number of boats to these areas. It was agreed that the wetlands were off limits during the period when they were flooded and the fish were spawning. Any transgressors would be judged by an assembly of the leaders of the lakeshore communities, with those found guilty being banned from fishing and even expelled from their community.

A more difficult problem arose many years later with the influx of a group of farming families into the catchment that drained into the lake. As they prospered and grew, these families cleared increasing areas of land. The land began to erode during the wet season, with the wetlands at the entrance to the lake beginning to silt up. Again, fish breeding was interrupted and fish numbers began to decline. However, the farmers did not accept the claims of the fishing communities that they were causing the siltation of the wetlands. They believed that the rivers were always silty during the wet season and that the decline in fish catch had nothing to do with them. And although this caused bad blood between the farmers and fisherfolk, it did not lead to violence because other fish breeding grounds were still operating and the fisherfolk were able to compensate by moving further offshore, and building fish traps and fish ponds. Nevertheless, tensions developed between the two groups that was never bridged, and to a large extent they led separate lives.

Over time, the lakeshore communities expanded into towns. The town people, while not relying directly on fishing for their incomes, continued to identify with the lake. They were proud of its scenery, enjoyed its waters for recreation, and used it for easy transport of their goods to other destinations. They also used it to dispose of their wastes. Rubbish was dumped in creeks, to be eventually flushed into the lake. To keep up with the amenity offered by other towns throughout the country, the local council installed sewage removal and primary treatment of the effluent to remove the worst part of the organic matter. The resulting effluent was then disposed of in the lake at a convenient distance from the town.

A major expansion of the region occurred many years later when the national government decided to develop a large irrigated cotton growing area upstream of the lake to take advantage of increasing international demands for cotton. The development was widely welcomed by the region's business interests (they had lobbied strongly for it), and the town councils were briefed on the plan and endorsed it. Of course, the land had to be expropriated from the farmers who had settled there many generations earlier. In compliance with national laws, the government intended to provide them with alternative agricultural land some days travel away. Many of the town people and the fisherfolk were uneasy about this development, but had no means of finding out much about it, let alone influencing it. They felt little solidarity with the farming communities, and actually felt quite relieved when the irrigation plan went ahead. New, wealthier farmers appeared and the old groups were moved away.

At first the new irrigation area appeared to cause no problem. The region prospered with the additional income and the towns grew rapidly to provide necessary services. A government agriculture office was opened in the major town and many new people arrived to take advantage of the employment opportunities in the irrigation area.

After some decades, problems started to appear in the lake. Dense mats of weeds began to grow around the mouths of the town creeks and spread into the boat harbors. Waterweeds even began to appear near the fish pens. Since the region had long ceased to be dependent on the fishing industry, this was seen more as a nuisance than a major problem by many people. In fact, some entrepreneurial women harvested the weeds to use for weaving. More alarmingly to most people, the water near the towns quite quickly and unexpectedly turned dirty and had a musty smell. Many of the townspeople, particularly the older residents who remembered the beauty of the lake when they were younger, were seriously upset and complained to the town council. The fishermen were also worried, but for a different reason. They had trouble launching their boats through the weeds and they had trouble selling their fish because of the widespread perception that the fish were dirty and tasted bad.

There was a strong local opinion that the problem was caused by the upstream irrigators although the government officials in the agricultural office claimed that it had nothing to do with their industry and that the problem resulted from the expansion of the towns. Under pressure, the government promised to upgrade the sewage treatment plant for the town to remove nutrients from the sewage, since this could be completed within three years. They also promised to launch a scientific investigation into the causes of the problem.

This lake story illustrates how the complex and unique characteristics of lakes can transform a tranquil situation involving people using their resources into a major issue over time. It illustrates the subtle nature of lake basin problems, and how incremental increases in the type and magnitude of these problems, as well as the manner in which they are perceived by various lake resource users, can slowly increase to the extent that major conflicts can arise between lake users, necessitating a lake basin management approach that ensures sustainable resource use and addresses the concerns of all the basin stakeholders. This approach exists in the form of integrated lake basin management (ILBM), which represents both a process and a mechanism through which the interests and the concerns of lake basin stakeholders can be addressed to the satisfaction of all. In fact, although problems will inevitably arise when multiple, and sometimes competing, lake uses must be accommodated over time, the situation need not always have a negative outcome. ILBM offers an approach to address such problems, facilitating the participation of all stakeholders, as well as a mechanism of cooperation whereby existing and emerging lake problems can be overcome.

The Degrading Trend of the World's Lakes

Increasing Global Pressure for Lake Resource Development

The resource values of a lake and its basin may be degraded by a number of causes triggered by the previously-noted resource development activities. The GEF-LBMI Project *(Table 1)* classified the 28 case study lakes *(Figure 3)* into 15 categories in three groups: (1) in-lake and littoral zone problems; (2) problems originating within the lake basin; or (3) from a wider region outside the lake basin, including global threats. as depicted in the top row of Table 1.

Most problems are not isolated to specific regions, but are distributed around the world, with most lakes facing multiple threats. The most frequently mentioned problems originate within the lake basin, with the ingress of sediments from the basin to a lake being the most commonly cited issue (21 out of 28 lakes). Some 48 percent of the nominated problems originated in the lake basins, illustrating the importance of managing the lake basin as a whole. Overall, the table shows that problems affecting lakes are not improving.

Lake Basin	In-lake						Basin origin						Regional/Global		
	① Unsustainable fishing practices	② Introduced faunal species	③ Salinity changes	④ Weed infestations	⑤ Nutrients from fish cages	⑥ Loss of wetlands	⑦ Excess sediment inputs	⑧ Non-point source nutrients	⑨ Agro-chemicals	⑩ Water abstraction and changes in run-off	⑪ Effluents and stormwater	⑫ Industrial pollution	⑬ Atmospheric nutrients	⑭ Atmospheric industrial contaminants	⑮ Climate change
Aral Sea			→ (yellow)			→ (yellow)				→ (yellow)					
Baikal							↓ (red)				↓ (red)	→ (yellow)		→ (yellow)	
Baringo	→ (yellow)						↓ (red)			↓ (red)					↓ (red)
Bhoj Wetland							→ (yellow)	→ (yellow)	→ (yellow)		→ (yellow)	↓ (red)			
Biwa				→ (yellow)		↓ (red)		→ (yellow)	→ (yellow)	↑ (green)	↑ (green)				↓ (red)
Chad						↓ (red)	↓ (red)			↓ (red)					↓ (red)
Champlain								↑ (green)			↑ (green)			→ (yellow)	
Chilika Lagoon			↑ (green)	↑ (green)			↓ (red)	↓ (red)	↓ (red)	↓ (red)	↓ (red)				
Cocibolca/Nicaragua							↓ (red)		↓ (red)		↓ (red)				
Constance		↓ (red)				→ (yellow)		→ (yellow)	→ (yellow)		→ (yellow)				
Dianchi					↑ (green)	↓ (red)	↓ (red)	↓ (red)	↓ (red)	↓ (red)	↓ (red)	→ (yellow)		→ (yellow)	
Great Lakes (N.Am.)		↓ (red)						↓ (red)	↓ (red)		↑ (green)	→ (yellow)		→ (yellow)	
Issyk-Kul		→ (yellow)					↓ (red)	↓ (red)	↓ (red)			↓ (red)			↓ (red)
Kariba Reservoir					↓ (red)			↓ (red)			→ (yellow)				↓ (red)
Laguna de Bay	→ (yellow)	↓ (red)	→ (yellow)	→ (yellow)	↓ (red)		↓ (red)	↓ (red)			↓ (red)	→ (yellow)			
Malawi/Nyasa	↓ (red)			↓ (red)			↓ (red)	↓ (red)	↓ (red)	↓ (red)	↓ (red)		↓ (red)		↓ (red)
Naivasha	↑ (green)	→ (yellow)		↑ (green)		→ (yellow)	↓ (red)			→ (yellow)	↓ (red)		↓ (red)		
Nakuru							→ (yellow)	→ (yellow)		↓ (red)	↓ (red)				
Ohrid	→ (yellow)	↓ (red)				↓ (red)	↓ (red)	↓ (red)	↓ (red)		↓ (red)				
Peipsi/Chudskoe	↓ (red)			→ (yellow)				→ (yellow)			↓ (red)	→ (yellow)			
Sevan	↓ (red)	↓ (red)				↓ (red)	↓ (red)			↓ (red)	↓ (red)				
Tanganyika	↓ (red)						↓ (red)				↓ (red)	↓ (red)			↓ (red)
Titicaca		↓ (red)					↓ (red)				↓ (red)	↓ (red)			
Toba	↓ (red)	↓ (red)		↓ (red)	↓ (red)	↓ (red)	→ (yellow)	→ (yellow)	↓ (red)	↓ (red)	↓ (red)		↓ (red)		
Tonle Sap	↓ (red)	↓ (red)					↑ (green)				↓ (red)				
Tucurui Reservoir				→ (yellow)			→ (yellow)								
Victoria	→ (yellow)	↓ (red)		↑ (green)		↓ (red)	↓ (red)	↓ (red)			↓ (red)	↓ (red)	↓ (red)		
Xingkai/Khanka	↓ (red)					↓ (red)	↓ (red)		↓ (red)		↓ (red)	↓ (red)			
Total	12	11	3	9	4	11	21	16	12	11	23	12	4	4	7

