

Lakes

Freshwater Storehouses and Mirrors of Human Activities

It is often said that water is life. We have a number of accessible freshwater sources on our planet, including rivers, lakes and groundwater aquifers. But whatever its source, freshwater is a critical resource for human health and livelihoods, food production, industrialization and economic development, and even security. One of the major examples of our failure to recognize the essential role of water in all these endeavours was highlighted previously in the freshwater chapter of Agenda 21, launched at the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro. This recognition has since been reiterated in various ways in numerous conferences and international gatherings throughout the 1990s and into the twenty-first century. To this end, virtually all countries, whether developed, developing or economies in transition, are striving to manage and use their water resources more effectively.

Understanding the Pressures on Water Systems

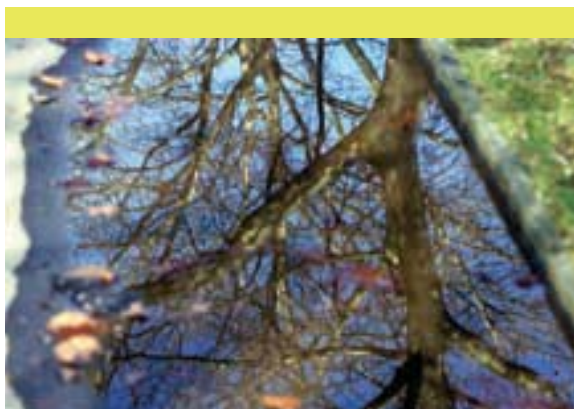
A major theme of the *UN World Water Development Report 3: Water in a Changing World* is that important decisions affecting freshwater management strategies and policies are made outside the water sector, being driven largely by external and largely unpredictable forces. Examples include demography, climate change, the global economy, technological innovation and financial markets. Many of these forces have become primary drivers of the pressures affecting water systems around the world. Accordingly, the third edition

represents a transition from a report directed primarily to water managers to one for a much wider audience, including addressing leaders at all levels of government, the private sector and civil society. It also provides a more holistic perspective in regard to the linkages between freshwater resources and health and human security, food, energy and climate change, as well as the need for public investments in water resources infrastructure and implementation capacity to address such issues.

Noting its critical role in meeting fundamental human needs, and humanity's collective pursuit of higher living standards, in addition to its role in sustaining the ecosystems that provide life-supporting goods and services to humanity (e.g., water supply, food sources, nutrient cycling, refugia, flood control), the third edition of the UN World Water Development Report highlights the fact that water is unique among our planet's natural resources. Freshwater has been characterized as: (i) finite, in that all the water on earth is all the water there is; (ii) fragile, in that it is more sensitive to the impacts of human activities that affect its quantity and quality than other environmental components; and (iii) irreplaceable, in that there are no substitutes for water in all its human uses.

In discussing the range of pressures on water resources, the third edition identifies a number of drivers that, individually and collectively, affect the state of freshwater resources. These include population dynamics (demography), changes in the global economy (economy), and individual human choices made on a daily basis (social). Technological innovation is one of the most unpredictable and most rapidly changing drivers, creating both positive and negative pressures. Policies, laws and finance represent another group of drivers, all fundamental to carrying out and enforcing the rules and regulations that govern water use and protect water resources. Climate change is another major driver; many of its most profound influences on humanity are predicted to be manifested as changes in the hydrologic cycle, demanding its consideration in water resources management.





Effective lake management requires that lakes and their drainage basins be considered a single, mutually-interacting water management unit.

Using Water Resources and Managing Competition

The *UN World Water Development Report 3: Water in a Changing World* identifies the many benefits of water in economic development, as well as the fundamental linkages between economic development and water development.

