Sustainable Lake Management and the Role of ILBM

Masahisa Nakamura

International Lake Environment Committee Foundation, Kusatsu, Japan

Summary

Lakes have been conspicuously missing from the global discussion on water and the environment over the past decades, even though natural lakes and wetlands occupy more than 90% of all the liquid fresh water on the Earth's surface. Fortunately, however, at the United Nations Environment Assembly held in March 2022, the member states unanimously adopted a resolution that called for global action to integrate lakes into national and regional development plans, including in climate adaptation, water resources management, conservation of biodiversity, to advance the attainment of SDG 6, climate resilience, and biodiversity conservation. This paper reviews the background leading to this new development. It discusses the challenges and prospects facing the international community to transfuse the conceptual framework evolved to deal with policy and governance challenges facing global lakes and lentic such as Integrated Lake Basin Management (ILBM) into the currently widely accepted global water management conceptual framework IWRM.

Keywords: sustainable lake management, UNEA5, SDG Target 6.6, ILBM, IWRM

~~Preamble~~

Part I: Mainstreaming Lakes in the SDGs

1. Introduction and Background

On 2nd March 2022, a resolution focused on achieving "Sustainable Lake Management" was adopted unanimously at the Fifth Meeting of the United Nations Assembly, UNEA5 (UNEP, 2020). It identified specific actions to take by the United Nations Organizations, particularly UNEP, which is now preparing to take a lead role in facilitating other UN specialty organizations and the member states to make joint efforts in striving to realize this resolution over the following years, particularly toward the SDG target year of 2030. This resolution resulted from earlier efforts by the concerned scientists and experts from various governmental and non-governmental organizations across continents to recognize that lakes have been conspicuously missing from the global water agenda and are acknowledged little in the SDGs, even though natural lakes and wetlands occupy more than 90% of all the liquid fresh water on the Earth's surface (ILEC, 2020). They provide a wide range of life-supporting ecosystem services that serve as essential habitats for various flora and fauna. They collectively play a vital role in reducing human water security and biodiversity security threats.

2, A Glimpse on the State of World's Lakes, from Some Past Assessments

While the scientific knowledge about global trends has significantly increased over the past decades, information

on the management experiences and lessons learned has been quite limited. Nonetheless, the following literature collectively gives a glimpse of the state of the world's lakes that require much greater attention than before through the upcoming mainstreaming process.

2-1. The Global Lessons Learned Report of 2005> (ILEC, 2005)

This report was published based on a GEF-funded project focused on the experiences and lessons from 28 selected lakes worldwide. It can be considered a pioneering work to comprehensively address the lake basin management governance issues. Regional workshops brought together 288 participants from 41 countries to review and comment on the briefs and thematic papers and discuss general lake basin management. A snapshot of the current direction of change in the status of the problems in the study lakes was shown in a tabular form. Impairment of a given lake use arises through overuse and when two or more users conflict. While some are in-lake problems (such as overfishing), most others originate from the lake's watersheds. The governance issues identified were categorized into **1. Institutions:** i.e., developing organizations for action; **2. Policies:** identifying effective actions; **3. Involving People and Stakeholders (or Participation):** an essential element of effective lake basin management; **4. Responding with technology:** opportunities and limitations; **5. Informing the process:** the role of science; **6. Mobilizing sustainable financing:** Local, national, and external funds, with detailed accounts of the key findings.[i] **Figure 1.** Shows the summary of problems affecting the 28 lakes as described in their individual reports.

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

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

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Figure 1. Status of 28 Selected Lakes Studied in the GEF-ILEC Project (ILEC, 2005)

2-2. GEF IW-Science Report> (United Nations University, 2012)

The report was prepared as part of the series of reports prepared by the Lakes Working Group convened under the IW-Science Project of the Global Environment Facility (GEF), which undertook a synopsis and analysis for each of five classes of global transboundary water systems: River Basin, Lake, Groundwater, Land-based Pollution Sources, and Large Marine Ecosystems and Open Oceans. The report states that "the Lakes Working Group reviewed 58 projects, 88 percent of which overlapped with those of the Rivers Working Group; only four focused solely on lake environments." It also stated, "Reviewing 58 project reports, many of which pertain to rivers, large marine ecosystems, groundwaters, and land-based pollution studies, concludes that GEF projects still need more links between natural sciences and social science. Effective research, monitoring, and assessment were affected by factors that showed some commonality, including baseline data, reference sites, the need for more rigorous study designs and regular, effective

evaluations of project deliverables, and ongoing challenges related to a lack of regional infrastructure." The project-specific issues hindering success were listed as long-range transport and deposition and effects on water quality; unique system characteristics that make achieving short-term change difficult; and challenges with the political will in the region. It also stated, "Lakes were not often considered specific ecosystems, and studies did not always consider external drivers," and mentioned that the review was undertaken to assess the project aims and objectives regarding "increasing and sharing knowledge, providing planning tools and capacity development, and catalyzing management." It concluded, "the success of science application and the potential for lasting impact are strongly related to how well science-management linkages are developed and managed before, during, and after the projects."

2-3. Global Wetland Outlook (Ramsar Convention on Wetlands. 2018)

The report provides the outlook facing the global wetlands on the "extent," "biodiversity," "water quality," and "ecosystem processes" as follows.

Extent

Global inland and coastal wetlands cover over 12.1 million km2, an area larger than Canada, with

54% permanently inundated and 46% seasonally inundated. While human-made wetlands, largely rice paddy and reservoirs, almost doubled over this period, now forming 12% of wetlands, natural wetlands are in long-term decline around the world; between 1970 and 2015, inland and marine/coastal wetlands both declined by approximately 35%, where data are available, three times the rate of forest loss. In contrast.

Biodiversity

Since 1970, 81% of inland wetland species populations and 36% of coastal and marine species have declined. The highest levels of extinction threat (over 30% of species globally threatened) are for marine turtles, wetland-dependent megafauna, freshwater reptiles, amphibians, non-marine mollusks, corals, crabs, and crayfish. Extinction risk appears to be increasing.

Water quality

Water quality trends are mostly negative. Since the 1990s, water pollution has worsened in almost all rivers in Latin America, Africa, and Asia. Deterioration is projected to escalate. Major threats include untreated wastewater, industrial waste, agricultural runoff, erosion, and changes in sediment. By 2050, one-third of the global population will likely be exposed to water with excessive nitrogen and phosphorous, leading to rapid algal growth and decay that can kill fish and other species. Severe pathogen pollution affects one-third of rivers in Latin America, Africa, and Asia. Other pollution, including salinity build-up, acidification, thermal pollution, microplastics, and excessive use of agricultural chemicals, disrupts food chains and reduces biodiversity. At least 5.25 trillion persistent plastic particles are in the world's oceans and significantly impact coastal waters.

Ecosystem processes

Land-use change and water regulation infrastructure have reduced connectivity in many river systems, and floodplain wetlands disrupted regulation functions of nutrient and trace metal cycles and filtering capacity as well as the global storage capacity of soil carbon, with added concern for the climate change possibly causing the release of carbon particularly by melting ice in the permafrost regions.