Table 1. Summary of Problems Affecting the 28 Study Lakes as Described in the Individual Lake Reports. A red symbol means the problem is not improving significantly; a yellow symbol means the problem has improved somewhat; and a green symbol means there has been significant improvement.

A red ■ symbol means that the problem is not improving significantly; a yellow ■ symbol means that it has improved somewhat; and a green ■ symbol means that there has been significant improvement.

Photo: ILEC

① Overfishing due to fine mesh size

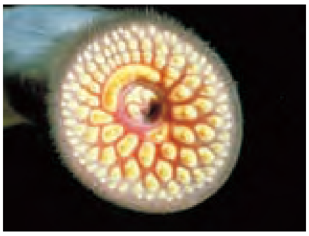


Photo: USEPA

② Invasive parasitic fish, sea lamprey

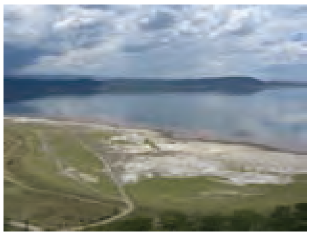


Photo: Thomas Ballatore

③ Exposed salt on Lake Nakuru shoreline

Photo: ILEC

④ Impacts of water hyacinth on lake transportation

Photo: Lake Laguna Development Authority (LLDA)

⑤ Fish pens in Laguna de Bay

Photo: Thomas Ballatore

⑥ Shoreline and littoral habitat destruction

Photo: USEPA

⑦ • ⑧ Inflowing sediment plume to Lake Superior

Photo: USEPA

⑨ Toxic contamination

Photo: Nick Aladin

⑩ Dried bed of Aral Sea

Photo: NOAA

⑪ Stormwater effluent

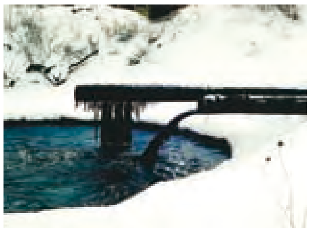


Photo: USEPA

⑫ Industrial wastewater

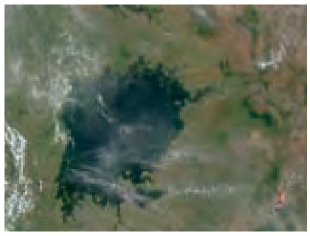


Photo: NASA Visible Earth

⑬ Smoke from biomass burning covering Lake Victoria

Photo: USEPA

⑭ Damage from acid rain

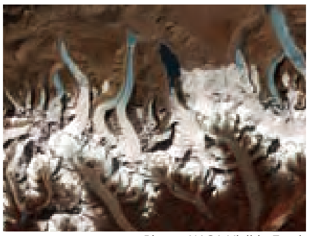
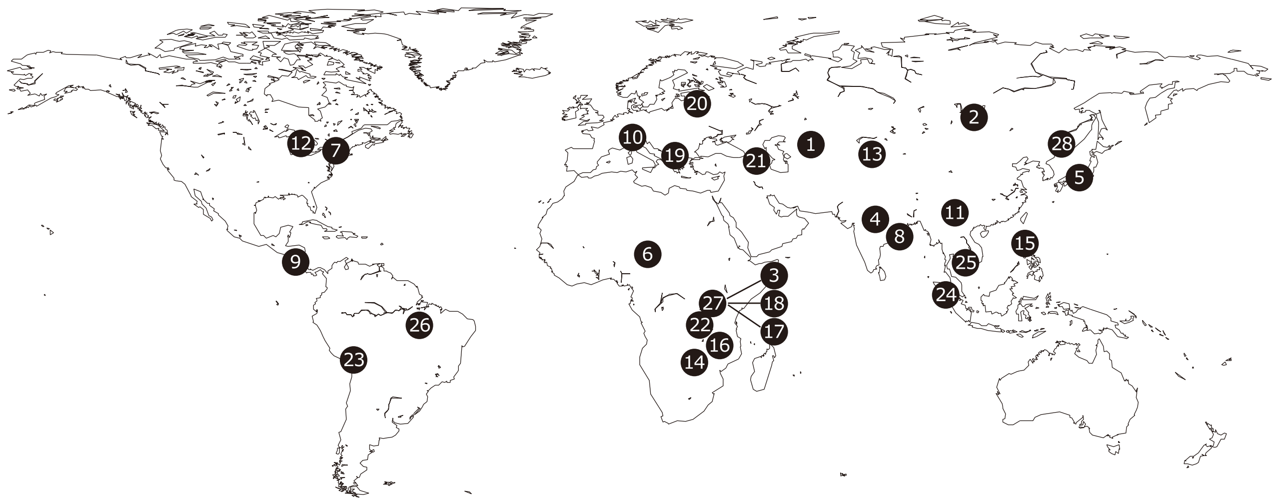


Photo: NASA Visible Earth

⑮ Increasing lake levels in Himalayas due to glacial melt

Box 1. The GEF-LBMI Project and Its 28 Case Study Lake Basins

GEF-LBMI Project stands for a Global Environment Facility Medium Sized Project entitled, “Towards a Lake Basin Management Initiative: Sharing Lessons and Experiences from GEF and Non-GEF Lake Basin Management Projects”. The Project was implemented over a period of 30 months (March 2003 through September 2005), being funded through a partnership of multilateral agencies, bilateral agencies, local government, and nongovernmental organizations. Twenty-eight lake basins were selected for study in this Project, representing a wide range of climate conditions, sizes, problems, political jurisdictions, and management challenges. The lakes include some of the major freshwater and saline lakes in the world. Twenty two the lakes contain globally significant biodiversity. Twelve lakes are national lakes; that is, their basins lie within a single nation-state. Sixteen of the lakes are transboundary, with more than one country having jurisdiction over their basins or waters. Three of these transboundary lakes (Lakes Baikal, Cocibolca/Nicaragua, Tonle Sap) lie entirely within one country, but have other countries in their basins. (http://www.ilec.or.jp)



