International Journal of the Commons
Vol. 9, no 1 March 2015, pp. 209–236
Publisher: Uopen Journals
URL:http://www.thecommonsjournal.org
URN:NBN:NL:UI:10-1-116927

ISSN: 1875-0281

Development of indicators for assessment of Lake Malawi Basin in an Integrated Lake Basin Management (ILBM) framework

Clara Limbitso Chidammodzi
Graduate School of Environmental Studies, Nagoya University, Japan
limbitso@yahoo.com

Victor Shiholo Muhandiki
Program for Leading Graduate Schools, Nagoya University, Japan
victor@urban.env.nagoya-u.ac.jp

Abstract: This paper sought to understand the current state of the management environment of Lake Malawi Basin, deduce a lake vision and develop indicators for assessing Integrated Lake Basin Management (ILBM) in the lake basin. The premise of the study was that targeted indicators are necessary to effectively monitor the lake basin and manage it sustainably. The study focused on the Malawian side of the lake. Interviews, field observations and review of existing lake management and indicator development approaches around the world were the methods employed. It was found that Malawi lacks focus on lakes in its strategies and the existing management of the lake is on a sector-to-sector basis with little coordination. Furthermore, the capacity of lake-related sector institutions is hampered by inadequate resources and unstable flow of funds. It was concluded that the current management of the lake basin is unsustainable and there is need to comprehensively monitor the lake basin as well as formulate and implement management plans and strategies that are based on the knowledge obtained from targeted monitoring. A set of governance indicators was developed taking into account the characteristics of the lake, the values that it offers and the threats that it is facing.

Keywords: Environmental management, integrated lake basin management (ILBM), lake assessment, Lake Malawi, lake vision, monitoring indicators

Acknowledgements: Special thanks go to Dr. Harvey Bootsma and Mr. Yappy Silungwe for the useful insights they provided throughout the study. Appreciation

also goes to officials in the related departments of the Government of Malawi who provided invaluable information for this work.

1. Introduction

Lakes are estimated to contain 90% of the freshwater occurring as surface liquid water (ILEC 2005). They provide water for human survival, economic development and support economically important aquatic ecosystems. However, lakes are very sensitive to the impacts of human activities. This entails that their use must be based on principles of sustainability. Among all water bodies, lakes are considered the most vulnerable to stresses because of the wide range of uses that they offer compared to other water bodies (Muhandiki et al. 2010). The Integrated Lake Basin Management (ILBM) concept is a management framework that takes into account the significant role lakes play in supporting societies as well as their vulnerability.

Lake Malawi is one of the African Great Lakes. It has greater fish biodiversity than any other freshwater body in the world (Bootsma and Hecky 1999) and has over 1000 fish species. It is the third deepest with a maximum depth of about 700 m (Bootsma and Hecky 2003) and ninth largest lake in the world with a surface area of 29,500 km^2 (ILEC 2005). The lake is shared among three countries; Malawi, Tanzania and Mozambique. It is called Malawi in Malawi, Nyasa in Tanzania and Niassa in Mozambique. The largest portions of the lake and catchment are in Malawi as Figure 1 shows. The lake comprises about 20% of Malawi's area (GoM 2008) and has only one outlet, the Shire River. The Lake Malawi-Shire River water system is a strategic water resource for hydro-electric power generation, irrigated agriculture, navigation and fisheries for Malawi.

The most important environmental concerns facing the lake and its basin are: deforestation; uncontrolled bush fire and poor land husbandry with their associated soil erosion; inorganic pollution from agricultural activities; overexploitation of fish; heavy extraction of water for irrigation from some rivers in the dry season; and climate change (Bootsma and Jorgensen 2005; Chafota et al. 2005). Many of these concerns are common in all the three riparian countries (see Chafota et al. 2005). Increasing mineral resource extraction, and industrialization are emerging threats (Jamu et al. 2011). In addition, the endemic fish species in the lake are susceptible to habitat change since they are specialists with small populations and a narrow distributional range (Chafota et al. 2005). Besides, the lake is a vulnerable resource because a significant proportion of the river inflow water (20%) comes from the catchment in Tanzania and any major water development activities within the catchment would have significant consequences for the economy of Malawi (GoM 2008).

Despite the serious threats, Lake Malawi and its basin are currently not monitored and managed as a whole system. This makes it difficult to monitor the trends of the changes taking place and undertake appropriate management actions.

Figure 1: Lake Malawi basin (ILEC 2005).

Such monitoring is also essential to determine the efficacy of any management strategies that are implemented. A comprehensive monitoring program is necessary if lake values are to be preserved.

It is also important to note that lakes in general are considered common-pool resources (CPRs) because their "non-excludable" but "rivalrous" aspects such as fish resources tend to be overused in the absence of management rules (Nakamura and Rast 2011). In addition, some lake uses such as flood and drought mitigation which are both "non-excludable" and "non-rivalrous" make them public goods. If

all the potential users of the Lake Malawi Basin are allowed to pursue extractive activities without any control, the lake basin resources may be deteriorated and/or depleted in a short period of time resulting into a "Tragedy of the Commons". Tragic consequences may also result from uses that are non-consumptive such as waste discharge and hydroelectric power generation.

Under this background, the objectives of this study were to understand the current state of the management of Lake Malawi and its basin, to deduce the desired future state of the lake (lake vision), and to develop indicators for assessing ILBM in the lake basin. Due to resource limitations, this study has focused on the Malawian portion of the lake, which is the largest and its basin is more densely populated than the portions in the other riparian countries. Lake Malawi is therefore the name used. Possible application of the proposed indicators in the entire basin including Mozambique and Tanzania has been considered. However, since the analysis is based on the situation in Malawi, some of the indicators and recommendations may not be appropriate for the other riparian countries. That being said, the study still provides an overview of the situation in the Lake Malawi Basin.

Some terms used – We use the terms governance, institutions and co-management a lot in this paper and here are the definitions we have adopted: " **'Governance'** is a concept that recognizes the importance of government's actions (in its diverse levels and components) while recognizing also the importance of linking such actions to be tied to other groups and sectors that interact within the same space, across 'public-private-civil interaction networks along the local/global axis' " (Nakamura and Rast 2011, 15); **Institutions** are establishments performing functions of service delivery, resource development and/or conservation, coordination, advising or regulation on aspects of lake basin management and they include government agencies, and traditional, nongovernmental, and private sector organisations; and **Co-management** is "a process of management in which government shares power with resource users, with each given specific rights and responsibilities relating to information and decision-making" (OECD 1997, 174).

2. Methodology

The information and data for our study were mostly from existing literature and key informant interviews. We reviewed a wide range of documents which included various journal papers and international water resources management publications such as World Water Vision, World Lake Vision, and Integrated Water Resources Management (IWRM) and ILBM publications. We also reviewed relevant national policies for Malawi to understand Malawi's strategic direction regarding water resources management and to capture the country's values and goals in the sector. In addition, we reviewed lake management approaches in other lakes (the Laurentian Great Lakes in North America, Lake Victoria in East Africa and Lake Biwa in Japan), and indicator development approaches taken by others around

the world to understand the global perspective on the issue and to determine if there are commonalities among various strategies. We conducted semi-structured interviews with key informants at the Lake Malawi National Park and the Departments of Irrigation Services, Fisheries, Forestry and Environmental Affairs in March 2012. We also interviewed other researchers and sector officials through the course of this study. A total of 12 people were interviewed. Observations of the situation in the lake basin were made during field visits to seven districts/cities (out of 15) in February and March 2012.

