Summary and Key Messages from "Additional Reports" of the Training Modules for Integrated Lake Basin Management (ILBM)

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This document provides summaries and key messages of additional reports and presentations that accompany each of the 11 training modules for Integrated Lake Basin Management (ILBM). The additional materials cover topics and real-world examples and applications related to the specific subject of the training modules. The broad categorizations of the topics covered include: 1) Tools (GIS, modeling, etc.), 2) Concepts (environmental education, institutions, participation, policies, etc.), 3) Case Studies, 4) Lake Science Subjects, 5) Water Quality Management, and 6) Specific Special Subjects (e.g., climate change).

This summary is prepared as a useful reference to help users of the training materials to identify additional materials of interest for further in-depth study. The summary also provides a quick glimpse at the wide range of issues and cases covered in the additional materials, hence serving as an overview and introduction to the issues.

First, a list of the additional reports is provided, followed by a one-page summary of each report.

Table 1. List of "Additional Reports" of the Training Modules for ILBM

No	Title	Author	Module	Category	Year
001	African Lake Basin Management: Key Issues and Challenges	Daniel Olago	1	Case Study	2019
002	Cyanobacterial Problems in South American Reservoirs: Historical Background, Current Status and Prospects for Countermeasures	Sandra Azevedo	2	Lake Science Subjects	2019
003	Lake Baringo: A Transient Environment, Diversity and Livelihoods	Jones Muli	3	Case Study	2019
004	Into the Golden Year of Lake Basin Management in Laguna de Bay, Philippines	Adelina Santos-Borja	4	Case Study, Concepts (Institutions and Policies)	2019
005	Role of District-level Organization in Decentralized Arrangement of Irrigation Management: Lessons from Water Users Association of Farmers in Japan and Egypt	Tsugihiro Watanabe	4	Case Study, Concepts (Institutions and Participation)	2019
006	Sewerage Policy and Finances in Lake Basin Management, a Case of Lake Biwa, Japan	Naoko Hirayama and Masahisa Nakamura	4,7,9	Case Study, Concepts (Policies, Technology, Financing)	2020
007	Water Resources Management within the Climate Change Context in Africa	Salif Diop	5	Specific Special Subjects (Climate Change)	2019
008	Climate Change Adaptation and Mitigation Measures in the EU Water Environments	Tiina Noges and Peeter Noges	5	Specific Special Subjects (Climate Change)	2019
009	Participation in Japan	Shinji Ide	6	Concepts (Participation)	2019
010	Chilika Lake: Restoring Ecological Balance and Livelihoods through Re-Salinization	Ajit K. Pattnaik	7	Case Study, Concepts (Technology)	2019
011	Assessment of Pollution Load on the Kenyan Catchment of Lake Victoria Basin using GIS Tools	Charles Kipkoech	8	Tools (Modeling, GIS)	2019
012	GIS-based Lake Basin Delineation and Computation of Risk Indicators as part of the TWAP Project	Khila Dahal	8	Tools (GIS)	2019
013	Open Source GIS-based Lake Basin Delineation Procedure: a Tutorial	Khila Dahal	8	Tools (GIS)	2020
014	Application of Remote Sensing to Generate Historical Water Quality Data to Support Lake Management in Indonesia	Luki Subehi	8	Tools (Remote Sensing)	2019
015	Environmental Education: Its Evolution, ESD, Participation and Governance	Masahisa Sato	8	Concepts (Environmental Education)	2019
016	Monitoring and Evaluation of Water Quality and Ecosystem in Lakes, Rivers and Coastal Zones in Japan	Shigekazu Ichiki	8	Water Quality Management	2019
017	Introduction to Lake Modeling	Shinji Ide	8	Tools (Modeling)	2019
018	Assessment of Management of Lake Malawi Basin through Application of ILBM-Based Tools	Clara L. Chidammodzi	10	Tools (ILBM Assessment)	2019
019	The Lake Cluster Pokhara Valley: An Overview of Lake Basin Environment and Governance Improvement	Shailendra Kumar Pokharel	10	Case Study, Concepts (Planning)	2019
020	Strengthening Integrated Lake Basin Management Implementation in Malaysia through Research Framework	Zati Sharip	10	Case Study, Concepts (Planning, Information)	2019

No.	001
Title	African Lake Basin Management: Key Issues and Challenges
Author	Daniel Olago
Modules	1 Presentation Report
Category	Case Study
Year	2019

Summary and Key Messages

This paper provides insights on a wide range of issues needed to understand and solve the problems relating to sustainable lake basin management, including: geophysical, climatological, socio-cultural and socio-economic development features, geohistorical changes, and global political history. The paper emphasizes the importance of taking a long-term (trans-generational) view since lakes tend to have a slow response time to some types of perturbations (e.g., pollution), a rapid response time to other types of perturbations (e.g., hydrological changes), and react with perceptible ecological effects to climate change.

Biophysical and socio-economic context: Increasing human populations in lake basins are impacting lakes negatively

- The human populations in many of Africa's lake basins are generally increasing and exerting increasingly rising pressures on the lakes leading to problems such as sedimentation, eutrophication, overfishing, species introductions, pollution and habitat destruction and biodiversity loss.
- Global warming and climate change pose the latest threat to the lakes.

Geological context: The "amplifier" lakes of the East African Rift Valley are highly climate sensitive

- Many lakes in the East African Rift Valley system are "amplifier lakes", meaning that they are highly sensitive to climatic changes, particularly in rainfall and temperature. Thus, apparently small changes in precipitation if persistent, can result in large hydrological responses such as drying or filling up.
- Long-term tectonic processes through which the lakes were formed have resulted in a basin morphology and precipitation-evaporation contrasts in the catchment areas which make the lakes very sensitive to climate change.
- Amplifier lakes link long-term tectonic processes and short-term environmental fluctuations, providing a possible explanation as to why East Africa may have been the origin of humankind because of the strong link between different time-scales (Trauth et al., 2010).

Governance context: Development of a National ILBM Strategy is ongoing in Kenya and similar efforts are expected to be replicated in other African countries

- Integrated Water Resources Management (IWRM) and Integrated River Basin Management (IRBM) approaches have been adopted by most countries in Africa, but these approaches have still not given lakes the kind of attention they deserve because of the complex socio-ecological systems.
- The Government of Kenya, with support from ILEC, has been developing a national ILBM strategy to mainstream lake basin management at the nationally. Such efforts are expected to be replicated in other African countries over the coming years, to ensure sustainable management of lakes in the content.
- ILBM plans are yet to be implemented at most lakes in Africa due to several factors, including: 1) Political jurisdictions (within and between countries) with competing needs, 2) Sectoral approaches to managing lake basin resources without harmonization of policies, strategies and programmes in lake basins, 3) Overlapping and duplicated institutional roles; 4) Inadequate or ineffective decision-support tools; 5) Low and uncoordinated participation by stakeholders; Inadequate levels of transboundary coordination; and 6) Differentiated and generally low capacities to manage transboundary lake basins.

