

The Case for a World Lake Vision*

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* Accepted for publication in *Hydrological Processes* as of 4 October 2001.

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Abstract

We regard the creation of a World Lake Vision as essential to achieving the sustainable management of the world's lakes. In this paper, we discuss the value of lakes, how those values have historically led to changes in watershed land-use and population, and how those changes have resulted in stresses on lakes that impair their value. Current approaches to lake management at both the local and international level are examined and their shortcomings are highlighted. We illustrate how a World Lake Vision, along with the individual lake visions it promotes, can redress the shortcomings of current lake management approaches. Details of the World Lake Vision and the process of its creation are put forth. We end with a critique the World Water Vision presented at the 2nd World Water Forum in March 2000 from the perspective of lakes and conclude that, in its current form, the World Water Vision cannot provide an adequate guide for sustainable lake management.

Keywords

lake management; sustainability; World Lake Vision; individual lake visions; World Water Vision

Introduction

Lakes¹ are key components of our planet's hydrological cycle. Additionally, they provide important social and ecological functions while storing water and supporting significant aquatic biodiversity. Much of the earth's available fresh water is contained in lakes. Saline lakes, while not a primary source of fresh water, also have many valuable attributes. Despite their crucial importance, most lakes are undervalued and therefore face stresses resulting from inappropriate management. These problems occur in developed as well as developing countries. Many efforts to protect lakes from stresses have been undertaken; however, problems remain, some even threatening the existence of certain lakes (*e.g.* Lake Chad, Aral Sea). Moreover, although scientific knowledge concerning the causes and effects of stresses on lakes has grown rapidly, effective management policies have lagged; in most cases, the values of lakes have not been fully considered by policymakers.

¹ For simplicity, we use the term lake to refer to both natural and artificial lakes.

This paper explains why a new, global approach to lake management, the World Lake Vision, is necessary to improve the state of the world's lakes. Such a vision will be an effective way of bringing scientific knowledge and stakeholder interests into the policy-making process while raising awareness of the value of lakes. The most comprehensive global-scale vision on water to date, the World Water Vision (Cosgrove and Rijsberman, 2000), provides a framework for global freshwater management for international agencies and national governments alike. It does not, however, adequately address the concerns facing lakes.

This paper considers the uses of the world's lakes and the numerous stresses impairing such uses. We examine current lake management approaches and discuss why they have been inadequate for many lakes. Then, we propose the World Lake Vision as a means of achieving sustainable² lake management³. We end with a critique of the World Water Vision, focusing on its consideration of lake issues.

Value of Lakes

To understand the value of lakes, try to imagine a world without them. In terms of water supply alone, lakes are invaluable as the source of approximately 90% of the world's available liquid surface fresh water (derived from Shiklomanov, 1993). Additionally, lakes are precious repositories of biodiversity. Even saline lakes are of great value, not the least for their role in supporting ecological and hydrological functions.

It is useful to have a systematic way of considering the many values that lakes provide. The World Bank, in its new Environmental Strategy (World Bank, 2001), divides the value of water and water-based ecosystems into the following four categories:

- Direct Values (consumptive and non-consumptive use of resources);
- Indirect Values (ecosystem functions and services);
- Option Values (premium placed on possible future uses and applications);
- Non-use Values (intrinsic significance).

Based on these categories, we examine the major types of lake values below.

Direct Values. The most obvious direct use of lakes is as source of drinking, irrigation and industrial water. The Laurentian Great Lakes contain 20% of the world's available freshwater and serve as a drinking water source for over 24 million people (National Research Council, 1992). Even relatively small Lake Biwa (volume = 17 km³) in central Japan supports the activities of over 13 million people in the Kyoto-Osaka-Kobe conurbation (Nakamura, 1995). Furthermore, lakes and rivers have also been used

² We follow the definition of sustainable development put forth by the Brundtland Commission in 1987: "Sustainable development is that which meets all the needs of the present without compromising the ability of future generations to meet their own needs."