2.1. A review of existing approaches on development of indicators

Existing approaches for developing indicators for assessing water resources and lakes that we reviewed are elaborated below. Sample indicators are presented in Table 1.

2.1.1. Global Environment Facility (GEF) indicators

Duda (2002) presented an indicator framework for evaluating operational programs in the international waters focal area for GEF. The framework is based on three types of indicators: process, stress reduction, and environmental status indicators. Process indicators move beyond the traditional approach of measuring progress in project activities in terms of input and output, to measuring the process to reflect the extent, quality and eventual on-the-ground effectiveness of efforts. These indicators aid in keeping track of the domestic and regional reforms in institutions, policy, legislation and regulations, and they help to monitor root causes of problems. The process indicators can be related to the six ILBM governance pillars (see Section 2.2.1). Stress reduction indicators pertain to specific on-the-ground efforts implemented by collaborating countries. They represent documentation that an on-the-ground action occurred e.g. point source pollution reduction investment completed. Environmental status indicators measure actual performance or success in restoring and protecting the targeted water body. Our approach is mostly building upon the process indicators.

2.1.2. World Bank – Environment Department's Economic and Sector Work

The Economic and Sector Work (ESW) extracted the main findings of the Lake Basin Management Initiative (LBMI) that led to the birth of the ILBM concept (World Bank 2005). ESW contributed to refining the Monitoring and Evaluation (M&E) framework applicable to GEF lake basin projects (introduced in Section 2.1.1). This approach, building on the GEF framework, applies the principles of Integrated River Basin Management (IRBM) to lake basin management whilst noting that in-lake problems have some characteristics that are different from river basin problems. The IRBM principles include devolution of responsibility to the lowest applicable level, coordination across sectors affecting lakes, and involvement of all relevant stakeholders (World Bank 2005). We have applied

these IRBM principles in our indicator framework under the 'institutions' and 'participation' pillars. The World Bank approach took into account the major problems affecting lakes grouped into their regions of origin i.e. in-lake, basin, littoral and regional/global problems. The GEF process-type indicators were separated into six components of good governance: policy, institutions, rules, stakeholder involvement, knowledge and finances, which are similar to those in the ILBM framework. The GEF environmental status indicators were also extended to include indicators of the environmental status of littoral zone and lake basins, like reduction of sediment loads from lake basins. On the governance components grouped in this approach, the rules component is encompassed within the policy pillar in the ILBM framework. It is notable that the ILBM framework's pillar of technology is not explicitly recognized as an important component in this approach.

2.1.3. Transboundary Waters Assessment Program (TWAP) indicators for lake assessment

TWAP (2009–2011) had the objective of developing methodologies for conducting a global assessment of transboundary waters for GEF purposes.

Table 1: Sample of indicators used in the approaches reviewed.

Program	Categories	Indicators
GEF	Process indicators	Formation and documentation of high level committee meetings; country adoption of specific legal reforms etc.
	Stress reduction indicators	Non-point source pollution control programs implemented; larger mesh fishnet policy enforced etc.
	Environmental status indicators	Changes in local community income and social condition; documented stakeholder involvement etc.
World Bank	Policy	Clarity of direction; assignment of powers etc.
	Institutions	Technical and administrative capacity etc.
	Rules	Recognized & respected source; inherently fair etc.
	Public Participation	All affected groups involved; clearly defined roles etc.
	Finances	Charge for resource use; legal authorization etc.
	Information	Reliable understanding; Long-term monitoring etc.
TWAP	Biophysical conditions	Hydrological position; lenticity; projected lake volume etc.
	Human use	Relative population pressure; human development index etc.
	Institutions	Government effectiveness; lake basin specific institution etc.
	Policies	Rule of law; zoning regulations and bans etc
	Participation	Voice and accountability; role of NGOs/CBOs etc.
	Technology	Access to improved sanitation; solid waste control etc.
	Information	Coverage in literature; resident scientific institutes etc.
	Finance	Gross national income; sufficiency of funds etc.
	Planning	National IWRM plans; integrated of plans etc.

The project developed indicators for assessing the five major water systems (lakes, rivers, groundwater, large marine ecosystems and the open ocean). The proposed indicators for lake systems took into consideration the concepts of basin approach, lake characteristics, ecosystem services and governance challenges which form the basis for ILBM (ILEC 2011). TWAP proposed indicators based on the following ILBM themes: biophysical conditions; human use; institutions; policies; participation; technology; information; finance; and planning. These indicators relate to a wide range of management issues affecting transboundary lakes in a way that allows comparison across lakes.

2.2. Indicator development approach taken by this study

This study mainly built upon the approaches reviewed above. We reviewed relevant national and international documents to identify the main problems affecting Lake Malawi and potential indicators. The proposed indicators focus on measuring progress in the development of an enabling environment for lake management. Our main criterion for selecting the approach was based on understanding the lake and its basin as a unit and therefore the ILBM framework forms the basis of our approach.

2.2.1. What is ILBM?

The "Survey of the State of World Lakes" initiated in the late 1980s (Kira 1997) identified the six major environmental problems in world lakes and reservoirs as: decreasing lake water level due to over-use of lake water and/or inflowing/out flowing rivers; rapid siltation resulting from accelerated soil erosion in catchments; acidification of lake water due to acid precipitation; contamination of lake water, sediments and organisms with agricultural and industrial toxic chemicals; eutrophication due to inflow of nutrients; and the complete collapse of aquatic ecosystems in some cases. As recognition of the need to protect water resources continued, the 1992 International Conference on Water and the Environment recommended the development of IWRM. The World Water Council, in an attempt to increase awareness of the water crisis and trigger action towards sustainable use and development of water resources, developed a "World Water Vision" in 1999, which further articulated the application of IWRM. The World Water Vision was however considered an inadequate and incomplete guide for sustainable lake management because it fails to resolve the major problems facing lakes (Ballatore and Muhandiki 2002).This led to the development of the World Lake Vision in 2003 which reflected this concern and highlighted key principles of lake basin management. A Lake Basin Management Initiative (LBMI) was later conducted to draw lessons from 28 of the world's lakes, representing different geographic and economic contexts (ILEC 2005). The LBMI sought to strengthen the capacity for improved lake and reservoir management. The initiative led to the proposal of the ILBM concept.

The ILBM concept is a management framework based on the following six governance pillars:

1. Policies –they establish the foundation for other aspects of management e.g. institutions and legislation.
2. Institutions – are at the centre of lake basin management since they implement the measures for management e.g. administer laws, provide a forum for involving stakeholders, gather and store knowledge, sometimes establish policies etc.
3. Participation –active stakeholder and public involvement fosters a better understanding of the implications of lake basin issues and helps gain support for better lake basin management.
4. Technology – if appropriately applied, can complement other interventions in addressing lake basin issues.
5. Information and science – since lake ecosystems are complex, reliable information is particularly valuable to guide decision-making.
6. Finance – long term availability of stable funds is necessary to implement and sustain management activities.

ILBM compliments the IWRM approach by highlighting the three unique characteristics of lakes and their management implications which need to be considered when formulating management plans. These characteristics are presented below:

Integrating nature: Lakes receive all kinds of inputs (resources and pollutants) from the basin and beyond, and disseminate them throughout the whole volume. This requires lakes and their basins to be managed as a unit irrespective of any existing boundaries.

