Guidelines for Lake Brief Preparation

Research Center for Sustainability and Environment, Shiga University (RCSE-SU),
in collaboration with International Lake Environment Committee Foundation (ILEC)
and the Department of Environmental Sciences, University of Shiga Prefecture, Japan

Authors: Masahisa Nakamura and Walter Rast

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A Guide to The Preservation and Sustainable Use of Lake Ecosystems

Guidelines for Lake Brief Preparation in Support of Integrated Lake Basin Management (ILBM)

Introduction

Containing over 90% of the readily-available liquid freshwater on the surface of our planet, lakes are key components of global water resource systems. Whether natural or artificial (reservoirs), they provide an enormous number and range of resource values that facilitate sustainable human livelihoods and economic development (drinking and industrial water supply, irrigation, fisheries, hydropower, recreation, transportation, aesthetics, cultural and religious significance, etc.). Thus, their development, use and conservation have been major human undertakings, on both a national and international scale. They also serve as essential habitats for an amazing variety of flora and fauna. In developing countries, they often are centers of livelihoods for small-scale local fishers and lakeshore communities.

At the same time, lakes are among the most vulnerable of water resource systems. Data from around the world indicates their overall condition continues to deteriorate. Although the source of essential resources necessary for human and ecosystem well-being, lake basins are easily impacted by complex land and water relationships. As primary freshwater storage systems, they receive water, sediments, pollutants, nutrients and biota from inflowing rivers, land runoff, groundwater aquifers, and from the atmosphere. Being used for a wider range of purposes than any other type of waterbody, they are much more vulnerable to stresses, and more difficult to manage, than other water systems.

Lakes can be created by natural processes such as glacial scour, plate tectonics and volcanoe. Humans also construct lakes by building dams across flowing water systems, pooling the water behind these structures and creating reservoirs (called dams in some countries). Whatever their origin, lakes and reservoirs can be considered "standing water" or "lentic" systems. This is in contrast to the flowing waters of rivers, known as "lotic" systems. Because lakes have both influent and outflowing rivers, a lake basin represents a complex combination of both lentic and lotic waters, an important consideration for lake basin management (Figure 1).

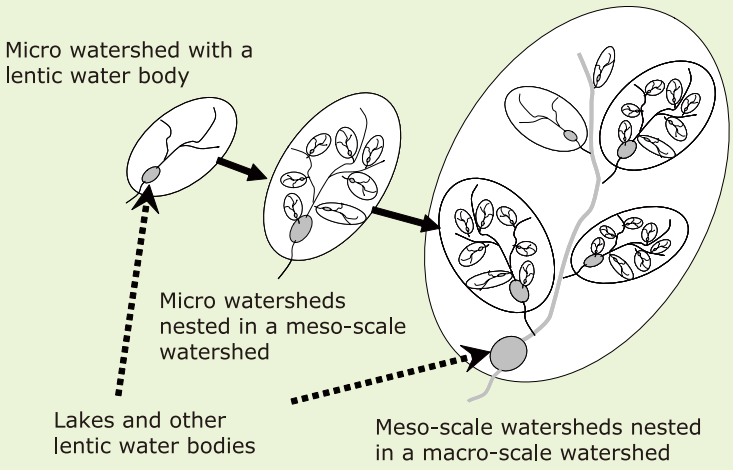


FIGURE 1. LOTIC-LENTIC NESTING STRUCTURE OF WATERSHEDS

In fact, the occurrence and management of lake basin problems is a function of three distinguishing characteristics of lentic water systems, including: (1) an integrating nature; (2) long water residence time; and (3) complex internal response dynamics.

Long Retention Time: The water residence time refers to the average time water spends in a lake. Large lakes are typically characterized by large water volumes and resulting long retention times, giving it a buffer capacity in that it is able to absorb large inputs of water, as well as the pollutant and sediment load carried by this water, without exhibiting immediate negative changes. This incremental response can make it difficult to notice degradation problems until they have become serious lakewide problems. Long water retention times also allow suspended materials in the water column, including pollutants, to settle to the bottom of the lake, thereby ensuring their role as a sink for many materials. A long water retention time also ensures that, even when remedial programs are implemented to restore a degraded lake, it can take a very long time — if ever — for the lake to recover. It also leads to lags in ecosystem response that are poorly matched to the human management time-scale.

The management implications of this characteristic of incremental development of degradation problems, and the potentially long time for lakes to respond to management interventions, include the need for long-term involvement of relevant lake basin management institutions and their activities, as well as long-term funding. The potential for long-term impacts also suggest a need for a precautionary approach in developing and implementing lake management interventions.

Complex Response Dynamics: In contrast to lotic water systems, lakes do not necessarily respond to perturbations or pollution in a linear fashion, due in large part to their large volume and long retention times that provide a degree of buffering capacity to such disturbances. The result can be a non-linear response (hysteresis) to increasing pollutant loads. As shown in Figure 2, for example, a lake can receive a considerable nutrient load (point A to point B) without exhibiting significant degradation until the nutrient concentration reaches a critical level (point B) that results in a shift from the existing trophic state. The lake can exhibit rapid degradation after this critical level is reached (point B to point C). The same buffering capacity also hinder achievement of the positive goals of nutrient remediation programs. As shown in Figure 2, even after pollutant loads have been reduced, a lake will not necessarily exhibit a positive response to such remediation efforts for some period of time until the lake has flushed or otherwise neutralized its previous high content of nutrients (point C to point D). Further, experience also suggests that only a certain degree of recovery may be possible, and that the good condition characterizing point A in Figure 1 may not be achievable.

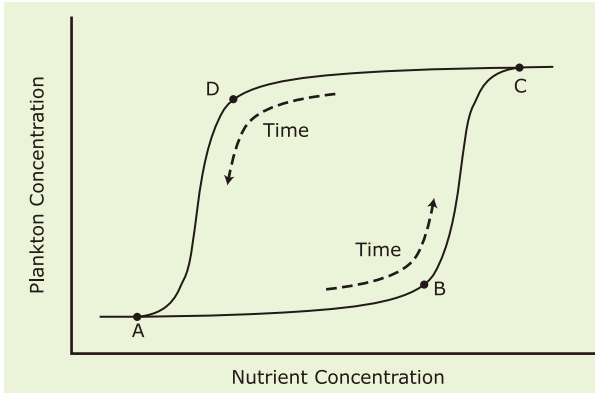


FIGURE 2. Complex Response Dynamics of Lakes

The management implications of this characteristic of non-linear dynamics include that lake basin problems must be anticipated as far in advance as possible through monitoring, developing indicators and analytical studies, as well as the need to carry out scientific studies to better understand the complex processes and their implications, and also to help develop solutions to the resulting problems.