³ Some may claim that reservoirs are inherently unsustainable. In this paper, we neither address that issue, nor the issue of decommissioning dams. The World Commission on Dams, in a recent report (World Commission on Dams, 2000) succinctly deals with these and other reservoir-related issues.

as a means of transportation. Additionally, some natural and most artificial lakes are harnessed for power. Fishing, along with aquaculture, provides protein and employment for many people. Lakes are also well known as foci of recreation. Many lakes serve as a breeding ground for migratory waterfowl. For example, Mono Lake in California is an essential feeding stop on the way to wintering grounds in South America for tens of thousands of phalaropes (Hart, 1996) and is an essential stop for thousands of photographers, both amateur and professional.

Indirect Values. Lakes can effectively absorb large inflows of water during floods, thereby moderating damage downstream. For example, the volume of the Tonle Sap in Cambodia increases dramatically during the flood season, effectively channeling the flood waters into an established basin (United Nations Environment Programme, 1994). Lakes often have a moderating influence on local climate due to the relatively high heat capacity of water. Decreases in lake size, such as has occurred in the Aral Sea, can have adverse impacts on local climate. Also, the method of waste disposal pioneered in Europe, namely the transport of wastes in water through sewers, has been adopted in many watersheds, with lakes acting as sinks for wastewater discharges. They provide dilution of waste, and in exorheic (open) basins, a way to send the waste elsewhere.

Option Values. Lakes are repositories of biodiversity. The ancient lakes in Africa are home to hundreds of endemic species. Besides the direct benefits of biodiversity known today, it is possible that future values may be large. Hence, one value of preserving lakes is to keep options open for many different kinds of future needs, including preservation.

Non-use Values. Henry David Thoreau went to Walden Pond to think. Others go to lakes to meet friends, relax, or to simply enjoy the grandeur of nature. Lakes can also provide a region with a collective symbol of culture. Furthermore, many lakes are sacred sites for religious and spiritual activities. In addition, simply knowing that a particular lake exists and has clean water carries a particular value. For instance, some people may be interested in the preservation of a particular lake, even though they may never expect to see it first hand.

Stresses on Lakes

It is the immense value of lakes, outlined above, that draws people to live, work and play in their watersheds. Ironically, the consequent changes in population and land-use inevitably lead to stresses that impact the lakes themselves, thereby decreasing the values that drew people in the first place. Because of their long retention times and the complexity of their ecosystems, lakes are particularly vulnerable to stress.

Table I (**at end of document**) summarizes the main stresses on lakes, their causes, effects and an example for each. Much work has already been done reporting on the state of the world's lakes. For example, based on a comprehensive survey of 217 lakes around the world carried out by the International Lake Environment Committee (ILEC) and UNEP (1995), Kira (1997) concluded that lakes were facing five major problems, namely lowering of water-level, siltation, acidification, toxic contamination

and eutrophication, all of which alone or in concert lead to adverse effects on aquatic ecosystems. Other works that give an overview of the various stresses on the world's lakes include National Research Council (1992), UNEP (1994), Dinar *et al.* (1995), Ayres *et al.* (1996), Nakamura (1997) and Duker (2001).

Lake Management Today

Given the magnitude of stresses impairing the value of lakes around the world, it is not surprising that many management responses have been undertaken. In this section, we will outline what has been done to address lake problems and discuss why those measures have not been completely successful.

Current Approaches

Laws and Regulations. Many countries have codified laws promoting environmental protection. These laws provide a statutory framework for the regulation of industrial and domestic discharges to water-bodies. Laws concerned with lakes in particular also exist at the international (*e.g.* Boundary Waters Treaty between US and Canada), national (*e.g.* Lake Law of Japan), and local (*e.g.* Lake Kasumigaura Eutrophication Prevention Ordinance) levels. Furthermore, direct bans on certain products such as phosphorus-containing detergents have been implemented in many watersheds.