Long retention time: Lakes have a large buffer capacity to hold both resources and pollutants for a long time. This is an advantage during floods and droughts but it is a disadvantage when pollution is underway as it takes long to detect the changes going on in the lake. In many cases the gravity of an issue is realized when it is too late to take preventive measures. The slow build-up of problems and the time it takes before they become noticeable necessitates long term institutional and financial commitments since addressing the issues equally takes long. It is also necessary to anticipate problems as far in advance as possible and hence the importance of monitoring.

Complex response dynamics: Lakes have a non-linear response to changes (e.g. biomagnification) hence they are unpredictable and uncontrollable. This calls for the application of the precautionary principle and the utilization of scientific studies to clarify the complex processes and implications.

ILBM, therefore, calls for lake management approaches that are based on the proper understanding of the biophysical characteristics of lake ecosystems and interactions between lake ecosystems and humanity.

2.2.2. The values offered by the Lake Malawi Basin

Lake Malawi and its basin offer the following values (ecosystem services) which ought to be taken into consideration when developing management plans:

1. Fisheries resources – Being home to a great fish biodiversity, Lake Malawi contributes the bulk of the total fish catch in Malawi. According to the Food and Agriculture Organization, FAO, it contributed 75% in 2003 while the Government of Malawi put the contribution at 87% in 2010 (GoM 2011b). Fish significantly contribute to the nutrition of the country's population and is a critical ingredient for nutrition security in Malawi (McKaye et al. 2008). Most of the fish caught is locally consumed, thus substituting for fish and animal protein imports (Jamu et al. 2011). In addition, about 1.6 million people in lakeshore communities derive their livelihood from the fishing industry (GoM 2011b), representing 10.6% of the total population (2012 estimate).
2. The lake basin supports human settlements, rain-fed and irrigated agriculture, hydropower generation and transportation. The agriculture sector, which includes fisheries and forestry, is the largest sector in Malawi. It contributes 39% to the GDP (GoM 2010b) and supports more than 80% of the population. Feasibility studies are underway for pumping water from the lake and Shire River to support irrigated agriculture. Navigation is also receiving great attention and plans are underway to develop the Shire-Zambezi water way, an attempt to open up the land-locked country to the Indian Ocean. About 95% of all electricity in the country is generated on the Shire River (Chafota et al. 2005).
3. The lake is an important tourist attraction and is a venue for 60–70% of domestic and international eco-tourism (Chafota et al. 2005).
4. The great diversity and endemicity in fish is important for research purposes locally, regionally and globally.
5. The lake and its basin support diverse ecosystems. The lake is also within flyways of migratory birds that utilize the lake margins for feeding on their way between Africa and Europe (Chafota et al. 2005).
6. Being vast in size and containing a large volume of water, the lake plays an important role in moderating local climate and providing a buffer for floods and droughts (see ILEC 2005 for explanation of buffering capacity of lakes).
7. It bestows a sense of pride to the nation. McKaye et al (2008), concerning the conservation and future of Lake Malawi National Park, states on page xxi, "With the publication and distribution of this book, Malawian children and adults alike will be encouraged to take pride in protecting their natural

resources. They are the ones who will protect their unique heritage – not only for themselves, but for the world".

8. The catchment contains mineral resources such as uranium and coal and further mineral exploration is underway (GoM 2013a).

These values however, are not widely recognized, calling for enhanced public education and awareness raising. The values have been embedded into the vision presented in Section 3.2.

2.2.3. Key conceptual tools of ILBM

Our approach was also guided by the underlying key conceptual tools of ILBM as they relate to Lake Malawi as explained below:

Lake characteristics: As noted earlier, Lake Malawi has a large surface area, is very deep and hosts the world's greatest freshwater fish biodiversity. It has long flushing time (648 years) and residence time (114 years) due to its relatively low outflow (Bootsma and Hecky 2003). All these characteristics need to be factored into the management programs for the lake basin.

Ecosystem services: The lake and its basin provide a wide diversity of values (Section 2.2.2). Provisioning services include drinking water, fisheries and hydropower generation. Regulating services include drought and flood mitigation, and local climate moderation. Cultural and support services include recreation and nutrient cycling. It is crucial to satisfy the management needs of the regulating services because evidence shows that loss of regulating services can result in a decrease of all the other services (Nakamura and Rast 2011). For example, changes in lake level have an impact on hydropower generation and fish speciation (the evolutionary formation of new biological species).

Basin approach: Most of the threats (noted earlier) originate from the catchment hence the need for a basin approach to the management of the lake.

Socio-economic issues: For the proposed indicators to be relevant, they need to address some important socio-economic issues that are related to lake basin management. Integrated approaches in water resources management are linked to poverty reduction (Mulwafu and Msosa 2005). In view of this, we have considered several socio-economic aspects in our indicators (Section 3.3) applying the IRBM principles utilized in the World Bank's approach (Section 2.1.2).

2.3. Analytical framework

Moving towards better lake basin management is a cyclic process that undergoes constant improvement as progress is made and new insights emerge (Nakamura

and Rast 2011). Figure 2 represents the process for improving basin governance through ILBM in the following steps:

1. *Acknowledge the state of the lake basin* – understand the present reality i.e. the physical, chemical and biological characteristics, current uses, etc.
2. *Identify issues, needs and challenges, and envision the future state of governance* – analyze the challenges with respect to the six governance pillars and foster and evolve a shared vision.
3. *Seek ways to strengthen the governance pillars through monitoring, reconnaissance survey, inventory and databases*.
4. *Assess the governance improvements* – utilize indicators to monitor the impact of resource utilization, conservation and management approaches.
5. *Continue with efforts to eventually reach the long-term goal.*

Through this gradual and repeated process, adjustments to the approaches and vision are made taking on board new insights as they emerge. Such cyclic management process allows the governance system to capture and sustain incremental improvements and build on them, ultimately leading to greater sustainability of the lake basin.

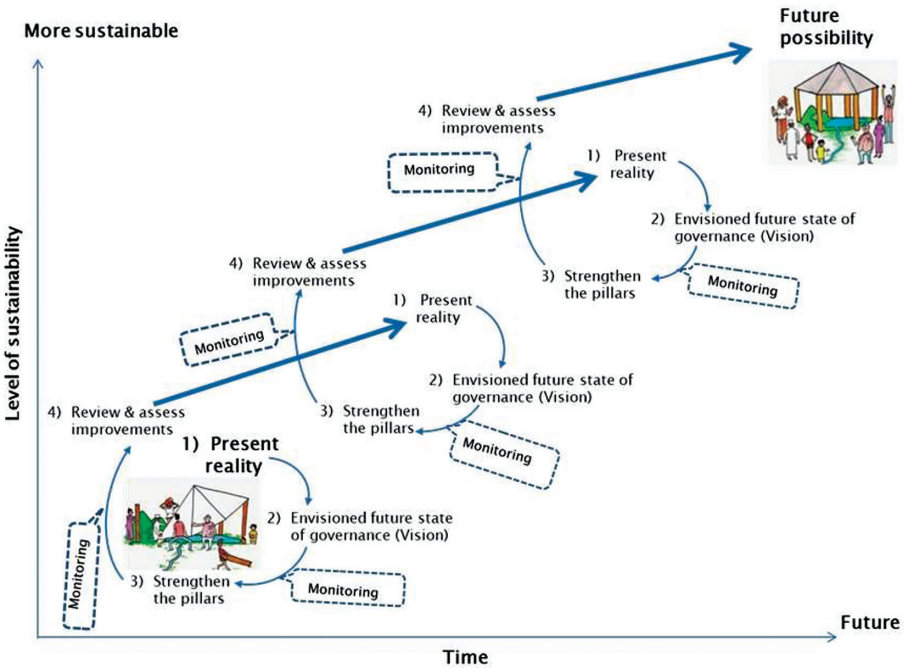

Figure 2: The cyclical process for improving lake basin governance through ILBM (Modified from Nakamura and Rast 2011).