Agriculture, industry and energy continue to be the major water users on a global scale. Experience suggests that investments in water management to address such uses in a sustainable manner are typically repaid through livelihood security and reduced health risks, vulnerability and poverty. The notion of ecosystem goods and services, as emphasized in the *Millennium Ecosystem Assessment*, also is becoming increasingly recognized as a major impetus for protecting and preserving aquatic and other ecosystems. The third edition also discusses the impacts of water use on water systems and the environment, noting that the pattern and intensity of human activities have disrupted – through impacts on its quantity and quality – the role of water as the prime environmental agent. Indeed, it provides the sombre prediction that some parts of the world now face a future without reliable water resources systems. Also problematic is the fact that information and data about water use, pollution loads and changes in water quality is decreasing and/or lacking precisely when water use is most intense. We are reducing monitoring efforts on a global scale, at the same time that we are trying to analyze and model the status of increasing complex freshwater systems and processes, thereby ensuring incomplete and incompatible data on water quality and quality for managing current water resources and for predicting future needs,

Challenges in managing competition for water and the pressures on ecosystems include wise planning for water resources, evaluation of water availability and needs in a watershed, possible water reallocation or expansion of storage capacity in existing reservoirs, a better balance between equity and efficiency in water use, inadequate legislative institutional frameworks and the rising financial burden of ageing water infrastructure.

Water System Responses and Management Choices

Water in a Changing World also emphasizes that, in spite of the number and magnitude of our water issues, we nevertheless have answers to address many of them. The best mix of responses to a country's development objectives and policy priorities to meet its water challenges appears to depend on several factors, including the spatial and temporal availability of freshwater resources, and a country's technical, financial, institutional and human capacities. It also makes a distinction between responses and options within the water domain and those outside the water domain, noting that leaders in the water domain can inform the processes outside their domain and implement decisions in the water domain. However, governmental leaders, the private sector and civil society are the entities that actually determine the directions that will be taken in water system management interventions. In fact, the responses outside the water domain are typically the ones most strongly affecting the macro-changes influencing how water is allocated and used, noting that many water stakeholders must participate in such decisions in order to achieve sustainable water systems. Drivers and policies outside the water sector have more impact on water management than do many policies developed and implemented by water-related ministries. Identifying trade-offs and synergies between water and other policy sectors, therefore, can enhance policy impacts in all sectors, helping us to avoid some adverse effects on water resources. Since governments, civil society and business leaders daily make decisions that can affect water, it is important to identify where such decisions also can lead to improvements in water sector management and in water sector and environmental services.

Experience around the world clearly illustrates that we have no choice but to manage our water and water systems in order to achieve social and economic development, as well as to sustain such development. Indeed, properly managed, water resources are critical to our collective survival and individual well-being. This will also ensure equity and security in water and sanitation for families, businesses and communities, as well as adequate water supplies for food, energy and the environment, all of which are highlighted in the Millennium Development Goals.

Lakes as Major Freshwater Sources

Against this background, lakes represent a major freshwater resource, whose importance cannot be underestimated. Less than two percent of the freshwater on our planet exists in a readily usable form for human uses. And of this total, it is estimated that lakes contain more than 90% of all the liquid freshwater on the earth's surface. Thus, this water source is important for meeting the needs of both humans and ecosystems, including the life-supporting services provided to humanity by the latter.

Lakes are the only water system so important to humans that they construct them in areas of water scarcity or excesses. In the former case, artificial lakes (reservoirs) store water during certain times of the year for use during other times of the year when it may not be available. In the case of the latter, reservoirs provide humanity with a means of temporarily storing excessive quantities of water, as a means of preventing downstream property damage or human deaths.

Some natural lakes have been around for millions of years, while others have only been in existence less than a hundred years. Although reservoirs have been a part of human history in many parts of the world since ancient times, most of the reservoirs on our planet have actually been constructed only over the past century. But why focus on lakes, and why now? The fact is that degradation of the world's lakes is a serious global water resources issue and, further, that the greatest degradation impacts to lakes and reservoirs are caused by human activities in their surrounding drainage basins. Thus, effective lake management requires that lakes and their drainage basins be considered a single, mutually-interacting water management unit.