Ref. No.	002
Title	Cyanobacterial Problems in South American Reservoirs: Historical Background, Current Status and Prospects for Countermeasures
Author	Sandra Azevedo
Modules	2 Presentation Report
Category	Lake Science Subjects
Year	2019

Summary and Key Messages

This paper provides an overview of cyanobacterial problems in Latin American reservoirs focusing on: 1) Causes and problems associated with cyanobacteria blooms and cyanotoxins, 2) Review of the current knowledge and state of research in Latin America, and 3) Critical gaps in research in Latin America and proposals for improvement.

Causes and problems associated with cyanobacteria blooms and cyanotoxins

- Harmful effects of cyanobacterial blooms include potential intoxication of humans and animals by cyanotoxins, crop contamination by irrigation with contaminated water, fish mortality, oxygen depletion, odour and taste problems in drinking water, and aesthetic problems in surface water.
- In Latin America, cyanobacteria bloom in surface water bodies is caused by the impact from diverse human activities in the drainage basins.
- Poor management of water prevails in Latin America. For example, only about 20% of wastewater is safely managed resulting in more than 20 million people living without clean, safe drinking water (WHO, 2017).
- Thus, public health in Latin America is at high risk of waterborne diseases due to pollution of water bodies including drinking water supplies.

Current knowledge and state of research in Latin America

- Cyanobacterial bloom occurrence and cyanotoxin analysis are well known in several Latin American countries, but there are few official reports and published data.
- Most published reports are on general issues on cyanobacteria, with reports about toxic cyanobacteria being relatively fewer and concentrated in six countries only.
- Divided according to research areas, the number of published studies in Latin America decreases in the order: 1) Taxonomy (identification and classification of bacteria), 2) Monitoring, 3) Ecology, 4) Chemistry, 5) Toxicology, 6) Molecular biology, and 7) Modeling.
- Researches on taxonomy, ecology, chemistry and toxicology are mainly undertaken by universities and are highly depend on availability of funding.
- Monitoring programs are undertaken by Environmental Agencies, which are generally not well resourced with technical expertise on causes and consequences of cyanobacteria blooms.
- Molecular biology studies, which are fundamental to toxic cyanobacteria issues, lag behind because of high cost associated with them.
- Modeling studies also lag behind because most aquatic ecosystems lack the basic minimum set of data for modeling since monitoring on most ecosystems is not continuous and not long-term.

Critical gaps in research in Latin America and proposals for improvement

The occurrence and consequence of cyanotoxins are usually underestimated by critical gaps in knowledge about ecology and physiology of harmful cyanobacterial species, management actions, and analytical methods for toxin detection. The following strategies are recommended to address the gaps:

- Taxonomy and systematics: Identification and classification of cyanobacterial groups.
- Monitoring: Establishment of continuous structured monitoring programs to collect long-term historical data and local knowledge to facilitate implementation of preventative plans and remedial measures.
- Ecology: Two important questions to be addressed are: 1) How do environmental forces drive toxic cyanobacteria and their biological interactions?, and 2) What are the effects of eutrophication and climate variability on the occurrence of toxic cyanobacterial blooms?
- To implement Chemical and (Eco)Toxicological studies related to cyanotoxins it is essential to improve the facilities and expertise available for analytical techniques.

No.	003
Title	Lake Baringo: A Transient Environment, Diversity and Livelihoods
Author	Jones Muli
Modules	3 Presentation Report
Category	Case Study
Year	2019

Summary and Key Messages

This "Lake Brief" for Lake Baringo, Kenya provides an overview of the lake basin and its management. The current Lake Brief updates an earlier one by Odada et al. (2006), providing recent information and data on water quantity and water quality monitoring, biodiversity, socio-economic and management environment of the lake. Lake Baringo is a shallow, internal drainage, freshwater lake located in the Kenyan Rift Valley with a drainage basin area of 6,820 km2 and a surface area of about 100 km2. The lake has a variable surface area, water depth and physical chemical characteristics. The rivers flowing to the lake are characterized by high variation in annual discharge. The lake is an important source of water for humans and livestock, as well as a significant income source for local communities through activities such as tourism, biodiversity conservation, and fish.

Threats to the Lake Basin Environment

- Sedimentation as a result of land use changes in the drainage basin. For example, forests decreased by ca. 50% since 1976 following deforestation to create land for farming.
- Water level change. For example, the mean water depth was 5.6m in the 1960s, more than 8m in the late 1970s, 3m in 1994, and 10.6m in 2013.
- Overfishing
- Climate change/variability

Major Impact Stories

- Fishermen involvement was strengthened by legalizing Beach Management Units (BMUs).
- The depth of the lake has increased from the time the last lake brief was prepared by Odada et al. (2006). The mean depth increased from 3m in 2003 to 10.6m in 2013, even though Odada et al. (2006) had predicted a continuous decrease in lake depth to 2050. As of early 2021, Lake Baringo, like all other Rift Valley lakes in Kenya was still facing a flooding problem with many households and businesses around the lake displaced.
- Recent studies demonstrate that the lake is climate sensitive, with lake water quality and fishing effort being highly variable because of the highly variable lake environment (especially water level). In earlier years of the 2000 millennium, the water of Lake Baringo had very low aesthetic value as its water was deep tea brown in color. However, since 2012, the lake water quality improved greatly with the transparency increasing 100 times. In early years of the millennium, sedimentation was assumed to be the cause of deteriorating water quality, however, the long-term view shows that the lake water quality is variable and corresponds to climatic pattern of the catchment and more so of climate change. Recent fossil diatoms evidence of the past 200 years showed water level fluctuations in lake are as consequence of climatic variations which follows 50 year climatic cyclic pattern. Thus, the lake is climate sensitive. Similarly, fluctuations in the fish production were always attributed to fishing effort, however, it has been demonstrated that a variable lake environment is responsible.

Major Lake Basin Governance Issues

- Sectoral approach to the management of the lake, with each organization implementing its plans according to its mandate.
- Lack of national or county government strategy or plan for managing the lake. Major interventions in the lake basin have been on project basis (local and donor funded), often ending once the funding terminates.
- Vandalism of scientific equipment for water monitoring is a common feature in the basin.

No.	004
Title	Into the Golden Year of Lake Basin Management in Laguna de Bay, Philippines
Author	Adelina Santos-Borja
Modules	4 Presentation Report
Category	Case Study, Concepts (Institutions and Policies)
Year	2019

Summary and Key Messages

This paper, based on the Lake Brief for Laguna de Bay in the Philippines, focuses on institutional development and change for lake basin management. It highlights the central role played by Laguna Lake Development Agency (LLDA), the only lake basin management authority in the Philippines. The current paper updates an earlier paper (Santos-Borja and Nepomuceno, 2006) with new developments in three main issues, namely: 1) Implementing ILBM at sub-watershed scale, 2) Managing aquaculture conflicts using Fishery Zoning and Management Plan (ZOMAP), and 3) Heightened increase in the use of the lake as a source of domestic water for Metro Manila.