To understand the current status of management of the Lake Malawi Basin, we used the six pillars of the ILBM framework to analyze the issues. Specific areas of analysis under each pillar were identified (Figure 3). The resulting understanding of the current status led to the deduction of a lake vision and ultimately to the development of indicators for assessing governance.

3. Results

In this section we present the results of the study based on the three objectives. We present the current status of the lake basin followed by the desired future state. Finally, we present our proposed indicators.

3.1. Current status of the management of Lake Malawi basin

The current status of the lake and basin has been analyzed as indicated in the analytical framework (Figure 3) and is presented according to the six pillars of ILBM.

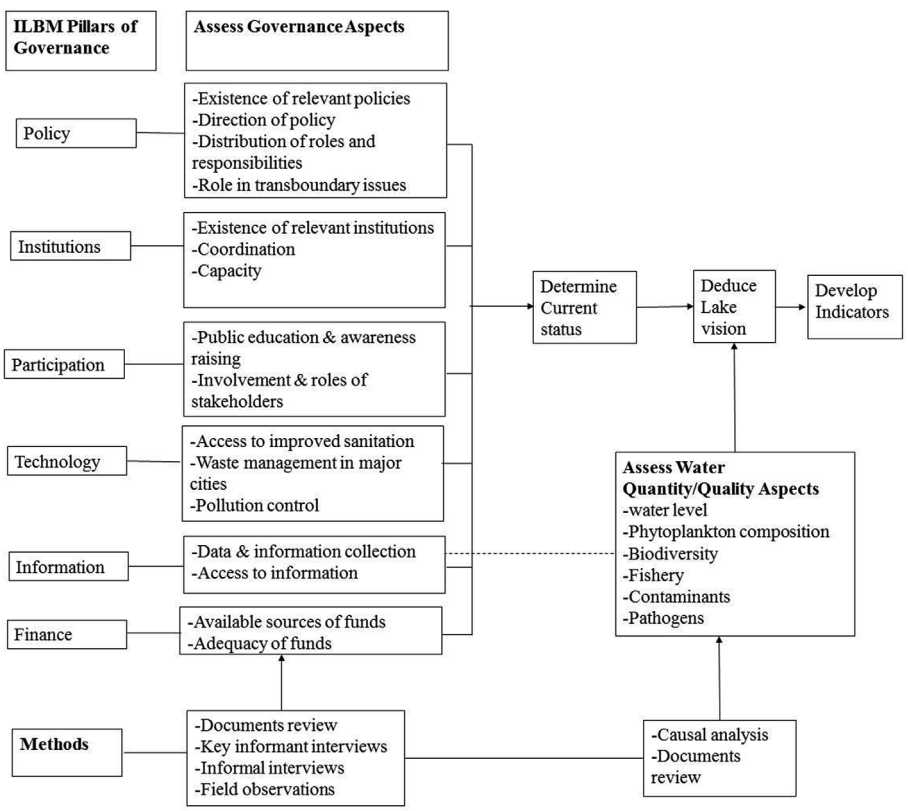

Figure 3: Analytical framework.

3.1.1. Policy

Policies that relate to lake basin management are in place. Water resources in particular are governed by the Water Resources Act (GoM 2013b) which provides the main regulatory framework, and the National Water Policy (GoM 2005) which provides guidance on the management and development of water resources. The Water Policy bases water resources management on the concept of decentralization and local participation, and it promotes the use of IWRM principles. The main focus is on water supply and sanitation provision for socio-economic development. The Water Policy states the roles of stakeholders and how the various institutions are linked. It outlines its specific goals and strategies. However, the involvement of some stakeholders (e.g. private sector and local communities) is limited. For instance, the policy promotes private sector involvement only in water resources development and supply, promotion of involvement in water resources conservation and management is lacking. In addition, lake management is not mentioned in the specific goals and subsequent objectives and strategies. It follows that the existing institutional linkages do not effectively tackle lake basin management. The key informants also revealed that some duplication of roles and conflicts of interest exists. For instance, use of treadle pumps in irrigation is being promoted and in many cases, the irrigated crops are cultivated within buffer zones of water courses.

On transboundary issues, some actions have been taken in the past to initiate international cooperation among the three riparian countries. A series of studies and consultations were conducted in 2003 with assistance from FAO, which resulted into a Draft Convention on Lake Malawi/Niassa/Nyasa and its Basin. The draft convention proposed the establishment of a Lake Malawi/Niassa/Nyasa Basin Commission whose mandate would include promotion of training, public education, research and monitoring, among others. The convention is not yet into force and its future was not clear at the time of this study since no significant further steps have been taken. We followed up on the issue in April 2014 through interviews at the Department of Water Resources and we learnt that negotiations are still underway.

3.1.2. Institutions

Institutions dealing with water and natural resources management on a sector-to-sector basis exist. The Environmental Affairs Department (EAD) has a mandate to coordinate sectors involved in natural resources management. The Ministry of Water Development and Irrigation (MoWDI) has authority over the management and development of the country's water resources and sanitation. Several other institutions are also playing a role in water resources management. The challenge is coordination of their sector specific activities as they relate to lake basin management. It was noted that current coordination is mainly restricted to reporting of activities being implemented.

Concerning institutional capacity building, some of the institutions (e.g. EAD, MoWDI and the Fisheries Department) are providing training and education to

qualified staff in IWRM and other related fields including on-the-job training and refresher courses. The retention rate of the trained professionals however, was not established but has been factored into the proposed indicator framework. Capacity of the institutions is hampered by lack of adequate equipment/facilities. Also important to note is the impact of the high turnover rate of government employees that affects the capacity of these institutions (Bootsma and Jorgensen 2005). Officers working at the Lake Malawi National Park for example, require specialized training to equip them with both onshore and offshore skills that are necessary to implement the park's mandate. Often, these highly trained employees get moved to other national parks that are land-based, rendering their specialized skills obsolete and hampering the Lake Malawi National Park's capacity (Banda B. 2012, pers. comm. 14 March).

3.1.3. Participation

The current general policy focus is the promotion of wide stakeholder participation in the management of water resources. This includes active participation of local communities and processes are underway to transfer power to lower levels of management.

3.1.4. Technology

Technology plays an important role in water resources management. The aspects considered were sanitation, waste management and pollution control. The national sanitation coverage was at 65.4% in 2010 (UNICEF 2011). Management of waste is a big challenge in the country. Lilongwe and Mzuzu are the major urban centres within the basin and have the highest population densities. Within the lake basin, wastewater treatment works exist only in these two cities. The major existing treatment types are primary and secondary treatment which only removes 30% of organic wastes and 50% of bacteria and suspended solids (Msilimba and Wanda 2012). This poses threats not only in terms of nutrient loading to rivers but also to public health. Information on quantities of wastewater generation is lacking. Although the country has national effluent standards in place, their enforcement is generally poor and there are concerns over release of untreated sewage directly into rivers and streams. The weak control of such non-consumptive uses of the lake basin threatens the sustainability of this commons. Management of solid waste is just as challenging. According to the Lilongwe City Council, the city generates about 350 tons of waste per day, of which only 30% is collected. This situation also poses threats to public health and the lake basin ecosystems in terms of suspended solids input and pollution.