Ecosystem services

Wetland ecosystem services far exceed those of terrestrial ecosystems. They provide critical food supplies, including rice, freshwater fish, coastal fish, freshwater, fiber, and fuel. Regulating services influence climate and hydrological regimes and reduce pollution and disaster risk. Natural features of wetlands often have cultural and spiritual importance.

2-4. Transboundary Lakes Assessment (ILEC and UNEP. 2016)

Part of the project supported by the Global Environment Facility (GEF) entitled "Transboundary Waters Assessment Programme (TWAP)," aimed to carry out the first global-scale assessment of transboundary water systems, namely, rivers, lakes, groundwaters, large marine ecosystems, and the oceans, assessment of the lakes component was undertaken by ILEC (ILEC and UNEP, 2018). The study identified some 1 600 transboundary lakes and reservoirs around the world, of which 204, including 33 in Africa, 51 in the Asia region, 30 lakes in South America, 70 in the European region, and 20 in North America, were subjected to what is called the "prioritization analysis," using 23 basin-scale drivers grouped under the thematic areas of catchment disturbance, pollution, water resource development, and biotic factors. After eliminating small lakes with sparse basin populations and frozen over for significant portions of the year, a glimpse of the threats to the global transboundary lakes comprising 23 lakes in Africa, eight in Asia, nine in Europe, six in South America, and seven in North America, was obtained.

Considering the Incident Human Water Security (HWS) and Biodiversity (BD) threats, as defined by Vörösmarty et al. (2010), the top dozen transboundary lakes exhibiting the greatest Incident HWS threats included five European, four Asian, two North American, and one African lake. The African lakes as a group generally ranked in the bottom half of the 53 transboundary study lakes. An "Adjusted Human Water Security" (Adj-HWS) threat was also developed to account for the positive benefits expected from technological investments directed to water supply stabilization, improved water services, improved access to water sources, etc. Subsequent comparisons of the incident and adjusted HWS scores highlighted the significant positive impacts attributable to such investments, with the relative threats to the transboundary lakes in developed countries (e.g., Europe, USA) decreasing substantially. At the same time, those in many developing nations increased markedly.

The top dozen lakes exhibiting the greatest Adj-HWS threats included ten African, one Asian, and one South American lake, highlighting the greater need for catalytic funding for transboundary lake management interventions in many developing countries. Regarding biodiversity, the top dozen lakes exhibiting the greatest

Incident BD threats included five European, four North American, and three Asian lakes. The African transboundary lakes again collectively showed lower Incident BD threats than those in the developed countries, meaning that although the developing nations typically lag behind the developed countries in terms of economic development, their biodiversity may exhibit a more robust condition, suggesting much biodiversity in developed countries has already been significantly degraded because of their increased economic development activities and stakeholder affluence. There was insufficient global experience to develop an 'Adjusted' biodiversity threat analogous to the Adj-HWS threat. Nonetheless, shown in **Figure 2.** is the ranking result of lakes based on one of the selected scenarios.

Cont.	Lake Name	Adj-HWS Rank	HDI Rank	RvBD Rank	Sum Adj HWS + RvBD	Overall Rank	Sum Adj HWS + HDI	Overall Rank	Sum Adj-HWS + RvBD + HDI	Overall Rank
Afr	Abbe/Abhe	7	7	7	14	1	14	3	21	1
Afr	Turkana	13	10	9	22	2	23	10	32	2
Afr	Selingue	16	2	15	31	11	18	5	33	3
Afr	Malawi/Nyasa	9	12	14	23	3	21	9	35	4
Afr	Chiuta	23	9	3	26	5	32	15	35	4
Afr	Cohoha	3	4	28	31	2	7	1	35	4
Afr	Kivu	12	6	18	30	8	18	4	36	7
Afr	Rweru/Moero	4	3	30	34	16	7	2	37	8
Afr	Lake Congo River	35	1	1	36	18	36	19	37	8
Afr	Tanganyika	26	8	6	32	14	34	17	40	10
Afr	Edward	6	13	22	28	7	19	6	41	11
Afr	Chilwa	21	11	10	31	10	32	14	42	12
Afr	Mweru	33	5	4	37	21	38	20	42	12
Asia	Sistan	1	20	25	26	6	21	8	46	14
Afr	Natron/Magad	8	23	17	25	4	31	13	48	15
Afr	Nasser/Aswan	20	16	16	36	19	36	18	52	16
Afr	Albert	10	19	24	34	15	29	12	53	17
Afr	Ihema	2	18	33	35	17	20	7	53	17
S.Am,	Azuei	5	21	31	36	20	26	11	57	19
	Aral Sea	27	26	5	32	13	31	31	58	20
Asia	Sarygamysh	29	29	2	31	9	32	32	60	21
Afr	Cahora Bassa	34	15	13	47	25	25	25	62	22
Afr	Victoria	11	22	32	43	24	16	16	65	23
Afr	Chad	25	17	23	48	26	21	21	65	23
Afr	Kariba	36	14	19	55	30	28	28	69	25
S.Am	Titicaca	32	32	8	40	22	25	35	72	26
Afr	Aby	28	24	21	49	27	30	30	73	27
S.Am	Chungarkkota	31	33	12	43	23	34	34	76	28
Asia	Shardara/Kara-kul	22	28	35	57	31	27	27	85	29
Eur	Dead Sea	14	34	38	52	29	24	24	86	30
Afr	Josini/Pongola-poort Dam	24	27	37	61	34	29	29	88	31
S.Am	Salto Grande	40	38	11	51	28	39	39	89	32
Asia	Darbandikhan	17	30	46	63	35	23	23	93	33
S.Am	Lago de Yacyreta	38	36	20	58	32	38	38	94	34
Asia	Aras Su Qovsaginin Su Anbari	15	35	44	59	33	26	26	94	34
Asia	Mangla	18	25	53	71	39	22	22	96	36
S.Am	Itaipu	37	37	29	66	37	37	37	103	37
Asia	Caspian Sea	39	41	27	66	36	40	40	107	38
Eur	Galilee	19	46	47	66	38	36	36	112	39
Eur	Cahul	30	31	51	81	42	33	33	112	39
Eur	Scutari/Skadar	41	42	34	75	41	41	41	117	41
N.Am	Amistad	47	45	26	73	40	47	40	118	42
Eur	Macro Prespa (Large Prespa)	44	40	40	84	43	42	42	124	43
Eur	Ohrid	49	39	39	88	46	44	44	127	44
Eur	Szczecin Lagoon	43	43	43	86	44	43	43	129	45
N.Am	Huron	51	50	36	87	45	51	51	137	46
Eur	Neusiedler/Ferto	42	47	50	92	47	45	45	139	47
N.Am	Ontario	48	49	45	93	48	49	49	142	48
Eur	Lake Maggiore	52	48	42	94	50	50	50	142	48
N.Am	Falcon	46	44	52	98	53	46	46	142	48
N.Am	Erie	45	51	49	94	51	48	48	145	51
N.Am	Champlain	53	52	41	94	49	53	53	146	52
N.Am	Michigan	50	53	48	98	52	52	52	151	53