Pollution Control. Effluent regulations often lead to the introduction of sewage treatment facilities for both industrial and domestic sources. In some cases, treated sewage is diverted out of the lake's watershed (*e.g.* Lakes Tahoe and Washington). Diffuse pollution resulting from agricultural, forestry, and urban land-use impairs most lakes. Governments often provide incentives to farmers to implement nonpoint runoff control (*e.g.*, Best Management Practices in the US) but diffuse pollution remains a large problem. International agencies such as DANIDA (Danish International Development Agency), JICA (Japan International Cooperation Agency), SIDA (Swedish International Development Cooperation Agency), the World Bank and the Global Environment Facility (GEF) have provided funding and expertise for direct pollution control measures in many developing countries.

Restoration Measures. Lake sediments are sometimes dredged to remove either toxic compounds or nutrients from the system. Liming has been employed in the treatment of acidified lakes. Biomanipulation is sometimes used to accelerate the recovery of a lake's ecosystem. Rehabilitation of littoral communities, such as the conservation and reintroduction of reed beds, has also taken place. The Reed Colonies Conservation Ordinance for Lake Biwa has required that existing colonies (only 120 ha in 1990 compared to 280 ha in 1953) be maintained and that new colonies be introduced (Ohkubo, 2000).

Research. The fields of limnology, hydrology, and water resources management have generated a substantial body of knowledge on the processes occurring within lakes, their watersheds, and on lake management in general. Lake modeling efforts have contributed greatly to the development of an integrated ecosystem theory (Jorgensen,

1997). Great strides have been made in ecohydrology, many with important implications for lake management (Zalewski, 2000). Academic societies such as SIL (Societas Internationalis Limnologiae) and ASLO (American Society of Limnology and Oceanography) have long promoted research and its dissemination.

Data Collection and Assessment. Governments sponsor the collection of data on the state of lakes within their borders. Many citizens also undertake lake monitoring activities and submit information to public databases. Comprehensive data compilation efforts, such as the ILEC-UNEP World Lake Database (1995) have been prepared and have shed light on the types of problems facing lakes. Additionally, the GEMS/Water program assembles data on water quality provided by over 100 national governments. A new program of the GEF, the Global International Waters Assessment (GIWA), will also be monitoring and assessing many problems of concern to lakes.

Information Sharing. The sharing of experiences and ideas concerning lake management among citizens, governments and scientists is the goal of many conferences and workshops. Electronic forums on lake management issues have been established and allow participants to discuss their concerns with others.

Education. Educational activities, such as training programs, school excursions, and the creation of resource materials have played an important role in teaching concerned stakeholders about lake issues. For example, all fifth-grade students living in the Lake Biwa watershed spend one day and night on the lake measuring water quality, identifying flora and fauna, *etc.* as part of a school program called “The Floating School” (Kawashima, 1998).

Advocacy. Citizens concerned with either a specific lake or lakes in general have formed non-governmental organizations that have a range of activities. The Mono Lake Committee was instrumental in stopping the City of Los Angeles from diverting freshwater inflows to Mono Lake. International NGOs like ILEC, LakeNet, Living Lakes, and NALMS (North American Lake Management Society) have been advocates for sustainable lake management around the world.

Shortcomings of Current Approaches

Despite the approaches discussed above, stresses that impair the use of lakes remain and lakes continue to be degraded. In short, most of the world’s lakes are still not sustainably managed. Several reasons why the counter-measures to date have not been entirely effective are as follows.