1. Aral Sea
2. Baikal
3. Baringo
4. Bhoj Wetland
5. Biwa
6. Chad
7. Champlain
8. Chilika Lagoon
9. Cocibolca/Nicaragua
10. Constance
11. Dianchi
12. Great Lakes (N. American)
13. Issyk-Kul
14. Kariba Reservoir
15. Laguna de Bay
16. Malawi/Nyasa
17. Naivasha
18. Nakuru
19. Ohrid
20. Peipsi/Chudskoe
21. Sevan
22. Tanganyika
23. Titicaca
24. Toba
25. Tonle Sap
26. Tucurui Reservoir
27. Victoria
28. Xingkai/Khanka

Figure 3. Case Study Lakes in GEF-LBMI Project

Unique Features of Lentic (Static) Water Systems Affecting the Sustainability of Lake Basin Resources

Another Fundamental Factor Affecting Human-Nature Relationships with Water Resources

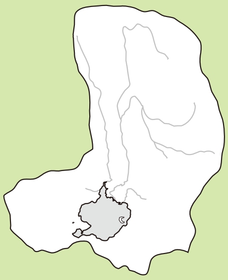
In the broadest sense, lakes, wetlands and reservoirs can be considered “standing water” systems *(Box 2)*. In scientific terms, standing waters are termed “lentic” systems, whereas flowing waters (rivers) are known as “lotic” systems. In general, because lakes usually have both inflowing and outflowing rivers, a lake basin can be characterized as a complex combination of both lentic and lotic waters, with this distinction between the two being of great importance for lake management *(Figure 4)*. In fact, the occurrence and management of lake problems is influenced by three characteristics of lentic water systems -- integrating nature, long water retention time and complex response dynamics.

Box 2. Categorization of Lake Basin Types

(a) Surface Drainage Basin

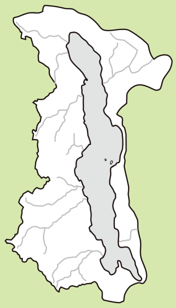
Lake Constance Basin

(b) Subsurface Drainage Basin



Lake Naivasha Basin

(c) Transitional Drainage Basin

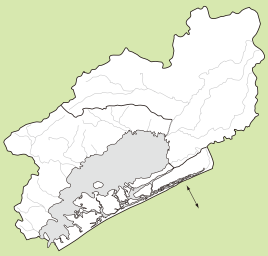


Lake Malawi/Nyasa Basin

(d) Closed Drainage Basin

Issyk-Kul Basin

(e) Coastal Drainage Basin

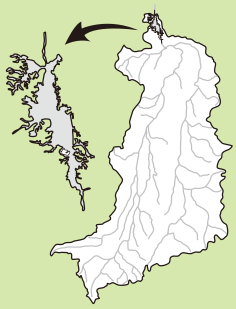


Chilika Lagoon Basin

(f) Mixed Flow Drainage Basin

Tonle Sap Basin

(g) Reservoir Drainage Basin



Tucurui Reservoir Basin

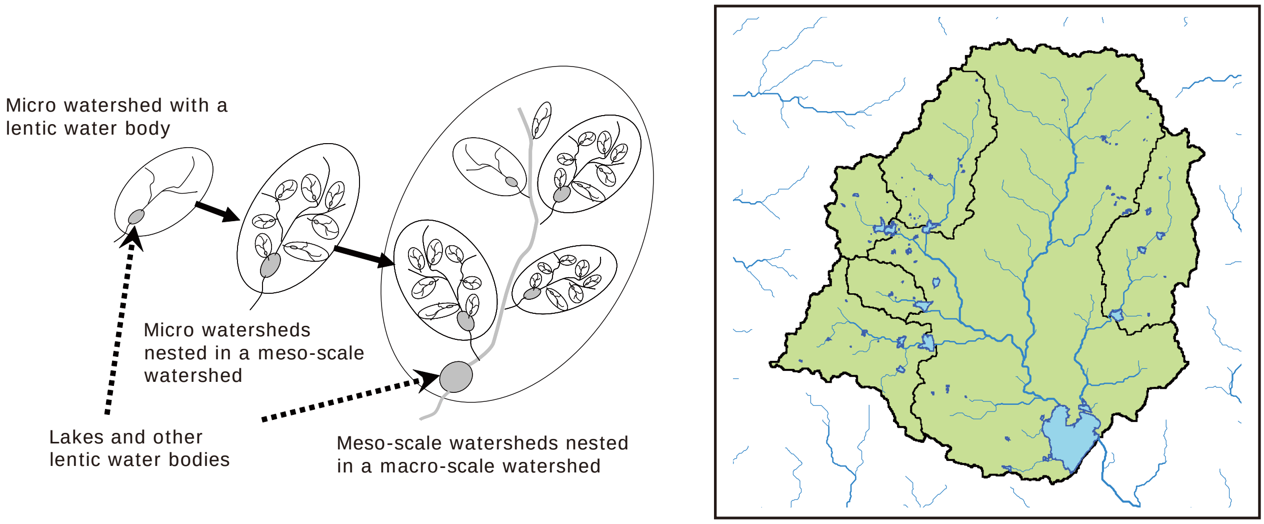


Figure 4. Nesting structure of watersheds consisting of lentic and lotic water bodies Lake Hussain Sagar, India

Long Retention Time: The water residence time of a lake gives an indication of the average time water spends in the lake. Large lakes with long retention time are able to absorb large inputs of floodwaters, pollutants and heat without exhibiting immediate changes. Large or small, lakes with long water retention time also allow for suspended materials to settle to the bottom, thus acting as efficient sinks for many materials. Further, the long-term stability of older lakes has allowed complex, often unique ecosystems to evolve. Although lake ecosystems are resilient when faced with stresses that have existed over evolutionary time scales, they can be extremely vulnerable to "new" stresses, such as the introduction of exotic species. The long water retention time also means that once a lake is degraded, it can take a very long time – if ever – for it to recover or be restored. It also leads to lags in ecosystem response that are poorly matched to the human management time-scale.

Management Implications: Because the problems can build up and become noticed slowly, and take equally as long to be managed, institutions involved in lake basin management need to be prepared to engage in sustained actions, with long term funding commitments. The implications of lake ecosystem vulnerability being affected for a long time necessitate management with a precautionary approach.

Complex Response Dynamics: Unlike rivers, lakes do not always respond to changes in a linear fashion. Figure 5, for example, illustrates a non-linear response (hysteresis) of many lakes to increases in their nutrient concentration. The consequence is that a lake's degradation in response to developing pressure, such as increased nutrient concentrations (from point A to point B), may not be apparent until the nutrient concentration is high, and the lake abruptly switches its trophic status. The management difficulty for a decision maker is that the lake cannot simply change from point C back to point B. There are likely to have been changes to the ecosystem, so the recovery phase can follow a delayed path from point C through point D , and back to point A or a similar position indicating some degree of recovery. Biomagnification, the increase in concentration of certain compounds (such as PCBs and diox-

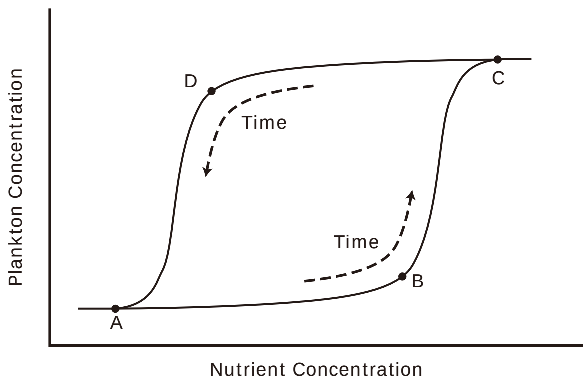


Figure 5. An example of the complex response dynamics of a lake to human-induced impacts and management interventions

ins) in organisms as one goes up the food chain, is another important response dynamic with complexity *(Box 3)*.