Figure 2. TWAP 53 Lakes Ranking Assessment Example (for one of the Human Water Security Threat - Biodiversity Security Threat scenarios)

Since the calculated threat ranks also do not consider in-lake conditions because of a severe lack of data on a global scale. They also do not evaluate the capacity of lakes and other lentic water systems to assimilate or buffer basin-derived stresses. Thus, some transboundary lakes categorized as only moderately threatened based on their basin characteristics, for example, may be seriously degraded, while some transboundary lakes experiencing serious threats may not be identified as such because of insufficient data, which is the prevailing situation for most of the TWAP transboundary lakes. Differing regional physical and socioeconomic perspectives can result in a lake being classified as threatened in one region and may not be considered threatened elsewhere. These factors, considered alone or collectively, can readily lead to erroneous conclusions regarding the comparative transboundary lake threats. Thus, the calculated lake threats represent only one approximation of the actual risks (although a high threat rank may signify future degradation under a 'business-as-usual' scenario). The reality is that more definitive conclusions can only be derived from more intensive lake data compilation and analyses on a global scale.

3. Addressing the Deteriorating Trend of World's Lakes

3-1. The SDG Target on Lakes

The UN Sustainable Development Goals (SDGs) adopted in September 2015 consist of 17 Goals and 169 Targets (United Nations, 2021), serving as the apex platform of the Global Policy Agenda. But how are lakes and wetlands treated in the SDG programs? There are two approaches to evaluate this question. The first is to be rather stringent and seek direct references to the terms "lakes" and "wetlands" in the SDGs. The second is to be rather broad-minded

and find indirect and implicit references to the opportunities offered to "lakes" and "wetlands" about the other SDG targets.

As for the first approach, both terms "lakes" and "wetlands" appear in SDG Target 6.6 (i.e., "By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes"), which is included under Goal-6 of the SDGs (United Nations. 2022). The terms "lakes" or "wetlands" do not appear explicitly in the remaining Targets under Goal-6, including Target 6.1 on safe and affordable drinking water; 6.2 on adequate and equitable sanitation and hygiene; 6.3 on water quality improvement; 6.4 on water-use efficiency; and 6.5 on integrated water resources management, although these targets implicitly relate to the role lakes and wetlands may play as sources of water supply.

The second and more relaxed approach considers how "lakes" and "wetlands" are implied in the SDG goals and targets. This approach assumes that implicit reference to lakes and wetlands in the broad range of 17 SGD Goals and their Targets is sufficiently encouraging in the pursuit of the sustainability of their ecosystem services. One literature source focusing on wetlands states, "Thus, SDGs represent an opportunity for collaboration and synergies across conventions. In turn, wetlands protection, wise use, and restoration provide governments with a path to reconciling numerous commitments under the environmental agreements…." (Ramsar Convention, 2018). Another literature source focusing on "lakes and reservoirs" refers to the possibility of using multiple indicators for evaluating their sustainability concerning the SDGs by recognizing the synergy and potential conflicts facing them. It relates to nine of the 17 Goals, for example, exhibiting direct and indirect interlinkages to "lakes" and reservoirs. It also has identified positive links with the Goals characterized by the environmental dimensions (Goals 6, 13, 14, and 15), noting that they would be "mutually reinforcing with each other." It further states that "…..policymakers can keep track of the development of lakes and reservoirs and, hence, decide on holistic and multidimensional management and policies for the sustainable future of lakes and reservoirs (Ho and Goethals, 2019)."

3-2. The Lake-Related SDG Achievement

Regarding the lake-related SDG Achievement, the latest report on the progress on SDG 6.1 (United Nations, 2021) states that besides severe impacts facing river basins, a sample of 2,300 large lakes, almost a quarter recorded high to extreme turbidity readings in 2019. It also states that approximately twenty-one million people, including 5 million children, live within a 5 km radius of the high-turbidity lakes infested by such pollutants as heavy metals and bacteria, impacting human and ecosystem health. Although the SDG Target 6.6 states, "By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes," nonetheless, the progress toward meeting the Target 6.6 has been quite far off-target, at least about the initial target year of 2020 and most likely about the revised the target year of 2030. The above report indicates that meeting other SDG Targets, i.e., Targets 6.1–6.5, is also quite challenging, though not even close to what appears to be happening about Target 6.6.[ii]

3-3. Why Is the State of World's Lakes Deteriorating Despite the SDG Efforts?

Natural lakes, as well as artificial lakes to a great extent, possess three unique behavioral features, i.e., 1) an integrating nature; 2) long residence time, and 3) complex response dynamics (ILEC, 2005, pp 12-13) collectively make it quite challenging to meet such an expectation as stipulated in Target 6.6, i.e., "By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes". The above view was reflected in one of the early writings on dealing with lakes in an article entitled, "Sustainable Management of Lake Basins in the Context of IWRM" (UNEP Collaborating Center for Water and Environment. 2007), where the author states by referring to the above same document, "Due to their vulnerability and high values for the society

they need special attention in the approaches and management framework. Policies and legislation may make special allowance for lakes, and separate institutions or cooperative arrangements may have to be created. Lake management tools may have to be readily available to the water resources management agencies." The author also states, "Lakes are then included in the national water resources management framework, which is described and explored during the preparation of the IWRM 2005 Plans." The context under which the author made these statements will be discussed **under Section 6.1** below.

4. Addressing the Lake-Mainstreaming Challenges

According to the UN-Water (2020), "SDG 6 is alarmingly off track." It states, "Water sources and associated ecosystems are being degraded because of unsustainable use, increased pollution, and climate change, while an increasing frequency/severity of floods and droughts poses additional threats." It goes on to say on the matters of concern to lakes, "Of course, SDG 6 goes beyond provision of water supply, sanitation and hygiene services to include targets on water scarcity, water pollution, biodiversity, and ecosystem protection, disaster risk reduction, leveraging water for peace, and water management that reflect the ever-growing global pressures on our most precious and finite resource." The bottlenecks that impede more significant progress include policy and institutional fragmentation between levels, actors, and sectors, funding gaps and fragmentation, and data and information too often not available or not shared between different sectors of government and across borders to inform decision-making effectively. The Guiding Principle and the Action Pillars to "Solve" the above issue provided in the report include **a)** Prioritizing the vulnerable, **b)** Inclusivity, **c)** Conflict sensitivity, **d)** Unleashing female and youth potential and reaching gender equality, **e)** Planning for resilience/sustainability, and **f)** Making scientific evidence a prerequisite for the Guiding Principles, and

① Engage
   1. Respond efficiently and effectively to country and regional requests
   2. Unify external backing around government-led plans
   3. Engage with local authorities, civil society, particularly excluded groups and geographical areas
   4. Build and empower a multi-stakeholder movement
   5. Finetune existing international frameworks
   6. Establish/scale-up powerful partnerships at the global, regional, and river-, lake- and aquifer-basin levels

② Align
   1. Adapt our ways of working to become more effective and efficient
   2. Commit to sustainability by supporting whole systems approaches
   3. Raise the ambition

③ Accelerate
   1. Financing:
   2. Data and information:
   3. Capacity development: Focus on the human capacity to deliver SDG 6
   4. Innovation: Leverage and scale up innovative practices and technologies
   5. Governance: Make SDG 6 everyone's business through clear roles and strong institutions

④ Account
   1. Better coordination among the UN entities
   2. Streamlined support
   3. A purpose-driven collaboration

for the Action Pillars. Since these Guiding Principles and Action Pillars apply to the whole of Goal 6, they also apply

to Targe 6.6. where "lakes" are mentioned. These Guiding Principles and Action Pillars pertain to implementing IWRM as stipulated in Target 6.5, "By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate", which seems to make good sense.