Integrating Nature: Because of their location at the terminus of a drainage basin, lakes receive pollutant inputs via rivers and other inflowing channels from all sources within their surrounding drainage basin, as well as beyond (via long-term atmospheric deposition). These inputs are mixed within a lake, thereby ensuring that both the resources and problems associated with them are disseminated and integrated throughout the water

volume of a lake. In fact, this integrating nature often provides the 'trigger' for development and implementation of remediation programs, in that many symptoms of pollutant loadings only become visible after they have reached a lake and have sufficient time to become visible problems. Thus, the condition of a lake can be viewed as a type of 'barometer' of human activities within the basin of the lake. This observation has enhanced significance in that lakes are used for a greater range of human uses than any other type of water system, thereby ensuring that such degradation can affect a greater number and range of these uses. Algal blooms provide an example of this phenomenon, noting that algal cells require the same nutrient, temperature and light requirements in both rivers and lakes. However, excessive nutrient loads result in algal blooms in lakes because the algae have sufficient time to accumulate to nuisance levels in the lentic environment of lakes, whereas this is not possible in a lotic river environment.

The management implications of the integrating nature of a lake include the fact that many lake resources, as well as lake problems, are not restricted to a specific part of a lake, but rather are shared throughout the lake. Thus, managers cannot subject different parts of a lake to different management schemes or activities. This has implications for managing transboundary lakes, whose resources are shared by more than multiple countries, and the degradation of which may result from actions within multiple countries within a lake basin. In such situations, cooperation between the countries sharing a transboundary lake basin is essential for effective lake basin management.

Lake Basin Management and Ecosystem Services

Recognizing the unique resource values, and management challenges of lakes, the International Lake Environment Committee (ILEC), has studied lake basin management experiences in a number of countries around the world, with the goal of developing a practical, rational and scientifically-defensible means of managing lakes and their basins for the sustainable use of these resources. ILEC has subsequently focused on the resource values of lakes within the context of ecosystem services, as originally defined within the framework of the Millennium Ecosystem Assessment (MEA 2005). This concept suggests that ecosystems provide a range of life-supporting services to humanity, services that nature provides essentially free-of-charge, although not without their costs. As noted in Figure 3, virtually all ecosystems provide services essential for human health and

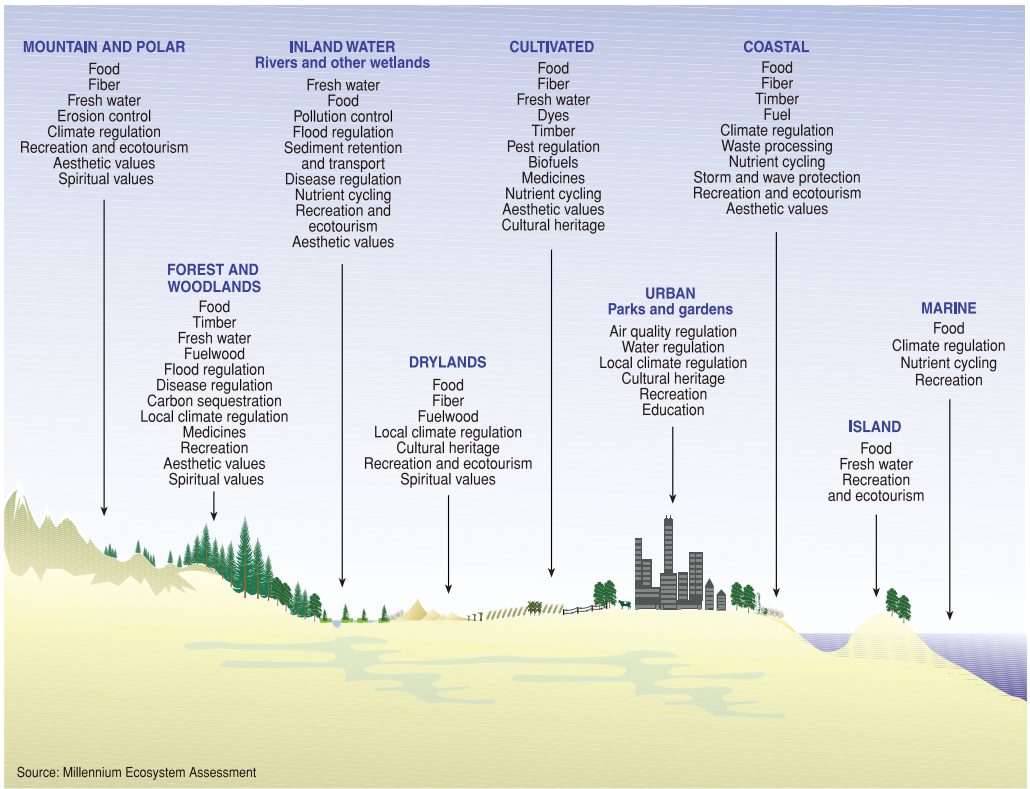


FIGURE 3. Terrestrial and Aquatic Ecosystem Services

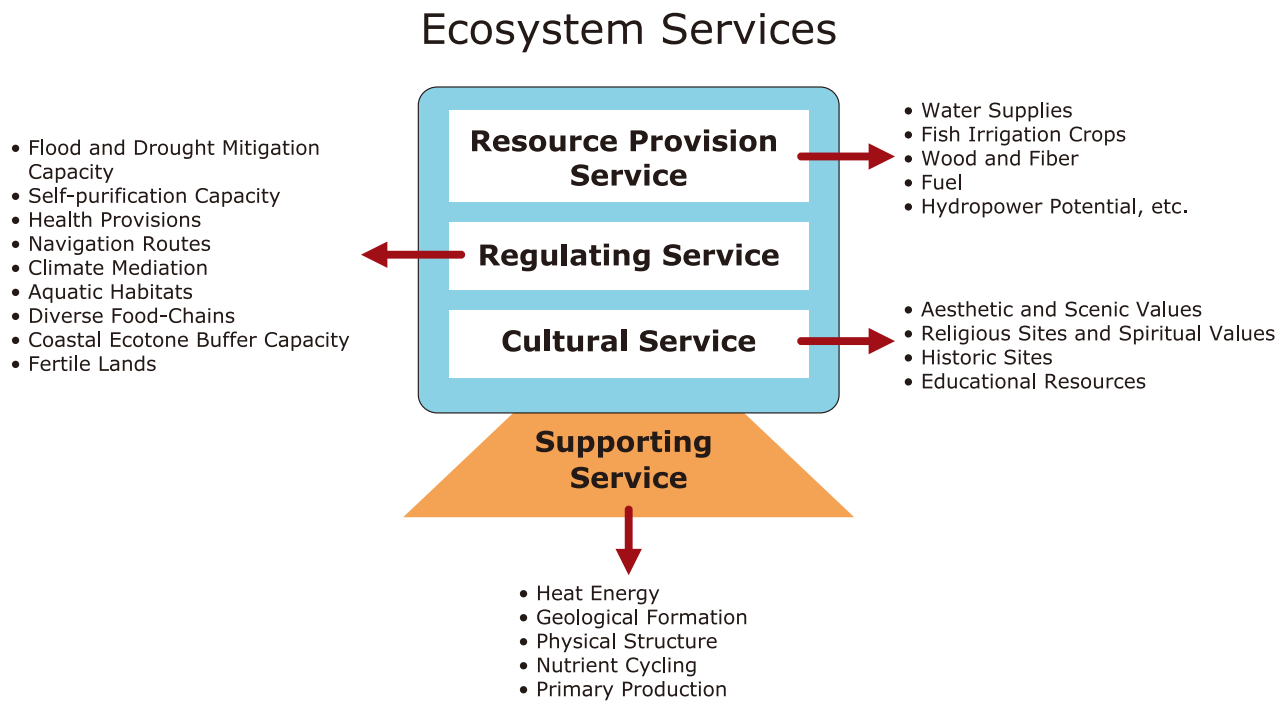


FIGURE 4. Four Classes of Ecosystem Services

economic well-being. As noted above, lakes provide a greater range of such services than virtually all other aquatic ecosystems.