3.1.5. Information

The sector and sub-sector Departments have Monitoring and Evaluation (M&E) units that monitor aspects relevant to their interest, i.e. the Water Department routinely monitors flow in the major rivers. Malawi recently developed an M&E framework for the Environment and Natural Resources Management (ENRM)

general sector that integrates monitoring and evaluation of the sector. The framework defines indicators for each sector, frequency of reporting to the EAD, and responsible institution for data collection. The effectiveness of implementation of this framework was not established. Universities and other research institutes also conduct studies that directly or indirectly relate to some aspects of lake basin management. Concerns over utilization of the generated information in decision-making have been factored into the proposed indicator framework. In spite of these efforts, there is no comprehensive monitoring program or integrated information collection system targeted specifically for the Lake Malawi Basin. It follows that no central access for information on the lake basin exists.

3.1.6. Finance

All key informants mentioned insufficient financial resources as one of the challenges their institutions are facing. It was also learnt that allocated budgets keep fluctuating and in some cases they are so substantially low that it becomes very difficult for the institutions to implement their crucial activities. The Lake Malawi National Park, for example, received substantial funds from the government during the 2010/2011 financial year and were used to purchase required equipment such as patrol boats. This improved the capacity of the park but there was uncertainty as to whether this trend would be sustained (Banda B. 2012, pers. comm. 14 March). Since no specific institution is responsible for managing the lake and catchment as a whole, and the ministry responsible for water affairs lacks focus on lakes, no Government funds are currently available specifically for lake management. Donor agencies are also a source of resources for natural resources management through project support in forms of loans and grants. These finances are for specific activities under the projects which may or may not contribute to better lake basin management.

3.2. Deduced Vision for the Lake Malawi Basin

It is easier to harness efforts towards a common goal if all stakeholders are aware of the desired destination. A shared vision plays a crucial role in moving towards sustainable management and utilization of lakes. The national documents reviewed and the studies of other researchers contain descriptions of the conditions that are desirable for water resources in Malawi in general and Lake Malawi in particular. We extracted these conditions, expressed explicitly in some cases and implicitly in others, and integrated them into a vision for Lake Malawi, which we present in six vision statements. Reflection of the lake values (Section 2.2.2), relationship with the identified threats, and linkages with the major issues highlighted in literature (i.e. findings of the Survey of the State of World Lakes etc) were the criteria used to select the statements. Malawi desires to achieve a state whereby:

1. Every citizen is aware of the importance of the lake and basin to the nation and is motivated to protect their integrity (National Water Policy; World Lake Vision (ILEC and UNEP 2003); McKaye et al. 2008 etc.).

2. The lake basin sustainably supports human settlements and activities by providing them with the resources necessary for their well-being (National policies in the natural resources sector; Chafota et al. 2005 etc.).
3. Water quantity and quality necessary for sustaining the viability of humans and dependent ecosystems (water for all) is maintained (National Water Policy; Malawi Integrated Water Resources/Water Efficiency (IWRM/WE) Plan; Malawi Growth and Development Strategy (MGDS) etc.).
4. Diversity and sustainable populations of fish are maintained and dependent livelihoods are secured (National Water Policy; National Fisheries and Aquaculture Policy etc.).
5. The lake's buffering capacity is maintained (National policies in the natural resources sector).
6. The nation's pride in the lake is preserved and the inheritance of future generations safeguarded (McKaye et al. 2008).

3.3. Proposed indicators for assessing ILBM in Lake Malawi

This section presents the 42 indicators we are proposing. Some existing indicators from the reviewed approaches have been adopted in addition to proposing new ones. Our approach draws insights from the three approaches reviewed in Section 2.1 and seeks to provide a framework that is specific to Lake Malawi, reflecting on-the-ground situation. Selection of the indicators was based on the approach explained in Section 2.2. The indicators have been organized according to the six ILBM pillars which form the major themes around which the indicators are formulated. Indicators within each pillar have been linked to a goal that describes the overall desired direction or state under that pillar. This is a way of checking whether or not an indicator is in line with the overall direction to which it is expected to contribute in the ILBM framework. The seven goals are taking into account the major environmental problems in world lakes (Section 2.2.1), the threats Lake Malawi is facing (Section 1 and 2.2.1) and the existing management situation (Section 3.1). Their attainment would contribute to the realization of the proposed Lake Malawi vision (Section 3.2). The following sub-sections present the indicators under each pillar along with their rationale and the goal to which they are linked. The proposed indicator list reflects the current needs according to the analysis we have done and they should be considered as a first step towards a more realistic set of indicators based on on-the-ground-realities. Under the "indicators and rationale" sub-section, indicators are shown in italics and the explanation that follows is the rationale behind the indicator.

3.3.1. Indicators for policy

Goal: To have policies that aim at improving holistic management of the lake basin and managing conflict of interests.

Indicators and rationale

Lake related sectoral policies – The existence of lake related national-level policies lays the foundation for better lake basin management activities as well as other aspects of management such as institutions, rules and incentives.

Relevance of lake related sectoral policies – To be relevant, a policy needs to address all important areas in the sector and involve stakeholders. Involvement of all relevant stakeholders in both policy formulation and implementation also ensures that the policy is fair and impartial (equitable). There is also need for the policy to protect sensitive areas related to that sector such as steep slopes in the catchment, fish breeding areas etc. since the impact of their degradation on lakes is big.

Commitment to integrated water resources management (IWRM) – ILBM embraces IWRM as a primary guiding principle for the sustainable use of lakes. The measures for this indicator are existence of an IWRM plan covering the lake basin, and recognition of the need for lake basin management in water policy or IWRM plan.

Policy implementation – Sustainable lake basin management requires managing people and their actions so as to discourage undesirable behaviour and encourage desirable ones. The three basic mechanisms to achieve this are command-and-control policies, incentives/disincentives, and education and public involvement (ILEC 2005).

Integration of water issues in economic development – The economy of Malawi and the livelihoods of the population are dependent on the environment and water resources are at the centre of the economy. Most of the energy driving the economy comes from hydropower generation which is solely dependent on the water level of Lake Malawi. National-level development and poverty reduction policies have great relevance on Lake Malawi and its management. Understanding the importance of the lake to the economy and the well-being of the population would enhance national commitment to actions against degradation of the lake and basin.

Implementation of IWRM/WE Plan – There is need to see how effective the implementation of the existing IWRM plan is. The plan outlines strategic projects/activities to be carried out to achieve the objectives of the National Water Policy. Ratio of completed projects to planned projects is the measure used.

Role in trans-boundary issues – For management to be effective and efficient across borders, there is need for explicit recognition of the need for a cooperative approach in the national policies. This paves the way for actual cooperation and provides guidance on how to cooperate.

3.3.2. Indicators for institutions

Goal: To have effective institutions with strong capacity.

Indicators and rationale

Existence of a lead institution in lake basin management – Institutions administer the laws and sometimes develop policies, rules and incentives for management of resources and are therefore at the centre of lake basin management (ILEC 2005).

