

**Assessment of the Management of Lake Malawi Basin
through Application of Integrated Lake Basin Management
(ILBM)-Based Tools**

統合的湖沼流域管理手法を適用したマラウイ湖流域の管理評価

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To Jesus, Mary and Joseph of Nazareth,
and
to Thoko my husband, and Patrick and Helena, my parents

Abstract

Malawi has a relatively rich water resource in which lakes feature highly. Despite the relatively abundant water resources, the country is water stressed. Lake Malawi forms the most important single water resource in the country. The lake basin is a shared resource among Malawi, Mozambique and Tanzania with the largest portions of both the basin and the water surface area in Malawi. The lake basin is a valuable resource to the riparian countries. The major environmental issues affecting the lake and its basin include deforestation, soil erosion, overexploitation of some fish species, pollution, and excessive extraction of water from some rivers. Emerging threats include increasing mineral resource extraction, industrialization and climate change. A comprehensive approach to the management of the lake and its basin is therefore necessary especially considering the significance of the lake basin to the riparian countries.

The Lake Malawi Basin is not monitored and managed as a whole system, despite the serious threats. Current management is fragmented across the riparian countries and across sectors within the countries. It is thus difficult to monitor the trends of the changes taking place and undertake appropriate management actions. Monitoring is also essential to determine the efficacy of any management strategies that are implemented. Policymakers, managers and other stakeholders need guidance to make sound decisions and take sound actions that ensure better management for sustainable utilization of the resource. By integrating various disciplinary perspectives, this thesis intends to contribute towards achieving a comprehensive understanding of the governance of the lake basin system to ensure sustainability of the resource.

Focusing on the Malawian side of the lake and basin, the study generally applies a systems thinking approach and utilizes mixed methods research design. The lake basin system is looked at in two dimensions: the socio-economic subsystem and the ecological subsystem. Data and information were obtained from both primary and secondary sources. These include a wide range of literature, questionnaire survey, key informant interviews at lake related institutions in Malawi, and site observations. This thesis makes several important contributions regarding the governance of the Lake Malawi Basin. Firstly, the study developed an indicator based

framework/tool for monitoring and assessing ILBM in Lake Malawi Basin that is context specific. Further, through pilot application of the developed framework/tool, the study conducted a holistic assessment of the status of lake basin governance and the findings presented can be applied in policy and management interventions. A further analysis was carried out, applying the strengths, weaknesses, opportunities and threats (SWOT) technique and causal loop diagram to better understand the issues in the lake basin.

Analysis of the situation revealed some strengths within the lake basin system that can contribute to better lake basin management if sustained and enhanced. These are especially in the aspects of policies, institutions and stakeholder participation. Considerable weaknesses were also identified that threaten the sustainability of the system. These are in the aspects of information and science, technology and finance. Several opportunities were identified, including the existence of stakeholder interest (NGOs, civil society etc.) in lake basin related issues. Climate change is an important threat to the system considering that the lake is especially sensitive to climatic changes due to its large surface area. A causal loop diagram developed to illustrate the linkages between the socio-economic and the ecological subsystems demonstrates the complex nature of the lake basin system. This highlights the difficulty of predicting the behavior of the system and underscores the importance of taking a holistic approach to management as well as application of the precautionary principle in management interventions.

Since this kind of holistic assessment of governance in the Lake Malawi Basin is the first, the findings provide useful baseline data/information on the status of the management of the lake basin. The knowledge accumulated can be a reference point for future studies and management interventions. The developed indicator framework can guide the collection of relevant data and information that is useful to lake managers, policy-makers, researchers and other interested parties. The developed indicator framework, with its long-term focus, multi-perspective approach, and flexibility that allows modifications as necessary, makes it a useful adaptive management tool.

論文の要旨

アフリカ大陸中部のマラウィは、マラウィ湖を有し比較的な豊かな水資源に恵まれているにも関わらず、水不足に陥っている。マラウィ湖の集水域はマラウィ、モザンビーク、タンザニアであるが、マラウィは集水域と水域の多くを領有している。マラウィ湖とその集水域に影響を与えている主な環境問題は森林伐採、土壌流出、魚の乱獲、水質汚染、過剰な集水である。そのため、関係各国において集水域の重要性を考慮した、水資源管理の包括的なアプローチが必要である。

マラウィ湖は上述のように深刻な問題を抱えているにもかかわらず、総体的な監視・管理が行われていない。集水域に存在する国々の水資源管理は独立しており、国家間の連携は図られていない。また同一国の中でも管理主体が複数存在することがあり複雑化している。そのため、水資源の変化を監視し適切な処置を施すことが難しい。湖の状態の監視は現在実施されている管理計画の有効性を見極めるためにも重要である。そこで、マラウィ湖流域の水資源を持続可能に活用するための管理手法が必要となる。本研究では、多様な視点を統合し集水域の統治に関して、システム思考アプローチを援用した統合的湖沼流域管理(Integrated Lake Basin Management; ILBM)手法を用いて、適切な決断と行動を促すための政策決定者および湖沼管理者向けツールの開発を目的とする。

まず、マラウィ側の湖とその流域に焦点を当て、システム思考アプローチを用いて、社会経済と生物多様性の二つの視点から評価を行う。ここでは、ILBM の適用により複数の指標に基づく評価ツールを開発し、現在の管理体制の状態を測定した。その後、流域内での問題をより深く理解するために SWOT 分析手法を用いて因果ループ図を作成し、問題の関係性を明らかにした。その結果、政策や制度、ステークホルダー関与において、持続可能な流域管理に貢献しうる強い要因が存在することが明らかになった。一方で、情報技術と科学技術、資金の面で流域システムの持続可能性を脅かす脆弱性が存在することも明らかになった。また、流域の複雑な問題の解決のために、ステークホルダーとなり得る NGO や市民団体が参加する機会(Opportunity)が存在することも確認された。マラウィ湖は広大な表面積を持つために気候変動の影響が重大な脅威(Threat)となることも示された。また、流域における社会経済システムと生態システムの関係性を示す因果ループ図により流域管理の複雑さを明示するとともに、流域管理において予防原則を適用した統括的なアプローチの重要性を示している。

以上のように本論文は、マラウィ湖流域の統治に関する統合的アセスメントは初めての試みであり、本研究による知見は、持続可能な流域管理に資する基準づくりのための基礎情報となりうる。また開発された指標群とデータセットは、湖沼管理者や政策決定者、研究者に有用なデータを提供することが期待される。

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List of Abbreviations

ASWAp	Agriculture Sector Wide Approach
CLD	Causal Loop Diagram
CMC	Catchment Management Committee
CU	Clark University
DANIDA	Danish International Development Agency
DC	District Council
DEC	District Executive Committee
DoI	Department of Irrigation Services
EAC	East African Community
EAD	Environmental Affairs Department
EIS	Environmental Information System
EsA	Ecosystems Approach
ENRM	Environment and Natural Resources Management
FRIM	Forest Research Institute of Malawi
GoM	Government of Malawi
GVH	Group Village Headman
GWP	Global Water Partnership
IFMSLP	Improved Forest Management for Sustainable Livelihoods Programme
ILBM	Integrated Lake Basin Management

ILEC	International Lake Environment Committee
IWRM	Integrated Water Resources Management
LBCPLCC	Lake Biwa Comprehensive Preservation Liaison Coordination Council
LBCPPC	Lake Biwa Comprehensive Preservation Promotion Council
MACOF	Malawi College of Forestry
MDGs	Millennium Development Goals
MEMP	Malawi Environmental Monitoring Program
MGDS	Malawi Growth and Development Strategy
MoWDI	Ministry of Water Development and Irrigation
NFP	National Forestry Programme
NWRA	National Water Resources Authority
NEP	National Environmental Policy
NGO	Non-Governmental Organization
NSSD	National Strategy for Sustainable Development
M&E	Monitoring and Evaluation
SADC	Southern African Development Community
TA	Traditional Authority
TWAP	Transboundary Waters Assessment Programme
UA	University of Arizona
UN	United Nations
USAID	United States Agency for International Development

UNICEF	United Nations Children's Fund
VH	Village Headman
WHO	World Health Organization
WUA	Water Users Association

CHAPTER 1. INTRODUCTION

1.1. Water Resources in Malawi and the Lake Malawi Basin

Malawi has a relatively rich water resource comprising of several natural lakes, manmade reservoirs, a network of perennial and intermittent rivers, and groundwater. Lakes feature highly in the country's water resource. Lake Malawi, with a surface area of 29,500 km², is the most dominant water body in the country spanning a length of 570 km across the country and a width of 16 to 80 km (Frenken 2005; ILEC 2005). It is seconded by the Lake Chilwa Wetland which covers an area of 2,400 km² of which a third each is for open water, swamp and marsh, and floodplain (Jamu et al. 2006). The lake is the southern most of the Rift Valley Lakes of Africa. It is a closed system with an average depth of 2 m and has several inflow rivers (Frenken 2005). The wetland is a listed Ramsar site and supports one of the most productive ecosystems in Africa, making it both ecologically and economically important. Lake Malombe is a swelling on the Shire River, the only outlet of Lake Malawi. It has an area of 390 km², a length of 30 km, a width of 16 km and an average depth of 4 m (Frenken 2005). Lake Chiuta covers 200 km² and an average depth of 5m (Frenken 2005; GoM 2008c; Jamu et al. 2006). Major Rivers in the country include the Shire, Bua, Linthipe, Songwe, North Rukuru, South Rukuru, Dwangwa and Ruu.

Despite the relatively abundant water resources, Malawi is a water stressed country. The Falkenmark Indicator (water stress index) proposes the threshold of 1,700 m³ of renewable water resources per capita per year (Falkenmark et al. 1989). The country's total renewable water resource per capita is less than 1,700 m³/year with the Government of Malawi reporting less than 1,400m³/year (GoM 2008c; USAID 2009). This is mainly due to infrastructure inadequacies and inefficiencies that affect water distribution and access. According to the National Water Policy, the main challenges in the water and sanitation sector are: (i) degradation of water resources; (ii) inadequate service coverage; (iii) inadequate financing; (iv) increasing water demand; (v) HIV and AIDS prevalence; (vi) insufficient capacity; (vii) lack of integrated approach; (viii) climate

change and climate variability; (ix) lack of mitigation measures for water related disasters; and, (x) inadequate promotion of hygiene and sanitation (GoM 2005). The policy's vision is "water and sanitation for all, always." Mulwafu (2010) observed that availability will be gradually reduced by competing demands of the water resource which include domestic, industrial and municipal use, irrigated agriculture, mining, and energy production. It is critical that the country manages and develops its water resource in a way that ensures sufficient reliable availability that is sustainable for the needs of both humans and nature.

Lake Malawi forms the most important single water resource in the country. This is a local manifestation of the fact that most of the accessible freshwater resources in the world are stored in lakes (ILEC & UNEP 2003; ILEC 2005; Muhandiki et al. 2010). It is the world's ninth largest freshwater lake by surface area, third deepest with a maximum depth of 700 m, and is home to the greatest freshwater fish biodiversity (Eccles 1974; Owen et al. 1990; Bootsma & Hecky 1999; Bootsma & Hecky 2003; ILEC 2005). The lake basin is a shared resource among Malawi, Mozambique and Tanzania with the largest portions of both the basin and the water surface area in Malawi. In Malawi, the lake and its basin are of high social and economic significance and among others, are important for: (i) water supply for domestic, agricultural and industrial use; (ii) fisheries resources that among others, represent the most accessible source of animal protein in the diet of most Malawians; (iii) hydro-electric power generation; (iv) navigation; (v) rain-fed and irrigated agriculture; (vi) mineral resources; (vii) tourism; (ix) local climate moderation; and, (x) research purposes. The major environmental issues affecting the lake and its basin include deforestation, soil erosion, overexploitation of some fish species, pollution, and excessive extraction of water from some rivers (GoM 1994; Bootsma & Jorgensen 2005; Chafota et al. 2005; Jamu et al. 2011; Ngochera 2014). Many of these concerns are common in all the three riparian countries (see Chafota et al. 2005). Emerging threats include increasing mineral resource extraction, and industrialization (Jamu et al. 2011). A comprehensive approach to the management of the lake and its basin is therefore necessary especially considering the significance of the lake basin to the nation's economy and well-being. This thesis contributes towards addressing this need.