In the meantime, the key points of the "Sustainable Lake Management" Resolution, as mentioned in 1. Introduction and Background go as follows:

The adopted Resolution requests all Member States and members of specialized agencies and invites relevant international organizations to individually and collectively, where applicable, undertake and implement:

a. Protection, conservation, and restoration as well as sustainable use of lakes, including aspects such as water quality, erosion and sedimentation, and aquatic biodiversity through integrated management at all levels, as laid down in SDG 6.5 and 6.6, addressing the water body and the entire lake basin, supported by relevant regulation, institutional development, budget allocations, well-managed monitoring and data, integrated research, sustainable technology, and relevant international cooperation,
b. Integration of lakes into national and regional development plans, including in climate adaptation, water resources management, and conservation of biodiversity, to advance the attainment of SDG 6, climate resilience, and biodiversity conservation,
c. Taking into account their dependence and impacts on lakes and their local culture, knowledge and prosperity, engagement and capacity building for local communities and indigenous peoples, as appropriate, and, by national circumstances,
d. Involvement of all relevant stakeholders, including university/research centers, private companies, and non-governmental organizations, in a concerted effort to implement Sustainable Lake Management,
e. Research and scientific guidance, including an emphasis on science-policy linkages, and
f. Development of international networking and collaboration for integrated sustainable and climate-resilient lake management also considers the regular exchange of data and information between states that share a transboundary lake as the relevant international agreements provide.

It also requests the UNEP Executive Director to undertake several key activities, i.e.:

a. First, to support the advancement of sustainable lake management at all levels, in coordination with relevant conventions, including the Ramsar Convention on Wetlands, as appropriate;
b. Second, to facilitate collaboration among the UNEP Member States and specialized agencies in research, capacity building, knowledge and information sharing, and best practices, including through North-South, South-South, and Triangular Cooperation; and
c. Third, to advance the mainstreaming of sustainable lake management in relevant global agendas and fora and raise awareness of sustainable lake management at the international level to further highlight their essential roles in supporting sustainable development and maintaining the well-being of humanity and ecosystems.

It is apparent that the above Guiding Principles and Action Pillars have to be also directed to pursue the above "Sustainable Lake Management" Resolution." But, urgently needed is a global policy framework dedicated explicitly to "lakes" that adequately reflects their fundamental behavioral characteristics and that is designed to meet their basin governance challenges, before expecting that those Guiding Principles and Action Pillars will "Solve" the highly challenging issues listed in the Resolution. This aspect will be discussed about the subject introduced in part II, Integrated Lake Basin Management (ILBM).

Part II: Integrated Lake Basin Management (ILBM) in the Mainstreaming Process

5. What is Lake Basin Management?

5-1. Lake Basin Management Approaches Differ Widely

The technical and institutional approaches in lake basin management differ widely depending on the management purposes, prevailing natural conditions, and financial, technical, and manpower capacities of the countries in which the lake basins belong.

They also evolve differently according to socio-economic, political, and environmental conditions. For example, the management approach may differ according to;

a) their biophysical features

b) the origin and state of their existence (high altitude lakes, coastal lakes, etc.)

c) climatic conditions (tropical, subtropical, etc.)

d) the anthropogenic and socio-environmental situations they exist (e.g., urban lakes versus pristine alpine lakes, etc.)

The legal frameworks for lake basin management, with policy, institutional, and technical guidelines, protocols, and principles, have been developed and implemented in most countries in Europe, North America, Oceania, and parts of Asia, but they are only beginning to be adopted in other regions still undergoing economic development. Some transboundary lake basins of international importance have also adopted suitable management frameworks through expert advice and support from international technical collaboration organizations.

In addition, there is an urgent need to substantially increase the knowledge and information from the global lessons and experience learned on lake basin management far beyond the level presented in Section 2 so that their cross-fertilization through joint global effort be made possible as soon as possible. Also urgently needed is to enrich and expand the conceptual scope of Integrated Lake Basin Management (ILBM) that has evolved over the past decades but with limited transfusion with such a grand conceptual framework as IWRM that has been considered to have been the driving force for the SDG 6.

5-2. Reasons and Purposes of Lake Basin Management

Globally, there are many lakes with little or no dedicated "formal management institutions." On the other hand, many such lakes are managed by "informal management institutions" that have evolved over centuries of community engagement with traditional rules and policies.

Regardless, the lake basin may be managed mainly for two reasons or purposes,

1) The first is the development and production of resource values by introducing the necessary management programs and actions (e.g., withdrawal of lake water for water supplies, harvesting fish by fishery boats for consumption and sales, recreational facilities for public leisure activities, dam impoundment of lake water for hydropower potential, etc.), and,

2) The second is the prevention, restoration, and recovery of the degraded resource values by introducing the necessary management programs and actions to deal with the causes of degradation (eutrophication, siltation, water level fluctuations…..etc.) However, over a long period of management time, the management reasons or purposes may undergo phase shifts from 1) to 2), but often in a complexly intertwined way.

For example (see Nakamura and Rast. P14), a lake may be managed for ….

a) gaining access to the amply available resource values such as water to be withdrawn for domestic and industrial uses, fish to be harvested for subsistence and local marketing, etc.

Over time, the management needs may grow to meet the demand for;

b) enhancing resource values by promoting tourism and recreational facilities while attending to the increased pollution load using small-scale wastewater systems; and

c) decongesting the resource extraction activities to reduce or alleviate undue pressures on the lake by, for example, introducing a quota system in the case of fisheries.

In the case of

d) resolving resource use conflicts, management plans may be needed for compensatory payments or for creating a new resource base elsewhere to ease the resource use competition.

Sooner or later, management plans need to be introduced for;

e) reducing the land-based environmental stress, particularly about lake water quality.

The plans may be structural (e.g., construction of sewerage systems) or nonstructural (e.g., strengthening of regulatory actions such as compliance monitoring of industrial effluent water quality). However, there is a whole range of stress reduction measures, depending on the kind of stress. Removing harmful sediments from the lake bottom, enhancing agricultural Best Management Practices (BMPs), etc., may be categorized under environmental stress reduction.

f) Rehabilitating and restoring riparian habitats, and

g) protecting resource value damages from disaster risks such as typhoons and earthquakes is not uncommon for lakes in regions prone to such extreme events.