> **Management Implications:** Complex response dynamics, particularly in relation to long water retention times, imply that the problems need to be anticipated as far in advance as possible through monitoring, development of indicators and analytical studies, while carrying out scientific explorations to unravel the complex processes and their implications. Scientific studies may also help develop novel solutions to these problems.

Box 3.

Toxic compounds such as PCBs and dioxins are extremely soluble in fat. Therefore, they can remain in the bodies of organisms that consume them, and get concentrated in lower-order organisms that are in turn consumed by higher-order organisms. The table below shows how the concentration of PCBs increases as one goes up the North American Great Lakes food chain.

Biomagnification of PCBs in the North American Great Lakes.

Organism	PCB concentration relative to concentration in phytoplankton
Humans	?
Herring Gull Eggs	4960
Lake Trout (a large fish)	193
Smelt (a small fish)	47
Zooplankton	5
Phytoplankton	1

(Adapted from USEPA and Government of Canada, 1995)

Integrating Nature: Lakes receive pollutant inputs from diverse sources in various forms from their drainage basins and beyond. The inputs to a lake can exist in the form of atmospheric precipitation; flows from rivers and other inflowing channels; heat- and wind-induced energies that cause waves; thermal energies that affect mixing properties; and land-based and airborne pollutants and contaminants, nutrients, and organic substances, both living and non-living matter. The integrating nature refers to the mixing of these inputs within a lake so that both resources and problems are disseminated throughout the volume of a lake. There are important limits to in-lake mixing: stratification can prevent complete vertical mixing of water, and restricted embayments can limit horizontal water movement. Nevertheless, valuable resources (fish; invertebrates), as well as problems such as floating plants and pollution, are able to move throughout most of the upper parts of a lake.

> **Management Implications:** The integrating nature of a lake means that many lake resources, as well as lake problems, are shared throughout the lake. As a result, it is not sensible to subject different parts of a lake to different management regimes. This is particularly relevant to transboundary lake basins. A related consequence of their integrating nature is that it is difficult to exclude users from accessing a lake's resources. These properties require lakes and their basins to be subjected to adaptive management, utilizing wide-ranging policy instruments.

Integrated Lake Basin Management and Governance

Lessons Learned from the Global Lake Basin Management Experiences

The global experience of lake basin management encompasses a wide variety of lessons. Some are at early stage of resource development and the resulting degradation of their environments is minimal. Others have been overexploited and their ecological services functions are suffering from serious degradation. And still others have been introduced with measures for achieving sustainable resource development, use and conservation. Regardless, the way in which the stress is exerted from the basin to the lentic body of lake water is the same, and a common and integrated approach is needed to address these wide ranging issues in lake basin management. As examples, the GEF-LBMI Project summarized the experiences from the management of 28 lakes as follows.

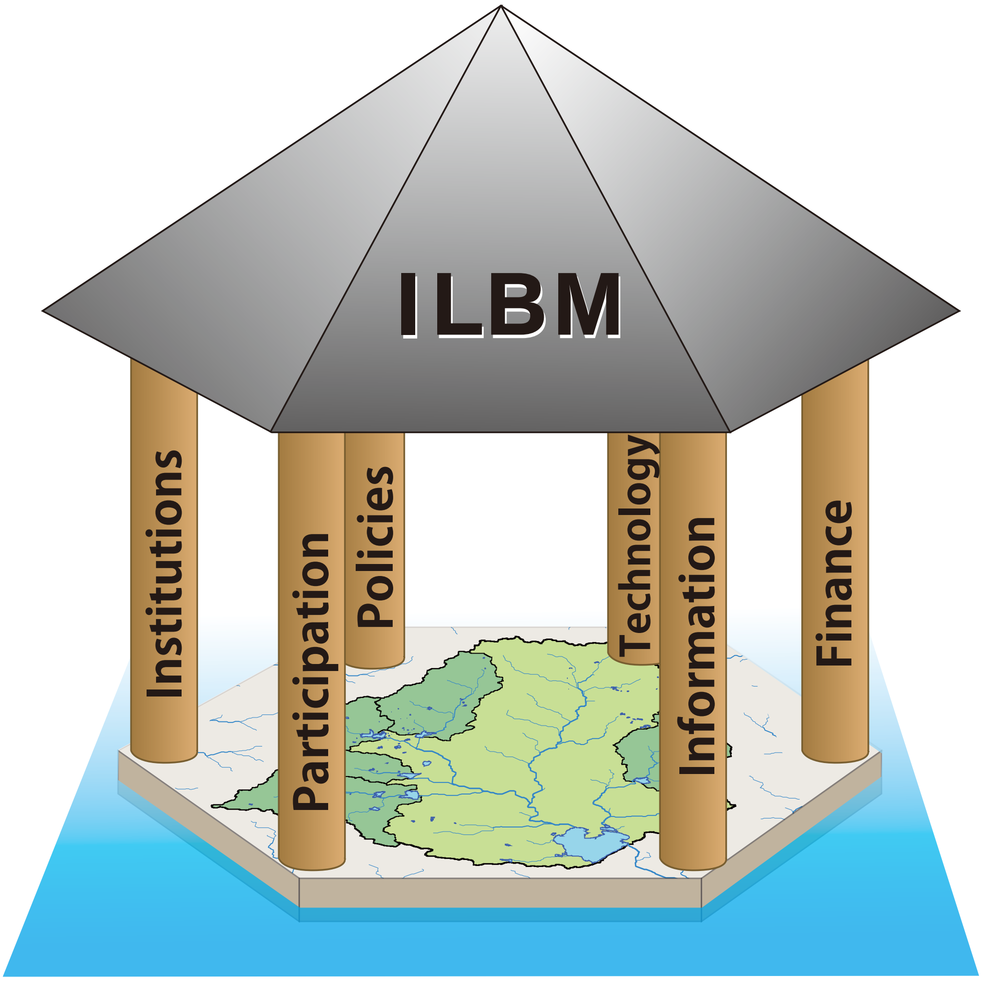


Figure 6. ILBM (Integrated Lake Basin Management)
ILBM is a conceptual framework for assisting lake basin managers and stakeholders in achieving sustainable management of lakes and their basins. It takes into account the biophysical features of as well as managerial requirements for lake basin systems, that are associated with the lentic (standing or static) water properties of lakes as well as the inherent dynamics between humans and nature in the process of development, use and conservation of lake and basin resources.

- **Importance of Basin Approach:** Management does not stop at the lakeshore, but must extend into the basin, and often beyond. The largest number of lake issues reported in the project originated from their upstream or downstream basins.
- **Border Barriers (Transboundary Lakes) Must be Overcome:** In principle, transboundary lakes are more difficult to manage. In practice, however, there is good progress in establishing agreed plans of action and institutions.
- **Technological Interventions Can be Effective:** Technologies can have dramatically positive effects on lakes, provided the root causes of their problems and their sustainability are properly addressed.
- **Success Depends Heavily on Stakeholder Involvement:** Degradation of the ecosystem services provided by lakes results from unsustainable human interventions for resource development. Sustainability can be best achieved when the respective stakeholders fully understand and appreciate their respective roles regarding the problems.
- **Long-term Commitment is Essential:** The long water retention time and complex dynamics of lakes means that successful project outcomes are seldom immediate. Thus, there is a need for indicators that illustrate both planning (Process Indicators), implementation (Stress Reduction Indicators) and actual lake basin improvements (Environmental Status Indicators).
- **Monitoring Should Not be Overlooked:** Long-term monitoring data sets can form the basis for mutual understanding of lake basin management issues, thereby leading to cooperative actions to address them.
- **Lake Basin Management is a Continuing Process not a One-time Project:** Management interventions at a lake basin usually first happen in isolation, often for non-lake related reasons. Through time, however, the need for the integration of projects can grow.