The ecosystem services provided by aquatic ecosystems can be further sub-divided into four major groups, as follows:

(1) Resources Provision Services — water supplies; fish; crop irrigation; wood and fiber; fuel; hydropower generation;

(2) Regulating Services — flood and drought mitigation; self-purification capacity; health provision; navigation routes; climate mediation; aquatic habitats; diverse food-chains; fertile lands; coastal ecotone buffer capacity;

(3) Cultural Services — aesthetic and scenic values; religious sites and spiritual values; historic sites; educational resources;

(4) Supporting Services — heat energy; geological formation; nutrient cycling; primary production; physical formation.

In defining these services in this manner, it is noted that resource provision services are typically valued in monetarily terms, while the other three classes of services are more difficult to value in this manner. As a result, the degradation of the latter services often is neglected in management efforts.

ILEC has provided evidence that increasing use of lake resource values can have profound negative impacts on the environmental status of lake systems. The recip-

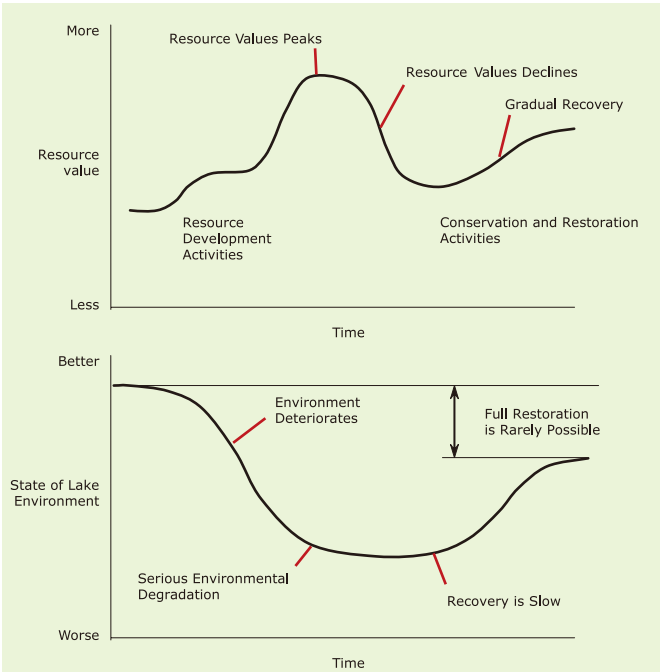


FIGURE 5. Relation Between Changing Lake Resource Values and Ecological State

rocal nature of these increasing ecosystem service uses, and their impacts on the environmental status of a lake, is illustrated in Figure 5. As illustrated, the progress of degradation within a lake and its basin often takes place on a wider, deeper scale than may be readily apparent. Of particular interest within the context of lake basin management is that increasing human use of lake-specific ecosystem provision services can result in degraded ecosystem regulatory services. Even more important, however, is that the increasing loss of regulatory services can, in turn, result in decreasing provision services, as well as loss of cultural and support services as well. This reality illustrates the need to transform unsustainable resource development to sustainable resource use.

Integrated Lake Basin Management (ILBM)

Against this background of the unique resource values of lakes, the negative impacts of excessive human use of these resources, and the resultant difficulties of managing lakes and their basins for sustainable use, the International Lake Environment Committee (ILEC) has examined lake basin management experiences in many countries around the world. The goal was to develop an effective, scientifically-sound integrated approach to lake basin management. This approach, designated integrated lake basin management (ILBM), is a way of thinking that assists lake basin managers and stakeholders to manage lakes and their basins for sustainable use, and particularly to sustain ecosystem regulating services. Based in part on a previous Lake Basin Management Initiative undertaken in cooperation with the World Bank and the Global Environment Facility, ILBM considers that lakes have many resources values requiring special management considerations because of their lentic water properties (ILEC,2005). Recognizing that lakes and their basins are a single, mutually-interacting management unit, ILEC has determined that good lake basin management can only be realized through ILBM. In addition to considering the biophysical features associated with lentic water systems such as lakes, this management framework promotes continuous improvement of lake basin governance, by integrating six management elements ('pillars') essential for effective lake basin management. These lake governance pillars include institutions, policy, stakeholder participation, science, technology and funding, and are fundamental to effectively addressing impairments to ecosystem services, especially those involving the regulating services. (Figure 6)

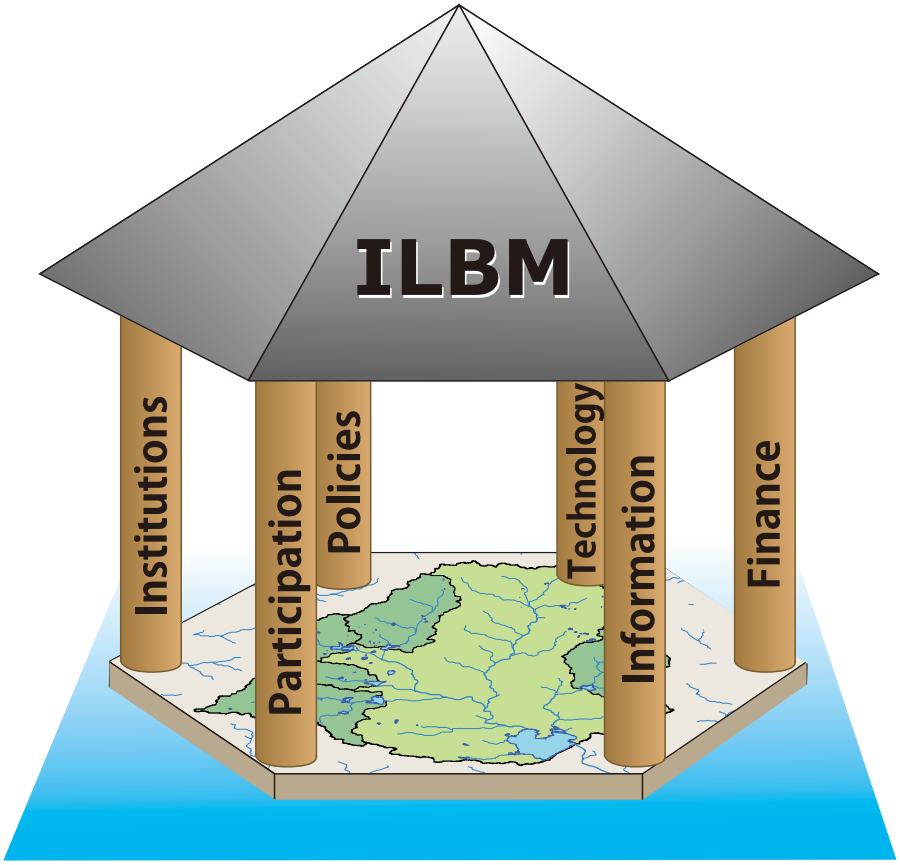


FIGURE 6. ILBM Governance Elements

Although not an exhaustive list, some of the major lessons learned from ILEC's ILBM study are as follows:

- ***A basin approach is essential*** — management efforts do not stop at the lakeshore, but rather extend throughout the entire basin and sometimes even beyond;
- ***Border barriers must be overcome*** — although transboundary lakes are usually more difficult to manage, good progress has been made in establishing transboundary approaches for management plans and institutions;
- ***Technological interventions can be effective in given situations*** — provided the root causes of their problems are addressed, technologies can have very positive effects on lake basin management;
- ***Stakeholder involvement is essential for successful lake basin management*** — sustainable use of lake basin resources can be best achieved when the relevant stakeholders fully understand and appreciate the issues, as well as their roles in causing the problems and their possibilities for helping to solve them;
- ***Long-term commitment is essential*** — Because the remedial programs, even successfully implemented, do not necessarily induce immediate improvement in lake environment quality, there is a need for indicators that illustrate both planning and actual lake basin improvements;
- ***Monitoring is fundamental*** — Long-term monitoring data sets are needed as the basis for mutual understanding of lake basin management issues; and
- ***Lake basin management is a continuing process, rather than a one-time project*** — Long-term institutional, policy and financial support is essential for successful lake basin management, particularly since changing lake resource values and emerging environment problems can necessitate revision of existing lake basin management plans and programs.

Development of Lake Briefs to Facilitate Implementation of ILBM

ILEC has utilized its experiences and the lessons learned from its lake basin studies around the world to develop and promulgate ILBM as the most effective approach to managing lakes and their basins for sustainable use. The identification and utilization of the above-noted lake basin governance pillars have figured prominently in this endeavor. In fact, there is considerable experience and knowledge regarding collection and analysis of data and information for describing the biophysical characteristics of lakes, their resources and their basins, which are more quantitative in nature. More difficult to analyze, however, are the governance pillars, which inevitably include more qualitative judgments of efficiency and purpose. To this end, ILEC has developed a '***lake brief***' outline designed specifically to help lake basin managers and stakeholders to more readily identify and collect the range of information and data needed to develop effective lake basin management plans within the context of ILBM. Described below are the elements and outline of a lake brief, supplemented with two annexes, i.e., Annex1 being a questionnaire on the state of the lake, described in terms of natural science parameters, and Annex2 being a procedural guide to identify the governance improvement needs and challenges. The relationship among each of the lake brief Chapters and two Annexes is described in Figure 7. It is noted that a major goal of ILBM is to preserve ecosystem regulating services, as the basis for supporting and facilitating the remaining categories of ecosystem services (see Figure 4).

Preparing a Lake Brief. The Lake Brief should have the following basic chapter structure:

1. Introduction
2. Description of the lake
3. Management of the lake and its basin
4. Major "impact stories" regarding the lake
5. Major lake basin governance issues
6. Key challenges to lake governance
Annexes

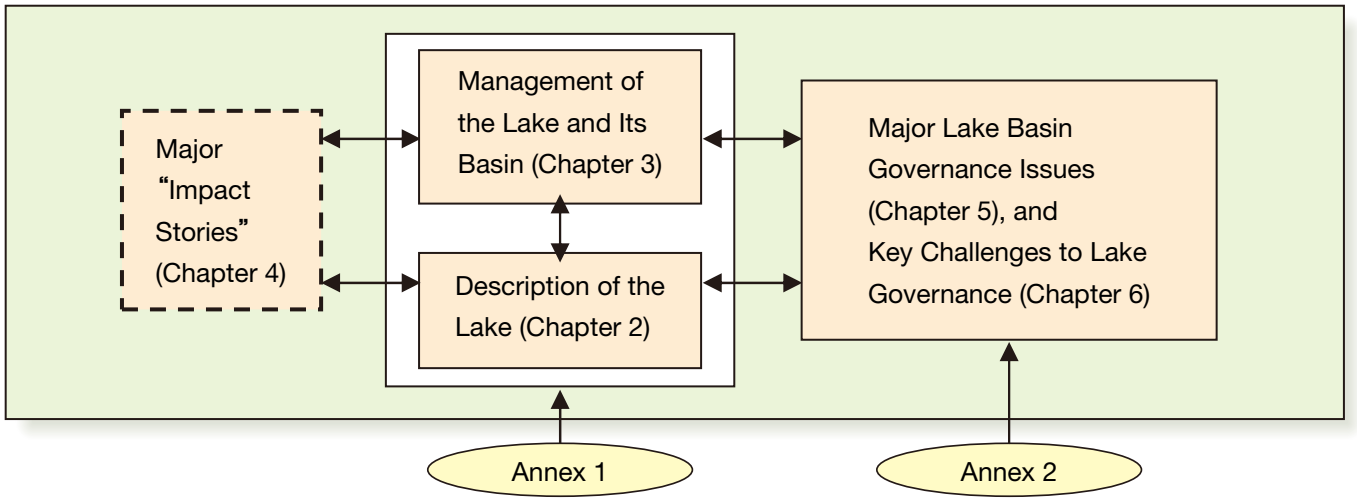


FIGURE 7. Structure of Lake Brief

The preparation of a Lake Brief will depend on individual cases. If information on Chapters 2 through 6 is already available, for example, a Lake Brief with the above chapter structure may be possible from the onset. However, preparation is typically undertaken easily in stages, starting from 'Impact Stories' (Chapter 4), and developing the remaining chapters around it, particularly with regard to the issues and challenges to be described in Chapters 5 and 6. Useful inputs, in the form of reviews and suggested refinements, can be obtained effectively through iterative process including workshop elaborations.

This suggested approach is especially useful when multiple authors are collectively preparing a Lake Brief. In such cases, the individual impact stories prepared by local stakeholder groups, which may discuss widely-varying subjects of differing spatial and temporal scales, can be compiled to form Chapter 5, which may then be related to the other chapters during the course of preparing the Lake Brief. Inclusion of appropriate figures, tables, illustrations, maps and other visual materials will obviously increase the usefulness of a Lake Brief.

ILEC also has prepared a Questionnaire (Annex 1) to guide the development of a comprehensive Lake Brief. The Questionnaire elements include the biogeophysical features of a lake basin, its socio-economic and governance features, and impairments to its sustainable use, including its ecosystem regulating services. In the discussions below that describe the components of the individual chapters that comprise the Lake Brief, reference is made to the relevant questions in the Questionnaire, which is provided below in Annex 1.

The accompanying Annex 2 provides additional questions, the answers to which provide information for characterizing and analyzing the status and efficacy of the governance pillars associated with lake basin management.