The former (rehabilitation and restoration) is becoming quite common in developed and some developing countries, with unconventional ecological technologies being introduced if the associated benefits outweigh their costs. The plan to delineate reed-bed protection zones for maintaining and enhancing ecosystem integrity, for example, probably falls in both categories.

h) Taking precautionary adaptation and mitigation measures is rare, other than for often heated debates as to whether or not to allow siting of facilities that may have potentially irreversible adverse impacts on the ecosystem properties of the lake (e.g., dams; resort complexes). Overall, the plans mentioned above are related to addressing

i) improving overall ecosystem health in balance with human needs.

Take, for example, a particular lake basin case where the current major issue may be whether or not to install a sewerage system in one of the lake basin communities with a growing population, falling within the category of the problems under b) above. The sewerage issue may be addressed without so much concern about the whole of the lake or its basin. It may be addressed simply as the public-sector environmental infrastructure development issue involving engineering and economics, with no particular need to referring it as a sustainable lake basin management challenge. In the long run, however, many of the range of management challenges a), as well as c) through i), will follow, with the governance challenges involving institutions, policies, participation, knowledge, technology, as well as funding/financing will arise, not only about the sewerage system but also to the integrated management of the lake and its basin for sustainable use of the entire resource base.

The management perspectives are another essential concept. They differ regarding **a) space, b) time and c) perception**. The spatial perspective, **a)**, has a lot to do with the biophysical characteristics of lake basins (Ballatore, 2005), where relationships among physical configurations, linkage structure, riparian land-water interface, and linkages to other water systems are typical characterization features. The temporal perspective **b)** relates to the geo-historical implications of the formation and alteration of lakes' physical, chemical, and physical presence, their relationships with their basins, and the history of human-nature interaction over if not tens of centuries. The perceptional perspective **c)** relates to how the lake basin society formed its values about the resources provided by

the lakes. This perspective is critical in terms of the cultural history of the riparian communities in evolving traditional management rules.

The challenges facing the sustainable use of lake basin resources are broad in spectrum, complexly intertwined in nature, and entirely encompassing to fulfill lake basin management needs over temporal, spatial, and perceptional scopes. It is not just a question of developing a single management plan and expecting it to be implemented by the prospective beneficiaries of managed resources. The ownership, not only of the lakes as a resource base but also of the causes of resource value degradation, is essential. The management responsibilities transpiring out of the ownership must be shared and fulfilled by the remotest of the causal chains of resource value degradation. The possible modes of transaction for fulfilling the responsibilities will have to be clearly understood by all. Challenges encompassing the issue domains of institution, policies and politics, participation, technologies, knowledge and information, and financial resources. These factors are discussed in the next chapter.

6. The Integrated Lake Basin Management (ILBM) in Brief

6-1. How Was ILBM Conceptualized

The concept of Integrated Lake Basin Management (ILBM) was developed to address wide-ranging management challenges facing lakes and their basins pursuing sustainability requirements. Joint and in-depth interdisciplinary review and analysis of the experience and lessons learned from the selected global lakes (ILEC, 2005) has led to the development of a categorization framework called the Six Pillars of Governance[iii], i.e., the domains of institution, policies, participation, technologies, information (including traditional knowledge and scientific information), and financial resources. Of course, these Six Pillars of Governance are pretty generic and are inherent to almost any public sector planning subject, including those about non-lake water management subjects.

However, it was important and also possible to draw the management approaches and processes projected to Six Pillars of Governance more specific to lakes and other lentic waters in the synthesis process. It was possible to apply this framework to a particular lake basin management situation, explore the emerging needs, and retrospectively analyze the past achievements and failures. The Six Pillars of Governance approach may be introduced for the basin stakeholders gradually, incrementally, and long-term to form a joint "platform," conveniently called the ILBM platform process. Depending on the reasons and purposes of lake basin management, the typology of such a platform and the associated cyclic process for Six Pillars of Governance can vary widely, accommodating the basin stakeholders as a whole to own the process rather than being imposed from outside with token participatory process. In a nutshell, the ILBM framework turned out to be much more versatile and catalytic for what appeared to be fragmented and disjointed stakeholder actions to come together to generate the synergy needed for pursuing management challenges for sustainable use of lake basin resources.

The ILBM concept, nonetheless, has been further enriched by participatory improvement through various research and applied study projects supported by several supporting programs, including those from Japanese and overseas funding sources over the past decades, particularly between 2005 to date, resulting in a non-prescriptive and generic rather than prescriptive and specific framework. The primary outputs produced in the "ILBM-Governance project" have already been presented in the article entitled "Outline of the Lake Basin Governance Research Promotion Activities" (Nakamura, 2011)[iv].

6-2 In What Way Has the ILBM Framework Been Useful and Contributary to the World's Lakes?

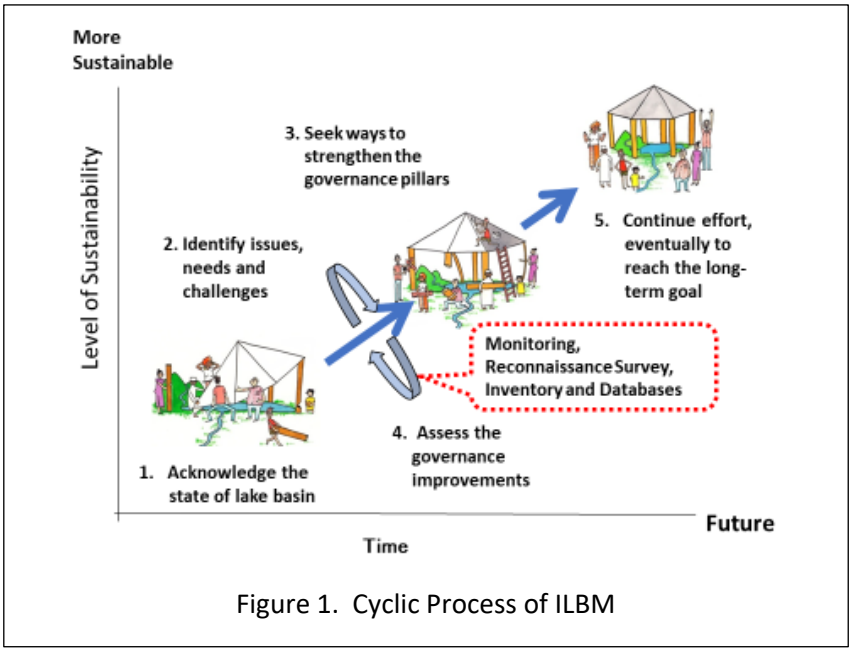

Figure 1. Cyclic Process of ILBM

As presented in Nakamura (2011), the merits of the ILBM platform process were identified through the implementation of pilot projects over initial five years, as reported in the article, and also confirmed over the period to date since then, as follows:

1) **Stakeholder collaboration in lake basin activities:** The ILBM Platform process has helped connect the stakeholder groups that have previously been independently working, making possible the improvement of the lake basin governance pillars from widely different perspectives.
2) **Formalization of collaborative relationship:** Government agencies, research institutions, citizen groups, NGOs, and private sector organizations, having previously had an only informal collaborative relationship, sometimes with competing and conflicting interests and activities, have been able to formalize the relationship, helping to accelerate the implementation of joint actions through ILBM.
3) **Advisory assistance from research institutions:** Research institutions, including universities, have played an instrumental role in providing consultative inputs by providing scientific information, participating in local meetings, and facilitating the ILBM Platform process.
4) **Cross linkage of existing activities:** Cross linkages on activities have been achieved among the participating members, regardless of their local, regional, national, and international focuses, regarding information sharing, contributory roles, and possible joint effort for the ILBM platform process.
5) **Cross linkage of new issues:** Cross linkages have emerged on such seemingly separate thematic issues as disaster prevention, child nutrition, maternity health, water and peace, health risk assessment and management, water and wastewater facility rehabilitation, etc.