The experiences learned from the GEF Project indicate that good lake basin management requires: **(1) Institutions** to manage the lake and its basin for the benefit of all lake basin resource uses; **(2) Policies** to govern people's use of lake resources and their impacts on lakes; **(3) Involvement of people** central to lake basin management; **(4)Technological possibilities** and limitations exist in almost all cases; **(5) Knowledge** both of a traditional and scientific nature is valuable; **(6) Sustainable finances** to fund all of the above activities are essential. These constitute the essential components of basin governance about which ILBM can provide the overall framework for application *(See Box 4)*.

Box 4. The Meaning of Governance

Although there is no universal definition of governance, the differing definitions exhibit similar features. Governance is seen as a process of interaction based on accommodation, rather than domination. It includes both public and private organizations and their relationships. Governance also is often considered as facilitating action, since it involves activities for resolving common problems. Governance also puts emphasis on networks, flexibility and informal institutions. The governance fabric also is dynamic, since it can take place from the very local to the global level.

This manner of characterizing governance is useful since it reinforces the notion that governance is something very concrete, and determines who gets what water, when and how. Governance manifests itself, for example, in daily interactions between local public official, citizens, communities and organizations. Thus, how water is governed is critical for reducing poverty. Further, from the perspective of practitioners and private and public decision makers, governance means more when tied to the common good and to resolving common problems.

(In: "Developing Water Governance Capacities: Water Troubles are Governance Troubles," Hakan Tropp, SIWI, Stockholm. Water Front: A Forum for Global Water Issues, No. 2, June 2006, p.10)

When the human population and industrial activity around a lake is minimal, informal and traditional institutions are usually sufficient to manage any problems that might arise. However, with development, the need for more formal government institutions and research groups can arise *(see Box 5)*. However, when state and national government policies become more important, local traditional societal measures often lose much of their function. Accordingly, the following questions should be considered when assessing management programs:

- Is our organizational structure correct?
- Do we have the necessary legislative powers?
- Have we formed alliances with all relevant organizations that must be involved in the basin management effort?
- Do we have good links to decision makers, and will they listen to us?
- Has political will and commitment grown, or has it waned?
- Are our capacity building and training programs effective?
- What mid-course corrections are needed; Are there new skills, for example, not considered when we started the management intervention?

An example from The GEF-LBMI Report

Box 5. Examples of Types of Different Agreements

Vision

Lake Chad. A Strategic Action Plan with a long-term vision (20 years) for the Chad Basin has been prepared with the assistance of the Global Environment Facility (GEF). It was adopted by the member states in 1998. The Lake Chad Vision for 2025 highlights a number of important issues needing to be addressed in the basin.

Memorandum of Understanding

Lake Champlain. The 1988 Memorandum of Understanding on Lake Champlain, and the Water Quality Agreement of 1993 signed by the states of Vermont and New York in the United States, and the Province of Quebec in Canada are examples of non-binding transboundary covenants. The MOU created a mechanism for the exchange of scientific information and encouraged cooperative planning for watershed protection. It established the Lake Champlain Steering Committee with diverse representation among the three jurisdictions, as well as a role for three citizens' advisory committees. The MOU is a five-year renewable agreement that sets the stage for the passage of national legislation and development of a comprehensive plan for the lake basin. This comprehensive plan is still under way.

Agreements

Lake Peipsi/Chudskoe. The Agreement between the Governments of the Republic of Estonia and the Russian Federation on Cooperation in Protection and Use of the Fish Resources of Lake Peipsi/Chudskoe, Lake Pihkva, and Lake Lämmijärv was signed in Moscow on May 4, 1994. The agreement goal is to develop cooperation on the protection and joint use of fish resources in Lake Peipsi/Chudskoe, Lake Pihkva, and Lake Lämmijärv. The agreement included the establishment of the Intergovernmental Commission on Fishery in Lake Peipsi/Chudskoe, Lake Pihkva, and Lake Lämmijärv.

The Great Lakes of North America. The United States and Canada signed the Great Lakes Water Quality Agreement in 1972. Signed by President Richard Nixon and Prime Minister Pierre Trudeau, the agreement does not have treaty status, but is a binational executive agreement that commits Canada and the United States to undertake specific actions to protect and enhance the water quality of the Great Lakes. Not only does the Great Lakes Water Quality Agreement address water quality issues, but also the issue of multiple fragmented jurisdictions. To this end, the agreement established the International Joint Commission (IJC) Great Lakes Regional Office (the only IJC regional office), with specific responsibilities for providing technical support, coordinating programs, and monitoring implementation of the two federal governments under the Agreement. The IJC subsequently established a Great Lakes Water Quality Board and a Science Advisory Board to carry out its mandate for the Great Lakes Basin.

Conventions

Lake Tanganyika. The Convention for the Management of Lake Tanganyika is a government-government agreement setting out the rights and duties of the four riparian countries of Tanzania, Burundi, the Democratic Republic of Congo, and Zambia that surrounding the lake. It establishes institutional structures for cooperative management, management principles, a GEF-initiated Strategic Action Program (SAP), and related matters. The convention was developed through a series of regional workshops bringing together senior lawyers and policy makers from each of the four riparian countries. The final draft of the Convention was adopted by the steering committee (July 2000) at the completion of the GEF-funded UNDP Lake Tanganyika Biodiversity Project (LTBP). The Convention was signed by the four riparian states on June 12, 2003, and is now being ratified by the various parliaments. Once it enters into force (after ratification by at least two countries), the Convention will provide the legal authority to implement the SAP and to regularly it on a regular basis as necessary.

Sources: ILEC/GEF Briefs for Lakes Chad, Champlain, Peipsi/Chudskoe, and Tanganyika, and the North American Great Lakes.

In most cases, development policies promoting fishing, agriculture, industry, etc., are the initial management focus, with lake environment preservation measures later becoming more important. When environmental degradation exerts serious effects on resource development and/or when people's interests in protecting biodiversity, ecosystems, scenery, and historical and cultural heritage becomes stronger, appropriate societal rules (direct regulation, economic incentives, etc.) become necessary *(see Box 6)*. Accordingly, the following questions should be considered when assessing management programs:

- When we developed rules, did we involve those who would be affected?
- Do we have adequate resources to enforce the rules, or do we need to use another approach?
- Are economic instruments likely to succeed in controlling the use of lake basin resources?
- Do we have an environment that allows charges for use of lake basin resources?

An example from The GEF-LBMI Report

Box 6. Command and control (CAC) and Economic Instruments Described in some of the 28 Case Study Lake Briefs.