Coordination among sectoral institutions – Coordination of plans and activities carried out by the various sectors related to lake basin management is important to ensure that these activities share the common goal of conserving and developing the lake basin sustainably, managing conflicting goals and harnessing synergies.

Capacity development in lake basin management related areas – Officers responsible for water resources and lake basin management need to have the capacity to ably carry out their duties.

Local community resource management – The management done by local community institutions needs to be monitored to track the progress of decentralization in natural resources management.

Coordination between local community institutions and relevant sectoral institutions – Sustainable management of local resources requires proper coordination between local community institutions and the relevant sectoral institutions. Among others, this ensures that local natural resource management is in line with national goals.

Degree of involvement in transboundary issues – The transboundary nature of Lake Malawi in relation to the integrating nature of lakes implies that activities done in one riparian country will have an impact on the whole lake. As Malawi works towards transboundary cooperation, there is need to monitor the adequacy of such cooperation.

3.3.3. Indicators for participation

Goal: To promote public participation and stakeholder involvement in lake basin management

Indicators and rationale

Existence of education/awareness programs – This is a crucial first step in raising awareness and gaining support for issues affecting the lake and basin. It shows willingness of the institutions to increase awareness. ILEC (2005, xii) states that "Simply raising awareness among resource users is one of the most effective and easiest policies to implement. People will often modify behaviour if they learn it has a negative effect on others".

Awareness level – Monitoring the level of awareness in the lake basin concerning important lake basin management issues will give an indication of the effectiveness of the existing education/awareness programs and will guide appropriate action.

Level of participation within local community institutions – Active participation of a greater number of the members is necessary for local community institutions to be vibrant and sustainable.

Gender distribution in local community institutions – IWRM emphasizes the importance of involving women at all levels. However, there is need to ensure that while womens' participation is being encouraged, men are not marginalized in the process. Increasing participation and involvement of women, men, girls, boys and vulnerable groups in planning, designing, implementation and evaluation of natural resources and the environment is also one of the objectives of the revised National Gender Policy (2007–2011).

Youth representation in local community institutions – Active involvement of the youth will help ensure a sustainable future since values of integrated water resources management will be imparted to them early on in life.

The role of traditional authority/leaders in local community institutions – Njaya (2007) observed that success of governance arrangements in co-management processes depends on how local leaders are involved. In addition, for a lake management plan to be effective, the values and cultural beliefs of local people and their norms need to be properly understood and appreciated (ILEC 2005).

Clear relationship between livelihoods of local communities and water resources management – Livelihoods of many catchment dwellers directly depend on the natural resources around them. There is need for a clear connection between lake basin management related activities done by the people and their livelihoods e.g. adoption of better farming practices increases yield, which is a positive impact while protection of forests may bar charcoal and firewood sellers from their livelihood source. In instances that the activity is improving their current livelihood, such connections may promote participation and commitment, and in instances where the activity is an impediment to their current livelihood, there is need to design the project/intervention in a way that provides livelihood alternatives to the people affected e.g. a forest protection project having a component of providing non-timber livelihood benefits to the charcoal/firewood sellers such as honey production or jam/fruit juice making from indigenous fruits etc.

Stakeholder involvement (other than sectoral government institutions and local basin communities) – Involvement of all relevant stakeholders in lake basin management provides many benefits including a greater acceptance of rules

for allocating lake basin resources (ILEC 2005). Monitoring the participation of other stakeholders (i.e. NGOs, private sector, etc) and their area and mode of participation will inform policy makers on how they can further enhance the positive impacts and maximize the benefits of their participation.

3.3.4. Indicators for technology

Goal: To utilize technological interventions for lake basin management where applicable

Indicators and rationale

Access to potable water – One of the Millennium Development Goals (MDGs) is to ensure environmental sustainability and increased access to safe drinking water forms part of the targets to be achieved. Malawi's 2015 MDGs target is 74% and the country reported to have reached 81% in 2010 (GoM 2010a). This indicator will check whether this achievement is reflected in the lake basin.

Access to improved sanitation services – It is necessary to accompany increased water withdrawal and usage with development of better sanitation and wastewater treatment considering that most of the water taken from lakes and rivers is at some point directly or indirectly returned to these water sources (World Lake Vision).

Degree of point source pollution control – ILEC (2005, xi) states, "Impairment of a given lake use arises through overuse and/or when two or more users are in conflict". Important aspects under this indicator are: sewer line connections in the major urban areas; sewage effluent standards compliance rate; sludge disposal compliance rate; and compliance of industries and mines with standards.

Extent of solid waste management in the cities of Lilongwe and Mzuzu – Solid waste management in these cities needs to be monitored as it has a bearing on suspended solids and pollutants transported to the lake.

Degree of non-point source pollution control – Non point sources represent a greater proportion of pollution entering rivers and lakes. Their type depends on the land uses in the catchment. Aspects covered are forest cover, minimization of bush fires, and adoption of good agricultural practices.

Management of invasive species – Water hyacinth is the invasive plant of major concern that has infested the southern part of the lake and the Shire River outlet. Infestation on the Shire River has caused challenges in the generation of hydropower. The aspects considered are efficacy of existing management plans for water hyacinth, and existence of measures to protect/prevent the lake basin from new infestations.

Protection and rehabilitation of wetlands and lagoons – Wetlands (marshes and swamps) function as natural traps for sediments and nutrients. They are not only effective, but also cheap, thus playing a very significant role in controlling sediment and nutrient loads to lakes at a very affordable cost (ILEC 2005). Wetlands and lagoons are also sanctuaries for fish and provide fish breeding grounds and therefore are crucial for enhancing fish reproduction and conserving biodiversity. In addition, the wetlands of the Lake Malawi Basin are important for their assemblage of birds, mammals, reptiles and amphibians that are of regional significance (Chafota et al. 2005).

Adoption of deep water fishing technology – The country is currently working to develop small-scale deep-water fishing to create a balance in fisheries utilization especially with the existing concern that shallow water fisheries are being overexploited (GoM 2011a). The aspects considered are percentage of small-scale fishermen adopting deep-water fishing technologies, and total deep-water fish catch in relation to determined stock.

Adoption of other related technologies – Technology, if appropriately applied, can help solve some of the problems the lake basin is facing. The main problems facing the basin are in the areas of sanitation, water provision, forestry, agriculture, pollution control and fisheries. A mix of innovative approaches to address the issues is required. Encouraging innovations in low cost technologies that utilize local resources is also important.

3.3.5. Indicators for information

Goal 1: To collect data and information that will aid understanding of lake basin dynamics, show limits of lake basin resources and enlighten hard-to-see connections.

Indicators and rationale

Existence of a lake basin wide monitoring and information collection system – A lake wide monitoring system that collects information on lake basin issues is important for developing better lake basin management plans.

Relevance of resident scientific research institutes – Scientific research is important for improving lake basin management as acquired information can be used to understand complex lake dynamics and provide innovative solutions to problems (ILEC 2005). The considered aspects are existence of formally defined research needs by managers, and relevance of research focus areas to the defined needs.

Citizens/indigenous knowledge input – Local communities' knowledge can be used to augment scientific knowledge and can be the only source of information about a lake in the absence of long-term monitoring programs (ILEC 2005). For instance, local knowledge can be used to identify and protect important fish breeding areas.

Goal 2: Improve access to information by decision-makers and the public

Availability of information – Since lake ecosystems are complex and lakes take a long time to exhibit changes going on within them, information is particularly valuable to decision makers. A long term commitment to acquisition of information is therefore necessary.