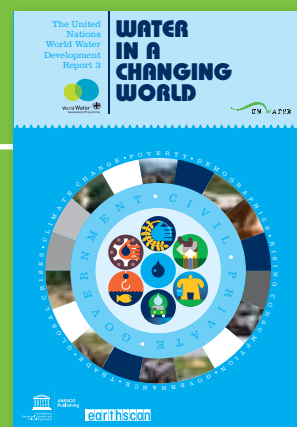
Unique Properties and Resource Values of Lakes

Per capita water availability is decreasing on a global scale. Accordingly, whether we like it or not, increased water storage appears to be an inevitability in our global future. And reservoirs particularly represent a primary means of providing this increased water storage capacity. Further, lakes and reservoirs provide a range of resource values, including drinking water, irrigation water, navigation, fisheries, tourism, recreation, flood and drought management, climate mediation, as well as having religious and historic values. Further, in addition to containing the vast majority of the liquid freshwater on the surface of our planet, humans use lakes for more purposes than any other type of water system. Accordingly, lakes also are subject to more use conflicts than any other type of water system. Although seemingly a problematic feature, their effective management also a greater potential for developing sustainable solutions to water resources issues than any other type of water system.

As pointed out by the International Lake Environment Committee (ILEC) in its ongoing research on management of lakes and reservoirs for sustainable use, as encompassed in integrated lake basin management (ILBM), is that these essentially standing (lentic) water systems have several unique attributes that must be considered for their effective management. In contrast to flowing (lotic) rivers, lakes and reservoirs have long water residence times, an indication of the average time water will spend in a lake. Lakes with long retention times are slow to respond to many inputs, being able to absorb floodwaters and pollutants, for example, without exhibiting immediate changes. This feature has both positive and negative consequences. Among the positive features, lakes are relative stable to short-term variations in water flows because of their large volumes. This long-term stability also has allowed complex, often unique ecosystems to evolve, an example being Lake Malawai/Nyasa, which has evolved over 500 endemic fish species because of its millions of years of relative isolation, coupled with natural selection. On the other hand, the long water retention time also means that, once degraded, a lake can take a long time to recover, meaning that reversing degradation can be hard, costly and can lead to lags in ecosystem responses that are poorly matched to the time scale associated with human management efforts.

Lakes also act as a sink for water and material inputs from diverse sources from their surrounding drainage basins. The mixing of these inputs within a lake ensures that the problems associated with them are disseminated throughout the volume of a lake. Thus, it is not possible for a pollutant to affect only a portion of a lake, nor is it possible to treat only a portion of a lake. Rather, water-related problems are typically lake-wide in nature. Another unique feature of lakes is that they exhibit complex response dynamics. Thus, the physical, chemical and biological characteristics of lakes and reservoirs can be viewed as a type of barometer of the consequences of human activities within their surrounding drainage basin.

In contrast to rivers, for example, lakes don't respond to changes in a linear fashion, instead exhibiting a highly non-linear response. An example is the hysteresis phenomenon associated with increases in nutrient concentrations, in which the consequences may not become apparent until the nutrient concentration is very high, and the lake exhibits an abrupt change in trophic status. Equally problematic, particularly from the perspective of management interventions, is that a highly nutrient-enriched lake may continue to exhibit a degraded condition, even after remedial actions have been undertaken, until the lake has essentially flushed or otherwise ridded itself of the bulk of the nutrients contained in its sediments. This latter property is particularly significant to decision-makers tasked with showing benefits of remedial programs in the often short time horizon associated with political office.



The Evolution of the World Water Development Report

The United Nations System resolved in 1999 to issue a World Water Development Report at regular intervals, targeting national decision-makers and water resources managers. This resolution was based on the complementary objectives of: (1) strengthening and stimulating national capacities and cross-sector institutions in integrated water development planning and in managing water resources for sustainable use at the basin and aquifer level; and (2) stimulating accelerated coverage and investments for basic human water needs (drinking water, sanitation, food security, flood and drought mitigation, and conflict prevention), with priority directed to developing countries.