Lake Basin	Command and Control			Economic Instruments			
	Standards	Bans/Quotas	Zoning	Licences to Access Resources	Subsidies	Effluent Charges	User Fees for Natural Resources
Aral Sea		Fixed water allocation quotas between countries					
Baikal	Lake water level standards	Timber harvesting banned within ecological zones	Zoning under "Baikal law" controlling permitted activities				
Baringo	Standards for fishing gear; Controls over tree cutting	Fishing moratorium		Fishing licenses; Licenses for water extraction			Fees for water use
Bhoj Wetland	Water quality standards	Ban on motorboats; Ban on recreation activities	Foreshore zoning; Buffer zone between settlements and plantations		Subsidy to washermen to move out of lower lake catchment		
Biwa	Water quality standards for industrial, urban and agricultural discharges; Voluntary pollution control agreements by factories	Detergent phosphorus ban; Ban on persistent organic pollutants; Ban on invasive fish	National park with controls over land use; Lake zones for recreation boating; Zoned protection of reed beds		Preferential national government subsidy rates for major prefectural environmental infrastructure development; Compensation to fishermen for loss of fishery; Subsidy for catching invasive fish.		Direct and indirect payments from the downstream water users
Chad	Water quality standards			Fisheries licenses			Water use charges (Nigeria)
Champlain	Water quality standards for effluent and industrial discharges	Detergent phosphorus bans; Restriction on emissions of atmospheric pollutants (USA Clean Air Act)	Buffer zones for wetland protection	Fishing licenses	Agricultural subsidies for riparian protection, etc.		
Chilika Lagoon		Allocation of water for environmental flows (to be approved)	Shoreline zoning (1 km) of restricted activities	Licensing of fisheries and prawns			

When fishing and agricultural activities are done on a small scale in each village, direct participation of the population is possible. When the activities and sources of problems go beyond the local scale, however, the possibilities for direct public participation can be lost, necessitating establishment of a regional mechanism *(See Box 7)*. Thus, it is important to have a shared means and/or place for the basin society as a whole to address conflicts. Accordingly, the following questions should be considered when assessing management programs:

- Do mechanisms exist for effective stakeholder participation?
- Do the mechanisms cover all basin stakeholders?
- What changes have occurred in regard to awareness and understanding of the problems and their links to stakeholder activities?
- What is the perception of the program's stakeholders?
- Is community participation sufficient?

An example from The GEF-LBMI Report

Box 7. Indigenous Peoples: Key Lessons from Lake Titicaca

Located in the Andes Mountains on the border of Bolivia and Peru, Lake Titicaca is, volumetrically, the largest high altitude lake in the world. Although year-round air temperatures on the high altitude plateau are cool at night (8-10 °C) and moderate during the day, the lake has a moderating effect on the local climate, leading to the development of unique plant and animal species, and the establishment of indigenous communities. With the exception of mixed populations found in cities and large towns, the general population of the Titicaca basin is comprised almost entirely of Indigenous Peoples: the Quechua zone in the north, the Aymara zone in the center, and another Quechua zone in the south. The Uro population also is located in some areas near the lake, including the Puno area in Peru, in the Desaguadero River basin in Bolivia, and around Poopo Lake in Bolivia.

With the change from Spanish colonial rule to national rule, large tracts of land were taken from the indigenous communities to form properties controlled by new landlords. This system of large haciendas remained until the application of agrarian reform laws in Bolivia in 1953 and Peru in 1969. This history, spanning centuries, created hostility and distrust among the indigenous population that remains to this day. Later policies to create an open market resulted in the reduction of prices for agricultural products. In addition, government investments in infrastructure and services in cities had a negative impact on rural areas. Nevertheless, the local population possesses a great desire to improve livelihoods in the Lake Titicaca basin which, if properly directed, could yet produce positive results for the people and the lake.

The introduction of exotic species in the Lake Titicaca basin, such as the Trout (*Salmo truta*) during the 1940s, and the Pejerrey (*Basilichtys bonaerensis*) to Lake Poopo in 1969, led to the extinction of native fish species and infestation of a protozoan parasite that affected 70 percent of the annual native fish harvesting in 1988. These fish introductions had negative impacts on the socioeconomic conditions of the Aymaras and the Urus, whose indigenous communities and livelihood patterns depend on native fish.

Source: Lake Titicaca Brief.

There is a potentially large role for technical interventions in development and protection of lake resources. Interventions such as sewerage development *(see Box 8)*, which are often used in developed countries to address water quality problems, face the problem of not having a sufficiently large base of people in developing countries to pay for the increased utility. Accordingly, the following questions should be considered when assessing management programs:

- Will the infrastructure be effective over the long term or does it need institutional changes?
- Have we budgeted for infrastructure replacement costs?
- How will we pay for operations and maintenance costs?
- Are the effects of infrastructural interventions on the lake environment being considered?
- Is the focus on addressing the root causes of the problems?
- Are measures in place to deal with non-point sources?

An example from The GEF-LBMI Report

Box 8. Conventional and Advanced Wastewater Treatment in the 28 Study Lake Basins

The extent of sewage treatment in the 28 lake basins is related to per capita gross national income (GNI) and population density, as summarized below. The extent and degree of wastewater treatment is indicated by the bold words in each cell (e.g., Low to High). The classes of treatment are indicated as low = primary, medium = secondary, and high = tertiary. For lake basins with a low population density and low GNI per capita (cell I-1), almost no sewage treatment is carried out. As both income and density increase (I-2, II-1, II-2), however, conventional treatment systems expand, usually with bilateral funding. For high GNI per capita countries (III-1, III-2), even in sparsely populated areas (III-1), conventional and advanced treatment are carried out, usually with central or local government funding.

Population Density / **GNI per capita**	**(1) < 100 persons/km^2**	**(2) ≥ 100 persons/km^2**
I) Low-Income Economies < US$765	I-1) No provision **Lakes:** Malawi, George, Tonle Sap, Issyk-Kul, Chad, Kariba Reservoir, Tanganyika, Baringo, Chilika Lagoon **Funding:** Not currently planned.	I-2) Low to medium provision **Lakes:** Victoria, Naivasha, Nakuru, Bhoj Wetland, Toba **Funding:** Mostly by international assistance.
II) Middle-Income Economies US$765-9,385	II-1) Low to medium provision **Lakes:** Aral Sea, Baikal, Titicaca, Ohrid, Xingkai/Khanka, Tucurui Reservoir, Peipsi/Chudskoe, Cocibolca **Funding:** Partly funded by international assistance.	II-2) Low-to-high provision **Lakes:** Dianchi, Laguna de Bay **Funding:** Mostly by international and/or central government assistance.
III) High-Income Economies > US$9,385	III-1) High provision **Lakes:** Champlain, North American Great Lakes **Funding:** By central and local governments.	III-2) High provision **Lakes:** Constance, Biwa **Funding:** By central and local governments.

Note that sewage treatment is provided at Laguna de Bay through a private sector initiative for new residential areas and industrial establishments. Source: "Possibilities and Limitations of Environmental Infrastructure Provisions for Lake Basin Management," S. Ide, Thematic Paper, Lake Basin Management Initiative.

There are few lakes for which continuous, or even periodic, diagnosis and surveys of the lake environment are carried out. Indigenous knowledge (e.g., where the important fish egg laying spots are located), along with scientific study and investigation, play a key role in lake basin management. Dissemination of research findings often accelerate social responses *(see Box 9)*. Accordingly, the following questions should be considered when assessing management programs:

- What is the status of the knowledge base?
- Is a monitoring system that can measure changes in key indicators in place?
- Is the database sufficient?
- What are the remaining key knowledge gaps?
- Are the information management tools sufficient to be effectively deployed?

An example from The GEF-LBMI Report

Box 9. The Lake Tanganyika Transboundary Diagnostic Analysis

The Lake Tanganyika Biodiversity Project commenced in 1995. Its objective was to "...establish a regional long term management programme for pollution control, conservation and maintenance of biodiversity in Lake Tanganyika." The main threats to Lake Tanganyika's biodiversity were identified by the country representatives at a workshop held early in the project, as follows:

- Unsustainable fisheries;
- Increasing pollution;
- Excessive sedimentation; and
- Habitat destruction.

The representatives ranked the perceived threats in order of national priority. A preliminary Transboundary Diagnostic Analysis (TDA) was developed on the basis of this information, as well as the outputs of a series of national review meetings. The preliminary TDA brought together the four national review exercises and added a regional and transboundary perspective. The final TDA was undertaken following the completion of the special studies programmes.
The TDA is structured as a three-level matrix with the four main threats to the lake, the transboundary implications, the institutional problems and the general action areas constituting the first level *(see Table)*.