Policy and Institutional Framework for implementing ILBM at sub-watershed scale

- The Philippine Clean Water Act of 2004 facilitates the development of a more participative approach in the protection and management of the country's water resources. The Clean Water Act provides for designation of certain areas as Water Quality Management Areas (WQMA). The governance of WQMA is delegated to local governments.
- The Laguna de Bay Region was the first WQMA to be designated, and all the 24 sub-watersheds were designated as Sub-WQMAs, with implementation of an Integrated Watershed Management Program (IWMP) in each sub-watershed being approved. LLDA further expanded the participation of various stakeholders in each sub-watershed through the creation of a Watershed Management Council (WMC) in each sub-WQMA.
- The Sta. Rosa sub-watershed was the first sub-WQMA to be organized since 2014 through initiatives of diverse stakeholders in the sub-watershed. The sub-watershed, especially the city of Santa Rosa, is facing tremendous pressure from rapid urbanization and industrialization. A common Action Plan was jointly formulated by the WMC and various environmental conservation activities have been initiated in the sub-basin. The WMC serves as a platform for continuous dialogue and joined efforts for the improvement of the environment in the sub-basin. The efforts in Sta. Rosa sub-watershed are being duplicated in other sub-watersheds.

Aquaculture conflicts, and the Fishery Zoning and Management Plan (ZOMAP)

- In the past (1980's and 1990's) a serious conflict existed between the fish pen operators (businessmen) and traditional fishermen. The conflict was resolved in 1983 by introducing a Fishery Zoning and Management Plan (ZOMAP). In recent years, faced with a threat of a possible "no fish pen policy" in Laguna de Bay by the National Government, the two groups closed ranks and formed a united front on the continuation of aquaculture business in the lake.
- The old ZOMAP was revised in 2019 following a presidential directive to transform Laguna de Bay into an economic zone and to give priority entitlements to fishermen. The carrying capacity of the lake for aquaculture was reduced from 150km2 to 92km2. Traditional fishermen are allocated 60% of the area, while fish pen operators (businessmen) are allocated 40%.

Heightened interest in the use of the lake as a source of domestic water for Metro Manila

- There has been heightened interest in the use of the lake as a source of domestic water for Metro Manila following a severe water shortage in early 2019 resulting from the drying up of the reservoir that is the main source of water for Metro Manila. The water supply utilities had to resort to Laguna de Bay as a source of water.
- How to improve the water quality of the lake from Class C (for fisheries and other compatible uses) to Class B (source of raw water for domestic supply which requires treatment) is an issue to be addressed. Water quality issues of particular concern are eutrophication and toxic contamination.

No.	005
Title	Role of District-level Organization in Decentralized Arrangement of Irrigation Management: Lessons from Water Users Association of Farmers in Japan and Egypt
Author	Tsugihiro Watanabe
Modules	4 Presentation Report
Category	Case Study, Concepts (Institutions and Participation)
Year	2019

Summary and Key Messages

The key question addressed by this paper is "what is the appropriate organization (governmental or non-governmental) to manage intermediate scale irrigation structures such as a branch canal?". The paper discusses decentralized participatory irrigation water management in Japan through district-level non-governmental water user organizations called Land Improvement District (LIDs). This Japanese model is shown to result in effective irrigation management and appropriate operation of irrigation systems, since the users participate in decision-making and act as the managers and operators at both farm level and tertiary level. Based on experiences and lessons learned in the case in Japan, the paper assesses how these lessons can be applied in developing countries in general and in Egypt in particular by introducing a case study on participatory irrigation water management in Egypt.

Land Improvement District (LID): Farmers' water management organization in Japan

- The irrigated paddy areas in Japan are institutionally divided into Land Improvement Districts (LIDs). LIDs are non-governmental entities legalized in accordance with the Land Improvement Act of 1949. The total number of LIDs was 4,455 in 2018 with 3.53 million beneficiary members (farmers) on 2.51million ha land. The size of land under each LID ranges from less than 100 ha to 10,000 ha.
- The functions of LID are: 1) to execute smaller scale facility construction or rehabilitation project; 2) to allocate and distribute water among users; and 3) to maintain irrigation and drainage facilities above tertiary level. LIDs ensure a stable water supply (including settlement of conflict among users), higher water use efficiency, and effective measures for water shortage in drought or dry spell.
- Construction of irrigation facilities is carried out mainly by the national or local governments, and by LID for small scale facilities. The operation and maintenance (O&M) of the constructed facilities is basically carried out by LID, including those constructed by the government. National or local governments carry out the management of larger facilities, including larger reservoirs and diversion works. LID responsibility for O&M is limited to control structures and canals above tertiary level. Individual farmers and farmers' associations/groups manage and control all facilities on-farm and tertiary levels, on almost voluntary basis or with cheap payment. The role of tertiary level farmers' association is indispensable to O&M of irrigation facilities. These tertiary level farmers' associations function well even though most of them are not legally authorized (unlike the LID which is legally authorized).
- LIDs work in close collaboration with different levels of government to ensure efficient delivery of services.

Lessons from Japan's Experience for Developing Countries

- District-level non-governmental irrigation management organization can replace similar governmental organization. Such institutional restructuring or decentralization can lead to effective irrigation management and appropriate operation of systems.
- Tertiary level association is indispensable to O&M of irrigation facilities, and it could function even if it is not legally authorized.
- Well-organized cooperation of non-governmental organization with governmental organization is required to secure and enhance the performance of the non-governmental organization.

No.	006
Title	Sewerage Policy and Finances in Lake Basin Management, a Case of Lake Biwa, Japan
Author	Naoko Hirayama and Masahisa Nakamura
Modules	4, 7, 9 Presentation Report
Category	Case Study, Concepts (Policies, Technology, Financing)
Year	2020

Summary and Key Messages

Sewerage systems can play a very important role in reducing pollution loads from households and other point sources of pollution. The development of sewerage systems for lake basin management invariably requires mobilization of financial resources, technology application capacity, as well as due institutional basis for implementing the long-term program for construction, operation, maintenance, as well as management of the systems. This paper gives an overview of the sewerage policies and finances in lake basin management in Japan, with particular reference to the Lake Biwa Basin in Shiga Prefecture. The information provided is hoped to facilitate the understanding of institutional and financial challenges to overcome in resorting to sewerage systems for lake basin management in the world, particularly in developing countries.

Historical Context

- Historically, there were occasional incidents of epidemics in late 19th through mid-20th century when improvement of human excreta management and water pollution control were only slowly making progress. The WW2 devastations and the subsequent population increase and rapid industrialization in the 1950s and 1960s was hardly matched by the amount of environmental infrastructure investment, resulting in rampant water pollution and public health outcries.
- It was in late 1960s and early 1970s when the legal frameworks were aligned to accelerate the environmental and sanitation infrastructure investment, with mobilization of the necessary financial resources by the responsible national and local government offices. Initially the process was fragmented across sectors, but in mid-1990s the fragmented sectoral policies and programs on sewerage management began to be unified.