Lack of Awareness. There is a lack of information and awareness on the full value of lakes at key decision-making levels. At the global level, the most conspicuous example of the marginalization of lakes is the World Water Vision (Cosgrove and Rijsberman, 2000). Even though lakes make up approximately 90% of the world’s available surface liquid fresh water, they are markedly absent from the World Water Vision itself. A quick check of the World Water Vision’s index reveals multiple entries for groundwater, reservoirs, rivers, and wetlands yet there is no mention of lakes. This omission is also evident in the text of the Vision and is discussed in detail below. At the

local level, lack of awareness of the values of a lake also occurs, especially in developing countries, where meeting basic needs often out-weighs long-term preservation of a lake. It may not be immediately obvious to a fisherman on the shores of Lake Malawi, nor more obvious to the foreign aid worker attempting to show him how to increase his catch, the value of the lake's biodiversity. At all levels, a lack of education has left the general public with insufficient understanding of lake issues.

Lack of Integrated Responses. All of the current approaches to lake management suffer from fragmentation to various degrees. The boundaries of laws (political jurisdiction) rarely coincide with the boundaries of watersheds. This situation is common for most lakes because local and/or national borders were rarely drawn with the watershed in mind; indeed, in the days when bridges were difficult and expensive to build, rivers, and the lakes they flowed into and out of often were *set* as the political boundaries and many, if not most, of those political boundaries still exist. Pollution control efforts are seldom comprehensive, focusing instead on easily controlled point-sources. Direct restoration efforts, such as top-down biomanipulation of the food web are invariably accompanied by bottom-up responses, many of which are difficult to predict and control (Kasprzak, 1995). Poorly planned dredging carries the risk of degrading a lake further in the short run by stirring up nutrient-rich benthos. There is a marked gap between scientists and policy-makers: the findings of the former are rarely translated into the language of the latter. Many local and national governments, along with researchers, are active in collecting data on the state of individual lakes and the stresses on them; however, efforts to assemble these diverse sources of data on the international scale lack coordination and result in significant overlap (*e.g.* GEMS/Water, GIWA, and ILEC databases). Furthermore, the disparity in resources between the developed and developing world means that even basic data are unavailable from poorer countries. Often the data that are available are of unknown reliability and in format hard to integrate into other assessments. Finally, a high degree of fragmentation exists among international organizations advocating sustainable lake management through information sharing, education, and advocacy. For example, significant overlap exists among the international activities (conferences, workshops, educational programs, *etc.*) carried out by ILEC, LakeNet, Living Lakes and NALMS.

Lack of Conflict Resolution. Conflicts are part and parcel of lake management. Upstream-downstream conflicts over the use of lake water were significant in the history of many lakes. With lakes in particular, conflicts can exist at the same place and time: consider the conflict between commercial fishing and oil exploration in the Caspian Sea. Conflicts across time are profound and common. For example, the desire to exploit a lake in the short-term (*e.g.* maximize fish catch) is often in conflict with the goal of long-term sustainable management (*e.g.* preserve biodiversity). Despite the pervasiveness of conflict in lake settings, institutions and methods intended to promote conflict resolution are usually nonexistent. Many lakes are international water bodies, yet the special issues this entails are rarely recognized at the local or regional scale. For example, after the break-up of the Soviet Union, the Aral Sea became an international lake (Kazakhstan, Kyrgystan, Tajikistan, Turkmenistan, and Uzbekistan share the watershed) but at the same time the institutional framework to deal with the lake's management was lost. Increasing conflict over water use for irrigation and hydropower

is one of the main reasons for the present wastage of large volumes of water in the desert areas of the Aral Sea Basin (Jansky and Nakayama, 2001).⁴

Lack of Meaningful Participation. Groups directly affected by lake management decisions are often not consulted. The displacement of large numbers of people resulting from reservoir construction is an extreme example of how a group can be marginalized in the decision-making process. In many cases, particular groups have gained a disproportionate influence in setting the management plans for certain lakes, precluding the participation of others. For example, the Japanese Ministry of Construction promoted extensive projects for the development of Lake Biwa including lakeshore road construction (Nickum, 1998) often neglecting the impact such projects had on water quality.