Table: Level 1 of Three-level Lake Tanganyika TDA

Main Threat to Biodiversity and Sustainable Use	Cross-Cutting Transboundary Implications	Cross-Cutting Institutional Problems	General Action Items
* Unsustainable fisheries * Increasing pollution * Excessive sedimentation * Habitat destruction	* Global loss of biodiversity * Loss of shared fisheries resources * Decline in water quality	* Lack of resources * Poor enforcement of existing regulations * Lack of appropriate regulations for Lake Tanganyika * Lack of institutional coordination	* Reduce impacts of fishing * Control pollution * Control sedimentation * Habitat conservation

The second level has four parts; one for each of the four identified General Action Areas. Each part describes the problems that, when considered together, form the threat that the General Action Area is addressing; the stakeholders that will need to be involved; the uncertainties requiring further information is required; a Programme of Actions to address the specific problem. The third level takes each specific problem and its Programme of Action and identifies its timing; the key agency that would lead a particular proposed Action; and the available human and material resources.

Source: "Lake Tanganyika: The Transboundary Diagnostic Analysis," Global Environment Facility (GEF), Washington, D.C.

Although management measures require funding, the funding level is not uniform, and the distribution must be a societal decision *(see Box 10)*. The allocation of funds depends on how various questions are being answered: how the values of the lake are being enjoyed and by whom; who bears what burden; and how can public resources be secured? Naturally, financing, policy making and the methods of participation all affect each other. Accordingly, the following questions should be considered when assessing management programs:

- Can we spend the funds collected locally?
- Do we have sufficiently strong links to the national government to obtain financial support for major projects?
- Are there globally important features in our lake basin that warrant international funding?
- How best can external funds be used so that the fundamental components of management are developed?

By focusing on these six issue domains, the conditions of management at each lake can be Grasped, and the topics related to integrated lake basin management can be prepared. The lessons synthesized in the GEF-LBMI Report provide a foothold for an approach to these issues.

An example from The GEF-LBMI Report

Box 10. User Fees for Lake Dianchi, China

Lake Dianchi, located near Kunming, China, is the center of a major urban, industrial, and tourism region. Pollution from industry, agriculture, and urban sewage is a major problem, and lake authorities have made major investments in sewage and wastewater control. In the year 2000 alone, authorities spent over RMB 340 million (about $41.5 million). To address the ongoing problem of industrial pollution, the lake authorities have combined a pollution levy system with a loan/grant program for installation of pollution control equipment.

Starting 15 years ago, old industries were charged a pollution levy if their discharges exceeded the stated discharge standard. In addition, the 1988 Dianchi Protection Ordinance prohibits the introduction of any new polluting industries in the Lake Dianchi basin.

Existing industries, when taking actions to control pollution, were provided with loans from the government for the required investments. These loans were funded by a combination of the environmental pollution levy receipts, plus special funds allocated for lake basin environmental improvements. As an added incentive, if it was shown that after the pollution controlling investments were made, the industry could then meet the pollution discharge standards, the loan was converted to a grant that required no repayment. By combining government investments, pollution levies, and a loan/grant program for pollution controlling investments, the authorities have begun to tackle the major pollution problem facing this important lake.

Source: Lake Dianchi Brief.

ILBM Applications

Synthesis of Governance Components to a Coherent Basin Management Framework

ILBM as a Planning Tool

All planning processes generally consist of steps to: (i) establish a goal (or a set of goals) agreed to by the stakeholders; (ii) develop alternative strategies for reaching the goal; (iii) select the preferred strategy on the basis of a feasibility assessment; (iv) implement the strategy, with mobilization of necessary resources; and (v) refine the strategy through monitoring and evaluation. While ILBM does not provide a prescriptive procedure, it does provide an effective analysis framework, for example, to: (i) those with no plan for development, use, or conservation; (ii) those with only a sectoral plan for resource development, but no plan for achieving sustainability resource use; and (iii) those aiming to achieve greater levels of sustainability in lake basin management efforts.

(i) Lake Basins with No Development, Use, or Conservation Plans

For lake basins with little exposure to human activities, preservation and prevention of problems is a top priority. To develop plans for sustainable resource use and ecosystem preservation, an assessment of the existing resource values, and the potential for development and possible degradation must be carried out through sharing of information at the appropriate level. As examples, a survey should be carried out on the necessary institutions, policies, and participation that need to be assessed in developing a long-term preservation plan. Technological interventions for development and/or preservation also must be investigated for possible future considerations. It is cheaper to use limited funds for necessary planning costs, rather than suffer the losses to values that can result from resource depletion.

(ii) Lake Basins With No Comprehensive Conservation Plans

It is urgent to introduce the ILBM perspective for these lakes. The details depend on location, with continental, regional, country and local versions of ILBM being desirable. ILBM issues for these lakes include: (i) sharing knowledge and information broadly among the various lake basin stakeholders; (ii) developing the necessary intuitional framework; (iii) a new policy framework that goes beyond the existing sectoral approach; (iv), wide participation of stakeholders to attain balance in policy development; (v) investigation of the potential technological options; and (vi) possible restructuring of the financing mechanism. Because the various elements of ILBM are integrated and goals agreed to, continuous improvement and flexibility are required.

(iii) Lake Basins Aiming to Achieve Greater Levels of Sustainable Resource Use

For these lake basins, a policy and institutional framework usually already exists for dealing with the various development and preservation issues. For lakes that extend over multiple jurisdictions, however, an integrated framework may not exist, or may not be functioning well. Further, a means for resolving any remaining conflicts over resource use between upstream and downstream users may not exist. In such cases, ILBM must be pursued with all the elements considered (GEF-LBMI Report chapters 4, 5, 6, 7, 8, and 9), recognizing for each case that it is important to understand the most appropriate means to proceed and the need to be flexible. As a comprehensive plan is being developed (GEF-LBMI Report chapter 10), flexibility and continual improvement also are necessary.

For all the above lake cases, however, the viability of a management plan for a lake basin is strongly dependent on aligning the plan with other, higher levels of national and regional plans for socioeconomic development and environmental conservation. Further, the individual intervention projects and activities will have to be integrated over time into an ILBM framework that can gradually be transformed into a sustainable institution *(see Box 11)*.

Box 11. Different Modes of Integration in Planning

Integration by Encompassing (Figure a)

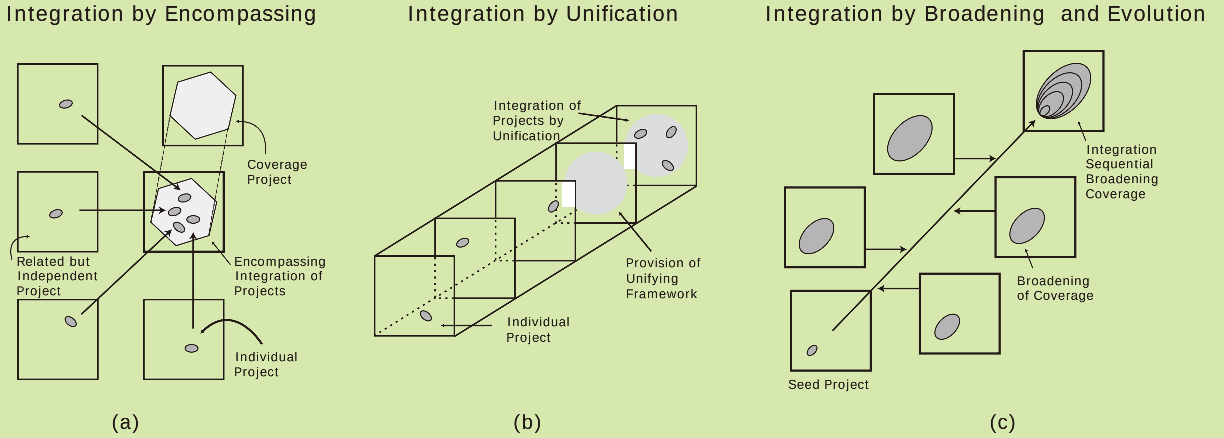
Independently-developed sectoral programs and projects may be beneficially integrated into a coherent and collaborative framework by introducing an encompassing framework. This integration typically includes cross-sectoral integration across different government Ministries, and different countries for transboundary lakes.