Institutional and Legal Framework

- Among others, two pieces of national legislation particularly helped to accelerate the spread of sewerage systems in Shiga Prefecture. They are the Special Measures Act for Lake Biwa Comprehensive Development (the LBCDP Law, enacted in 1972) and the Law Concerning Special Measures for Conservation of Lake Water Quality (the Lake Law, enacted in 1984).
- The LBCDP Law was enacted to realize water resources development, flood control and infrastructure development, of which the construction of Lake Biwa Regional Sewerage System was a major component. It was inaugurated in 1972 and completed in 1997, with special financial arrangements involving the national government and the downstream prefectural governments. Large scale financial mobilization for Lake Biwa Regional Sewerage System was made possible under the exceptionally favorable public investment for development of sewerage across Japan.
- Under the Lake Law, Lake Biwa was identified as one of the “designated lakes” whose water quality is in need of urgent improvement. The Lake Law requires Shiga Prefectural Government to implement a 5-year cyclic plan for lake water quality conservation, with clear targets for improvement.

Financing

- Mobilization of financial resources for sewerage systems is undertaken by the responsible national and local government departments.
- Capital costs such as construction costs are mostly covered by national treasury subsidies and local bonds, and the beneficiaries bear only the cost of developing end culverts. Local bonds are redeemed at a fixed amount every year from the viewpoint of intergenerational equity.
- Maintenance cost is based on the principle of public rainwater and private sewage, meaning that the local government meets the proportion of the cost for rainwater while user fee covers the portion for sewage (about 60% and 40%, respectively, for public sewerage).
- Long term financing of sewerage infrastructure is a challenge given the declining population in Japan.

No.	007
Title	Water Resources Management within the Climate Change Context in Africa
Author	Salif Diop
Modules	5 Presentation Report
Category	Specific Special Subjects (Climate Change)
Year	2019

Summary and Key Messages

This paper provides a cross-cut of the key insights of individual expert contributions in a book published in 2021 entitled "Climate Change and Water Resources in Africa: Perspectives and Solutions Towards an Imminent Water Crisis" (Diop et al., Eds.). It provides an overview of the current knowledge of climate change/water resources interactions, illustrated by a variety of regional, national and local level case-studies; discusses tools and methodologies, governance and institutional issues, and specific management approaches; and presents possible options and actions for improved management of water resources within the context of climate change in Africa.

Africa's climate and Climate Change

- Large parts of Africa are subject to seasonally variable hydrology and geographically uneven distribution of water resources. This will be compounded by climate change, to which Africa is particularly vulnerable.
- Climate change projections for Africa, like many climate projections, have large margins of uncertainty but there is a clear signal of warming across the continent since the 1960s.
- Climate projections show a possibility of mix drought in the horn of Africa and increased and more intense tropical storm events in the southern Indian Ocean by the end of the century, with significant impacts on agricultural production.
- IPCC predicts that across the continent, streamflow will change from -15% to +5% by 2050. In southern Africa almost all countries will experience a decrease in streamflow. In other areas there is a lack of certainty.
- Climate change and green water use in agriculture poses some risks as well as opportunities. Risks include increased soil erosion and reduced crop production due to reduced crop growing period in some regions. Opportunities include increased rainfall in some regions.
- The blue water use as a result of growing domestic consumption through urbanisation is also at risk of climate change. Under climate change, projected increased urbanisation through unplanned settlements in Africa over the next century will pose challenges to weak infrastructure and management systems.

Challenges of water resources management in the context of Climate Change in Africa

- Climate change is likely going to bring more frequent and more intense water-related disasters in many parts of Africa.
- Currently, it is difficult to predict climate change impacts on water systems with any accuracy; therefore, the challenge is to ensure flexible planning that incorporates adaptation measures to long-term climate change.
- To ensure water security under climate change scenarios, there is need to properly manage rivers, groundwater resources, lakes and reservoirs as readily-usable sources of large volumes of freshwater.

Measures for improved water resources management in the context of Climate Change in Africa

- Creating enabling policy and institutional frameworks
- Investing in ecological infrastructure
- Investing in climate smart infrastructure and technologies
- Improved science and information
- Working at different scales
- Decentralized adaptation at different levels
- Considering the water/energy/food and health nexus

No.	008
Title	Climate Change Adaptation and Mitigation Measures in the EU Water Environments
Author	Tiina Nõges and Peeter Nõges
Modules	5 Presentation Report
Category	Specific Special Subjects (Climate Change)
Year	2019

Summary and Key Messages

This paper reviews the information available in reports and scientific literature about potential or planned water related measures tackling climate change causes and consequences in the European Union (EU). There are different concerns and different adaptation plans and strategies even in neighboring countries. The span of measures is wide both by the main purpose (flood management, water scarcity, water quality, biodiversity, CC mitigation), type of intervention (legislative, administrative, financial, educational, hydrotechnical, technological, land use), and especially by the scale of generalization. Given the overlapping character and the enormous scale differences among measures, to make a comprehensive overview, the measures are grouped under a limited number of three general principles of environmental suitability, namely 1) Keep things in place, 2) Keep things natural and 3) Be informed and plan your actions.

Keep things in place

- Keep carbon in its present pools
- Keep water in the catchment by creating retention basins and slowing down the run-off
- Keep substances at source avoiding them becoming pollutants
- Keep species within their natural habitats

Keep things natural

- Protect and restore the natural regulating function of catchments, rivers, floodplains and coasts in order to manage water quality and to alleviate flood and coastal erosion risk.
- This could involve flow modification, floodplain reconnection instream and coastal habitat improvement, and riparian management.
- Restoring degraded peat bogs and reforestation will also help to slow run-off and increase infiltration.

Be informed and plan your actions

- A large and heterogeneous group of measures dealing with administrative issues, planning, and capacity building in the sense of research, education and stakeholder involvement. According to temporal scale, these issues can be divided into long-term, medium-term and short-term or operative issues.
- Inherent Uncertainty calls for Application of the Precautionary Principle: There is much uncertainty involved in both the climate change projections and reactions of aquatic ecosystems, and hence an undeniable need for the wide application of the precautionary principle.
- Long-Term Capacity Development: Research is needed to decrease the uncertainty in climate change models by filling knowledge gaps. All climate change and adaptation strategies contain as a basic principle the research needs to improve the temporal and spatial resolution of climate projections and to advance our knowledge on the relationships between climatic variations and water resources, ecosystems, flood risk, and pollution spreading.
- Medium-Term Management (Adaptive Planning in the RBMP Cycles): Adaptive planning measures within the time frame of a river basin management (RBMP) cycle of 6 years can be based on rather solid climate projections. These measures deal with concrete targets aiming at certain water resources regulation schemes, prioritization, water saving, metering, abstraction and discharge licensing and pricing.
- Short-Term Operative Measures: These include development of disaster forecasting early warning systems.
- Streamlining of Strategies and Avoiding Potential Cross-Sectoral Trade-offs in River Basin Management.