Information Dissemination – For people to be aware of lake basin issues, information needs to be disseminated from the custodians to them.

Information access – Available information has to be easily accessible to all interested parties.

Utilization of monitoring and research findings – The long retention time of Lake Malawi (114 years) implies that its management should be proactive, committed and well-planned over the long-term while displaying enough flexibility to adapt to changing values and emerging knowledge. There needs to be mechanisms for capturing monitoring findings/feedback.

Degree of information sharing among riparian countries – Each of the riparian countries conducts various research and project activities on lake and basin issues. It is important that they share such information to enhance learning from the experiences so as to promote positive interventions.

3.3.6. Indicators for finances

Goal: To ensure sufficient funding for lake basin management and involve stakeholders in mobilisation of funds.

Indicators and rationale

Government funding for lake basin management – There is a need for long term availability of stable funds. The long flushing and retention times for Lake Malawi imply that issues stay long in the lake and require long term committed efforts to address them hence the need for government funding to play a primary role.

International development funding – The lake being transnational, there are activities that might need joint cooperation and joint funding of the riparian countries and sometimes, donor agencies. There is need for riparian governments to commit some funds for such activities.

Charges for resource use – There is need to charge for some resource uses i.e. water abstractions for commercial purposes etc. to protect the lake from the "tragedy of the commons". The collected funds can contribute to the finances needed for lake basin management.

Local retention of revenue – It is also important that funds generated locally are largely retained locally for the stakeholders and the public to appreciate the importance of the funds.

4. Discussion

The existing policies and institutions have the potential to steer the country towards sustainable lake basin management. The challenge is to attain harmonization of the various sector policies and coordination of the sector activities. Basing water policy on IWRM principles is an important step but more needs to be done. Mulwafu and Msosa (2005) highlighted the need to implement some practical studies that can yield tangible benefits to the poor while providing lessons on the best IWRM practices. Our proposed indicator framework includes some indicators to monitor this. Another need is for the water policy to explicitly recognize the need for lake basin management. This would ensure that focus on important lake issues in relation to their three unique characteristics is not lost in the country's water resources management approach. Furthermore, the existing institutional links need to be enhanced to also promote integrated implementation of activities.

The limited involvement of some stakeholders in the policies may be a missed opportunity for further fostering better lake basin management. It is important to expand private sector participation to water resources conservation as well e.g. encouraging investment in renewable energy technologies that would help curb deforestation. Tourism is another sector that also needs to be actively involved as it is dependent on the lake and basin resources and their impact on the same is also important. Lake water quality for instance, is a key element of the beach resort business and encouraging the sector to support and get involved in lake water quality tests for example, would be a good start. On the participation of local community institutions, literature shows that the creation of a local institution to manage natural resources involves power sharing between the elected institution and the traditional authority/leaders. This power play determines the effectiveness of the elected institution which consequently affects the management of the natural resource (FAO 2009, unpublished forest management working paper FM/40). In the Malawi set up, conflict can arise between the traditional authority/leaders and the elected body if the issue of power sharing is not properly addressed in the early stages. This issue of power sharing and traditional leaders' role deserves committed dedication of the facilitators in order to realize a positive and synergetic effect.

In addition, allowing participation at all levels of management i.e. from project planning through design, implementation and monitoring may promote a meaningful participation of local community institutions. More important is the need to integrate them into the decision-making process. This includes decisions on regulations to be applied and enforcement mechanisms. Njaya (2007) pointed out that one of the major reasons for high rates of non-compliance with fisheries regulations in Malawi is lack of involvement of small-scale fisherfolk in the

formulation of regulations and the regulations are therefore perceived as designed to strip them of their livelihood.

On waste management and pollution control, the current management status of the lake basin makes nutrient loading to the lake an important concern (although its determination is outside the scope of our study). Nutrient loading (i.e. from poor sewage treatment, agricultural activities, etc.) has been a serious concern for many lakes around the world. Weak regulation enforcement contributes to the infliction of external costs on other people and ecosystems. If regulation enforcement is not improved soon enough, the lake water quality may deteriorate and some of the values derived from the lake may be lost. This may further exacerbate poverty and have implications on the well-being of the population. Malawi had better take preventive measures to avoid the situation whereby water quality needs to be restored since restoration is often much more expensive than prevention as has been experienced in some lakes, like Lake Biwa.

Another area to note is the importance of making lake basin information easily accessible to stakeholders and the general public. This supports decision making and helps raise awareness. Explicit recognition of the importance of lake basin management in water related policies would help the institution responsible for water affairs to better align its strategies and would also address the information gap. Management experiences elsewhere reveal that the existence of an institution with a clear mandate on comprehensive lake basin management is an important precursor in addressing the information gap. The Great Lakes Commission in Canada and USA for example, maintains the Great Lakes Information Network (GLIN) which provides a "one-place" online data access to all those with interest. Lake Biwa in Japan has similar databases that are easily accessible to the general public. Malawi needs to explore feasible means of making lake information easily accessible to stakeholders and the public. This can be introduced within the Department of Water Resources since they currently collect lake levels data for public and private use.

The challenge of insufficient resources mentioned by all key informants supports what literature also indicated (Bootsma and Jorgensen 2005; Njaya 2007; Jamu et al. 2011; CEPA 2012).There is need for sustained Government commitment to provide resources necessary for the effective operation of Government institutions including parastatals. Some activities are fixed to a certain period due to their nature and require funds to be available during that particular period (e.g. enforcement of closed season for fishing). Unavailability of funds for such activities dents many other efforts in the sector. Instability in the flow of funds negatively affects the operations of the institutions and they lose cumulative benefits that would have been gained had a stable flow of funds been maintained. More so, if lakes could become an important part of the country's development agenda, there may be opportunity for projects (including donor funded projects) in related sectors to be designed with components that ensure sustainability of lakes and their basins thus, opening up funding opportunities.

From the above discussion, we have highlighted the areas that require attention in order to move towards sustainable lake basin management and utilization. The vision presented in Section 3.2 is meant to provide the general direction. We expressed the vision in broad statements because we are only providing a starting point. There is need for lake basin stakeholders to come together and foster a common agenda for sustainable management of the lake basin from which plans and strategies may arise. We present below our proposed actions in implementing the vision based on the issues we have analyzed. It should be noted that the actions are presented in no particular order and the list is not exhaustive.

Immediate actions – Explicitly recognize the need for lake basin management in related policies; assign clear mandate on integrated management of the lake basin to the institution responsible for water affairs (or some other institution as appropriate); provide stable funds for lake basin management activities; improve education and awareness of lake basin issues among stakeholders and the general public; enhance local community natural resource management; improve wastewater treatment and solid waste management in the main urban centres; enhance stakeholder involvement; maintain the existing forest cover and continue with reforestation and afforestation efforts; protect existing wetlands and lagoons; eradicate or control established invasive species; continue with efforts to promote adoption of deep water fishing technologies; and enhance regulation enforcement.

Long-term actions – Attain universal access to potable water and improved sanitation services; improve wastewater treatment in the entire basin; increase farm area under sustainable land management; maintain optimum forest cover; ensure high compliance with regulations; rehabilitate degraded wetlands; establish a lake basin wide monitoring and information collection system; improve access to lake basin information; mobilize sustainable resources for lake basin management; establish mechanisms for transboundary cooperation; harmonize implementation of lake related sector policies; prevent further introduction of invasive species; and build capacity in lake related institutions.