How each of the case study lake basins will be able to improve its governance toward sustainability depends on several factors, with or without the ILBM Platform approach. The experience and lessons learned from the ILBM cases compiled over the years imply two things. Firstly, lake basin management is not a project but a governance process. The governance process will evolve, with or without ILBM, over many years, decades, and centuries toward the sustainability goal that, in many cases, may never be reachable.

Secondly, lake basin management, even without explicit reference to ILBM, is still ILBM implicitly. Without explicitly recognizing it, the conventional thinking in lake basin management is, when successful, always achieved through gradual but continuous improvement of lake basin governance.

Figure 3 illustrates that the process involves 1) acknowledging the state of the lake basin, 2) identifying issues, needs, and challenges, 3) seeking ways to improve the governance pillars, and then 4) assessing the governance pillars as being continuously cyclic where the eventual goal is never explicitly stated. The figure also illustrates that

there may be occasional opportunities for recollecting the wishful thought about the vision of the fully accomplished lake basin sustainability, which is unlikely to be known if it did not exist. The pursuit for operationalization of the concept of ILBM for practical application has reached a point where the development and implementation, as well as cross-fertilization of experience and lessons learned of ILBM Platforms ubiquitously promoted across continents, is becoming extremely important. It is so because the lake basin governance challenges faced by individual lake basins are the challenges to be shared globally by all lake basins because of the "integrating nature."

7. Transfusion of ILBM into IWRM (and IRBM) or Vice-Versa

As discussed in Nakamura and Rast (2016), the need for an integrated approach to water management had become a common understanding among water professionals since the Johannesburg Summit in 2002, when Integrated Water Resources Management (IWRM) was accepted as the common philosophy for all UN agencies to pursue in the future. IWRM stipulates a need to find appropriate means for coordinating policy-making, planning, and implementation in an integrated manner across sectoral, institutional and professional boundaries for managing any water-related systems (GWP, 2000). In pursuing IWRM, the Global Water Partnership (GWP) identified a need to recognize some overriding criteria regarding social, economic, and natural conditions, namely economic efficiency in water use, equity, and environmental and ecological sustainability. The IWRM framework and approach recognize that complementary elements of an effective water resources management system must be developed and strengthened concurrently, including the enabling environment, the institutional roles and functions of the various administrative levels and stakeholders, and management instruments such as effective regulation, monitoring, and enforcement. According to the GWP, IWRM is a "process that promotes the coordinated development and management of water, land and related resources, to maximize the resultant economic and social welfare equitably without compromising the sustainability of vital ecosystems."

"Integration" in the IWRM sense stipulates the need to integrate "natural system components," including (1) freshwater and coastal zone management; (2) land and water management; (3) "green water" and "blue water" management; (4) surface and groundwater management; (5) quantity and quality in water resources management; and (6) upstream and downstream water-related interests. IWRM also stipulates the need for integration of human system components, including (1) cross-sectoral integration in national policy development; (2) macro-economic effects of water developments; (3) basic principles for integrated policy-making; (4) influencing economic sector decisions; (5) integration of all stakeholders in the planning and decision process; and (6) integrating water and wastewater management.

While few people would dispute the importance of IWRM in water management, the reality is that 'operationalization' of the IWRM principles for lake basin management has been problematic, particularly for those dealing with on-the-ground basin management challenges facing lakes and other lentic water bodies. One of the overriding reasons for this deficiency is that most, if not all, lake basin management stakeholders are not in a position to play a significant role in influencing most IWRM integration needs. While ILBM also is based on an integrated approach, it focuses on on-the-ground governance improvement rather than on governance improvement at a higher level of policy making at the national government level. The government sector in charge of lake basin management is relatively weak and sometimes virtually non-existent in many countries in developing regions. Further, ILBM takes an "integration by necessity" approach, as contrasted to IWRM, which takes more of an "integration by design" approach. Adaptive Integration in ILBM Platform Process The Cyclic ILBM Platform Process discussed in Section 3-2 is a process of integrating the Six Pillars of Governance. It is meant as a gradual process leading to overall lake basin governance improvements, which, in turn, can lead to the more efficient and more harmonized implementation of plans and programs that stakeholders can collectively be involved in developing. Even if they may not be able to

participate in the process at the outset, the stakeholders should be able to join the ILBM Platform gradually. While this proposed process seems to be well-suited for the "Common-Pool Resources" type problem, it is suggested that this approach also be actively applied to deal with lake basin management cases involving emerging important issues, examples being an adaptation to climate change, restoration of biodiversity, and addressing extreme hydrological events such as flooding.

Infusion of ILBM into IWRM for lake basin management is an important challenge for achieving "sustainable lake basin management." The Ecosystem Service (ES) concept may relate to these water management philosophies, i.e., ILBM and IWRM. ES consists of Provisioning Service (PS), Regulating Service (RS), Cultural Service (CS), and Supporting Service (SS). ILBM emphasizes the continuous effort for gradual, incremental, and long-term improvement of basin governance so that PS and RS will be balanced at a desirable level over a long period far beyond decades or even centuries. The preservation of CS would also be possible if the above achievement of balance is realized.

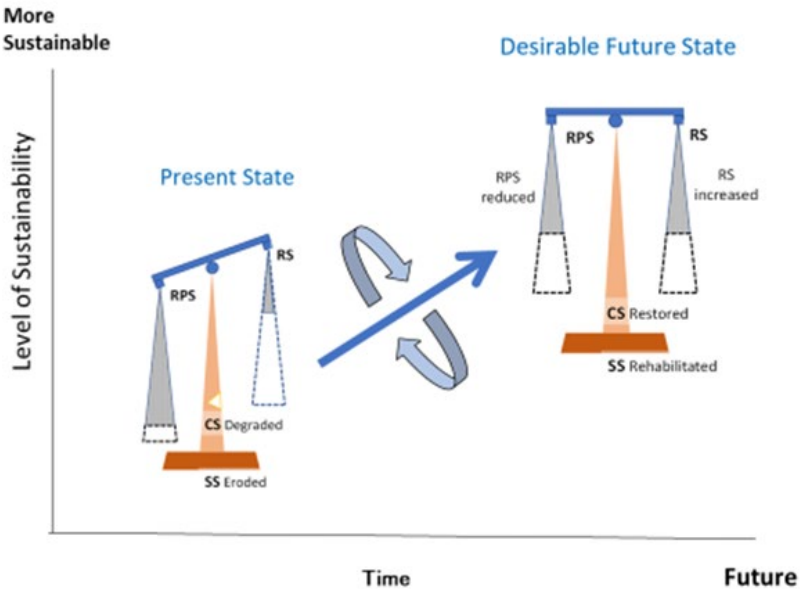

Figure 3. The Cyclic Platform Process of ILBM via Ecosystem Service

(i) Rehabilitation and restoration of the diminished and diminishing RS would not be easy.