No.	009
Title	Participation in Japan
Author	Shinji Ide
Modules	6 Presentation Report
Category	Concepts (Participation)
Year	2019

Summary and Key Messages

This paper, with a special focus on Community Based Organizations (CBOs), discusses how Japanese citizens have been taking active and effective part in the conservation of the water environment. Several case studies on Lake Biwa in particular and Japan in general are introduced. CBOs, such as Basin Consociations, as well as non-governmental organizations (NGOs) are playing a key role in environment protection today in Japan. Those organizations are not only spokespersons or agents of people but also important partners of governments. Without collaboration with CBOs or NGOs, environmental administration cannot be carried out these days. However, CBOs in Japan have a unique and complicated social background.

Community Based Organizations (CBOs) in Japan

- There are two different kinds of CBOs in Japan, one is traditional Japanese community organization (TJCO) style and the other is western style (such as Basin Consociations), both playing complementary roles.
- Many different types of CBOs have been established in Japan since 1970 through Community Building Activities (CBAs) supported by both local governments and the central government.
- CBO activities also try to meet local people's diverse needs such as cultural needs and human services.

Lake Biwa Soap Movement

- The movement originated in the beginning of 1970s with a Use-Soap campaign by homemakers who were concerned about babies' diaper rash and housewives' eczema caused by synthetic detergents.
- In 1977, with an outbreak of red tide in the Lake Biwa, the movement changed its direction, shifting to a boycott campaign of phosphate-containing synthetic detergents to prevent eutrophication (red tide).
- Backed by strong public support, Shiga Prefectural Government enacted Eutrophication Control Ordinance, the very first act for eutrophication control in Japan, in 1979.

Other Water Environment Protection Movements in Japan

- Other distinguished examples of citizens' movement in protecting the water environment in the other part of Japan, include: (1) Isahaya Bay Reclamation Project, (2) Nakaumi-Shinji-ko Reclamation and Desalination Project, (3) Partnership in Yahagi River Basin, and (4) Watershed conservation of Shimanto River.
- All these cases demonstrate how citizen activities, sometimes starting as protest movement, have evolved into citizen activities for conservation and preservation of the water environment.

Community Initiative and Basin Consociations at Lake Biwa

- Shiga Prefectural Government (SPG) established 13 environmental protection groups, named "Basin Consociation" at each sub-basin of major rivers flowing into Lake Biwa to implement the "Mother Lake 21 Plan", a comprehensive conservation plan for Lake Biwa of the 21st Century developed by SPG in 2000.
- The consociations were typical CBOs consisting of local organizations and people, and had strived for the comprehensive conservation of Lake Biwa through collective efforts and activities at each watershed.
- Although there were high expectations for Basin Consociations when they were formed, regrettably, most of them had ceased their activities by 2020. There has been a shift towards activities involving a wider range of citizens, focusing on, among others, conscious individuals.

No.	010
Title	Chilika Lake: Restoring Ecological Balance and Livelihoods through Re-Salinization
Author	Ajit K. Pattnaik
Modules	7 Presentation Report
Category	Case Study, Concepts (Technology)
Year	2019

Summary and Key Messages

This paper focuses on successful technological intervention to re-salinize and restore ecological balance and livelihoods in Chilika Lake, India. The paper updates the Chilika Lake Brief prepared earlier (Ghosh et al., 2006) with recent information on changes and status of basin management in the last 15 years.

Background

- The unique ecosystem, biodiversity and productivity of the lake were on the decline during the early 1990s, because of blockage of the lake's mouth by silt coming from upstream catchments, as well as oceanic long-shore transport.

Approach Taken and Results

- Chilika Development Authority (CDA) was created by the Government of Odisha in 1992 to address the multiple issues involving multi-stakeholder interests and for sustainable management of the lake and its basin.
- The dynamic salinity of the lake was restored by dredging a new mouth to the lake in 2000, based on results of modeling studies done by local experts.
- To address the lake basin issues, participatory micro-watershed management concept was adopted by CDA, with a "sustainable livelihood" approach for the holistic management of natural resources of the basin.
- Management efforts by CDA resulted in a spectacular revival of the lake ecosystem and fishery resources and contributed to a sharp rise in the incomes of fisherfolk.

ILBM6 Principles as Viewed from this Case

- This case study illustrates, with concrete examples, how the strategy adopted by CDA for successful restoration and management of Chilika Lake mimics the principles of the six pillars of ILBM, and provides lessons learned from the perspective of each of the six pillars of ILBM.
- The primary feature of the restoration model is the integration of the basin and the coastal process with active participation of the local communities with a shared decision-making process.
- Another strong attribute of the restoration initiative is the presence of enabling institutional framework, policy support and "good governance".
- Institutional coordination mechanism is identified as the greatest strength of CDA because of its ability to coordinate among various agencies, departments and resource user groups, by virtue of its Governing Body being headed by the Chief Minister of Odisha State.

No.	011
Title	Assessment of Pollution Load on the Kenyan Catchment of Lake Victoria Basin using GIS Tools
Author	Charles Kipkoech Cheruiyot
Modules	8 Presentation Report
Category	Tools (Modeling, GIS)
Year	2019

Summary and Key Messages

This paper provides a case study on modeling and assessment of pollution load on the Kenyan catchment of Lake Victoria using GIS and remote sensing technologies under data scarce conditions.

Background: Data scarcity is a major limitation to pollution load assessment

- Estimation of pollution load to Lake Victoria has been carried out by several studies in the past. However, these efforts have always been hampered by scarcity of data which adversely affects the accuracy and reliability of results. The methods used in the past borrowed nutrient export coefficients (UAL) from other areas to estimate pollution load in Lake Victoria basin. The borrowed coefficients were not adjusted to fit local conditions because of lack of relevant data and information.
- This paper addresses these gaps by developing a framework for estimating local coefficients based on observed water quality and quantity data. The paper also undertakes simulation of hydrology, sediment and nutrients as well as watershed management plans to provide useful insights on amount of pollution load and effectiveness of various watershed interventions.

Approach used

- First, estimation methods of pollution load in Lake Victoria in past studies were reviewed and their strengths and weaknesses highlighted in tandem with advancement in technology in watershed modelling.
- Second, nutrient export coefficients for three land covers (cropland, forest and vegetation/grassland/shrubland) were derived using a model equation with land use and rainfall-runoff coefficient as main variables.
- Third, hydrology, sediments and nutrients (TN & TP) as well as their spatial-temporal distribution in the watershed were simulated using Soil Water Assessment Tool (SWAT) to identify sediment and nutrients source hot spots.
- Finally, effectiveness of three watershed management plans (maintaining the existing situation, application of 1 m filters on agricultural land covering 54 % of the watershed, and 11.2 % addition of forest cover through reforestation) was assessed using SWAT.