Toward a World Lake Vision

In this paper, we propose the creation of a World Lake Vision as a comprehensive way of dealing with the shortcomings of the current approaches to lake management. We see the creation and implementation of the World Lake Vision as a crucial step forward on the road to the sustainable management of the world's lakes. In this section we define what the World Lake Vision is and how it addresses the current failings in lake management.

Outline of World Lake Vision

A vision embodies a long-term set of goals and a plan for how to achieve them. It can exist merely in someone's head (*e.g.* our plans for our families) or be a formal written document (*e.g.* World Water Vision and Framework for Action). For a vision to be achievable, it must be realistic. Visions can have different scopes. For lakes, two different scales are important. First, there are individual lake visions, such as Lake Biwa's "Mother Lake 21 Plan" (Shiga Prefectural Government, 2000) or UNESCO's "Water-related Aral Sea Basin Vision" (UNESCO, 2000). Individual lake visions set out a long-term management plan for a given lake. Because the authority to implement such a plan lies at the local level, individual lake visions are essential in achieving effective changes in lake management. Second, there can be an over-arching, global-scale vision encompassing all lakes. We refer to the global-scale vision that we are calling for as the World Lake Vision. It will be a written document that outlines principles for sustainable lake management and raises the profile of lakes on the international agenda. It will serve as a guide for the creation of individual lake visions, yet at the same time, it will be informed by existing individual lake visions. An outline of the document is given in Figure 1 **(at end of document)**

Details of the World Lake Vision document itself will emerge during its creation—a process already initiated by ILEC and other organizations. Nevertheless, at this point, we can note the following:

⁴ Some may argue that the collapse of the Soviet's institutional framework to manage the Aral Sea was actually *good* for the lake because that previous institution greatly contributed to crises the Aral Sea faces today. Nevertheless, until recently, the five countries sharing the Aral Sea did not have a means of managing the lake jointly.

- It must start with a visionary statement, *i.e.* something that captures the imagination of decision makers and the general public about the importance of lakes and the problems facing them;
- It must highlight the values of lakes and provide a framework for analysis of those values;
- It must clearly state the scientific basis for the stress on lakes and their causes in easy-to-understand terms;
- It must provide universally acceptable principles of lake management. We expect these principles to include a focus on the special nature of lake ecosystems, the importance of integrating lake management on multiple scales, the need for meaningful participation among affected stakeholders, the need for more education, and the need for increased conflict resolution;
- It must give case studies illustrating the application of the principles and how they have led to sustainable lake management. It must also illustrate how the lack of or misapplication of the principles has led to problems; and,
- It must provide guidelines on the implementation of the principles for individual lakes, *i.e.* how to create and implement individual lake visions and management plans. There must be a template for an individual lake vision itself as well as a checklist of actions needed to successfully implement a management plan.

The written document will probably be between 50 and 100 pages and follow the outline given in Figure 1. It will be written in an easy-to-understand language. To have legitimacy, the World Lake Vision must be widely shared; that is, all concerned stakeholders must have meaningful input into the process. We expect a series of regional workshops along with gatherings at pre-scheduled international meetings along with an electronic forum to be sufficient. The document is intended, in general, for anyone concerned with lake management, but will specifically target individual lake managers and international organizations dealing with lakes. ILEC is expected to continue taking the lead as coordinator of the vision process. Many international lake organizations have expressed strong support for the development of the World Lake Vision. Several international organizations with large roles in the water field are also lined up to promote the process through related projects. The vision development process is expected to culminate at the 3rd World Water Forum in Kyoto in 2003.

How the World Lake Vision Can Solve Shortcomings of Current Approaches

If a World Lake Vision like the one outlined above comes into existence, then it will be able to address the shortcomings of the current approaches to lake management.

Lack of Awareness. The process of creating a shared vision, as well as the final document itself, is designed to raise awareness among all stakeholders. We expect that international organizations dealing with lakes or water in general, along with individual lake organizations and managers, will come away with an increased awareness of the value of lakes. By providing principles, cases and guidelines, the World Lake Vision will promote the creation of individual lake visions and management plans, which in turn foster increased awareness at local levels.