(ii) Pursuit of PS must be appropriately balanced with available RS.

(iii) It is usually the case that the unrecoverable loss of benefit and the associated colossal cost to incur from diminished or diminishing RS would be realized only after the irreversible damage has been done by the excessive pursuit of PS.

(iv) It is not easy to find the cases of PS pursuits resulting in appropriate balance with RS in the short cycles of pursuits.

On the other hand, the importance and usefulness of PS pursuits throughout the SDG period in a much shorter time than what ILBM intended to be meaningfully pursued. The differences in the scope of time frame on the sustainability of source water systems such as lakes, rivers, and groundwaters exist. For example, while the definition of IWRM provided in the literature is "a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment"), the tendencies of ecosystem degradation become much greater, and the difficulties associated with restoration of the already degraded ecosystems also becomes much greater in the case of lakes and other lentic waters, as compared to "water" perse. Such tendencies necessitate the gradual, long-term, incremental approach for governance improvement and balancing PS and RS in the long run.

8. Conclusions

The adoption of the "Sustainable Lake Management" Resolution at the 5th Session of the United Nations

Environment Assembly (UNEA5) was a landmark event for many lakes, their basin communities, and their local and national governments that have been highly concerned about the rapidly deteriorating lake environments and their resource values. Now that one crucial step has been made for all to closely work together to pursue what is being stipulated in the Resolution, with close collaboration with the international organizations concerned. Among the spectrum of global actions expected to be launched, the ILBM framework, having been adopted to a wide variety of lake basins as case study subjects, needs to be reviewed and improved, particularly about other frameworks of importance in water and ecosystem management, with particular emphasis on IWRM.

References

- Ballatore, T.J. and V.S. Muhandiki. 2005. "Biophysical Characteristics of Lakes" in Managing Lakes and Their Basins for Sustainable Use: A Report for Lake Basin Managers and Stakeholders. International Lake Environment Committee Foundation (ILEC), Kusatsu, Japan. 146 p.
- Global Water Partnership. 2011. What is IWRM? Accessed at https://www.gwp.org/en/GWP-CEE/about/why/what-is-iwrm/
- Ho, L. T., and P. L. M. Goethals. 2019. Challenges for the Sustainability of Lakes and Reservoirs about the Sustainable Development Goals (SDGs). Water, MDPI. Open Access Publication. Accessed at: https://www.mdpi.com/2073-4441/11/7/1462
- ILEC. 2005. Managing Lakes and Their Basins for Sustainable Use: A Report for Lake Basin Managers and Stakeholders. International Lake Environment Committee Foundation (ILEC), Kusatsu, Japan. 146 p. Accessible at: http://www.ilec.or.jp/en/pubs/p2/lbmi
- ILEC. 2007. How Can We Stop Degradation of the World's Lake Environments? Accessed at: https://www.ilec.or.jp/wp-content/uploads/pub/ILBM-Guide_en.pdf
- ILEC and UNEP. 2016. Transboundary Lakes and Reservoirs: Status and Trends, Summary for Policy Makers. United Nations Environment Programme (UNEP), Nairobi. Accessed at http://geftwap.org/publications/lakes-spm
- ILEC. 2020, The Need to Mainstream Lakes and Other Lentic Waters within the Global Water Agenda, Accessible at: https://www.ilec.or.jp/wp-content/uploads/MAINSTREAMING-LAKE-ACTION-STATEMENT_16-9-20.pdf
- Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: General Synthesis. Island Press, Washington D.C. USA. 137 p. Moore, P. 2010. Coming to Terms with Governance - Definition, Components, Principles. Regional National Working Group Meeting, IUCN Mekong Water Dialogues Project, Kunming, China.
- Nakamura M. 2011. Outline of the Lake Basin Governance Research Promotion Activities. Science for Environment & Sustainable Society, Research Center for Sustainability and Environment, Shiga University. Vol8, No.1.
- Nakamura M, W. Rast. 2014. Development of ILBM platform process: evolving guidelines through participatory improvement, 2nd edition. Shiga University Center for Sustainability and Environment (RCSE-SU) and International Lake Environment Committee (ILEC). Accessed at: https://www.ilec.or.jp/wp-content/uploads/pub/DevOfILBMPP_en_2nd.pdf.
- Ramsar Convention on Wetlands. 2018. Global Wetland Outlook: State of the World's Wetlands and their Services to People. Gland, Switzerland: Ramsar Convention Secretariat. Accessed at: https://www.ramsar.org/sites/default/files/documents/library/gwo_e.pdf
- Ramsar Convention on Wetlands. 2018. Scaling up Wetland Conservation, Wise Use, and Restoration to

Achieve the Sustainable Development Goals. Accessed at: https://www.ramsar.org/sites/default/files/documents/library/wetlands_sdgs_e.pdf

- UNEP. 2021. Progress on Freshwater Ecosystems: Tracking SDG 6 Series – Global Indicator 6.6.1 Updates and Acceleration Needs. Accessed at: https://wedocs.unep.org/handle/20.500.11822/36691
- UNEP. 2022. Sustainable Lake Management. Resolution adopted by the United Nations Environment Assembly on 2 March 2022. Fifth Session of the United Nations Environment Assembly (UNEA5). Accessed at: https://wedocs.unep.org/bitstream/handle/20.500.11822/39858/SUSTAINABLE%20LAKE%20MANAGEMENT.%20English.pdf?sequence=1&isAllowed=y
- UNEP Collaborating Center on Water and Environment. 2007. Sustainable Management of Lake Basins in the Context of IWRM Concepts & Issues Paper No. 2. Accessed at: https://www.gwp.org/globalassets/global/toolbox/references/sustainable-management-of- lake-basins-in-the-context-of-iwrm-unepdhi-2007.pdf
- United Nations University. 2012. A global Synopsis of Lakes science and transboundary management prepared by the GEF IW-Science Lakes Working Group. Accessed at: https://inweh.unu.edu/wp-content/uploads/2021/03/Lakes-Synopsis-Report.pdf
- United Nations. 2021. Progress on Freshwater Ecosystems Global indicator 6.6.1 updates and acceleration needs 2021. Accessed at: https://www.unwater.org/app/uploads/2021/09/SDG6_Indicator_Report_661_Progress-on- Water-related-Ecosystems_2021_EN.pdf.
- United Nations. 2022. Sustainable Development Goals: Goal 6 (Clean Water and Sanitation) Ensure access to water and sanitation for all, United Nations Sustainable Development Goals. Accessed at: https://www.un.org/sustainabledevelopment/water-and-sanitation/
- UN-Water. 2020. The Sustainable Development Goal 6 Global Acceleration Framework. Accessed at: https://www.unwater.org/app/uploads/2020/07/Global-Acceleration- Framework.pdf.
- Vörösmarty, C.J., P.B. McIntyre, M.O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S.Gliddens, W.E. Bunn, C. A. Sullivan, C. Reidy Liermann and P.M. Davies. 2010. Global threats to human water security and river biodiversity. Nature. 467:555-561. (Supplemental Information available online as doi:10.1038/nature09440).