Lake Brief Outline

1. Introduction (*based in part on items 10, 11, 14 and 15 in Questionnaire*)

This section should describe the socio-economic context (people, livelihoods, economic characteristics, types of institutions, laws and policies, political structure, etc.) of the region, country, or basin in which the lake is located. It should summarize the overall importance of the lake and its basin from the perspective of its significance as a natural habitat, and its social, economic, institutional, political, cultural and/or recreational importance to the human population in the region, and its global importance, if any.

2. Description of Lake (*based in part on items 1-9 in Questionnaire*)

2.1 Overview

This section should provide information on the lake's biophysical features, including basic physical characteris-

tics (lake surface and drainage areas, lake depth and volume, water residence time, etc). It also should describe drainage basin characteristics (the lake watershed and the lake's upstream and downstream river basins), including the basin landscape and land use patterns. The Lake Brief also should summarize the lake's environmental state in relation to its drainage basin. The human and environmental benefits derived from the lake/reservoir and its drainage basin also should be identified and discussed.

2.2 State of the Lake

This section should include scientific findings and data that describe the past and present state of the lake's water environment, including water quantity and quality, aquatic biota (flora and fauna), and the state of its ecosystem health. Any regionally- or globally-important aspects of the lake's environment also should be identified.

3. Management of the Lake and Its Basin (*based in part on items 10-14 in Questionnaire*)

- What do we know about the management of the lake and its basin? Relevant questions can include:
  - ➲ What are the major resource values of the lake and its basin; how are they used/exploited economically; and who benefits and who loses in the use/exploitation?
  - ➲ What are major socio-economic and political implications of the lake and its basin, particularly with regard to development, use and conservation of their resources, to the basin population?
  - ➲ What are the resource use conflicts, how are they managed, and are they managed well?
- What is the current problems with the lake and/or its basin, and how are they being managed. Relevant questions can include:
  - ➲ What do basin inhabitants, including fishermen, consider the overall environmental and ecosystem status of the lake to be? Are their perceptions consistent with scientific findings?
  - ➲ What is (are) the apparent and not-so apparent root cause(s) of identified problems?
  - ➲ Who or what suffers from the impacts of these problems/issues, and how?

4. Major "Impact Stories"

The 'impact stories' represent narratives of human interventions, whether successful or not, in the lake basin that were introduced to attempt to deal with lake basin management challenges. The stories must be told simply and concisely, with particular emphasis on the context of their development and their results. A well-known example is the Soap Movement started by housewives in the Lake Biwa basin in the late-1970s, which ultimately resulted in development of phosphate-free detergents by the detergent industry, and by enactment of a eutrophication ordinance that subsequently served as a model for the national lake water quality control law. Other well-known cases include:

1. Lake Chilika (India) — Fish and prawn stocks have recovered; water weeds have been reduced; and the economic livelihoods of fisherfolk have significantly improved as a result of remedial works, backed by strong political support;
2. Laguna de Bay (Philippines) -- The industrial effluent load has been reduced without the use of technology-based approaches (i.e., introduction of an innovative environmental user charge);
3. Lake Dianchi (China) — Investments in wastewater treatment and diversion works have brought waste loads to the lake under control;
4. Transboundary lakes — Although managing transboundary lake basins is more complex than national lakes, various examples of successful management interventions exist, including (i) reduced nutrient and toxic contaminant loads to the North American Great Lakes and Lake Champlain (USA, Canada); and (ii) reduced phosphate loads from detergents in the Lake Constance and Lake Biwa basins, through coordinated management actions.

Impact Stories involving: (i) engagement of political leaders and civil society, (ii) policy frameworks enhancing cross-sectoral coordination, and (iii) institutions addressing specific resource development, use and conservation needs, etc., also are very important. Although the Impact Stories associated with a lake do not need to be

exhaustive or interrelated, they should be presented in a way that facilitates better understanding of the governance issues to be discussed in Chapter 5 of the Lake Brief.

5. Major Lake Basin Governance Issues (*see Annex 2*)

Managing a lake and its basin may be depicted by answering the following types of questions:

- Who (individuals, groups, institutions) are the key players in developing and implementing the actions/programs to be undertaken to address identified lake basin problems?
- What is the existing legal and policy basis for lake basin management?
- What plans and policies have been introduced to manage a lake and its basin, and how well have the problems been addressed?
- What roles do the general public and NGOs have in managing the lake and its basin?
- What are the major introduced control measures (to address domestic, industrial and other pollution loads; urban and agricultural runoff; water flows and withdrawal; commercial fishing; wetlands and riparian zones, etc)?
- What are major financial mechanisms used to facilitate the control measures (user fees, taxes, fish levies, zoning charges, tradable permit systems, etc).

These questions are more comprehensively addressed in the boxes on the left sides of the flow diagrams in Annex 2 for each of the lake basin governance categories.

6. Key Lake Basin Governance Challenges (*see Annex 2*)

Key lake basin governance challenges may be characterized by answering the following types of questions:

- What attempts have been made to establish sustainable institutions to address multi-national and mult-sectoral issues, and mult-stakeholder interests involved in managing a lake, its basin and its resources for sustainable use?
- Has there been an emergence of political interest and/or commitment to managing and/or using a lake, its basin and its resources in a more sustainable manner and, if so, what were the reasons for the emergence?
- Will efforts be undertaken to establish a new legislative framework and/or policies for managing lake basins for sustainable use?
- Will efforts be undertaken to enhance stakeholder participation in the design and implementation of lake basin management programs?
- Will plans/programs be developed to strengthen linkages between lake basin management programs, and broader national and regional water resources management efforts?
- Will efforts be undertaken to better incorporate scientific information and research results into lake basin management programs?
- Will efforts be undertaken to develop financing and/or subsidizing mechanisms for lake basin management activities focusing on sustainable use?

These questions are more comprehensively addressed in the boxes on the right sides of the flow diagrams in Annex 2 for each of the lake basin governance categories.

References

ILEC (Intemational Lake Environment Committee). 2005. *Managing Lakes and Their Basins for Sustainable Use: A report for Lake Basin Managers and Stakeholders.* intemational Lake Environment Committee Foundation, Kusatsu, Japan. 146p

ILEC. 2007. *Integrated Lake Basin Management: An Introduction.* Intemational Lake Environment Committee Foundation, Kusatsu, Japan. 23p

MEA (Millennium Ecosystems Assessment). 2005. *Living Beyond Our Means: Natural Assets and Human Well-Being.* Statement from the Board, Millennium Ecosystem Assessment. 24p

Improvement and Enhancement of Lake Basin Governance using an ILBM Platform

Lake basin management is a process not a plan, that has to take into account a broad range of management challenges including variable natural conditions and phenomena, competing interests and concerns and the continuously changing anthropogenic inputs and influences. ILBM is a conceptual framework that supports such a process. Therefore, it also has to adjust to the broad range of issues and challenges that evolve continuously over time, space and people' s mind. Shown in Figure 8 is a conceptual framework that supports the evolving process, conveniently regarded as an ILBM platform. Forming the backbone of the platform are the fundamental features of lentic water systems and three basic principles of sustainability for lake basin resource use and conservation. With the help of the prepared Lake Brief that reflect the essential features of governance, i.e., institutions, policies, participation, technology, information and knowledge and finances, improvement and enhancement of lake basin governance has to be explored. The lessons and experiences learned through the process, complemented with the global experience, have to be reflected through the cyclic process of Lake Brief revision, supported by various informational resources, including those being prepared by ILEC, i.e., a knowledge base called LAKES, the World Lake Database, and the ILBM training module.