Findings

- Nutrient export coefficients were estimated with satisfactory performance for the three land-covers both at validation phase and when matched with those in literature.
- The SWAT model performance was satisfactory at both phases of stream flow and sediment simulations with scarce observed data notwithstanding.
- For sediment loss management, focus should be on downstream, Central and upstream West of Sondu watershed which are high sediment and nutrient yield zones; and during February - April and November – January.
- Areas covered by agriculture and densely populated are hotspots for yielding high sediment, runoff, and nutrients.
- Application of filters on agricultural HRUs reduced the yield from the baseline annual sediment yield of by 17% while reforestation reduced by 28%. Both filter and reforestation plans were more effective in wetter months; Reforestation plan consistently ranked higher with respect to sediment yield reduction in both time and space.
- Use of reforestation upstream and filters downstream was proposed as a watershed management strategy.

No.	012
Title	GIS-based Lake Basin Delineation and Computation of Risk Indicators as part of the TWAP Project
Author	Khila Dahal
Modules	8 Presentation Report
Category	Tools (GIS)
Year	2019

Summary and Key Messages

This paper presents a GIS-based methodological tool for delineation of lake drainage basins and computation of risk indicators that was applied in the Transboundary Waters Assessment Project (TWAP). The paper presents a few selected illustrations to show how simple GIS-based overlay operations can be used to help make comprehensive assessments of lake/river-basins, and their risk ranking, which ultimately provides a paramount amount of help to make decisions toward an efficient management of our stressed resources of surface water.

Methodology

- The first task is to delineate the drainage basins of the lakes, which is accomplished by using commonly available GIS tools and functions.
- The second step is to overlay other relevant data (such as population) on top of the drainage basins.
- The third task is to compute indicator data for each lake basin so that the lakes can be compared statistically in terms of composite score of all indicators included.
- The fourth step is to normalize (i.e., standardize) these indicator values into the same ranking scale such as 0 to 1.
- The final task is to combine the indicators to get the composite risk/threat score for each lake.
- The computed composite risk can be visualized as a risk/threat map in GIS.

Results and Significance

- As part of the TWAP Lakes Project, a comprehensive database of global transboundary lake basins was developed. The risk ranking carried out in the study is expected to assist national and international agencies such as Global Environmental Fund (GEF) to prioritize their fund allocation and management projects.
- The results (derived based on a non-weighted linear combination scores for a selected set of indicators) show that Lake Ranseren along with the cluster of other small-sized lakes bordering Norway and Finland is the least degraded transboundary basin lentic water body. On the other hand, Lake Kalmalo at the border between Nigeria and Niger is at the highest risk. Overall, the lakes in desert areas and with higher population densities within the basins are in highly degraded condition, thereby wanting the prioritized management efforts.
- The illustrations presented here do not represent the actual final results and conclusion of the TWAP Lakes Project. It describes a part of the methodology adopted for the project. For details, refer to Rast et al., 2016.

No.	013
Title	Open Source GIS-based Lake Basin Delineation Procedure: a Tutorial
Author	Khila Dahal
Modules	8 Presentation Report
Category	Tools (GIS)
Year	2020

Summary and Key Messages

This document provides a detailed GIS-based procedure to delineate lake watersheds (other names include drainage basin and catchment area). The purpose is to illustrate a procedure for lake basin and stream network delineation based on digital elevation model (DEM) in a freely available open source GIS platform. This document is accompanied by a video tutorial, which explains some of the steps in a more meaningful way with visual graphics and screen-shares. Therefore, it is a better idea to refer to the video version of this tutorial as needed. These two versions are complementary to each other. For GIS beginners, it is recommended that going through this document be done as an actual exercise on the computer, rather than by merely reading of the text, in order to enhance the learning process.

Methodology

- QGIS (https://www.qgis.org/en/site/) is the selected open source GIS platform for use in this tutorial. Other commonly used open source Desktop GISs are GRASS, SAGA, GeoDa, DIVA-GIS and gVSIG. QGIS was selected because it is a more comprehensive platform outperforming other existing open source GIS packages. On top of being an open source platform, it is user-friendly, highly reliable (i.e. not buggy), faster in geo(processing), presents a better documentation along with elaborate illustrations and tutorials, has one of the largest GIS user-communities, allows for the widest range of geoprocessing operations, and consumes all GIS data types. It comes with most regular and timely updates. Moreover, it is treasured with an ever-growing number of native as well as user-developed plugins. It integrates external packages such as GRASS, GDAL and SAGA, thereby adding to the repository of available tools and operations.
- In this tutorial, QGIS is used to generate basin boundary and stream networks. Generally, hydrology and channel tools such as Fill Sink, Flow Direction, Flow Accumulation, Stream Orders and Upslope Area are run in a special sequence in GIS for the delineation purpose (Figure 1). In the QGIS desktop interface, these tools are available under GDAL, GRASS and SAGA toolboxes as QGIS well integrates these packages and other plugins. Although the Hydrology tools under each of these packages/plugins work in their own special way, in this tutorial SAGA tools are used simply because SAGA has an edge in terrain analyses and spatial statistics. SAGA has a more sophisticated array of Hydrology and Channels tools with comparatively more accurate algorithms and their smooth (bugless) implementation. Thus, SAGA tools are run from within the QGIS interface in this exercise.
- Here, different hydrology operations such flow direction, flow accumulation, streams, stream segments, and watersheds are run using both raster and vector datasets.
- Figure 1 below illustrates the generic lake/river basin delineation workflow used in this tutorial.

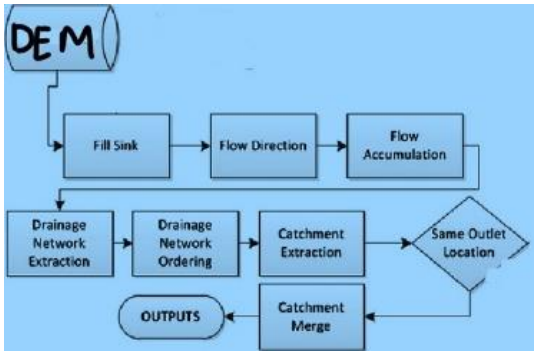

Figure 1. A generic lake/river basin delineation workflow
(adapted from Anornu et al. 2012)

No.	014
Title	Application of Remote Sensing to Generate Historical Water Quality Data to Support Lake Management in Indonesia
Author	Luki Subehi and Fajar Setiawan
Modules	8 Presentation Report
Category	Tools (Remote Sensing)
Year	2019

Summary and Key Messages

This paper provides an overview of assessment of historical lake water quality in Indonesia using remote sensing. More specifically, the paper introduces the work of Setiawan et al., (2019) on development of an empirical model and its application to capture the long-term change of Secchi disk depth (SD) in Lake Maninjau from 1987 to 2018 from Landsat TM and ETM+ data.

Objectives of the Study

- Develop a robust SD estimation model by using a wide range of in situ-measured SD values (0.5–18.6 m) collected from nine Indonesian lakes/reservoirs and the corresponding atmospherically-corrected and filtered Landsat TM and ETM+ images.
- Evaluate the performance of the developed SD estimation model using another in situ-measured SD dataset collected from Lake Maninjau, Indonesia.
- Generate a long-term SD database for Lake Maninjau from historical Landsat TM and ETM+ images (1987–2018) using the developed SD estimation model.
- Determine the water quality changes of Lake Maninjau during the study period by using the generated SD database, in order to further confirm the robustness of the developed SD estimation model.