1.2. Problem statement

The Lake Malawi Basin is not monitored and managed as a whole system, despite the serious threats. Current management is fragmented across the riparian countries and across sectors within the countries. In Malawi, management is on a sector-to-sector basis. The sectors playing a role in the management include environment, water, sanitation, forestry, fisheries, agriculture, irrigation and several others. Coordination of activities is minimal. This makes it difficult to ensure that all players share a common vision and direct their actions towards its achievement and realize synergy. It is also difficult to monitor the trends of the changes taking place and undertake appropriate management actions. Such monitoring is also essential to determine the efficacy of any management strategies that are implemented. Therefore, current management does not ensure sustainability of the lake and its basin.

Policymakers, managers and other stakeholders need guidance to make sound decisions and take sound actions that ensure better management for sustainable utilization of the lake basin. There is need to obtain a comprehensive understanding of the current management status by identifying key issues, strengths, needs and challenges to ably guide stakeholders. This study aimed to contribute towards addressing this need. Through a mixed methods research design (Kumar 2014), this study sought to find answers to the following research questions;

- 1) What is the status of the management of the Lake Malawi Basin from the perspective of ILBM (i.e. in terms of policies, institutions, stakeholder participation, technology, information and science, and finances)?
- 2) What are the issues, needs and challenges surrounding the management of the lake basin?
- 3) How can management of the lake basin be improved to ensure sustainable use?

Thus, the study sought to understand the management environment of the lake basin from which a status, based on ILBM perspective was determined and recommendations made. The aim was to highlight areas that require attention to aid the formulation of management plans and strategies that are integrated and implemented through cross-sectoral cooperation and ensure sustainability of the lake basin. This study is therefore, an effort to contribute towards achieving a comprehensive understanding of the lake basin system by integrating various disciplinary perspectives into governance practices of the lake basin.

1.3. Research Objectives

1.3.1. Overall Objective

To conduct a comprehensive assessment and analysis of the issues, needs and challenges in the management of the Lake Malawi Basin.

1.3.2. Specific Objectives

Focusing on the Malawian side of the basin, the study sought;

- 1) To develop an indicator-based tool for monitoring and assessing Integrated Lake Basin Management (ILBM) in the Lake Malawi Basin.
- 2) To determine the status of current management of the Lake Malawi Basin in the aspects of institutions, policies, participation, information, technology and finance through pilot application of the tool developed in specific objective (1).
- 3) To identify and analyze the issues, needs and challenges in the management of the Lake Malawi Basin through SWOT analysis.
- 4) Based on the issues identified in objectives (2) and (3), to identify critical points requiring management attention through application of systems thinking approach.

1.4. Justification of the study

Proper management of the lake and basin is crucial for the well-being of Malawians and the economic development of the country. Most of the studies undertaken on the lake basin focus on isolated aspects such as fisheries, lake environment, agricultural aspects, waste management and health issues. A comprehensive study focusing on the governance of the lake basin ecosystem based on an understanding of the interactions of the lake ecosystem with humans has not been done. This study is relevant as it is comprehensive in that it considers both natural and human

systems and how they interact. To the extent possible within the constraints of the study, it comprehensively considers the ecosystem services the lake basin system provides and how these relate to the various sectors that play a role in the management of the lake basin. Through this approach, the study captures important areas of interaction and highlights how comprehensive management can be realized and synergy harnessed through cross-sectoral cooperation and in so doing move towards ensuring sustainability of the lake basin.

The study adds to the existing body of knowledge through the development of an indicator framework for assessing the management of the lake basin through which the status of the lake basin is determined. It acts as a bridge between scientific research, and policy and management with due consideration of socio-economic aspects of environmental management and natural resource utilization. The applied methodology integrates perspectives from various disciplines (i.e. environmental, policy, social and technological) and seeks an understanding that reflects the big picture of the lake and basin as one system, and the interactions between the lake basin natural system (i.e. the natural resource itself) and human system (i.e. policy, institutional, socio-economic and technological contexts). In addition to synthesizing information from scientific literature, the study also generated primary knowledge through which the perceptions of various stakeholders were captured. The developed assessment framework is practical and incorporated on-the-ground realities from a wide range of disciplines as they relate to the lake basin. The findings can be useful in supporting on-going efforts in policy formulation as well as in the development of management plans and strategies for the lake basin since they provide an indication of the current status of the management of the lake basin system and highlight areas that require attention.

1.5. Scope and Limitation

The study focused only on the Malawian side of the lake and basin, due to resource constraints. It focused on sectors relevant to the management of the Lake Malawi Basin as well as rural communities, who represent the majority of the basin population. However, many of the issues discussed are common in all the riparian countries. As such, the study gives a fair picture of the situation in the lake basin. Figure 1.1 shows the entire Lake Malawi Basin while Figure 1.2 shows the study area.

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, p. 174).

“**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 & Rast 2011, p.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 organizations.

Public participation is a process of involving affected or interested stakeholders in the planning, decision-making and policy-forming activities. This study uses the terms ‘public/stakeholder participation’, ‘public/stakeholder involvement’ and ‘public/stakeholder engagement’ interchangeably.

1.7. Structure of Thesis

The thesis is organized into six chapters. Chapter 1 provides the background and highlights the objectives and importance of the study. Chapter 2 discusses the theories, principles and approaches in the management of lake basins. In Chapter 3, the methodology, including the proposed indicator framework is provided. Development of the indicator framework is presented by means of a reprint of the accepted version of a 2015 publication. The assessment of the Lake Malawi Basin with respect to the six governance pillars of ILBM is presented in Chapter 4. The chapter has six main sections, each focusing on the assessment of one ILBM pillar. Two of the sections are presented by means of reprints of accepted versions of 2015 publications, with some editorial and formatting changes to minimize duplication with other sections of this document and to maintain consistency. Chapter 5 synthesizes the findings from each ILBM pillar to obtain

a lake basin wide understanding of the implications of the findings. This is done through application of SWOT analysis and systems thinking approach. Chapter six provides the conclusion, recommendations, and areas for future research.

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CHAPTER 2. THEORIES, PRINCIPLES AND PRACTICES IN THE MANAGEMENT OF LAKE BASINS

This chapter presents the theories, principles and approaches in the management of natural resources in general and lake basins in particular. The chapter discusses the systems thinking approach, ecosystem approach, theoretical aspects of the governance of common-pool resources, and trends in lake basin management

2.1. Systems Thinking Approach and System Dynamics

This sub-section is based on the works of Haraldsson (2000) and Midgley (2007) who outlined how the system thinking approach has evolved over time and how it can be better applied to modern times. Haraldsson also explains the system dynamics concept and application.

2.1.1. Systems Thinking Approach

Systems thinking involves taking a holistic perspective to issues. Haraldsson (2000) defines systems thinking as “a science that deals with formulation of logic and integration of disciplines for understanding patterns and relations of complex problems.” It aids understanding of cause and effects of a problem and the interrelationships of different aspects of society and the natural environment through feedback loops. Citing the work of Alexander Bogdanov in the 1920s, he presents three elements characterizing complex systems as follows: (1) organized complexities (the whole is greater than the sum of its parts); (2) disorganized complexities (the whole is less than the sum of its parts); and, (3) neutral complexes (the organizing and disorganizing activities cancel each other out). People’s immediate response to difficulties is to address the most visible problems by applying quick remedies (end-of-pipe solutions) that show quick results and restores

the issue to its original state. However, the problems usually resurface in another form that was unexpected Haraldsson (2000).

Midgley (2007) provides an outline of the emergence of different approaches within systems thinking over time. Using a "wave" metaphor (i.e. a wave throws useful materials onto the beach which are then added upon and sometimes rearranged when the next wave hits), he describes three waves of systems research since the 1940s, in the context of evaluation.

The **first wave** was characterized by the following three parallel and mutually supportive fields of inquiry:

1. General system theory (GST) which proposes looking at things as open systems (i.e. systems that exchange matter and energy with their environment) as opposed to "reductionist science" which seeks explanation of phenomena in terms of their smallest identifiable parts. Useful concepts within this theory include the view that evaluation of the viability of an organization is possible. One approach emerging from this is the viable system model (VSM), a model of the organizational structure of any autonomous system seeking to survive in a changing environment. VSM proposes five essential functions that must be carried out by an organization for it to become and remain viable in a dynamic environment. The five key systems which a viable system needs to have are implementation, coordination, control, intelligence and policy (Espejo and Gill 2000). Another useful concept Midgley describes is the idea of the hierarchical structure of open systems i.e. systems are embedded within wider systems e.g. individual human beings living within communities which are within ecosystems. In terms of water resources, an example would be individual trees making up a forest which is part of a river system that is also part of other wider systems e.g. a lake or ocean. The whole affects the parts, and the parts affect the whole. Many aspects may be important and it may be overwhelming for one who is trying to understand what is going on. One rule of thumb Midgley proposes when thinking in terms of hierarchies is: "Once the system in focus has been defined (i.e. a particular policy implementation system, service or organization has been chosen for evaluation), look at least one level up and one level down to gain a greater understanding of what is happening." (p. 15);

2. Cybernetics, whose basic idea is feedback. A key insight from both GST and cybernetics that Midgley highlights is that observation by researchers is not done outside social and ecological systems, rather it is done within particular relationships and it influences those relationships through communication and actions. Hence, it is better for researchers/evaluators to acknowledge and take explicit responsibility of their involvement in situations rather than purporting context-independent and value-neutral practice. Another insight is the importance of methodological aids without which human consciousness has a tendency to over-simplify causality and in the process, making many feedback loops and interdependencies invisible, thus missing out on the dynamic pattern of interaction. He highlights two implications for evaluation. The first implication is that modeling feedback processes to aid understanding can be useful. Several systems methodologies exist that can be useful including systems engineering, systems analysis and systems dynamics. Similarly, as Haraldsson (2000) explains, the problem solving strategy of humans is often based on linear thinking. This linear approach can be explained from mental models humans use which are a simplification of how the world works around them. Through these models, people develop routines and skills which help them cope with life e.g. putting on an extra sweater when going out on a cold day. Such models are static, describing a set of linear relationships that do not change over time. Most problems however, are dynamic whereby variables and relations change with time. Hence, feedback is a critical factor to understanding dynamic behavior. To some extent, the human mind can understand dynamic behavior e.g. including into their mental model weather fluctuations during the day and so one decides to take a rain jacket to be on the safe side. However, when the dynamic variables exceed three or four components, it becomes too complex for the human mind to comprehend especially if the time aspect is long. At this point, the challenge is to identify what, how and when to act. Systems thinking was developed to assist in such situations (Haraldsson 2000). The second implication Midgley points out is that since “human thoughts and behaviors are part of wider systems of causality, evaluators need to be very careful about engaging in “blame games”” (p. 17). As opposed to a linear view which looks at responsibility very simply and seeks to identify something or someone that must be responsible (Haraldsson 2000). The insight from cybernetics that causality has a systemic character, combined with the

insight from GST that organizations can usefully be described as open systems led to the emergence of the *systems failure* evaluation approach. This approach seeks to evaluate organizational failures without simply attributing blame to a single entity; and,

3. Complexity science, whose important insight for evaluation is that although some degree of regularity and order exist in the world, most systems are highly complex, as such, the human ability to understand and predict their behavior is limited. Evaluators therefore should guard against assuming “systemic invariance” i.e. assuming no change in the existing social or organizational condition. Rather, evaluators should be alert to contextual changes that may affect how the evaluation needs to proceed. Another useful insight is the phenomenon of *emergence* whereby new characteristics of complex systems emerge over time. This means that the evaluation criteria that seem most relevant today may become redundant or might need to be adjusted or reinforced by others in future.