Integration by Unification (Figure b)

Projects and programs that arise at different times of the planning horizon may be integrated by providing a post-hoc unifying framework. This integration typically occurs when new or more refined projects and programs are being introduced within a particular lake basin resource development or conservation sector, while older ones are still functional, but beginning to be outdated, if neglected.

Integration by Broadening and Evolution (Figure c)

Some project activities grow because of early successes, expanding their spheres of operation either spatially or sectorally. The management scope for the North American Great Lakes, for example, has expanded from control of point sources of pollution, to toxic contaminants, to invasive species and, more recently, to non-point source pollution.



Three Forms of Integration.

ILBM will Continue to Evolve as Lake Problems Continue

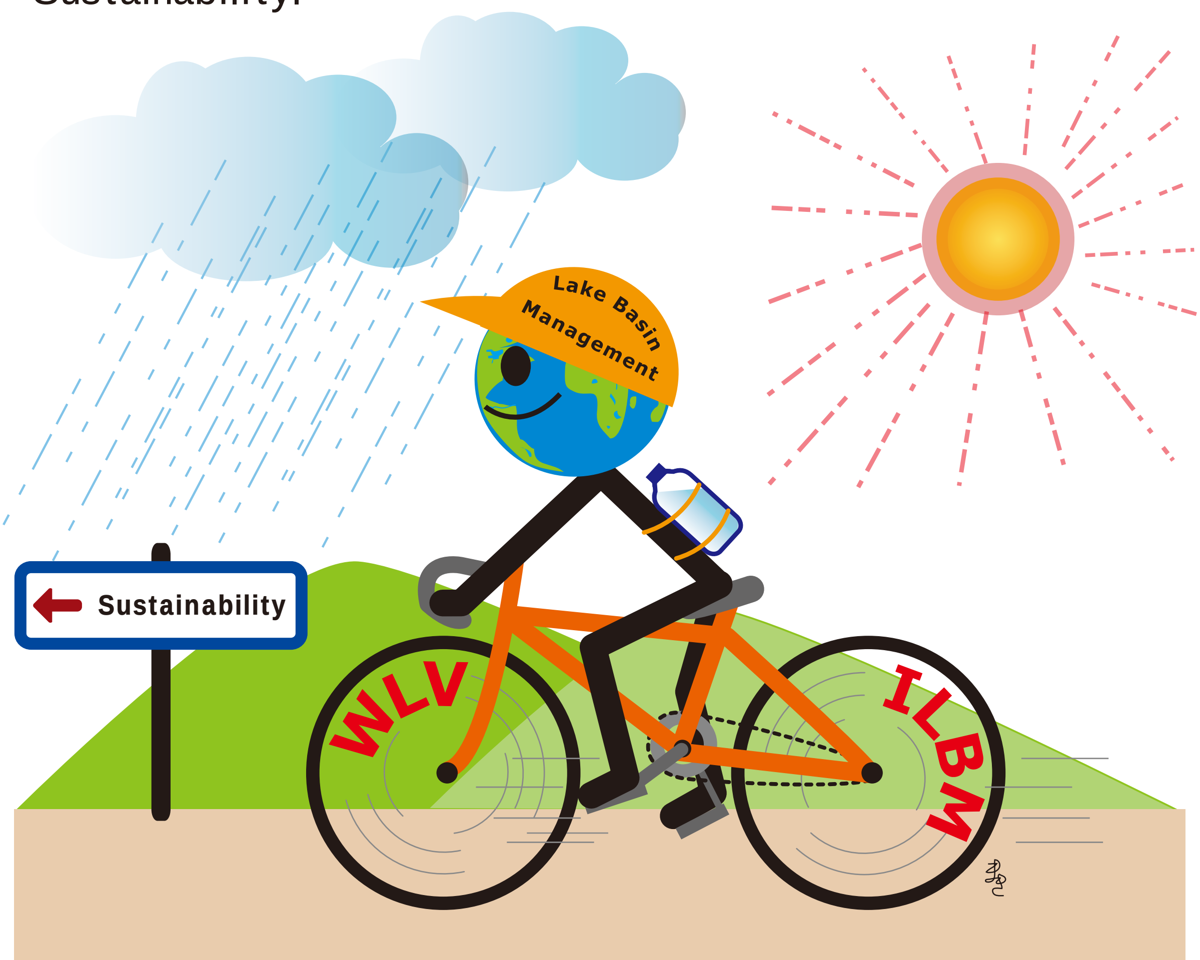
Toward Achieving Greater Sustainability in Global Lake Basin Governance

ILBM as the Basis for Lake Basin Management Evaluation Tools

ILBM is not a prescriptive planning procedure. Rather, it is a compilation of the lessons learned from lake basin management experiences globally, synthesized to address complex planning issues using a basin governance framework that reflects the unique features of the lentic waters as lakes and reservoirs. Since it is a product of compilation and synthesis, ILBM will continue to evolve as we continue to learn more from other lake basin management experiences, and from other perspectives of governance that have not yet been adequately reflected. Continuous efforts will be needed to further expand, and refine, the concept of ILBM for it to have significant impacts on the future of lakes and other waterbodies facing serious threats of degradation, particularly from human activities within their basins.

There is no doubt that lakes, whether natural and artificial, are important for human development and well-being, as well as the preservation of sound, life-supporting ecosystems and biodiversity on our planet. Their resource values are numerous and provide many uses of different values to humanity, making their protection and conservation of special importance value to humanity. Nevertheless, lakes and their unique characteristics and values have not yet received the attention they need because we are only now beginning to appreciate the complex interactions between lakes and their surrounding drainage basins, the latter being the source of most of the problems threatening the sustainable use of lakes, and most of which are human-induced and, therefore, require human solutions. The concept of ILBM, even while still evolving, provides a powerful concept and tool towards achieving this goal. We have learned much, and we have much yet to learn about managing lakes and their resources for sustainable use. Nevertheless, we are taking major steps in this direction. Indeed, as stated eloquently in the World Lake Vision, the first of the ILEC efforts directed to the goal of integrated lake basin management, *"...if we are able to use lakes in a sustainable and responsible manner, there is much hope we can meet the needs of the human and natural communities that depend on them for clean freshwater resources, the key to life."*

WLV (World Lake Vision)* and **ILBM** (Integrated Lake Basin Management)* are two "wheels" needed to carry "Lake Basin Management" forward to "Sustainability."



＊WLV (World Lake Vision)
WLV is a participatory approach, complementing ILBM, for developing broad consensus of the basin stakeholders on the future state of the lake in question. It consists of guiding principles for identifying significant lake problems and developing practical solutions, particularly for the general public assisted by government officials and experts. (http://www.ilec.or.jp/eg/wlv/index.html)

＊ILBM (Integrated Lake Basin Management)
ILBM is a way of thinking that assists lake basin managers and stakeholders in achieving sustainable management of lakes and their basins. It takes into account that lakes have a great variety of resource values whose sustainable development and use require special management considerations for their lentic (static) water properties. Good basin management of a lake can be realized only through ILBM, or continuous improvement of lake basin governance that integrates institution, policy, participation, science, technology and funding. Improvement of the state of world' s lakes can be realized by promoting ILBM globally, with long-term and strong political commitment.

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