Lack of Integrated Responses. The World Lake Vision itself cannot be expected to cause the realignment of all the world's political boundaries to coincide with watersheds. Nevertheless, it will promote the creation of organizations like the International Joint Commission (Laurentian Great Lakes) with authority to implement integrated management plans. The World Lake Vision will also bridge the gap between scientists and policy makers by making a case for lakes, based on science, yet put forward in an easy-to-understand format. The main problem is not a lack of scientific knowledge of lakes, but rather the limited role that knowledge currently plays in lake management. The vision process will require a coordinated effort to pull together existing data on the state of the world's lakes. It will also call for international funding to assist developing countries to collect high quality, relevant and uniform data tailored to meet the needs of lake managers. Finally, the process of making the World Lake Vision will focus the efforts of all organizations in the field on a common task, thereby alleviating the overlap and fragmentation that currently exists.

Lack of Conflict Resolution. The World Lake Vision will highlight that conflicts are an inherent part of lake management; it will call for increased conflict resolution efforts. It will expand the focus from the traditional upstream-downstream point of view to include international lake issues as well. If individual lake visions are developed according to the guidelines of the World Lake Vision, then key conflicts will be exposed in the individual lake vision-building process. The airing of conflicts is the first step toward their resolution, though the conflicts themselves may not be fully resolved.

Lack of Meaningful Participation. To manage a lake sustainably, a long-term set of goals and a plan to achieve them must exist. To be widely shared, this vision must have meaningful participation from all stakeholders. The World Lake Vision and the individual lake visions it promotes will explicitly call for the extensive and effective participation of all concerned groups.

Critique of the World Water Vision

Visions on the global-scale dealing with water already exist. Of particular importance is the World Water Vision produced by the World Water Council (Cosgrove and Rijsberman, 2000) and presented at the World Water Forum in March 2000. It aimed to provide a vision for global water management, yet we conclude that it is an inadequate guide for the sustainable management of lakes.⁵

The World Water Vision was a direct response to the freshwater crisis currently affecting billions of people around the world. In short, the population explosion, along with pressures from development such as urbanization and industrialization, has put enormous pressure on the world's limited freshwater supply. In many parts of the world, people do not have access to enough fresh water to meet basic needs. Additionally, improper sanitation means that the water they do have is often contaminated, leading to millions of deaths each year. The World Water Vision is a vision of "a world in which all people have access to safe and sufficient water resources to meet their needs,

⁵ It is probably also an inadequate guide for the management of individual rivers and aquifers; however, in this paper we restrict our critique to lake issues.

including food, in ways that maintain the integrity of freshwater ecosystems (Cosgrove and Rijsberman, 2000).” Its companion document, the Framework for Action (Global Water Partnership, 2000b), provides a plan for how to achieve that vision. As such, the documents are well designed to meet their goals; however, the term “World Water Supply Vision” would have perhaps been more appropriate than World Water Vision.

In particular, the World Water Vision calls for the implementation of integrated water resources management (IWRM) (Global Water Partnership, 2000a) to meet its objectives. It proposes that IWRM can be achieved by:

- Involving all stakeholders in integrated management;
- Moving to full-cost pricing of water services for all human uses;
- Increasing public-funding for research and innovation in the public interest;
- Recognizing the need for cooperation on integrated water resource management in international river basins; and,
- Massively increasing investments in water.