These approaches were criticized for regarding models as representations of reality rather than as aids for establishing interdisciplinary understanding. Human beings were viewed as objects that could be easily manipulated as components of bigger systems disregarding that they are individuals with their own goals which may or may not be in line with wider organizational priorities. The first wave of system thinking did not recognize the value of stakeholder engagement in activities of planning and decision-making. Furthermore, the emphasis of open systems theory resulted in seeing surviving and thriving in a turbulent environment as an end in itself, rather than a means to deliver some other socially-valued ends.

The **second wave** placed emphasis on dialogue, mutual appreciation, the inter-subjective construction of understandings, and seeking to reconcile different perspectives. Ideas include the importance of a careful consideration of the boundary of analysis i.e. what is to be included or excluded, both the knowledge and the people who generate that knowledge and who have a stake in the results of any management intervention. This called for a rigorous self-reflection that exposes the most cherished assumptions to the possibility of overthrow. Also highlighted is the importance of communication, use of qualitative data about different perspectives rather than being restricted to a given set of quantitative indicators, and adopting a formative methodology (an evaluation focusing on the process of a program in contrast to summative methods which focus on the outcome) to enhance continuous learning.

The other aspect is the shift from expert-led modeling to the development of *participative* methodologies to include multiple perspectives and move away from the previous practice of assuming that the researcher was an expert. An essential assumption is that people are more inclined to take ownership of analyses and implement the resulting recommendations if they can participate in defining the goals and scope of those analyses and even in their execution.

The participative methodologies from the second wave of systems thinking were criticized for lack of adequate consideration of power relationships within interventions and/or conflicts built into the structure of society. It was observed that stakeholders have varying degrees of power that often affects their ability to speak openly in front of one another for fear of consequences. This runs the risk of reinforcing the viewpoints of those with authority with inadequate consideration of the voices that might have been silenced.

The **third wave**, from the 1980s to the present brought the *critical systems thinking* approaches many of which provide a rationale for picking the best methods from both the first and second waves and utilize them in broader systems practice. *Methodological pluralism* (the use multiple methodological approaches that are context-sensitive) and *boundary critique* (an ethical process for exploring and justifying boundaries through stakeholder dialogue) were seen as better approaches.

In his own contribution, Midgley further develops the third wave ideas in his work on systemic intervention. He advocates taking issues of marginalization seriously. Thus, it is important to design methods that can support cross-boundary dialogue; consider the importance of contributions of marginal groups; and, include issues that might not receive proper consideration. He highlights the importance of the synergy of boundary critique with methodological pluralism. He notes that practicing boundary critique on its own poses a danger of the resulting analyses not being acted upon while practicing methodological pluralism without up-front boundary critique can result in superficial diagnoses. The synergy from the two approaches ensures that each aspect corrects the shortfalls of the other. While noting that drawing methods from all three waves of system thinking and the evaluation literature might be overwhelming for researchers and practitioners without much experience of using systems approach, Midgley advises starting from the systemic insights and methodological resources one already has and building on that. It is good to work on synthesizing what one already knows as

building systemic resources requires both a theoretical and methodological learning journey with respect to practice.

2.1.2. System Dynamics and Causal Loop Diagrams

The System Dynamics Society describes system dynamics as follows “System dynamics is a computer-aided approach to policy analysis and design. It applies to dynamic problems arising in complex social, managerial, economic, or ecological systems — literally any dynamic system characterized by interdependence, mutual interaction, information feedback, and circular causality” (http://www.albany.edu/cpr/projects_systems_dynamics.shtml). Haraldsson (2000) describes systems thinking as “mental modelling and science of structuring logic” which also has a practical application, system dynamics. Providing mathematical representation of the mental models, system dynamics is the next step after the mental model is developed. The feedback concept (i.e. any reciprocal flow of influence) shows how actions can reinforce or balance each other. In systems thinking, every influence is both cause and effect. Nothing is ever influenced in one direction. As such, responsibility for problems generated by a system is shared by everyone. Causal loop diagram (CLD) is a useful tool in systems thinking that assists in the structuring of and conceptualization of a problem (Haraldsson 2000). With a CLD, the connections and feedbacks surrounding a problem can be constructed in a circular way making it possible to predict the behavior of the problem. A fundamental characteristic of a system is that its behavior can only be understood by looking at it as whole, not at individual parts.

System dynamics is based on the view that all the behavior of a system is a result of its structure i.e. the success and failure of a system is determined by its structure. As Haraldsson (2000 p. 12) states, “everything you need to solve within a system is right there and going outside it to look for a cause of the problem is erroneous and indicates that we need to expand our system boundaries”. While it is important to understand dynamic complexity, it does not entail understanding detailed complexity. As such, generalization is often indispensable when dealing with complex systems.

2.2. Ecosystem Approach

The Convention on Biological Diversity (CBD) defines the ecosystem approach as “a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way” (Secretariat, C.B.D. 2004). The basis of the ecosystem approach (EsA) is the application of appropriate scientific methodologies focused on levels of biological organization, which include the essential structure, processes, functions and interactions among organisms and their environment. Adaptive management is important in the EsA as ecosystems are complex and dynamic and often knowledge or understanding of their functioning is incomplete. Ecosystem processes are often non-linear and their outcomes often exhibit time-lags and this leads to uncertainties. The ecosystem approach has twelve principles as follows;

- 1) The objectives of management of land, water and living resources are a matter of societal choice.
- 2) Management should be decentralized to the lowest appropriate level.
- 3) Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
- 4) Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management program should:
 - (a) Reduce those market distortions that adversely affect biological diversity;
 - (b) Align incentives to promote biodiversity conservation and sustainable use;
 - (c) Internalize costs and benefits in the given ecosystem to the extent feasible.
- 5) Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the EsA.
- 6) Ecosystems must be managed within the limits of their functioning.
- 7) The EsA should be undertaken at the appropriate spatial and temporal scales.
- 8) Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term , i.e. the formulation of management plans should explicitly consider time.
- 9) Management must recognize that change is inevitable.

- 10) The EsA should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
- 11) The EsA should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
- 12) The EsA should involve all relevant sectors of society and scientific disciplines.

In applying these principles, the following operational guidance is proposed presented in five points;

- 1) Focus on the functional relationships and processes within ecosystems.
- 2) Enhance benefit-sharing.
- 3) Use Adaptive Management Practices.
- 4) Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to lowest level, as appropriate.
- 5) Ensure inter-sectoral cooperation.

Consideration of ecosystem services within decision-making amplifies the complexity in the assessment of what matters and why in a decision since the ecosystems services in the EsA framework span different sectoral areas and “places the natural environment directly in the service of human well-being” (Fish 2011, p. 675). Fish points out that in the context of environmental resources as portrayed in the EsA, there is need for more creativity in deciding which stakeholders to include and why.

2.3. Theoretical Aspects of the Governance of Common-Pool Resources

This section is based on Elinor Ostrom’s work particularly her paper titled “Reforming the Commons” (2002). The work highlights the shortfalls of the conventional theory of common-pool resources and makes a case for self organized resource governance systems. Common-pool resources are non-excludable but rivalrous i.e. most common-pool resources are sufficiently large that multiple actors can simultaneously use the resource system and efforts to exclude potential beneficiaries are costly. In addition, the extraction or consumption of a resource by one

appropriator precludes its extraction or consumption by another e.g. fish taken out of a lake by one fisherman makes the fish unavailable for another. The conventional theory of common-pool resources assumes that;

- 1) The resource generates a highly predictable finite supply of one type of resource unit;
- 2) Appropriators (harvesters) are homogenous (i.e. in terms of assets, skills, discount rates and cultural views);
- 3) Appropriators are short-term, profit-maximizing actors who possess complete information;
- 4) Anyone can enter the resource and appropriate resource units. Appropriators gain rights to only what they harvest and they sell in an open competitive market; and,
- 5) Appropriators act independently and do not communicate or coordinate their activities in any way.

In the past, based on the theory, it has generally been thought logical that authorities must intervene (e.g. government ownership and control, and private property rights). Theorists assumed that regulators will act in the public interest and induce better social behavior. The possibility that appropriators themselves could organize themselves was not seriously considered until recently. However, evidence in the field has shown that most common-pool resources are more complex than the conventional theory depicts. Evidence also shows that if appropriators can engage in face-to-face bargaining and have autonomy to change their rules, they may attempt to organize themselves. According to what is seen in reality, whether appropriators organize depends on attributes of the resource system and the appropriators themselves that affect the benefits to be achieved and the costs of achieving them. Furthermore, whether their self-governed enterprise succeeds over the long-term depends on whether the institutions designed are consistent with the design principles underlying robust, long-sustained, self-governed systems. Based on the views of researchers familiar with field realities, Ostrom presents a list of attributes of resources and of appropriators that are conducive in enhancing the likelihood that self-governing associations will develop. The following are attributes of the Resource;

- 1) *Feasible improvement*: resource conditions have not deteriorated to the point that organization is pointless, or are so underutilized that organization yields little advantage;

- 2) *Indicators*: frequent availability of reliable and valid indicators of the condition of the resource system at a relatively low cost. This affects the capacity of appropriators to adapt relatively soon to changes;
- 3) *Predictability*: it is much easier to understand and manage a flow of resource units that is relatively predictable than it is to manage one that is erratic. For an erratic system, it is difficult to judge whether changes in the resource stock or flow are due to overharvesting or to random exogenous variables; and,
- 4) *Spatial extent*: sufficiently small resource system, considering the transportation and communication technology in use, so that appropriators are able to develop accurate knowledge of external boundaries and internal microenvironments. Spatial extent affects the costs of defining reasonable boundaries and of monitoring them in the long run.

The following are attributes of the appropriators;

- 1) *Salience*: the resource system is a major source of livelihoods for the appropriators. The high costs of organizing and maintaining a self-governing system may not be worth the effort if the resource does not represent a major source of their income;
- 2) *Common understanding*: appropriators have a shared image of how the resource system operates (resource attributes) and how the resource system and their actions interact;
- 3) *Low discount rate*: appropriators still believe the resource can be sustained and continue to be utilized in the future;
- 4) *Trust and reciprocity*: there is trust among appropriators to keep promises and mutually relate to one another (where trust and reciprocity is high expected costs for monitoring and sanctioning one another are lower);
- 5) *Autonomy*: appropriators are able to determine access and harvesting rules without external authorities revoking them. Autonomy tends to lower the costs of organizing; and,
- 6) Prior organizational experience and local leadership.

The larger regime in which users are embedded is a very important factor as it affects many of these variables. Such larger regimes can facilitate local self-organization by providing; accurate information about natural resource systems; fora for participation; and, mechanisms to back up local monitoring and sanctioning efforts.

These Attributes affect the benefits as well as the costs of institutional change. If resource units are relatively abundant, appropriators do not have much incentive to invest time and effort in organizing. If the resource is already substantially destroyed, the costs of organizing may be too high to yield substantial benefits. As such, only after appropriators observe substantial scarcity is self-organization likely to occur. If expected benefits are less than expected costs for many appropriators, the costs of enforcing a change in institutions will be much higher than when most participants expect to benefit from a change in rules over time. It is not necessary for all attributes to be favorable but the relative size of the expected benefits and costs they generate as perceived by participants is key.