[i] **The Global Lessons Learned Report of 2005 (ILEC, 2005)**

The main output of the report was an in-depth analysis of the governance challenges facing the basin management of the lakes. Shown below are parts of such outputs, on Institutions and Policies.

Institutions are the "who" of lake basin management; that is, they are the ones who have the authority to make changes in behavior that society deems desirable.

- In the 28 case studies, there is no single institution with authority over all aspects of a lake basin's management. In general, the most important institutions are the national-level, sectoral institutions.
- A sectoral approach is problematic, though, because of the integrating nature of lakes. Various users are likely to impact each other, but their activities often fall under the jurisdiction of different sectors.
- Transboundary lake basins face the additional hurdle of international jurisdictions.
- Because lake basin boundaries cannot change and because the sectoral institutions within most nation-states are not likely to change, a compromise is necessary. This usually means the creation of a coordinating mechanism that brings the sectors (and states) together on issues related to a given lake and its basin.
- However, goals may not be necessarily achieved by a single, coordinated lake basin management organization if the other necessary governance is not met.
- The success of transboundary lake basin management depends on the member states' political will, commitment, and fulfillment of obligations, rather than the particular form of institution or its legal status. Non-riparian basin countries of a lake that may be reluctant to join a formal lake basin management authority may be successfully engaged through informal mechanisms.
- It is hard to anticipate all the types and magnitudes of problems that will face a lake basin in the future. Therefore, an institutional arrangement that can accommodate changes is more likely to be effective in meeting goals than one that is inflexible.

Policies: Policies are what institutions implement to change and reinforce certain behaviors. Policy options range from awareness-raising to creating rules and incentives.

- Simply raising awareness among resource users is one of the most effective and accessible policies. People will often modify behavior if they learn it has a negative effect on others.
- Command-and-control policies(rules) are effective when there is an excellent capacity to implement, a clear environmental goal is known, and the number of regulates is low. Direct regulation has contributed to significant stress reductions in the lake basins in high-income countries in this survey.
- The cases show that declaring an area protected is easy; protecting it by restricting activities is much more complicated.
- Economic instruments such as taxes and fees on discharging pollutants to the environment may be politically challenging to initiate (as polluters have to pay something for something free before). Still, the revenues from economic instruments can be used to build institutional capacity—the key point when power is low.
- For a given lake, there is invariably a mix of policies; "pure policies" only appear in textbooks).
- Meaningful participation of all relevant stakeholders is essential for the legitimacy of an institution's policies.
- Broader national-level policies, particularly those related to development and poverty reduction, significantly impact a lake and its management. This further supports the need for policy coordination

among sectors.

[ii] **Summary of the "Progress on Freshwater Ecosystems. Global Indicator 6.6.1 Updates and Acceleration Needs 2021 (UNEP.2021)**

Target 6.6 is: "By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes." Indicator 6.6.1 tracks change over time in water-related ecosystems. Earth observations determine changes to surface water bodies, such as lakes, large rivers, flooded wetlands, and reservoirs. This report makes the following remarks on SDG Target 6.6.1 Change in the extent of water-related ecosystems over time.

The extent of surface water available in one-fifth of the world's river basins has changed significantly in the last five years. These impacted river basins are experiencing both rapid increases in their surface-water area due to flooding, a growth in reservoirs and newly inundated land, and rapid declines due to the drying up of lakes, reservoirs, wetlands, floodplains, and seasonal water bodies. Coastal and inland wetlands are experiencing ongoing loss, with more than 80 percent of wetlands estimated to have been lost since the pre-industrial era. At present, only 10–12 million km^2 are estimated to remain. The area covered by coastal mangroves has also declined globally, by 4.2 percent since 1996. Wetlands are needed to mitigate climate change, reduce the impacts of floods and droughts, and protect freshwater biodiversity loss.

It is crucial that the quality of lake water be improved. From a sample of 2,300 large lakes, almost a quarter recorded high to extreme turbidity readings in 2019. Approximately 21 million people, including 5 million children, live within a 5 km radius of the high-turbidity lakes, and likely rely on their water for various purposes. High turbidity can indicate water pollution, as the large volume of suspended particles acts as hosts for pollutants such as metals and bacteria. Lakes with high turbidity can therefore adversely impact human and ecosystem health and must be improved to prevent this.

The summary statistics for the SDG regions suggest that there is no dominant global trend in water-quality issues for large lakes. All SDG regions have experienced issues with turbidity and trophic state. While there is a tendency for turbidity to be the more common issue, it is not always the case (such as in Oceania). The highest share of impacted lakes is in sub-Saharan Africa, Latin America, Europe, Northern America, and Oceania. More than 40 percent of lakes show deterioration relative to the 2006– 2010 baseline. In contrast, Australia, New Zealand, and Central and Southern Asia have much lower affected lakes share."

[iii] **Key Questions to Ask on Six Pillars of Governance (ILEC, 2007)**

The report makes the following as the recommended key questions to ask for each of the Six Pillars.

On "**Institutions**" for "developing effective organizations":

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

On **"Policies**", for "broad directions and specific rules":

- What are the existing policies?

- Have they been properly implemented?
- Have they been effective in addressing the identified problem(s)?
- If not, is a new policy needed to address the problem(s) to be identified with the current information and data?

On **"Participation**", for "expanding the circle of involvement".

- Do mechanisms exist for effective stakeholder participation?
- Do the mechanisms cover all the basin stakeholders?
- Are the stakeholders capable of addressing the root causes of their problems, including those originating from their own activities?

On "**Technology**", for "possibilities and limitations".

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

On "**Information**", for "pursuing the sources of knowledge and wisdom".

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

On "**Financing**", for "large sums of money are not always necessary".

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

[iv] **Outline of the ILBM, RCSE Special Issue (Nakamura and Rast, 2014)**

Title: Outline of the "Lake Basin Governance Research Promotion Activities".

1. Background and Rationale for the Need for ILBM Approach
2. Activities Undertaken in the ILBM-Governance Project
3. Lake Basin Management as a Governance Improvement Challenge

3-1 Lake-River as Lentic Lotic Systems, and their Unique Features

3-2 Common-Pool Resources and Ecosystem Services

3-3 A Six Pillar Framework, Preparation of a Lake Brief, and Development of an ILBM Platform

4. Summary of the National ILBM Project Activities and their Implications
5. Summary of the Three-Year Study Outputs

5-1 Beneficial Attributes of the ILBM Lake Briefs

5-2 Reported Merits of the ILBM Platform Process

6. ILBM Platform as a Basis for Pursuing Sustainable Lake Basin Management
7. Supplementary Notes