Can the World Water Vision and the above-recommended actions resolve the four problems we stated regarding the current state of lake management? The immediate reaction of the participants in the ILEC Session of the World Water Forum was a clear “No” (Ballatore, 2001). In the wake of the Forum, several issues have become clear. First, the World Water Vision does little to raise awareness of lake issues; in fact, by marginalizing lakes, it probably lowers them on the international agenda thereby decreasing awareness rather than raising it. The call for full-cost pricing of water services is relevant to water supply concerns, but all of the services lakes provide need to be valued, not necessarily priced. Second, the World Water Vision makes a strong call for the implementation of IWRM in several places including the first and fourth actions given above. Indeed, many of the principles of IWRM will become principles of the World Lake Vision. The need for integration of all areas of lake management is obvious, yet the World Water Vision does not spell out how such integration can take place in the lake setting⁶. Third, the fourth action above cites the need for cooperation in international river basins. While international upstream-downstream conflicts must be solved, lakes also require the resolution of conflicts among users in the same watershed and over time. This point, as well as a means of promoting conflict resolution, is absent from the World Water Vision. The World Lake Vision, by calling for individual lake visions, will create a framework for bringing all parties together to at least “agree to disagree.” Finally, the first action given above makes a strong and laudable call for participation of all stakeholders in the decision-making process. This has been lacking in lake management and we completely agree with the World Water Vision on this point.

Nevertheless, it is clear that the World Water Vision does not comprehensively and adequately address the four major problems that exist with current lake

⁶ In fact, the World Water Vision itself was fragmented into various sectors such as Water for People, Water for Food, Water and Nature, *etc.* An adequate integration of these issues, although important and obvious within the lake context, did not occur.

management. Unfortunately, a lake manager trying to promote the sustainable management of a lake by coordinating the creation of an individual lake vision and management plan would find little to go on in the World Water Vision. In the end, by failing to promote the sustainable management of lakes, the World Water Vision jeopardizes its own goal of achieving world water security, a goal that is dependent on the sustainable management of all water resources, including lakes.

Conclusion

Lakes are valuable; lakes are stressed. The dilemma of how to alleviate the stresses in order to protect the values has faced lake managers in particular and society in general for ages. The result of this long experience with lake management has undoubtedly slowed the degradation of these valuable resources; nevertheless, many lakes are facing severe crises—most are unsustainably managed. Some lakes, such as the Aral Sea and Lake Chad, are in danger of disappearing altogether.

In this paper, we have argued that a World Lake Vision is necessary to surmount the shortcomings of current management approaches. We have shown how current policies are plagued by a lack of awareness of the value of lakes and the stresses on them, by a lack of integrated responses in all facets of lake management, by a lack of effective conflict resolution, and by a lack of meaningful participation of those affected by management decisions. We have illustrated how a World Lake Vision can be used to overcome these failings. In particular, the World Lake Vision will raise awareness of the value of lakes directly at the international level through the process of its creation and indirectly at the local level by fostering the development of individual lake visions. These local visions are the workhorses of sustainable lake management, yet they have never had comprehensive guidelines to assist in their creation or a global effort to champion them. The World Lake Vision will fill this gap. Importantly, the World Lake Vision can be expected to lead to increased integration of all aspects of lake management as well as increased conflict resolution. Furthermore, a shared vision, whether it is global or local in scale, must be created through the meaningful participation of all stakeholders.

We find that the World Water Vision presented in March 2000 at the 2^d World Water Forum is an inadequate, incomplete guide for the sustainable management of the world's lakes. In its current form, it serves to lower the profile of the world's lakes and fails to provide a guide for those seeking how to manage lakes sustainably. Given the momentum created by the World Water Vision at the international level, we feel that the World Lake Vision is an idea whose time has come.

Acknowledgements

We thank Masahisa Nakamura for extensive discussions on the ideas contained in this paper: the good ones are his. Wayland Eheart, James Nickum, Richard Robarts and William D. Williams provided comments on an early draft. We have benefited greatly from the stimulating discussions at two recent workshops on the subject of the World Lake Vision held at ILEC headquarters (January and September 2001). The ideas contained in this paper do not necessarily reflect those of our organization.