Ostrom further provides design principles illustrated by long-enduring common-pool resource institutions that determine their success. These are;

1. *Clearly Defined Boundaries*: individuals rights to withdraw resource units and the boundaries of the common-pool resource itself are clearly defined;
2. *Congruence*: the distribution of benefits from harvesting rules is roughly in proportion to the costs imposed by provision rules and that harvesting rules are related to local conditions and generally considered fair;
3. *Collective-Choice Arrangements*: most users can participate in modifying operational rules;
4. *Monitoring*: those undertaking monitoring activities of both the system and the appropriators are accountable to the appropriators and/or are the appropriators themselves;
5. *Graduated Sanctions*: appropriators who violate operational rules are likely to receive graduated sanctions in line with the seriousness and context of the offense;
6. *Conflict-Resolution Mechanisms*: local arenas are available for users and officials to access conflict resolution rapidly;

7. *Minimal Recognition of Rights to Organize*: the rights of users to devise their own institutions are not challenged by external governmental authorities; and,
8. For common-pool resources that are part of larger systems, *nested enterprises* are important e.g. from small local institutions to sub-catchment and catchment institutions. Appropriation, provision, monitoring, enforcement, conflict resolution and governance activities are organized in multiple layers of nested enterprises. This provides a means for addressing externalities from one group to others.

As such, a supportive legal structure at the macro-level that authorizes users to take responsibility for self-organizing and crafting at least some of their own rules is important. Creation of large-scale agencies by policy makers for monitoring performance of both natural resource systems and users is also important. These agencies should also compile accurate information and make it readily available to users to enhance their knowledge. In addition, conflict resolution mechanisms are important. Furthermore, it is important to develop programs whereby users gain more benefits from local resources as this changes the benefit-cost computation and makes self-organization more likely.

2.4. Worldwide Trends in Lake Basin Management

Several countries have made significant strides in lake basin management. Management approaches have evolved in various ways, reflecting the needs and challenges the lakes and their communities have faced. This section looks at lake management approaches in the Laurentian Great Lakes (North America), Lake Victoria (East Africa), Lake Biwa (Japan), Lake Chad (West Africa), Lake Constance (Germany, Austria and Switzerland), and the Lake Chilwa Wetland (Malawi). These cases were selected in consideration of size, transboundary nature (except for Lake Biwa), significance, and management history.

2.4.1. The Laurentian Great Lakes

The Laurentian Great Lakes are a group of five freshwater lakes namely, Superior, Michigan, Huron, Erie and Ontario. All but one (Lake Michigan) are shared between the United States of America (USA) and Canada. They comprise the largest system of fresh surface water lakes on earth, containing about 18% of the world's surface freshwater supply in their total surface area of 244,000 km² (MacDonagh-Dumler et Al., 2005; Waples et al., 2008). The Great Lakes region is characterized by a large and diverse economy which includes manufacturing, services, agriculture and forestry (MacDonagh-Dumler et Al., 2005). Water resource projects for these water bodies have existed since the late 1700s and initial emphasis was on transportation (MacDonagh-Dumler et Al., 2005). Resource management evolved from being mainly development oriented to the creation of government institutions with broad powers through federal legislation, to comprehensive basin planning approaches and adoption of partnerships and state stewardship responsibility that incorporated environmental protection. The current focus is a shift from top-down, command-and-control approach dominated by government to a bottom-up, partnership-based and inclusive approach. This evolution has been accompanied by legislative and institutional changes.

A combination of legal instruments (agreements, treaties and policies) institutions (e.g. the International Joint Commission - IJC, the Great Lakes Fishery Commission – GLFC, and the Great Lakes Commission - GLC), benefits sharing approach, use of science and technology, transparency, public involvement and joint fact finding, among others, have contributed to the success in transboundary cooperation and basin wide management of these lakes (MacDonagh-Dumler et Al., 2005; UNU-INWEH, 2011). Strides have been made in monitoring the lakes and their basins through collaboration with various stakeholders and the public (Barr et al. 2010). The Great Lakes are still facing challenges such as threats to water quality (i.e. point and non-point source discharges), threats to water quantity (e.g. human diversions and urbanization) and threats to ecosystem integrity (e.g. invasive species) (MacDonagh-Dumler et al., 2005; Evans et al. 2011). Lessons from the management experience include: both formal arrangements (e.g. formal agreements and conferences) and informal arrangements (e.g. relationships that develop among colleagues and evolve into collaborative research) are important in research and management; both the academia and Government play important roles in research and strong coordination is therefore important; both disciplinary and multidisciplinary research are

important and the need for more multidisciplinary research is increasing; utilization of relevant indicators/parameters in monitoring is important and there is need to pay sufficient attention to data synthesis and reporting; characterization of roles and relationships, and gaps in institutions and among stakeholders, creative use of informal institutional arrangements, flexible institutions, regional, international and global knowledge and experience sharing can enhance institutions and governance; and, management experience shows it is now important to shift towards a shorter adaptive management review cycle (MacDonagh-Dumler et Al. 2005; Evans et al. 2011).

2.4.2. Lake Constance

Lake Constance is located in Central Europe and has a surface area of 571.5 km² (Hammerl & Gattenloehner 2005). Its basin spans an area of about 11,500 km². The water body and basin are shared by Austria, Germany and Switzerland while the Principality of Liechtenstein is located within the basin (Ostendorp et al. 2004; Hammerl & Gattenloehner 2005). The lake basin is a representative and significant natural habitat for plants and animals in Central Europe and is particularly important as a resting and wintering area for water birds. The lake is also important for tourism and recreation especially in the German portion. Other important uses include settlements, industry, agriculture and drinking water supply (Ostendorp et al. 2004; Hammerl & Gattenloehner 2005). Threats include pollution from agriculture.

There has been cross-border cooperation among the riparian countries for quite a long time. Notable early cross-border cooperation include the 1857 treaty on the establishment of an international working committee for the regulation of Lake Constance and the founding of the International Proxy Conference for Lake Constance Fishery (IBKF) in 1893 (Hammerl & Gattenloehner 2005; Roeber 2010). Regular daily water gauge recordings begun in 1816 (Ostendorp et al. 2004). There are several established international bodies handling various aspects of lake management. These include: the International Bodensee Conference (IBK), an international organization of the lakeside federal states and cantons, founded in 1972; International Commission for Boating on Lake Constance (ISKB); International Proxy Conference for Lake Constance Fishery (IBKF); Lake Constance Fishery Federation (IBF); International Commission for the Protection of Lake Constance (IGKB); and, Lake Constance Foundation. IBK organizes annual conferences with all prime ministers of the member states.

IGKB was founded in 1959 by the three riparian countries as an advisory agency to protect the lake ecosystem from further degradation (Ostendorp et al. 2004; Hammerl & Gattenloehner 2005). It publishes annual investigation data of lake monitoring (green reports), and case studies and special topics (blue reports). IGKB is not an executing agency but only gives recommendations to members.

Challenges include morphological modifications and damage to the shore zone and shallow areas of the lake resulting from construction and use of settlements, recreation and transport infrastructure; introduction of non-native fish species; and, difficulties with continuation of some efforts e.g. the “The BodenseeClick”, a web-based information system which combined public transportation schedules with destinations in the tourist attraction region, created by the Lake Constance Foundation in 2001 was not embraced and continued by the Lake Constance Tourism Association (Ostendorp et al. 2004; Hammerl & Gattenloehner 2005). Lessons that have been learnt from the management experiences include the importance of: international agreements in the protection of endangered habitats and species (i.e. designation of protected areas is important); management plans and monitoring systems with a legally binding concept; states’ support for organic farming in the basin; the integration of women into the development and decision-making process; fishery protection; improvement of environmental quality of accommodation and recreation facilities by the introduction of environmental management systems and incentives; sensitization of locals and guests by highlighting human-environment connections and providing tips for environmentally friendly behavior; recognizing the pollution caused by private automobiles and other transport modes and the need for securing reliable, sufficient and high quality public transport; the inclusion of civil society actors and lower state level authorities in the management framework; and, environmentally sound land use planning (Ostendorp et al. 2004; Hammerl & Gattenloehner 2005). Roeber (2010) described the pattern of administrative cooperation in the Lake Constance Region as highly fragmented. The reasons he gave are that it relies on tightly-knit experts communities and lacks significant grassroots approaches. Cross-border cooperation in the region involves a variety of actors (such as the private sector, Non-Governmental Organizations (NGOs), local, state and federal administration, parties, and associations of cooperation initiatives), a variety of legal forms and a variety of organizational forms. Despite the wide array of relations among riparian states, cooperation explicitly focused on Lake Constance is “limited to natural related policy issues”

(Roeber 2010, p. 5). He observed that generally, involvement of actors from private businesses and civil society in political and administrative cross-border cooperation is limited and that local governments are absent. Interestingly, although local level cooperation structures are rudimentary, strong ties exist between local actors, municipalities and small areas in the region. However, these are often exclusive and informal and that NGOs and regional municipalities feel marginalized and ignored. Nevertheless, he concludes the existing institutional arrangement has been successful so far, especially in tackling technical and regulative tasks. However, he expressed concern of whether this pattern will continue to work, considering emerging issues which include demand for increased legitimacy from the grassroots.

2.4.3. Lake Biwa

Lake Biwa is the largest lake in Japan with a surface area of 670 km² and is one of the oldest lakes in the world (Shiga Prefectural Government 2000; Lake Biwa Comprehensive Preservation Liaison Coordination Council - Promotion Council 2003; Bamba 2011). It has only one outlet, the Seta River which is an important tributary of Yodo River, that supplies water to Japan's second largest mega-city area of Kyoto-Osaka-Kobe with a 2012 population of around 17 million. The lake is entirely located in Shiga Prefecture with part of its basin in Kyoto Prefecture. Catchment area for the lake is about 3,700 km², of which 98% is located in Shiga Prefecture (Kira et Al., 2005), making management less complicated than that of many lakes around the world. The Lake Biwa Yodo River basin is very important to the prefectures of Shiga, Hyogo and Osaka. It provides water for domestic, industrial, irrigation and hydropower. Water level in the lake is controlled by the Seta Weir which regulates outflow of the Seta River. Residents of the lake area have had a long history of floods, droughts and water related conflict.

Early management efforts focused on water resources development and flood control. The country's rapid economic growth in the 1960s increased water demand downstream as a result of growing industrialization and population. This, in addition to the threat of natural disasters such as floods, management interventions sought to provide more water to downstream users and reduce the threat of floods in the lakeshore areas, while preserving the lake's natural environment and restoring its water quality. This was the aim of the Lake Biwa Comprehensive Development Plan (LBCDP:1972-1997), a national project based on a special arrangement

designed to develop the upstream region (Shiga Prefecture) through a special financing arrangement that included partial cost coverage by downstream governments and subsidy from the national Government. LBCDP enabled flood control, ensured a steady water supply and significantly improved the lake's water quality (Lake Biwa Comprehensive Preservation Liaison Coordinating Council – Promotion Council 2003). Despite the plan being largely a success, lake and river shore degradation, increase of water plants in the lake, increase of exotic fish in the lake and Yodo River, and lake water quality problems remained. Later, changes aimed at shifting from a lifestyle based on mass production and consumption to one based on symbiosis of humans and nature became the focus of Shiga Prefecture (Shiga Prefectural Government, 2000). A 22 year plan, the Mother Lake 21 Plan: Lake Biwa Comprehensive Preservation and Improvement Project was developed. The plan recognizes the crucial role of local communities and stakeholders and clearly provides for and supports their involvement.