Major Results and their Significance

- An empirical model to estimate SD values from Landsat TM/ETM+ data was developed.
- Results of estimated long-term SD time series in Lake Maninjau indicated that Landsat data, along with the developed model, can be used to generate a long-term SD database to monitor water transparency changes in Indonesian inland waters.
- These findings are applicable to not only Indonesia but also other developing countries where lack of water quality data is a major problem.

No.	015
Title	Environmental Education: Its Evolution, ESD, Participation and Governance
Author	Masahisa Sato
Modules	8 Presentation Report
Category	Concepts (Environmental Education)
Year	2019

Summary and Key Messages

The concept of Environmental Education (EE) has evolved since the name of EE was used in the world community. It seems that the evolution has been strongly reflected from the needs and interests for the achievement of sustainable development and for the enhancement of quality education. This paper describes historical development of EE in terms of thematic areas and approaches, and the concept of Environment and Population and Information for Human Development (EPD) and Education for Sustainable Development (ESD) as the evolution of EE. The role of Formal Education (FE) in the context of ESD is also described.

Evolution of EE

- EE evolved to the concept of EPD, and then to the concept of ESD.

Thematic Areas Covered

- EE focused on the improvement of environment and its quality.
- EPD focused on the three aspects: (1) environment (quality and quantity); (2) development (economic, education, social services, and capacity building); and (3) population (size, growth, distribution, and structure).
- ESD expanded further, to include three spheres: Environmental Issues like waste and how waste affects every nation, as do Social Issues like employment, human rights, gender equity, peace and human security, and Economic Issues such as poverty reduction, corporate responsibility and accountability. Further it includes Overarching Issues such as HIV/AIDS, migration, climate change and urbanization. The thematic areas of ESD are comparatively diversified than the conventional thematic areas of EE.

Approaches Employed

- In EE special focus was given to quantity, knowledge transfer, formal education, cause-effect relationship and problem solving, which were emphasized under the theory of RDDA (Research, Development, Dissemination, and Adoption). The RDDA approach is characterized by a managerial-hierarchical system, technocracy, and positivistic epistemology, that learners were regarded as defective model, that experts and researchers take a role of knowledge/skills/ awareness providers.
- In ESD, special focus is given to participatory-dialogical learning, high-order thinking and action research which enable to promote bottom-up approach, knowledge acquisition and its connection, construction of values and ethics, attitude change, life-long learning through formal education, non-formal education and in-formal education. It also respects accommodation to the evolving nature of the concept of sustainability.

Education for Sustainable Development Goals (SDGs)

- SDGs consist of 17 ambitious goals to be achieved by the year 2030.
- Education is both a goal in itself and a means for attaining all the other SDGs. It is not only an integral part of sustainable development, but also a key enabler for it.
- Therefore, education (including Formal Education) is an important strategy for SDGs.

No.	016
Title	Monitoring and Evaluation of Water Quality and Ecosystem in Lakes, Rivers and Coastal Zones in Japan
Author	Shigekazu Ichiki
Modules	8 Presentation Report
Category	Water Quality Management
Year	2019

Summary and Key Messages

This paper describes the process of monitoring of water quality of surface water bodies in Japan. The paper introduces monitoring methods and evaluations using the case of water quality monitoring in public water bodies in the field of environmental administration in Japan. The monitoring takes into account the chemical composition of dissolved and suspended substances as water quality and the biota (phytoplankton, zooplankton, etc.). Sediment is also a factor that affects water quality, and it is necessary to consider it as a monitoring target, even if it is done infrequently.

Institutional and Legal Framework

- In Japan, Environmental Standards are set in the water area for items related to the protection of human health (Health Items) and the items related to the preservation of the living environment (Living Environment Items). These standards provide the basis for establishing whether a given water body meets the requirements for its intended use.
- Article 15 of the Water Pollution Control Law of Japan stipulates that Prefectural Governors should constantly monitor public water bodies. Article 16 states that the Governor shall specify items, points and methods as a water quality measurement plan.
- Article 17 also stipulates publication of the monitoring results.
- Water area managers are stipulated by various laws, but the water quality measurement plan is to be formulated by the Prefectural Governor in consultation with various agencies and the results are to be published. This does not prevent the management of the water area or the water authority from conducting individual surveys. By complementing those surveys undertaken by the government, waste can be avoided.

PDCA Cycle of Monitoring

- Clarification of objectives
- Preliminary survey
- Formulation of survey plan
- Field work
- Laboratory analysis
- Data analysis
- Evaluation of water area and analysis of causes
- Proposal for water area management

Monitoring Items, Equipment and Resources

- Monitoring Items: Water Quality (Inorganic, Organic Chemical Substances), Plankton (Phyto-, Zoo-), Microorganisms, Macrophytes, Bentos, Fish Community
- A laboratory and/or experts are essential for each item.

Public Participated Monitoring

- In Japan ordinary citizens, as key stakeholders, are involved in water quality survey activities from the viewpoint of deepening their involvement.
- Since these surveys are conducted by ordinary citizens and not experts, there are limitations on the methods that can be applied, and the survey is conducted in a limited manner depending on the purpose.

No.	017
Title	Introduction to Lake Modeling
Author	Shinji Ide
Modules	8 Presentation Report
Category	Tools (Modeling)
Year	2019

Summary and Key Messages

This paper introduces a modeling and assessment tool for nutrient balance in a lake. It is designed to help readers understand how to develop a simple lake model and run the model for simulation. It provides a step-by-step guide on the modeling process and includes a simple Microsoft Excel spreadsheet model.

No.	018
Title	Assessment of Management of Lake Malawi Basin through Application of ILBM-Based Tools
Author	Clara L. Chidammodzi
Modules	10 Presentation Report
Category	Tools (ILBM Assessment)
Year	2019

Summary and Key Messages

This paper explains an indicator framework that was developed and piloted for assessing the management of Lake Malawi basin through application of ILBM-based tools. The paper is based on an assessment that was carried out on the Lake Malawi Basin from which several publications and a doctoral thesis ensued. In this paper, a step-by-step guide on how the assessment was conducted is given in a summarized synthesis. For more details, the reader is encouraged to see Muhandiki et al. (2014), Chidammodzi and Muhandiki (2015a, 2015b, 2016, 2017), and Chidammodzi (2016 unpublished doctoral thesis).

Overall Objective

The overall objective was to conduct a comprehensive assessment and analysis of the issues, needs and challenges in the management of the Lake Malawi Basin based on the ILBM six pillars of governance framework.