The first edition of the UN World Water Development Report, *Water for People, Water for Life*, released in March 2003 at the third World Water Forum in Kyoto, Japan, provided an inaugural assessment of progress made in addressing global water needs since the 1992 Rio de Janeiro conference. The second edition, *Water, A Shared Responsibility*, was released in March 2006 at the fourth World Water Forum in Mexico City. In both cases, individual United Nations agencies provided stand-alone assessments for various water sectors, focusing on key challenge areas (water for food, energy, etc.).

The water sector unfortunately remains plagued by poor governance, underinvestment and inadequate monitoring. The third edition of the UN World Water Development Report, *Water in a Changing World*, released at the fifth World Water Forum in March 2009 in Istanbul, Turkey, is the most recent attempt to emphasize the fact that urgent action on many fronts and on many levels is necessary if we are to avoid a global water crisis. The third edition also marked a significant departure from the sector-based approach of the first two editions. Instead, it presented a more holistic structure, focusing on the second of the above-noted objectives of accelerating coverage and investments for basic human water needs.





Integrated Lake Basin Governance

As with the range of water systems highlighted in the *UN World Water Development Report 3: Water in a Changing World*, the global experience of lake basin management encompasses a wide variety of lessons, particularly in regard to ILBM governance issues.

These include:

- Importance of a basin approach – lake management does not stop at the lakeshore, but extends into the basin and other beyond it (e.g., long range transport of airborne pollutants); the demise of the Aral Sea in central Asia provides ample evidence of not considering water impacts on a basin scale;
- Border barriers must be overcome – effective lake basin management requires consideration and integration of transboundary concerns, whether geographic or jurisdictional in nature;
- Consideration of technological versus non-technological interventions – technologies can have dramatic effects on lakes, provided the root causes of the problems also are

properly addressed; in other cases, more labor-intensive solutions may be appropriate, particularly in situations in which a country may have limited resources for implementing such technology;

- Success depends heavily on stakeholder involvement – because degradation of the many ecosystem services provided by lakes and reservoirs is largely the consequence of unsustainable use of such services for economic development, the sustainability of these water systems requires that respective stakeholders understand and appreciate their respective roles in causing the problems (and in formulating solutions);
- Long-term commitment is essential – because lakes possess long water retention times and complex dynamics, successful outcomes from management interventions are almost never immediately, meaning a range of indicators that illustrate both planning (Process Indicators) and implementation (Stress Reduction Indicators), as well as actual lake basin improvements (Environmental Stress Indicators) are required to gauge the success of such interventions;
- Monitoring is essential – because long-term monitoring data sets can be a basis for mutual understanding of lake basin issues, they are an essential component of lake basin management interventions;
- Lake basin management is a continuing process – managing lake basins is not a one-time project; rather many management interventions often occur in isolation, often for non-related reasons, with the need for integration of projects growing over time.

The third edition of the UN World Water Development Report, as well as those preceding it, recognizes the important role of lakes and reservoirs in addressing the water needs of humanity, both for survival and development purposes, as well as the need to protect and maintain the ecosystems that provide life-supporting services to it. It also identified the efforts of the ILEC directed to effective lake basin governance, as encompassed in its ongoing research efforts directed to integrated lake basin management. Indeed, as noted in its World Water Vision, ILEC's first effort directed to the goal of integrated lake basin management (ILBM);

"...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."

The United Nations World Water Development Report 3: Water in a Changing World

Coordinated by the World Water Assessment Programme, the *United Nations World Water Development Report 3: Water in a Changing World* is a joint effort of the 26 United Nations agencies and entities that make up UN-Water. The report brings together some of the world's leading experts to analyse the state of the world's freshwater resources: it monitors changes in our water supplies and in how we manage them, and tracks our progress towards achieving international development targets.

The *World Water Development Report* also provides decision makers with the tools to implement sustainable use of our water – offering best practices to help stimulate ideas and actions for better stewardship of this most essential resource.

An accompanying case studies volume, *Facing the Challenges*, examines the state of water resources and national mechanisms for coping with change in 23 countries and numerous small island developing states.