The administration system and structure has undergone constant evolution in response to changing demands covering areas of pollution control, eutrophication, wastewater management, and watershed management. Public and stakeholder involvement is also high. Capacity for monitoring and research is strong making it the most studied lake in Japan and has an extensive database. To enhance the research capability, the prefectural Government established the Lake Biwa Research Institute in 1982 and University of Shiga Prefecture and Lake Biwa Museum in 1995. The prefectural Government's efforts for international cooperation and information exchange on lake issues include the world lake conferences that it organizes since 1984 and the founding of the International Lake Environment Committee (ILEC) in 1986. Existing problems include loss of forest land, freshwater red tides, decrease in reed bed area which is affecting fish population, reduction in the number of attached lakes (naikos), exotic species invasion, and habitat loss (Lake Biwa Comprehensive Preservation Liaison Coordinating Council – Promotion Council 2003; Bamba 2011). The importance of upstream and downstream cooperation and pursuing a sustainable system for basin management are some of the lessons (Bamba 2011).

2.4.4. Lake Victoria

Lake Victoria, home to the world's largest fishery, is an African Great Lake and the world's second largest freshwater lake with a surface area of 68,000 km² (Kayombo & Jorgensen 2005;

Muyodi et al. 2010). The lake is shared among Uganda, Tanzania and Kenya. Rwanda and Burundi share the basin but not the water body. The lake is used for fishing, transportation, hydropower generation and as a source of water (Muhandiki & Ballatore 2007). There have been efforts among the three riparian countries to collaborate on issues concerning the lake. The East African Community (EAC) established in 1999, is the main regional forum for collaboration.

The lake is the source of the White Nile which together with the Blue Nile constitutes the main tributaries of Nile River. Nile River provides hydropower through several power plants downstream, supports extensive irrigation schemes in Egypt, ecological values in Sudan and other wetlands, tourism industry, and navigation. The extensiveness of the values of the lake basin to its upstream and downstream users makes management more complex and challenging often causing tension between managing the lake for the benefit of riparian countries and managing it for the benefit of downstream countries of the Nile River (Kayombo & Jorgensen 2005). Major threats to the lake ecosystem are introduction of exotic species, nutrient inflows, agricultural chemical pollution, unsustainable utilization of major wetlands and proliferation of water hyacinth that is causing biodiversity and economic losses (Kayombo & Jorgensen 2005; UNU-INWEH 2011).

The need to promote development and eradicate poverty in the Lake Victoria region led the EAC members to establish several institutions i.e. the Lake Victoria Basin Commission (LVBC), a regulatory body, and the Lake Victoria Fisheries Organization (LVFO), a fisheries management body. Kayombo and Jorgensen (2005) reported that with the exception of Tanzania, relevant sectoral policies at national level do not give particular attention to lake issues or transboundary water resource management. As such, in many cases management is sectoral with little coordination and no agreed baselines for management actions. Although steps have been taken for regional inshore and offshore data collection through the Lake Victoria Environmental Management Project (LVEMP), inadequate capacity of some institutions to continue using equipment is a challenge (Muyodi et al. 2010). Lessons from the management experience include: the need for a shared vision; the need to align lake management policies and action plans with national activities; the need to involve communities in all aspects of management; the importance of designing research and development around management objectives; the importance of utilizing a basin perspective in addressing lake environmental issues and

coordination among all the countries in the basin; the need to link environmental benefits to the improvement of livelihoods for local people; the importance of awareness raising and promotion of the involvement of the public and parliamentarians; the crucial role played by targeted research; and, the need to ensure sustainability of project outcomes and activities through mainstreaming of project implementation in the relevant national ministries and regional institutions (Kayombo & Jorgensen 2005; Muyodi et al. 2010; UNU-INWEH 2011).

2.4.5. Lake Chad

Lake Chad is a closed lake located in West-Central Africa with a basin that spans an area of about 2.4 million km² while the current lake area is 1,350 km² (ILEC 2005, Odada et al. 2005). The Lake's surface area used to be 25,000 km² within the twentieth century but has shrunk significantly due to high evaporation rates, and decreased flows from its major inflow rivers resulting from climate fluctuations and unsustainable water projects (Odada et al 2005; Geerken et al. 2010; Okonkwo & Demoz 2014). The lake depth varies from 2-8 m with an average of 1.5 m (Odada et al. 2005). The shallowness of the lake makes it very sensitive to changes in rainfall and river inflows. Cameroon, Chad, Niger and Nigeria are the four riparian countries while Algeria, Central African Republic, Libya and Sudan are non-riparian countries located within the basin (ILEC 2005, Odada et al. 2005). The lake and basin are important for water supply, fisheries, as a habitat and vital refuge for migrant birds and other animals, agriculture and settlements (Odada et al 2005; Okonkwo & Demoz 2014).

Groundwater plays an important role in the water balance of the lake. According to Geerken et al. (2010) existing data suggests that groundwater used to recharge the lake during the dry season while the lake recharged the aquifer during the rainy season. They assert that currently, the lake permanently loses water to the aquifers as a result of the existing lower groundwater levels. Among other reasons, the low groundwater levels are a result of excessive pumping. Although annual precipitation in the region has shown a continuous recovery since the mid 1980s, lake levels are not showing corresponding change, indicating water losses by infiltration into groundwater. However, these are preliminary observations of the interaction between the lake and the underlying aquifer and this area is still being studied to enhance understanding.

Challenges include disappearance of some plant and fish species; overexploitation of fisheries; use of smaller mesh sizes; destructive fishing practices; loss of canopy cover; soil erosion; reduction in agricultural productivity; energy poverty and its implications for the environment; and, changes in economic development parameters such as organization of labor and terms of trade (Odada et al 2005; Okonkwo & Demoz 2014). Weak regulations enforcement is also a concern (Odada et al 2005). The shrinkage of the lake affected all economic activities in the region (e.g. fishing, farming, livestock rearing) and the population had to migrate as environmental refugees, leading to a major transboundary crisis in the region (Odada et al. 2005; Okonkwo & Demoz 2014).

Management of the lake basin exhibits well rooted transboundary cooperation which can be traced to pre-colonial era (Odada et al. 2005). Lake Chad and its basin were adversely affected by the European colonization of Africa which re-drew the political boundaries and resulted in the disintegration of traditional links among the people in the area (Odada et al. 2005). The earliest initiative for cross-border cooperation after independence of the riparian countries is the Fort Lamy Convention and Statutes, formally drawn and signed in 1964 (Odada et al. 2005). The Convention and Statutes established the Lake Chad Basin Commission (LCBC) as the coordinating body for development and cooperation in the lake basin. LCBC played an important role in the resolution of conflict associated with the transboundary crisis that resulted from the lake shrinkage (Odada et al. 2005). Later, the Central African Republic and Sudan joined the commission. While the efforts of transboundary cooperation in the management of the lake basin are appreciated, resource management approaches in the Lake Chad region have been considered largely inadequate (Odada et al. 2005). Environmental degradation continues and management of access and utilization of natural resources is poor. It has been challenging to ensure adherence to agreements by the riparian countries since there are no international monitoring and sanctioning bodies. As such, the agreements remained voluntary e.g. the 1977 Agreement on Common Regulation of Flora and Fauna (Odada et al. 2005).

Lessons learnt in the management of the lake basin include the need and importance of: encouraging sustainable natural resources management and agricultural practices in the basin; addressing farming and irrigation practices, groundwater extraction, biomass burning and increasing population pressure; promotion of water conservation techniques; high degree of

regional cooperation and commitment; political will to support the activities of LCBC and the need for member states to vest the LCBC with more power regarding conflict resolution on water and land disputes; sustainable institutions and effective stakeholder participation; appropriate and effective legal frameworks and financing strategies for LCBC to achieve its goals; improvement of local, national, regional and international coordination and minimizing fragmentation of approaches; application of appropriate technologies; the role of scientific research, data and capacity building; regional data monitoring, data base creation and establishment of early warning systems for surface and ground water as well as invasive species (Odada et al. 2005; Geerken et al. 2010; Okonkwo & Demoz 2014).

Sustaining water services will continue to be a problem considering the projected basin population for 2015 of 51 million which is expected to rise to 80 million by 2030 (Okonkwo & Demoz 2014). There is a proposal for inter-basin water transfer from the Congo River Basin to the lake (Odada et al. 2005; Okonkwo & Demoz 2014). Okonkwo and Demoz (2014) assert that the proposed inter-basin water transfer appears to be the most comprehensive policy option for mitigating socio-economic drought.

2.4.6. Lake Chilwa Wetland

Lake Chilwa Wetland covers an area of 2,400 km² of which a third each is for open water, swamp and marsh, and floodplain (Jamu et al. 2006). The catchment area is about 8,349 km² of which about 30% belongs to Mozambique but the water course belongs entirely to Malawi (Jamu et al. 2006; Kafumbata et al. 2014). The lake is the southern most of the Rift Valley Lakes of Africa and is the second largest lake in Malawi by both surface area, after Lake Malawi. It is a closed system with several inflow rivers. The wetland is a listed Ramsar site and supports one of the most productive ecosystems in Africa (Jamu et al. 2006). It is therefore both ecologically and economically important and supports the livelihoods of about 1.5 million people through agriculture, fisheries, bird exploitation, livestock rearing and other ecosystem goods and services (Jamu et al. 2006; Kafumbata et al. 2014). As a result of the ecosystem services it provides, the Lake Chilwa wetland basin is one of the most densely populated wetlands in Africa. The lake is

known to have experienced recessions and in some cases complete drying on nine occasions since 1900 (Njaya 2001; Rebelo et al. 2011). As far as holistic management is concerned, the Lake Chilwa Wetland Basin is probably the most studied lake basin system in the Malawi and advanced in lake basin focused management initiatives compared to other lake systems in the country. Jamu et al. (2006) discuss some studies, projects and management plans implemented in the region by various stakeholders, including local communities.

Main challenges include deforestation, siltation, wetland degradation, alterations of river systems (e.g. damming and weir installations), reduced river flows and climate variability and climate change (Jamu et al. 2006; Kafumbata et al. 2014). Many of these challenges are related to poverty and population pressure (Jamu et al. 2006). Kafumbata et al. (2014, p.5) describe the Lake Chilwa ecosystem as being in a “downward spiral into diminished capacities for providing ecosystem goods and services in the face of human intervention”. This is due to unsustainable resource use, climate variability and increasing population pressure. Multi-sectoral and integrated management approaches based on sound scientific knowledge are therefore crucial to ensure sustenance of the lake and its resources (Kafumbata et al. 2014). It is therefore important to integrate the sustainability of natural resources management with livelihoods to better inform policy on the impact of land use and climate change on food security and the associated ecosystem services (Kafumbata et al. 2014).

A Lake Chilwa Wetland Management Plan was developed in 2001 as an action plan aiming at promoting sustainable use by local communities. The objectives surrounding the major uses are promoting: community-based management of the fishery to obtain maximum sustainable yield; community-based management of the waterfowl to sustain optimum yield; optimum production of rice especially by gravity-fed irrigation and use of deep water rice; and, maximum carrying capacity for livestock on the floodplain grassland (Jamu et al. 2006). The plan was later modified and updated to incorporate transboundary issues and to involve Mozambique. The Management Plan has not been implemented and current management is through a joint committee by District Councils riparian to the lake (Kafumbata et al. 2014).

Lessons include: the revelation from research that management of the wetland fishery should concentrate on protecting habitat (i.e. marsh vegetation and regulating upland agriculture) rather than focusing on regulation of fishing; both scientific and community development

approaches to the management of environmental resources in developing countries are important; involvement of local stakeholders in decentralized planning and governance and empowerment of local communities is important; it is possible to implement strategic research within the framework of development activities to address existing issues; increasing agricultural productivity through improved soil fertility and soil conservation technologies is required; transboundary watershed planning is crucial for long-term sustainability (Jamu et al. 2006). The Lake Chilwa Basin Authority that was proposed in the plan is not yet established.