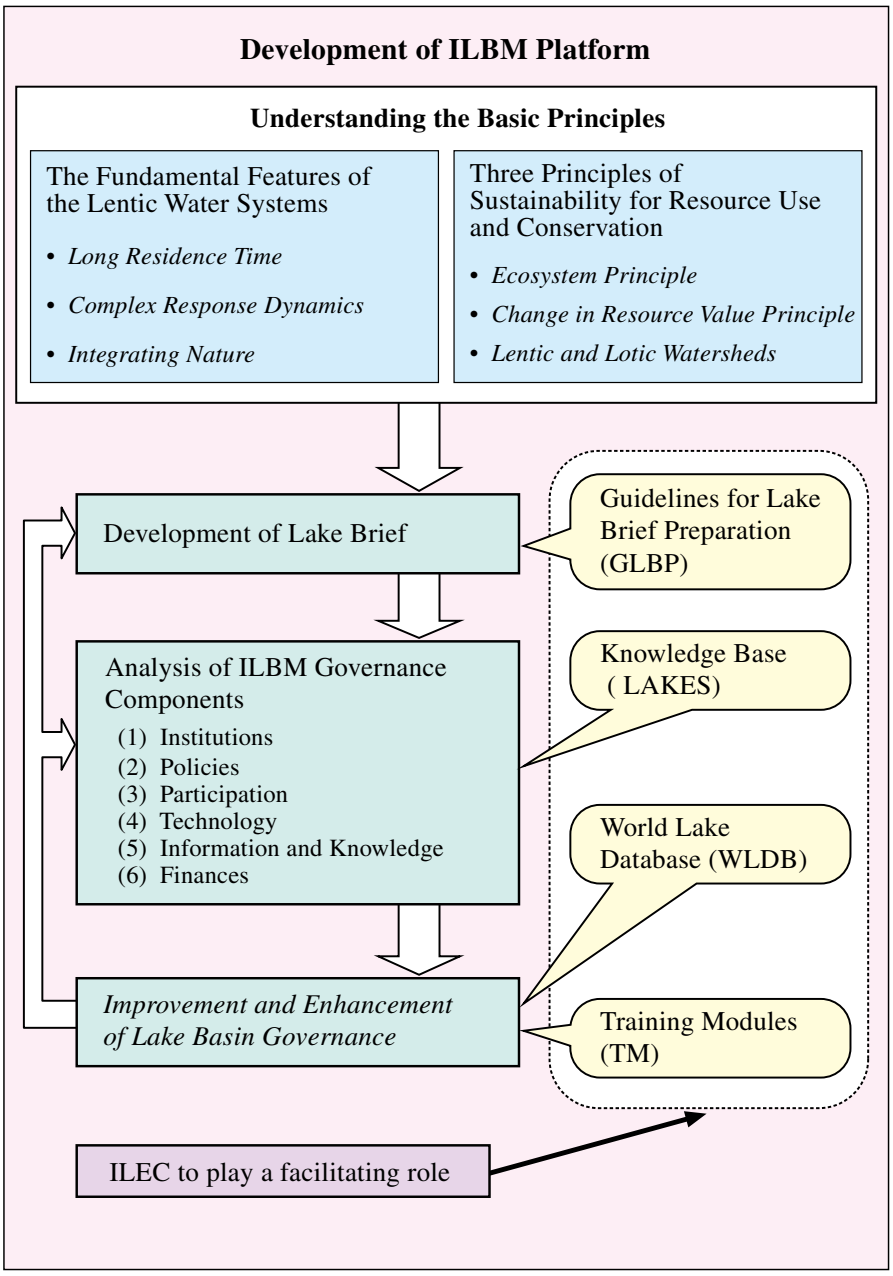


FIGURE 8. A Conceptual Framework of the ILBM Platform

Annex 1 Lake Questionnaire

The components listed below will serve as a useful basis for preparing the Lake Brief. Although it should be filled out as much as possible, it may be necessary to initially ignore items for which there is little or no accessible information. The missing information and data may subsequently be obtained by the scientific community in the course of revising and improving the Lake Brief. As many reference materials as possible on the subjects being discussed also should be identified.

1. Basic Information

1.1 Name(s)

1.1.1 In English (All official names if identified by different names in different countries)

1.1.2 In local language(s)

1.2 Location

1.2.1 Latitude (range from West to East) and Longitude (range from South to North)

1.2.2 Water surface elevation, relative to mean sea level

1.2.4 Riparian country and sub-national (state, province, etc.) jurisdictions

1.2.5 Non-riparian basin (upstream) countries and sub-national jurisdictions

1.3 Origin

1.3.1 For natural lakes: Origin (e.g., glacial, tectonic, volcanic) and estimated age of lake

1.3.2 For artificial lakes (reservoirs): Physical features and years of construction in phases

1.4 Basin and/or Watershed Map(s)

1.4.1 Major inflowing and outflowing rivers

1.4.2 Main cities and other relevant points of interest in basin

1.4.3 National/sub-national jurisdictional boundaries

1.4.4 Other maps, as appropriate

1.5 Basin Demography, Map(s)

1.5.1 Population numbers, density and distribution

1.5.2 Other relevant information (maps, etc. regarding geographical, demographical, land use, geohydrological information for lake and its basin and/or watershed, etc.)

1.6 Landscape and Waterscape

1.6.1 Visual features of lake and basin (various photos of landscape, physical facilities, water quality problems, land and water uses in riparian and upstream regions, biological and ecosystem conditions, unique fauna and flora, etc.)

2. Morphology

2.1 Bathymetric Map (*if available*)

2.2 Lake volume (km^3) and surface area (km^2)

2.3 Lake Length and Width (km) and length of shoreline (km)

2.4 Maximum and means depths (m)

2.5 Intra- and inter-annual Changes in Water Levels and Volumes; and Water Level Changes due to Flow Regulation, if available

3. Water Balance

3.1 Inflows (annual average in m3/year), including Precipitation, Rivers (*including indication if they are controlled*), Groundwater, and Water diversions

3.2 Outflows (annual average in m3/year), including Evaporation, Rivers (*including indication if they are controlled*), Groundwater and Water Diversions

3.3 Water Retention Times (*in years, if information is available*), including Theoretical filling time (*calculated as*

lake volume/annual inflow), and Theoretical flushing time (*calculated as lake volume/annual outflow*)