Major Results

- An indicator-based framework for assessment of the ILBM six pillars of governance was developed.
- The current status of each of the ILBM six pillars of governance in Lake Malawi Basin was determined using the developed indicator framework.
- Issues, needs and challenges in the management of the Lake Malawi Basin were identified and analyzed through SWOT analysis.
- Critical points requiring management attention were identified through application of systems thinking approach.
- The paper provides a useful guide for lake basin monitoring and assessment that can be flexibly adapted to suit specific lake basin situations.

No.	019
Title	The Lake Cluster Pokhara Valley: An Overview of Lake Basin Environment and Governance Improvement
Author	Shailendra Kumar Pokharel
Modules	10 Presentation Report
Category	Case Study, Concepts (Planning)
Year	2019

Summary and Key Messages

This paper provides an overview of lake basin environment and ongoing governance improvement efforts in the Lake Cluster Pokhara Valley (LCPV) in Gandaki State, Nepal. The LCPV consists of nine lakes, namely, Phewa, Kamalpokhari, Gunde, Khaste, Neureni, Dipang, Maidi, Begnas, and Rupa lakes. The basin area of the lakes is 262 km^2 with the water bodies covering an area of 9 km^2. Lake Phewa with a surface area of 4 km^2 is the largest in the cluster and the second largest in the country by surface area. The LCPV was listed as Nepal's 10th Ramsar site in 2016. The spectacular panoramic views of the mountain ranges, rich local cultural practices and the biological diversity found in the area make the LCPV a top tourist destination. The LCPV provides diverse ecosystem services, including: drinking water and water for biodiversity, navigation, fishery, irrigation, and hydropower; recreational, religious, spiritual and inspirational values to local inhabitants and visitors.

Nepal was exposed to the 6th World Lake Conference in 2007 with the participation of Nepal's lake dedicated government institution, the National Lake Conservation Development Committee (NLCDC). Hereafter, ILEC has been building the national capacity for lake basin governance in Nepal through NLCDC to implement Integrated Lake Basin Management approach in compliance with the National Wetlands Policy (2012), 4th Ramsar Strategic Plan (2016-2021) and Nepal's National Ramsar Strategy Plan and Action (2018-2024). In this context, the Gandaki state at the gravity of federal restructuring responded first to address issues of lakes, wetlands and freshwater in the State with a special geographical focus on Pokhara valley that established a dedicated and separate entity the Lake Conservation and Development Authority (LCDA) empowered by the Forests and Watershed Policy of the Gandaki State-2018, and the Lake Conservation and Development Authority Act-2018. However, both the NLCDC and LCDA have to go a long journey in harmonizing efforts on lakes and wetlands under many overlapping institutions like Department of Forests and Soil Conservation, Department of National Parks and Wildlife Conservation, many other line agencies, and local governments such as Metropolitan Cities, Municipalities and Rural Municipalities.

Threats to Lake Basin Environment

- Reclamation of lake area and encroachment
- Sedimentation and siltation
- Pollution and eutrophication
- Spread of alien invasive species
- Overfishing and illegal wildlife poaching
- Climate change impacts

Major Drivers of Degradation

- Policy overlaps creating lack of institutional clarity about roles and responsibilities
- Weak technical capacity and governance in line agencies and communities
- Weak knowledge management
- Political instability of the past

Major Milestones in Lake Basin Governance Improvement

- Lake basin management in Nepal is gradually evolving. ILEC has made many efforts through training, workshops and exposure to improve the technical capacities of Nepal for lake basin governance. As a result, the Gandaki State has been demonstrating proactive response towards ILBM approach for lake basin management.
- National Lake Conservation Development Committee (NLCDC) was established as an apex body for conservation and development of lakes in 2007, and is responsible for the development of strategic plans for lake conservation at the national level. It also coordinates the planning and implementation of strategic plans at the provincial level in collaboration with the provincial authorities. However, NLCDC's institutional, administrative, and technical capacities are poor.

- Development of a National Lake Strategy was initiated by NLCDC in 2013 (with support from ILEC), though the process has not yet been finalized.
- "Integrated Lake Basin Management Plan of Lake Cluster of Pokhara Valley, Nepal (2018-2023)" was developed by the Government of Nepal in 2018 and is to be implemented by Gandaki State.
- "Lake Conservation and Development Authority Act-2018" has been enacted by Gandaki State to conserve, restore and manage lakes and their basins in the state. This is a first and historic initiative made at the state level in Nepal for lake basin governance.
- Lake Authority by Gandaki state has been established and in full operation, empowered by the Lake Conservation and Development Authority Act-2018.

No.	020
Title	Strengthening Integrated Lake Basin Management Implementation in Malaysia through Research Framework
Author	Zati Sharip
Modules	10 Presentation Report
Category	Case Study, Concepts (Planning, Information)
Year	2019

Summary and Key Messages

This paper outlines the national efforts made to establish an agenda for lake research and development in Malaysia directed towards Integrated Lake Basin Management (ILBM). These efforts are anchored on the recognition that research provides data and information needed to understand lake ecosystems and is therefore important in decision making for sustainable management of lakes.

Process of Development of a National Blueprint

- A national blueprint for Lake and Reservoir Research and Development (R&D) in Malaysia was developed in 2015 with the objective of preparing a common research framework and identifying priority research areas needed to support sound lake management in Malaysia.
- The scope of works involved assessing major issues and challenges, identifying research clusters and interdisciplinary research areas, and identifying lakes to be prioritized for integrated research.
- The process was led by NAHRIM (National Hydraulic Research Institute of Malaysia) and ASM (Academy of Sciences Malaysia) with collaboration from various agencies and experts.
- The blueprint was developed as one of the Action Plans for implementation of the "Strategic Plan for Sustainable Lake Basin Management in Malaysia".

Five Primary Research Thrusts and Five Secondary Cross-Cutting Thrusts

- The blueprint formulates five primary research thrusts comprising major scientific disciplines (hydraulics and hydrodynamics, pollution and water quality, eco-hydrology, biodiversity and natural products and ecosystem services) and five secondary cross-cutting thrusts (governance, climate change, technology, socio-economics and basin management).
- The blueprint emphasizes a collaborative, interdisciplinary approach involving joint research and information sharing among research institutes, institutes of higher learning and other stakeholders.

Outputs/Outcomes

- The expected main outputs of the bluepint are: 1) Lake management guidance documents such as a basin management plan, 2) Scientific publications, 3) New innovation and technology to improve or rehabilitate lakes, 4) Information database, and 5) Capacity building and resource development.
- Thirty (30) lakes (out of 98 major lakes in Malaysia) were identified as priority lakes for integrated research.
- Integrated studies have been undertaken and ILBM Plans developed for Sembrong and Batang Ai reservoirs.
- ILBM implementation has evolved from strategic planning phase to implementation phase beginning in Sembrong and Batang Ai reservoirs.
- National Lake Water Quality Criteria and Standards were established in 2015 to support research and management activities. Standardized monitoring parameters have been introduced to support lake basin management plans.
- The ultimate goal of all these efforts is to enhance research and development on sustainable lake basin management directed to conservation and development targets. The blueprint provides an integrated research framework that can support management and lead to improvement in ILBM governance elements (pillars).