2.5. Integrated Lake Basin Management (ILBM)

2.5.1. How Did the ILBM Concept Come About?

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.

2.5.2. What is ILBM?

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.

Individually, these characteristics are not unique to lakes as they are also exhibited by other water bodies e.g. groundwater exhibits long retention time as well. However, the combination of these three characteristics is unique to lakes (see ILEC, 2005, for details) and in this way, the ILBM approach complements the IWRM approach.

2.5.3. Key Conceptual Tools of ILBM

There are several underlying key conceptual tools of ILBM. These are presented in relation to their relevance to Lake Malawi as explained below:

Lake characteristics: As noted in the introduction, 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 & 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 (see section 3.3.2. in Chapter 3). 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 & 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 facing the lake basin 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). It is therefore important to consider socio-economic aspects in lake basin management approaches.

These key conceptual tools need to be taken into account in the management and utilization of lake basins. Thus, ILBM is a management framework that advocates 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.

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CHAPTER 3 METHODOLOGICAL FRAMEWORK

This chapter outlines the methodology applied throughout the research process. The study generally applies a systems thinking approach in that it looks at the Lake Malawi Basin as a unit. However, it was not possible to assess the entire basin encompassing all the three riparian countries due to resource constraints. As a result, the assessment was limited to the Malawian side of the lake basin. Some of the issues, however, are common across the riparian countries as literature suggests. The first section explains the systems thinking approach as applied in this study. This is followed by a section that explains why this study selected the ILBM approach for the assessment. The following sections detail out the research methodology applied.

3.1. Systems Approach

Delineating the boundary for the system under study is an essential step in systems approach. The Lake Malawi Basin in Malawi, as a functional unit forms the *system boundary* of this study. The lake basin management components under analysis, i.e. the six ILBM pillars form the *system parts*. The indicator framework as a whole (all the six pillars together) provides a picture of the whole system whereas the individual pillars provide a picture of the sub-systems which together form the lake basin management system behavior. Alone, each pillar cannot ensure sustainable management and utilization of the lake basin (i.e. focusing on strengthening only one sub-system e.g. policy, cannot work). The indicators themselves are the parts which together, will help us understand the management of the whole (lake basin). The ecosystem services derived from the lake basin are a result of the conditions (the diverse specializations that perform certain functions) mutually created by the various parts of the lake basin system, thus forming the whole. The entire system, as well as each sub-system has been considered in two dimensions. These are the ecological system (based on the ecosystem services that the lake basin provides) and the socio-economic system (based on the utilization and management by humans). Understanding how the ecological and socio-economic systems interact would enhance the understanding of the

behavior of the whole lake basin system and inform how to better pursue sustainable management and use.

3.2. Why ILBM?

Management of natural resources requires a holistic approach to better address the interlinked issues characteristic of such resources. The ecosystem approach (EsA) becomes important as it aims to integrate the management of various segments of the environment (i.e. land, water and living resources) to ensure sustainable and equitable use and conservation. The EsA can thus be integrated with other similar approaches and methodologies to deal with complex situations. The EsA is well in line with the systems thinking approach i.e. its focus on the functional relationships and processes within ecosystems can be related to the process of delineating boundaries in systems thinking approach so as to understand the “whole”. The IWRM approach forms the basis for ILBM and it is a well known approach embraced by many countries around the world, including Malawi. Basically, IWRM seeks to balance water for livelihoods and water for nature through the integration of both the natural and management systems (GWP, 2000). However, IWRM, with its focus on rivers, does not accord appropriate attention to lake specific concerns in relation to their three unique characteristics as indicated in Chapter 2. As such, the ILBM approach was selected as the most appropriate tool for the assessment as it accounts for lake basin specific concerns and aims to balance the integration of conservation and sustainable use to maintain the ecosystem services provided by lake basins. ILBM can thus be considered the ecosystem approach focusing specifically on lake basins.

3.3. Applied Research Methodology

Kumar (2014, p.11) classifies research types from three different perspectives as follows;

1. *Application* of the research study i.e. pure or applied research.
2. *Objectives in undertaking* the research i.e. descriptive, correlational, explanatory or exploratory research.
3. *Inquiry mode* employed i.e. quantitative or qualitative.

These classifications are not mutually exclusive in that a research study can be classified from the view point of all the three types. This study utilizes mixed methods research design. While it is an applied research under “application” classification, it exhibits all the aspects under the “objectives” classification i.e. it attempts to describe systematically the situation in the Lake Malawi Basin, seeks to discover or establish existence of relationship between two or more aspects of a situation, attempts to clarify why or how the relationships exist, and develops, refines and tests an indicator-based tool for monitoring and assessing the management of the lake basin from an ILBM perspective. The study also utilizes both quantitative and qualitative research methods under “inquiry mode” classification. The methods are selected based on appropriateness with respect to the objectives and constraints of the study. As such, aspects from all the three classifications have been integrated in this study. There is no single approach to qualitative research and often, it utilizes a rich variety of approaches as appropriate (Bryman & Burgess 1994). The procedures that were applied in the study are outlined in Figure 3.1.

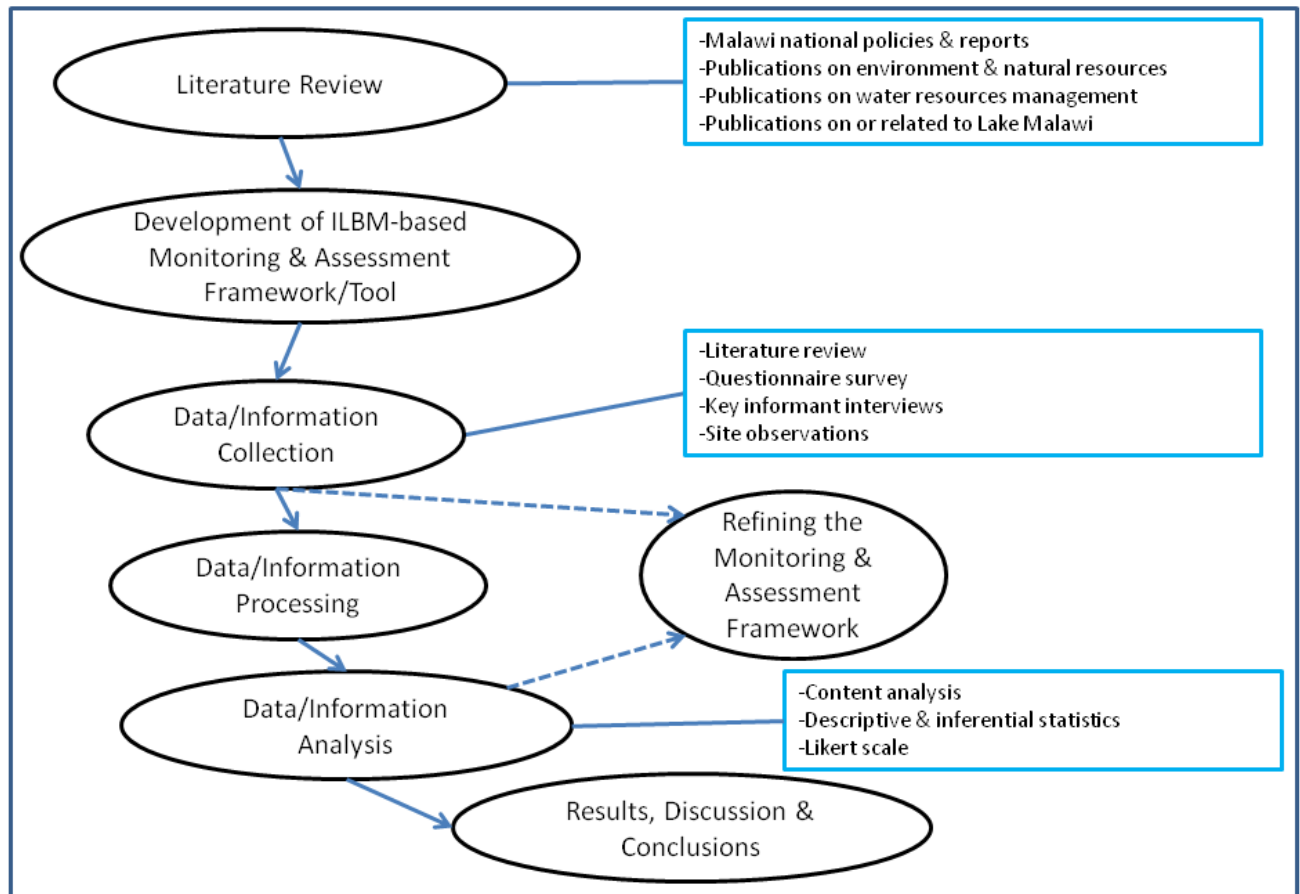


Fig. 3.1. Applied research methodology

3.3.1. Literature Review

Literature review was the first step. It provided the theoretical background of the study and guided the refinement of the research methodology. A wide range of literature was reviewed. This included national policies and reports for Malawi in the environment and natural resources sector to understand the country's goals and strategies in the sector. Publications on natural resources management in general and water resources management in particular, such as IWRM, ILBM, journal papers and publications by global and international organizations (e.g. United Nations and the World Bank) were also reviewed. The aim was to understand the global perspective regarding water resources and environmental management in general as well as lake basin management in particular. This review guided the next step, i.e. the process of identifying

and refining indicators for assessing the management of the Lake Malawi Basin from the perspective of ILBM. The result was the development of an indicator-based framework for monitoring and assessing ILBM in the lake basin and it was published (Chidammodzi and Muhandiki 2015). The accepted version of the publication is reprinted in the next section, with some editorial and formatting changes to minimize duplication with earlier sections of this document and to maintain consistency.

3.3.2. Development of Indicators for Assessment of Lake Malawi Basin in an Integrated Lake Basin Management (ILBM) Framework

Chidammodzi C.L. & Muhandiki V.S. (2015). International Journal of the Commons, 9: 209-236 (Reprinted with some editorial and formatting changes). The published version is available at: <http://www.thecommonsjournal.org/index.php/ijc/article/view/URN:NBN:NL:UI:10-1-116927>.

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.

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 700m (Bootsma and Hecky 2003) and ninth largest lake in the world with a surface area of 29,500 km² (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 (See Figure 1.1 in Chapter 1). The lake comprises about 20% of Malawi's area (GoM 2008c) 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 2008c).

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. 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 & 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.

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.

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 3.1.

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 2.5.2 in Chapter 2). 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.

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). EWS contributed to refining the Monitoring and Evaluation (M&E) framework applicable to GEF lake basin projects (introduced in the previous section *Global Environment Facility (GEF) indicators*). 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.

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. 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.

Table 3.1. 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.

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.

What is ILBM?

See Chapter 2, section 2.5.

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 endemism 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 3.3.2.