3.4 Information on Any Long-Term Changes

4. Climate

4.1 Monthly Average, Minimum and Maximum Temperatures (˚C) and Precipitation(mm)

4.2 Prevailing Wind Directions by Season; Wind Strength

4.3 Seasonal and Inter-annual Variability (description)

5. State of Ecosystem

5.1 Description of State of Ecological Health, including Conservation of Fauna & Flora

5.2 Description of State of Biodiversity Conservation

6. Physical Characteristics

6.1 Water Temperature (*versus time and depth*)

6.2 Freezing Period and Extent of Freezing

6.3 Lake Mixing (*vertical and horizontal, including main bays and sub-basins*)

6.4 Lake Stratification (Period and Extent)

7. Chemical Data

7.1 General chemical water quality (*e.g., oxygen demand; nitrogen and phosphorus concentrations [organic, inorganic, particulate, and total, if available]; salinity; organic and inorganic chemical pollution*)

7.2 Pollutant Loadings (*tons/year*) from rivers, groundwater and atmosphere

8. Biotic Data (Main species, Exotic species, Productivity changes over time)

8.1 Overall state of lake ecosystem, including biodiversity

8.2 Phytoplankton; zooplankton; fish

8.3 Benthos; avifauna

8.4 Brief description of general ecosystem/biodiversity issues in regard to littoral wetlands, rivers, atmosphere *(birds, etc.)*

9. State of Lake Basin

9.1 Description of Catchment Area (*including size (km2); general geography of region in relation to lake and neighboring waterbodies [e.g., other lakes connected in cascade]*); inflow catchment system; outflow catchment river system

9.2 Basin Hydrology (*brief description of basin hydrology, including active and non-active parts*)

9.3 Soil Types (*refer to soil map, if available*)

9.4 Land Cover, including Changes Over time (*briefly describe seasonal land-use changes, via reference to land use maps*)

9.5 Sub-surface Drainage (*briefly description of groundwater flows, referring to hydrographical and hydrological maps, if available*)

10. Uses of the Lake and Its Resource Development Facilities

10.1 Water, including Flood/drought control facilities; Drinking water withdrawals and facilities; Agricultural water withdrawals and facilities; and Industrial water withdrawals and facilities

10.2 Fisheries and Facilities

10.3 Tourism Facilities

10.4 Other Uses

11. Impairments to Lake Resource Uses, including Ecosystem Regulating Services

11.1 Increased Algal Growth
11.2 Increased Salinity
11.3 Wetland Destruction
11.4 Declining Fish Stocks
11.5 Other Impairments, including Governance Issues

12. Causes of Impairments

12.1 Upper-watershed Degradation (*including erosion and siltation*)
12.2 Point and Non-point Source Runoff from Urban Areas
12.3 Shoreline Degradation and Alterations
12.4 Other Impairments

13. Structural Management Responses

13.1 Sewerage Systems
13.2 Industrial Wastewater Treatment Systems
13.3 Solid and Hazardous Waste Management Systems
13.4 Other Relevant Systems

14. Non-structural Management Responses

14.1 Rules
14.1.1 Informal (informal community rules; voluntary restrictions)
14.1.2 Formal (industrial effluent regulations; protected areas [land use restrictions, ecological reserves]; etc.)
14.2 Economic Incentives (*subsidies, taxes, etc.*)
14.3 Raising Publilc Awareness *(public awareness, including environmental education, environmental campaigns, activities of environmental NGOs and CBOs, etc.)*

15. Socioeconomic Information (partial duplication of item 1.5 above)

15.1 Population Dynamics (*numbers, distribution, main cities, percent urban/rural, etc.*)
15.2 Education (*extent and types of education, literacy rates, etc.*)
15.3 Culture (*languages, ethnicities, including indigenous peoples, religion, legends and beliefs about lake*)
15.4 Economic Sectors (*major industries and production statistics; regional economic development issues, including transportation, commerce sectors, livelihood issues in different parts of lake basin such as coastal upland and upper watershed regions; Gross National Income per capita within basin [noting also how it might differ from national average(s)]*)

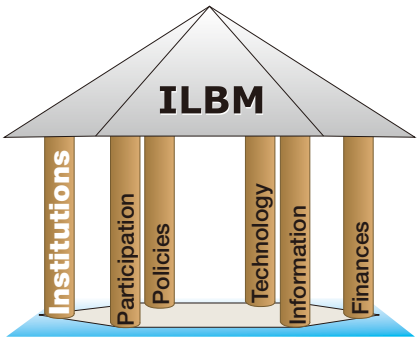
16. Political Situation (partial duplication of Item 1.2 above)

16.1 Nations Within Lake Basin
16.2 Sub-national Boundaries
16.3 Brief Description of Region’s History
16.4 Brief Description of Governance Challenges Facing People
16.4.1 Access to information
16.4.2 Rights to participation
16.4.3 Access to justice

Annex 2

What are the Major Lake Basin Governance Issues?

(Getting a clearer picture of lake basin governance)



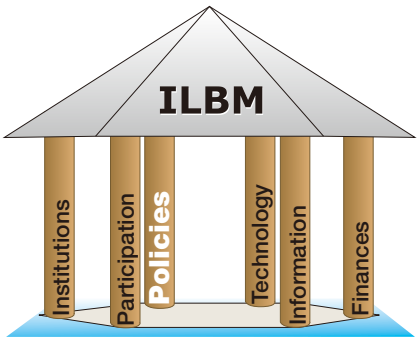
(A) On "*Institutions*", the key questions to ask are:

- *What are the current lake basin management institutions?*
- *What do they do, and what are their strengths and weaknesses with regard to facilitating sustainable use and conservation of lakes and lake basin resources?*
- *What are the priority needs for institutional development and/or reform?*

We need to address further questions such as:

- *Is there a national program specifically directed to developing institutions for formulating and implementing individual lake basin management plans and programs (i.e., vertical institutional linkage)?*
- *Do provisions in national programs encourage local governments, industries, scientific institutions and citizen groups to work together (i.e., does horizontal institutional linkage exist)?*
- *What are the priority needs for improving vertical and horizontal institutional linkages?*
- *What improvements are required to enhance institutional capacities, particularly for dealing with command-and-control, economic instruments, and voluntary compliance?*

For "*Institutions*", organizations and programs to be more relevant and effective;



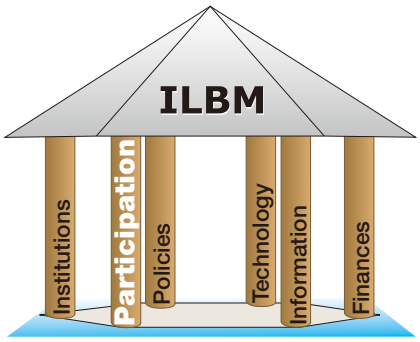
(B) On "*Policies*", the key questions to ask are:

- *What are the existing policies?*
- *Have they been properly implemented?*
- *Have they been effective in addressing identified problem(s)?*
- *If not, can new policy needed to address the problem(s) be identified with the current information and data?*

We need to address further questions such as:

- *Is there an overall national policy framework that addresses lake basin management (i.e., are there national/regional conservation plans)?*
- *Do national/regional development plans recognize the importance of the sustainable use and conservation of lake basin resources?*
- *What are major legislative provisions pertaining to development and conservation of lake basin resources (laws, regulations, ordinances, etc.).*
- *Are there lake-specific laws, ordinances or other regulatory provisions (i.e., effluent standards; ambient standards [e.g., nutrient and chemical concentrations]; source-water protection classifications; etc), have they been implemented and have they been effective?*
- *What types of policy reforms have taken place, or are being considered, to address sustainable use of lake and lake basin resources?*
- *What is currently being done to strengthen institutional capacity, promote environmental investments, and develop human resources?*

For "*Policies*" to be complimentary, facilitative and integrative of competing objectives;



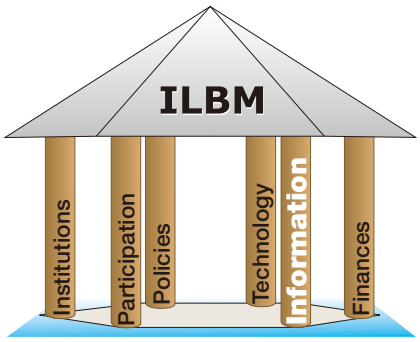
(C) On "*Participation*", the key questions to ask are:

- *What are the major lake basin management stakeholder groups (i.e., government agencies and/or sectors; institutions; organizations; interest groups; private sector; lakeshore residents, downstream water users, etc.)?*
- *What mechanisms exist for stakeholder involvement, and how well are they functioning (e.g., how well have non-governmental organizations conveyed their concerns within the context of government plans and programs)?*

We need to address further questions such as:

- *How can existing stakeholder involvement in designing and implementing lake management program(s) be improved?*
- *How can the involvement of voluntary associations, village organizations, CBOs, NGOs, etc., be better promoted?*
- *How can the involvement of women, the disadvantaged, and affected members of community be promoted/assured?*
- *What are the relevant roles and involvement of international/external NGOs? What are the benefits and disbenefits*

For "*Participation*" to be more instrumental in obtaining public opinions and inputs;



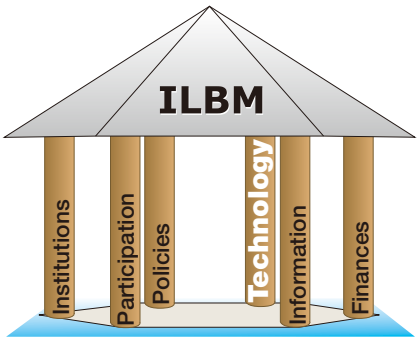
(D) On "*Information*", the key questions to ask are:

- *What information and data are available for lake basin management decision-making?*
- *Are the existing information and data sufficient to inform stakeholders? Are they used for lake basin management decision-making?*
- *Do they include sources of information from non-traditional sources, and from local sources?*
- *Are there regular monitoring programs, and have they produced useful research results?*

We need to address further questions such as:

- *What scientific information and data are available to improve lake basin management?*
- *If the knowledge base is inadequate, how can the needed information and data be obtained?*
- *How can collaboration among scientific institutions working on a given lake basin be enhanced (including universities, governmental/ non-governmental research institutes, private sector laboratories, etc.)?*
- *How can such institutions collaboratively facilitate lake basin management decision-making?*
- *How can information dissemination and sharing be improved?*
- *How can transparency and access to data and information be improved?*

For "*Information*" to be more relevant to both the immediate and long-term needs of decision-making;



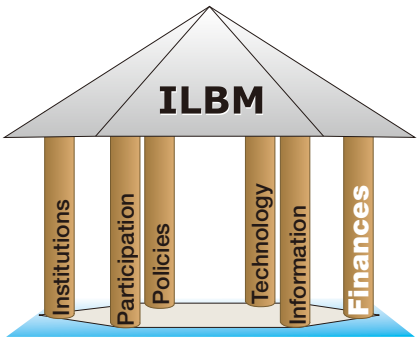
(E) On "*Technology*", the key questions to ask are:

- *What types of technological interventions been introduced for water resources development, and what have been the resulting impacts on the lake?*
- *What types of technological interventions have been used for lake resource conservation (e.g., sewerage; industrial pollution control; solid waste management; wetland conservation; etc.), and how well have they addressed the adverse impacts?*

We need to address further questions such as:

- *What are the possible technological innovations?*
- *What is the range of technological interventions facilitating lake basin management that have not yet been explored?*
- *What have been the application results of such technologies elsewhere?*
- *Can a combination of technological and non-technological solutions be usefully combined, and how would they be implemented?*

For "*Technology*" to complement non-technological options;



(F) On "*Finances*", the key questions to ask are:

- *What magnitude of funding is currently available for lake basin management activities, and are these funds sustainable over the long term?*
- *What is the status and sustainability of funding at the national level for lake basin management activities?*
- *What external funding sources are available, and how have they been used for sustainable lake basin management?*
- *What other potential funding sources exist?*

We need to address further questions such as:

- *What are the realistic options for raising local funds (taxes; user charges; pollution fines; etc.) for lake basin conservation projects?*
- *How can the existing financial mechanisms be improved to address the conservation of lake basin resources (e.g., pollution charges; tradable permits)?*
- *Can locally-raised revenues from lake basin resources be retained for local use and, if not, what actions might be possible to ensure such funds are retained?*

For "*Finances*" to be identified, mobilized, and appropriately used from local, national and international sources;

(G) Other Important Issues:

- *What other important or emerging issues should be considered within the context of lake basin management (i.e., climate change; ecosystem degradation and loss of associated environmental goods and services; water pollution from medicine and home care products; long-range transport of airborne pollutants; unsustainable water uses; agricultural water implications for growing crops for biofuel production; etc.)?*
- *Are these various issues currently being addressed and, if so, how well are the approaches working? If not, what are the possibilities they will be addressed in the future?*

It is emphasized that the Lake Brief Outline and Questionnnaire were developed primarily to obtain the necessary information and data for developing and implementing integrated management programs for the sustainable use of lakes, their resources and their basin. Compiling the relevant information and data, however, is only part of the equation. As noted in Figure 6, the lake basin governance elements, which describe the socio-economic and political realities, also are particularly important in such efforts. Although accurate biogeophysical information and data is necessary to establish the current environmental status of a given lake basin, and trends over time, there is little hope for a successful lake basin management program, for example, if the appropriate institutions do not exist, if policy relating to the management program is inadequate or even contradictory, if stakeholders are not directly involved in its development and implementing, if awareness of the problems and their root causes does not exist, if sustainable financial sources are not found, etc. Accordingly, the reader is directed to utilize the Lake Brief Outline and Questionnnaire to obtain the relevant information and data on these important elements of lake basin management. Addressing such lake govemance elements also is a prerequisite for ensuring sustainable ecosystem services, particularly the regulating services (Figure 4)

Guidelines for Lake Brief Preparation

Research Center for Sustainability and Environment, Shiga University (RCSE-SU)
2-5-1 Hiratsu, Otsu City, 520-0862, Japan
http://rcse.edu.shiga-u.ac.jp/eng/

International Lake Environment Committee Foundation (ILEC)
Kusatsu, Shiga 525-0001, Japan
http://www.ilec.or.jp