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Table I. Stresses on lakes, their causes and effects with examples

Stress	Cause	Effect	Example
<i>Biological</i>			
<i>Exotic species</i>	Natural, intentional, or unintentional introduction	Food web changes, loss of biodiversity	Nile perch, Lake Victoria
<i>Pathogens</i>	Fecal contamination from domestic and livestock sources	Waterborne diseases	Cryptosporidiosis outbreak (1993), Lake Michigan, Milwaukee, USA
<i>Chemical</i>			
<i>Eutrophication</i>	Excessive nutrient input	Algal blooms, excessive macrophyte growth, loss of transparency, taste and odor compounds, algal toxins	Lake Dianchi
<i>Acidification</i>	Acidic precipitation, direct input of acidic effluent	Ecosystem degradation	Many lakes in Canada and Northern Europe
<i>Toxic contamination</i>	Industrial effluents, agricultural and urban runoff, atmospheric deposition	Toxicity to fish and disruption of endocrine system, bioaccumulation in fish increases risk to humans and other predators	DDT and PCB contamination, Laurentian Great Lakes
<i>Salinization</i>	Diversion of inflow, discharge of saline waters from irrigated lands, runoff of salts from deforested land	Ecosystem degradation, loss of freshwater supply	Lake Toolibin
<i>Physical</i>			
<i>Water level decline</i>	Diversion of inflow, over-withdrawal of water	Secondary salinization, ecosystem degradation	Aral Sea
<i>Siltation</i>	Soil erosion from cultivation and deforestation	Decrease in lake volume and flood control capacity, destruction of aquatic habitats	Tonle Sap
<i>Structural impacts</i>	Lakeshore developments (e.g. embankments, weirs, roads)	Destruction of littoral communities	Lake Biwa
<i>Climate variability</i>	Natural and anthropogenic	Changes in hydrological balance of lakes	Caspian Sea
<i>Ultraviolet Radiation</i>	Ozone layer destruction	Mortality and reproductive problems in aquatic biota	Cascade Lakes, Oregon, USA

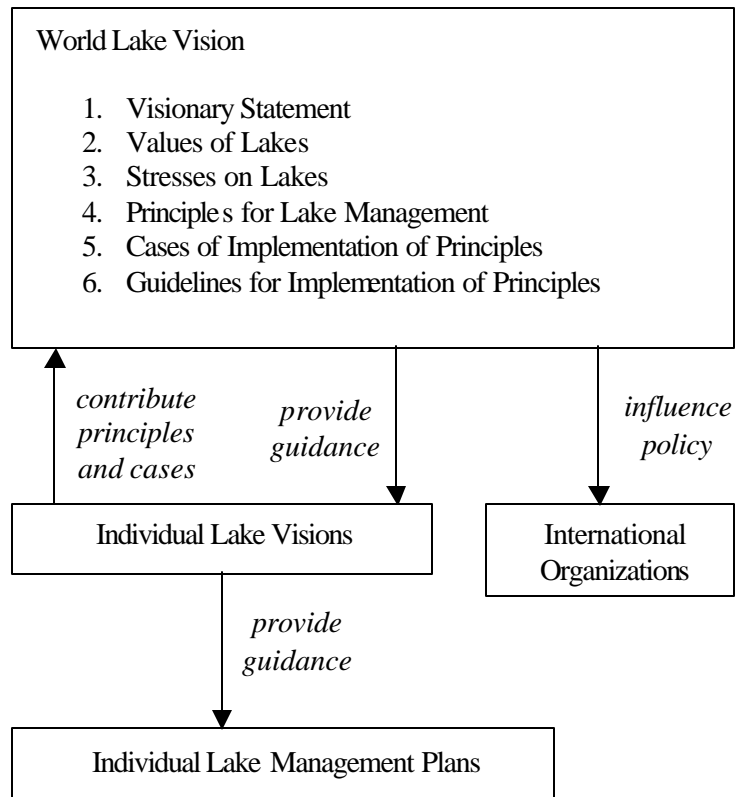


Figure 1. Interrelationships between the World Lake Vision and Individual Lake Visions