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 3.2. 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.*

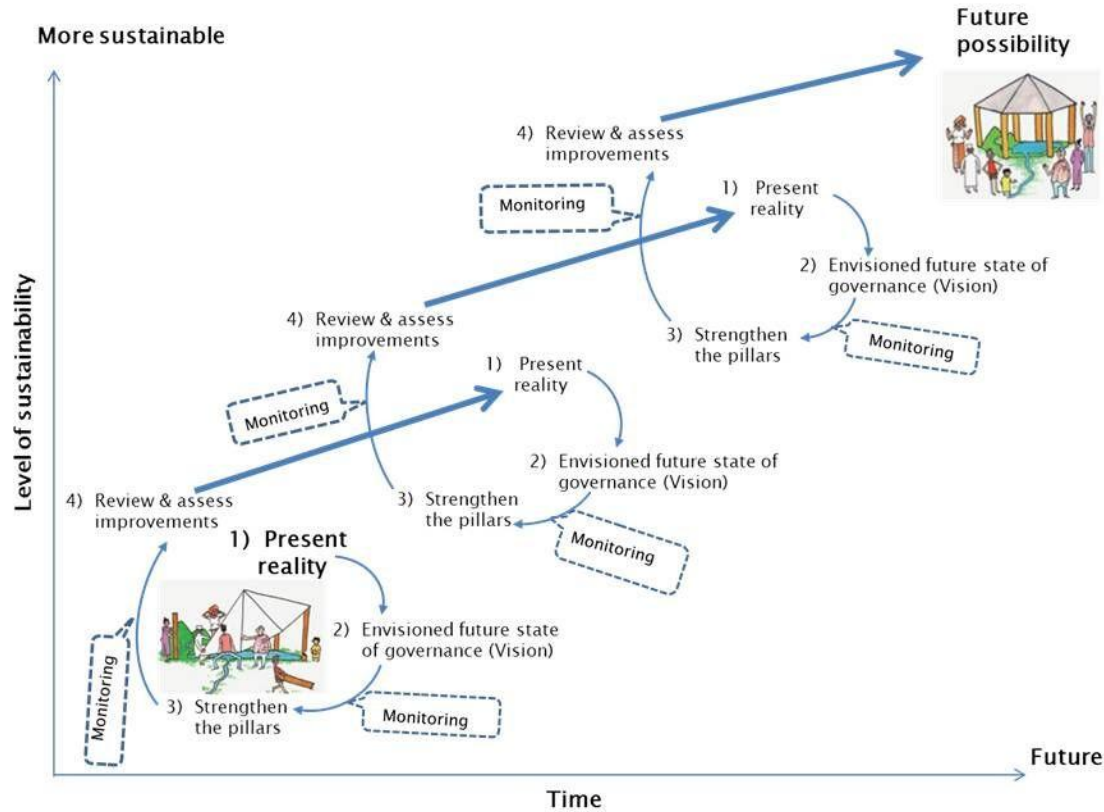


Fig. 3.2. The cyclical process for improving lake basin governance through ILBM (Modified from Nakamura and Rast 2011).

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.

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 3.3). 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.

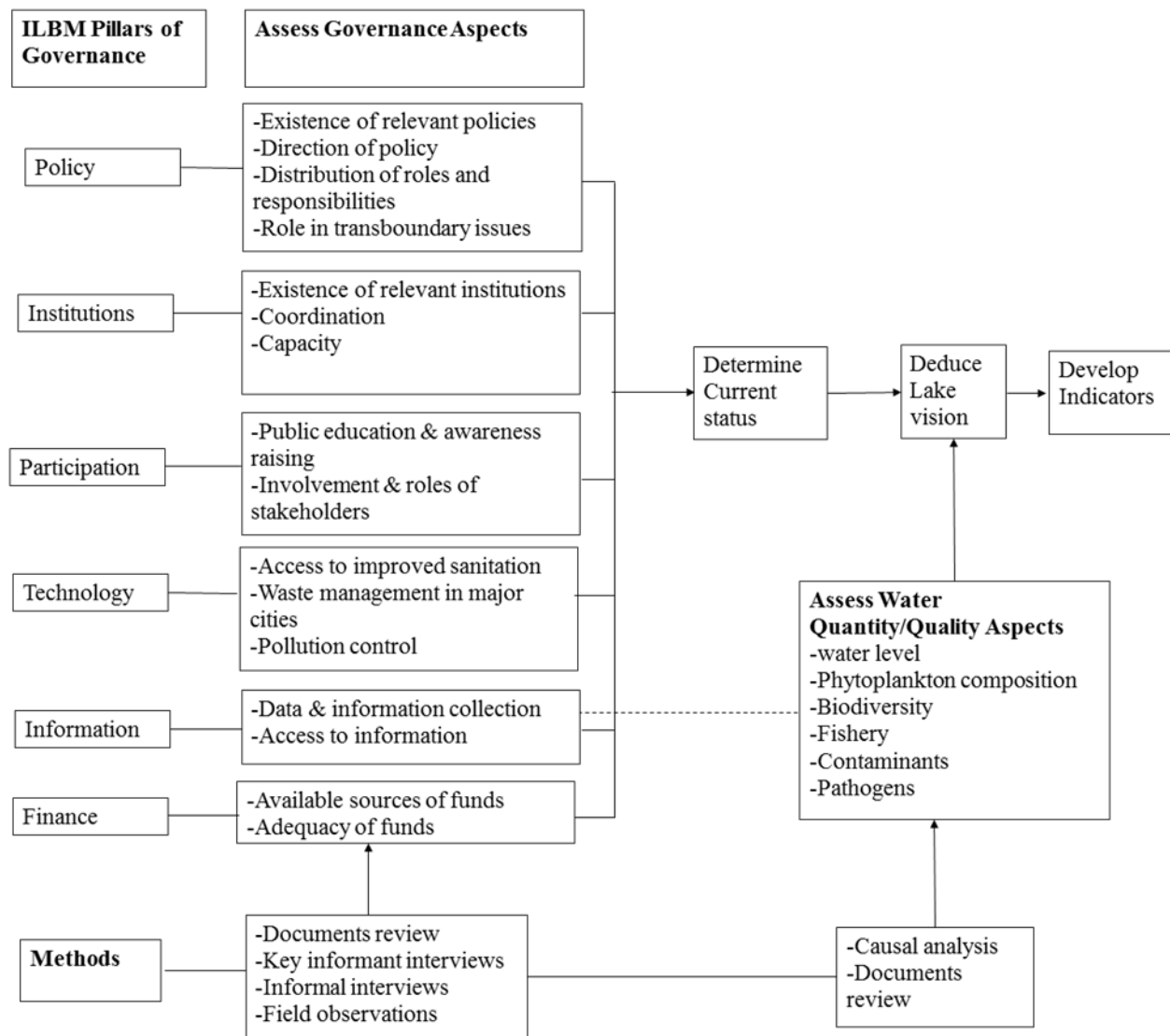


Fig. 3.3. Analytical Framework

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.

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 3.3) and is presented according to the six pillars of ILBM.

Policy

Policies that relate to lake basin management are in place. Water resources in particular are governed by the Water Resources Act (2013) which provides the main regulatory framework, and the National Water Policy (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.

Institutions

Institutions dealing with water and natural resources management on a sector-to-sector basis exist. The Environmental Affairs Department (EAD) has 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).

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.

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.

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.

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 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.

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 3.3.2), 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; 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).

Proposed indicators for assessing ILBM in Lake Malawi

This section presents the 42 indicators proposed. Some existing indicators from the reviewed approaches have been adopted in addition to proposing new ones. The applied approach draws insights from the three approaches reviewed in section 3.3.2 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 3.3.2. 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 (Chapter 2 section 2.5.1), the threats Lake Malawi is facing, and the existing management situation (section 3.3.2). Their attainment would contribute to the realization of the proposed Lake Malawi vision (section 3.3.2). 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.

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.

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.

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, p.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 women 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.

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, p. 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.

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.

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 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.

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 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 3.3.2 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.

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.

3.3.3. Refined Indicator Framework, Targets and Computation

Improvement of the indicator framework presented in section 3.3.2 continued throughout the study as new insights emerged. In the process, some indicators were modified and one indicator, under information pillar, “information dissemination” was removed as aspects it was to check are also captured under participation pillar by the indicators “existence of education/awareness programs” and “awareness level”. Also, under finance pillar, the indicator “charges for resource use” was dropped during the pilot stage due to difficulty in reconciling findings from the various sectors as each sector's perspective and approach to resource use charges was different. Figure

3.4 (a and b) shows the refined indicator framework that was used as a guiding tool in the following stages of the study.

One fundamental assumption in the proposed indicator framework is that the following seven sectors are key in the management of Lake Malawi/Nyasa basin; fisheries, agriculture/land resources conservation and development, irrigation, forestry, water, sanitation, and environment. Other sectors that have been considered are health, gender, parks and wildlife, industry, mining, energy, education, infrastructure, weather and climate, and information. The sectors under consideration in this study include most of the sectors covered in the Monitoring and Evaluation (M&E) Framework for the Environment and Natural Resources Management (ENRM) Sector that was developed by the Environmental Affairs Department in 2011 (GoM 2011a). Most of the indicators in this study have been developed in consideration of the key sectors.

Another assumption is that all the indicators carry equal weight in contribution to the assessment. The weight of each indicator is also equally distributed among its sub-indicators. This is because the data and information available in this study is not sufficient for the researcher to apply meaningful weights. Although employing equal weights may introduce an imbalance regarding the importance of the individual sub-indicators and their contribution to the final score, the approach still provides a reliable picture of the situation in the lake basin. The choice of weights is not purely a scientific approach, especially regarding such a complex lake basin. Assigning meaningful weights would first require all key stakeholders to agree on the indicators that are to be applied, considering the big picture as well as their respective sectors. In deciding some weights, it would be necessary to involve various stakeholders to ensure their respective values and viewpoints are reflected, an activity beyond the scope of this study. Since ILBM aims at achieving sustainable management of lakes through gradual, continuous and comprehensive improvements, the study serves as a starting point and the judgment of indicator performance, though providing useful insights, is not final. It should be noted that the six pillars of ILBM are not stand-alones rather, they are interrelated. As such, all the indicators in the framework should be viewed as complementary to one another in assessing the lake basin.



Fig. 3.4a Indicator Framework for Assessing ILBM in Lake Malawi Basin



Fig. 3.4b Indicator Framework for Assessing ILBM in Lake Malawi Basin

3.3.4. Data/Information Collection and Analysis

The indicator framework (presented in section 3.3.3), was used as guiding tool in extracting data/information from documents concerning indicators pertaining to policy and other issues whose information was available in documents. The framework was constantly refined throughout the document review process as well as during data/information analysis. Refinement that was done during data/information analysis was mainly modification of the language used to enhance clarity.

Data/information collection

The study utilized both primary and secondary data/information. Data and information were obtained through document review, questionnaire survey, key informant interviews and site observations. Except for document review which has been ongoing throughout the study, all the exercises were conducted in April and May 2014. This section elaborates on these procedures.

Document Review

This step is a continuation of the literature review discussed in section 3.3.1. A wide range of documents were reviewed as earlier indicated. The highlight of the document review at this stage is that it provided information for some of the indicators. In addition, it helped contextualize the findings of the study. Table 3.2 lists the main documents reviewed with regard to Malawi's policy direction.

Table 3.2. Major Documents Reviewed in the relevant sectors

Sector	Documents
Environment	National Environmental Policy (2004); Environment Management Act (1996); National Environmental Action Plan (1994); National Biodiversity Strategy and Action Plan (2006)
Water	National Water Policy (2005); Water Resources Act (1969; 2013); IWRM/WE Plan (2005)
Sanitation	National Sanitation Policy (2008)
Agriculture	The Agriculture Sector Wide Approach - ASWAp (2010)
Irrigation	Irrigation Act (2001) National Irrigation Policy and Development Strategy, 2000
Forestry	National Forest Policy (1996); National Forestry Program (2001)
Fisheries	National Fisheries Policy (2012); Annual Fish Frame Survey Report (2008); Fisheries Conservation and Management Act (1997)
Others	Decentralization Policy (1998); Local Government Act (1998); National Strategy for Sustainable Development, NSSD (2004); The Foreign Policy of the Government of the Republic of Malawi (2010); Malawi Growth and Development Strategy MGDS II (2011)

Questionnaire survey

Questionnaire design was guided by the indicator framework. Five districts out of the 15 basin districts in Malawi were surveyed. These are Rumphi and Nkhata Bay in the northern region, Nkhonkhotakota and Dedza in the central region and Mangochi in the southern region (see Figure 1.2 in Chapter 1). These districts were chosen considering representativeness of the country regions, the major lake basin users, geographical position (so as to better capture upstream-downstream issues), and accessibility. Judgment non-probability sampling was utilized. This sampling technique relies on the researcher's judgment as to who is most suited to provide information relevant to the research objectives (Kumar 2014). This type of sampling is useful when the study aims to describe a phenomenon or understand something which is little known (Kumar 2014).