5. Conclusion

It is evident that several important initial steps towards lake management in Malawi have been taken. However, the existing management environment does not ensure sustainability of the lake basin. Lake management has no solid backing since Malawian policies lack focus on lakes despite the country's high dependence on Lake Malawi and other lakes for its economic and social needs. There is need for the policies to explicitly address lake management issues. Lumping up the issues within general water resources management creates the risk of losing focus on how the various CPRs and public goods associated with lake basin interact and affect the whole commons. We have highlighted many areas that require monitoring, most of which cut across several sectors, thus supporting our position that the

lake basin needs to be managed as a unit. Although the context in Malawi forms the basis of our paper, and we are mainly calling for national level integrated lake basin management in Malawi, many of the issues pointed out are of importance to the other riparian countries too, likewise their implications. Therefore, integrated management of the Lake Malawi Basin across borders is necessary if this commons is to be sustained. The proposed indicator framework can aid the collection of relevant data and information which would play an important role in the formulation of management plans and strategies for the sustainable management and utilization of the lake basin. As this study is a baseline, our next step is to pilot the indicators in the lake basin and refine and prioritize them in line with on-the-ground reality and come up with a more practical set for the lake basin.

Literature cited

Ballatore, T. and V. Muhandiki. 2002. The Case for a World Lake Vision. *Hydrological Process* 16(11):2079–2089.

Bootsma, H. A. and R. E. Hecky. 1999. Lake Malawi/Nyasa – An African Great Lake and Great Resource. In *Water Quality Report, Lake Malawi/Nyasa Biodiversity Conservation Project,* eds. Harvey A. Bootsma and Robert E. Hecky, 17–28. Senga Bay: SADC/GEF.

Bootsma, H. A. and R. E. Hecky. 2003. A Comparative Introduction to the Biology and Limnology of the African Great Lakes. *Journal of Great Lakes Research* 29(Suppl. 2):3–18.

Bootsma, H. A. and S. E. Jorgensen. 2005. Lake Malawi: Experience and Lessons Learned Brief. In *Lake Basin Management Initiative: Experience and Lessons Learned Briefs (on CD),* 259–276. Kusatsu, Japan: International Lake Environment Committee Foundation.

Centre for Environmental Policy and Advocacy, CEPA. 2012. Developing Innovative Solutions with Communities to Overcome Vulnerability through Enhanced Resilience and Enhancing Community Resilience Programme. Policy Framework for Climate Change Adaptation and Disaster Risk Reduction in Malawi: A Review of Key Policies and Legislation. Analytical Report. http://www.cepa.org.mw/documents/legislation/policies/Analysis_CCADRR_Policies_Instruments_Final_Report.pdf. (accessed October 29, 2013).

Chafota, J., N. Burgess, M. Thieme, and S. Johnson. 2005. *Lake Malawi/Niassa/Nyasa Ecoregion Conservation Programme: Priority Conservation Areas and Vision for Biodiversity Conservation*. n.p.:WWF-SARPO.

Duda, A. 2002. *Monitoring and Evaluation Indicators for GEF International Waters Projects.* Working Paper 10. Washington DC, USA: Global Environment Facility.

Government of Malawi, GoM. 2005. *National Water Policy.* Lilongwe: Ministry of Water Development and Irrigation, Capital Printing Press.

Government of Malawi, GoM. 2008. *Integrated Water Resources management and Water Efficiency Plan.* Malawi: Ministry of Water Development and Irrigation, Lilongwe.

Government of Malawi, GoM. 2010a. *Malawi Millennium Development Goals Report*. Malawi: Ministry of Development Planning and Cooperation, Lilongwe.
Government of Malawi, GoM. 2010b. *The Agriculture Sector Wide Approach (ASWAp).* Malawi: Ministry of Agriculture and Food Security, Lilongwe.
Government of Malawi, GoM. 2011a. *Monitoring and Evaluation Framework for the Environment and Natural Resources Management Sector.* Malawi: Ministry of Natural Resources, Energy and Environment, Lilongwe.
Government of Malawi, GoM. 2011b. *Annual Economic Report.* Malawi: Ministry of Development Planning and Cooperation, Lilongwe.
Government of Malawi, GoM. 2013a. *Mines and Minerals Policy of Malawi*. Malawi: Ministry of Mining, Lilongwe.
Government of Malawi, GoM. 2013b. *Water Resources Act*. Malawi: Lilongwe.
ILEC and UNEP. 2003. *World Lake Vision: A Call to Action.* Kusatsu, Japan: International Lake Environment Committee Foundation.
ILEC. 2005. *Managing Lakes and their Basins for Sustainable Use: A Report for Lake Basin Managers and Stakeholders.* Kusatsu, Japan: International Lake Environment Committee Foundation.
ILEC. 2011. *Methodology for the GEF Transboundary Waters Assessment Programme. Volume 3. Methodology for the Assessment of Transboundary Lake Basins,* UNEP viii+69. Kusatsu, Japan: International Lake Environment Committee Foundation.
Jamu, D., M. Banda, F. Njaya, and R. Hecky. 2011. Challenges to Sustainable Management of the Lakes of Malawi. *Journal of Great Lakes Research* 37:3–14.
Kira, T. 1997. Survey of the State of World Lakes. In *Guidelines of Lake Management, Vol. 8: The World's Lakes in Crisis,* eds. S. Jorgensen and S. Matsui, 147–155. Kusatsu, Japan: ILEC and UNEP. International Lake Environment Committee Foundation.
McKaye, K., A. Wiklund, M. Shawa, A. Konings, J. Stauffer, H. Madisen, K. Theiss-Nyland, P. Kite, and M. McKaye. 2008. *Lake Malawi National Park: World Heritage Site.* HEEED (NEDI), and Office of the President and Cabinet Malawi.
Msilimba, G. and E. M. Wanda. 2012. Wastewater Production, Treatment and Use in Malawi: National Report. Paper Presented at the Third Regional Workshop 'Safe Use of Wastewater in Agriculture', Johannesburg, South Africa, September 26–28.
Muhandiki, V. S., T. J. Ballatore, M. Nakamura, and K. Yamada. 2010. Managing Lakes and their Basins for Sustainable Use: Biophysical Characteristics of Lakes. Keynote Paper. Proceedings of the 14th International Conference on Diffuse Pollution, Quebec, Canada, September 12–17.
Mulwafu, W. and H. Msosa. 2005. IWRM and Poverty Reduction in Malawi: A Socio-economic Analysis. *Physics and Chemistry of the Earth* 30(11):961–967.
Nakamura M. and W. Rast. 2011. *Development of ILBM Platform Process: Evolving Guidelines through Participatory Improvement.* Shiga University, Japan: Research Centre for Sustainability and Environment (RCSE) – Shiga University and ILEC.

Njaya, F. J. 2007. Governance Challenges for the Implementation of Fisheries Co-Management: Experiences from Malawi. *International Journal of the Commons* 1(1):137–153.

OECD. 1997. *Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources.* Paris, France: Organisation for Economic Co-operation and Development.

UNICEF. 2011. Malawi Annual Report 2010. http://www.unicef.org/malawi/MLW_annualreport_2010.pdf. (accessed October 27, 2013).

World Bank. 2005. *Lessons for Managing Lake Basins for Sustainable Use.* Washington DC, USA: World Bank – Environment Department.