The technique is appropriate for this study as it has aspects that are descriptive and exploratory. The survey focused on farmers, fisherfolk, and local forestry management groups (henceforth referred to as local forestry managers). These constitute the majority of the lake basin population and also represent the main users. The Lake Malawi Basin runs across most of the country, is largely rural and agriculture is the main occupation. Over 80% of the population obtains its livelihoods from the agricultural sector, including fisheries and forestry (GoM 2012). Furthermore, agriculture contributes about 30% of the Gross Domestic Product (GDP) and 80% export revenue (McConnell et al. 2007; GoM 2014) and the majority of farmers are small-holders. In this respect, the major uses of the lake basin are settlements, agriculture, fishing, craftworks and as a source of fuelwood. In collaboration with the relevant institutions in the three sectors focused in the survey (agriculture, forestry and fisheries), local community groups were selected to provide a sample for the study, taking into consideration the factors earlier mentioned (e.g. representativeness).

Structured questionnaires administered by trained enumerators were used, interviewing a total of 515 basin dwellers (205 farmers, 182 local forestry managers and 128 fisherfolk). The interviews were privately conducted on a one-to-one basis. Females comprised 53% of the sample. Farmers, fisherfolk and local forestry managers in Malawi are usually organized into local groups or clubs and the survey focused on these groups, in addition to interviewing basin dwellers not belonging to any group but still falling under these three broad categories. In total, 18 local community institutions were surveyed ten of which were farmer groups, six forestry management groups and two fisherfolk groups. The questionnaire was translated into Malawi's common language *Chichewa* to ensure standardization of the interviews. However, as there are many local languages spoken in the various regions surveyed, there were cases when the Chichewa version needed instant translation to the local language. In such cases, the local field officers who assisted in the data collection process functioned as interpreters. The questionnaire used for farmers is provided in the appendix as a sample.

Key informant Interviews

Key informant interviews were conducted at the Departments of Environmental Affairs, Fisheries, Land Resources Conservation and Development (agriculture), Forestry, Water Resources, Irrigation, Energy, and the City Councils of Lilongwe and Mzuzu. A total of 16 interviews were conducted. They were conducted in person by the researcher using semi-structured questionnaires. Only two out of the interviews utilized self administered questionnaires sent through email because meetings could not be scheduled at the time of the survey. Formulation of the semi-structured questionnaires was also guided by the indicator framework and questions were organized according to the six ILBM pillars and customized as appropriate for the sector. Questionnaires were sent to the institutions at least two weeks before the interview for their preparation with regard to the kind of information required. Some informants returned answered questionnaires prior to the interview and interview sessions for such focused on following up on the issues highlighted and seeking clarifications where necessary. In general, notes were taken during the interview for later reference. Wherever necessary, follow-ups were made even after the stated data/information collection period and these utilized E-mail and phone communication.

Site Observations

Site observations were also guided by the indicator framework. Field notes and pictures of the situation in the basin (e.g. dump sites, river bank and forest conditions) were taken to enhance understanding of the status of the lake basin.

Data/information Processing and Analysis

Data and information were analyzed using both descriptive and inferential statistics. For comparison and indicator scoring purposes raw data values were normalized using a five point Likert-type categorical scale. A scale of 1 to 5 was used where 1 is very low/very weak and 5 is very high/very strong.

Data/Information Processing and Initial Analysis

The collected data/information were arranged into two different data sets, one for key informant interviews, documents review and site observations and the other for questionnaire survey. Through content analysis, responses to open-ended questions (from both questionnaire survey and key informant interviews) were manually coded based on key words contained therein i.e. the data were scrutinized for patterns, inconsistencies and differing views from the different groups of respondents. The data were sorted and categorized to allow quantification of the different patterns that frequently emerged while capturing unique views that appeared to enhance understanding.

The Likert scale aided indicator scoring and was used to obtain averages especially regarding rates provided by key informants and survey respondents. Each indicator has a minimum potential score of 1 and a maximum of 5. The same is true for each pillar. Table 3.3 shows how the indicators and sub-indicators were scored. Targets were set for some of the sub-indicators based on existing targets either in Malawi or relevant literature. The target values are provided in brackets after each sub-indicator (shown under assessment of each pillar in Chapter 4). Where an existing target is adopted, the source of the target is indicated after the target value. The source is not indicated for the targets the study is proposing. Targets were not set for some indicators. This is either because target setting for them requires an analysis of other related aspects which is beyond the scope of the study, or the indicators were only establishing a baseline at this step which will act as a benchmark for future assessments. The sub-indicators were assessed against the targets in relation to the applied Likert scale. This is similar to the proximity-to-target concept applied in the 2012 Environmental Performance Index approach (Emerson et al., 2012). However, for the sub-indicators for which no specific target was set, the rate provided by key informants was applied. Details of how each indicator was utilized in the assessment are presented in Chapter 4.

Table 3.3. Rating Scale

Rating	Interpretation
1	Very low/very weak ($\leq 20\%$)
2	Low/weak (21- 40%)
3	Moderate (41 – 60%)
4	High/strong (61-80%)
5	Very high/very strong ($\geq 81\%$)

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

To synthesize the findings from all the six pillars of ILBM, the study applies the Strengths, Weaknesses, Opportunities and Threats (SWOT) framework to highlight the issues, needs and challenges in the management of the Lake Malawi Basin. SWOT is a useful tool in planning and can aid decision making based on the understanding of the internal factors (strengths and weaknesses) and external factors (opportunities and threats) that affect or may affect the sustainable management and use of the lake basin. Studies by Diamantopoulou and Voudouris (2008) and Nouri et al. (2008) are some of the examples applying SWOT analysis in water resources and environmental management. In this way, an understanding of the status of the management of the Lake Malawi basin through ILBM lens is obtained.

Applying the system thinking approach, the issues identified from the findings through SWOT became the factors for developing a causal loop diagram (CLD) so as to capture the dynamics behinds cause, effect and feedback. The purpose was to identify critical points that require management attention. Vensim PLE software was used to develop the CLD.

3.4. References

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CHAPTER 4 ASSESSMENT OF THE LAKE MALAWI BASIN

This chapter presents results of the assessment of the management of the Lake Malawi Basin. The ILBM indicator framework introduced in Chapter 3 is the tool applied for the assessment. The organization of the chapter is as follows: the chapter is broken down into six main sections (4.1 to 4.6). Each section focuses on the assessment of one ILBM pillar. Each main section consists of several sub-sections as follows; the first sub-section presents the details of each indicator (i.e. rationale, sub-indicators/measures, targets, source of the indicator, data sources, computation and limitations). This is followed by a presentation of the findings. A discussion sub-section follows after findings from all indicators have been presented. Then, the conclusion sub-section is presented. Sections 4.3 and 4.4 are presented by means of reprints of the accepted versions of work published in 2015. Their structure is slightly different from the other sections. Figure 4.10 provides an overview of indicator performance for all the six pillars.

4.1 Assessment of the Policies Pillar

4.1.1. Indicator Details

The overall goal for the pillar is to have policies that aim at improving holistic management of the lake basin and managing conflict of interests.

Indicator 1. Lake Related Sectoral Policies

Rationale: In many cases, the government's intentions for managing lake basins are contained in water resources policies and the policies of water dependent sectors (ILEC 2005). 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.

Key Sectors: Environment, fisheries, water, agriculture (land resources conservation and development), irrigation, forestry, and sanitation.

Sub-indicator/measure: Existence of a national-level policy in each of the seven key sectors (Target: policies exist).

Computation:

- 1) A rate of 5 is assigned to the sector with a national-level policy and a rate of 1 to the sector without.
- 2) Average the scores in step 1 above.

Data Sources: Relevant ministries/departments, national policies, strategies and plans

Indicator Source: This study

Limitations: It doesn't show effectiveness of existing policies

Indicator 2. Relevance of Lake Related Sectoral Policies

Rationale: 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 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 the protection of sensitive areas as one of the objectives of the relevant policies ensures that proper attention is given to such areas in the conservation and development activities. Powers and responsibilities also need to be clearly separated and assigned among the sectors to avoid conflict and ensure harmonization.

Key Sectors: Environment, water, fisheries, agriculture (land resources conservation and development), irrigation, forestry, and sanitation

Sub-indicators/measures:

- 1) Commitment to protection of sensitive areas (Target: commitment exists).
- 2) Provision for stakeholder involvement (Target: provision exists).

- 3) Clearly stated roles of stakeholders (Target: stakeholders roles clearly stated).

Computation:

- 1) For sub-indicator 1, a rate of 5 is assigned for the explicit mention of required protection of the sensitive areas and a rate of 1 if no explicit mention exists, according to the Table 4.1. Add up the sector averages to obtain a total score for the measure;
- 2) For sub-indicator 2, a rate of 5 is assigned to a sector if stakeholder involvement is explicitly provided for and a rate of 1 if not. Average the sector scores to obtain a score for the measure.
- 3) For sub-indicator 3, a rate of 5 is assigned to a sector if stakeholder roles are clearly stated and a rate of 1 if not. Average the sector scores to obtain a score for the measure.
- 4) Add up the results of steps 1, 2 and 3 above and divide by 3 to obtain an average for the indicator.

Data Sources: Relevant ministries/departments, national policies, strategies and plans.

Indicator Source: This study.

Table 4.1. Scoring criteria for Indicator 2 sub-indicator 1

Sector	Sensitive Areas	Score		Average for Sector
		Yes	No	
Environment	Water bodies			
	Forests	5	1	
	Land	5	1	
	Air	5	1	
	Sanitation	5	1	
Water	Wetlands (marshes & swamps) & estuaries	5	1	
	Lagoons	5	1	
Fisheries	Breeding sites	5	1	
	Zones of importance for endemic fish (rocky islands, river mouths of importance to migratory fishes, and shallow waters)	5	1	
Agriculture	Steep slopes	5	1	
	Control of agricultural chemicals	5	1	
Irrigation	Water use efficiency	5	1	
	Control of agricultural chemicals	5	1	
	Drainage quality	5	1	
	Buffer zone observance	5	1	
Forestry	Watershed protection	5	1	
	Habitat & biodiversity protection	5	1	
Sanitation	Wastewater management	5	1	
	Solid waste management	5	1	
	Hazardous waste management	5	1	
Potential total score for all sectors				1 to 5

Indicator 3. Commitment to Integrated Management of Water Resources

Rationale: Existence of a national IWRM plan indicates willingness to manage water resources (lakes inclusive) with an integrated approach. Explicit mention in the policy/plan of the importance of sustainably managing lakes is required to put the agenda of lakes in the minds of policy implementers, since lakes contain the bulk of the water resources. This will contribute to making lake management the business of every stakeholder. This indicator checks the relevance of the water policy and plan to lake management.

Key Sectors: Water (National Water Policy and IWRM/WE Plan).

Sub-indicators/Measures:

- 1) Existence of IWRM plan (Target: plan exists).
- 2) Recognition of the need for lake basin management in water policy or IWRM plan (Target: explicit recognition exists).

Computation:

- 1) A rate of 5 is assigned if IWRM plan exists and a rate of 1 if it doesn't.
- 2) A rate of 5 is assigned if explicit recognition of the need for lake basin management exists in the policy or plan and a rate of 1 if it doesn't.
- 3) Average the scores in 1 and 2 above.

Data Sources: National Water Policy, IWRM/WE plan.

Indicator Source: This study.

Limitations: Does not show the status of implementation of lake basin management.

Indicator 4. Policy Implementation

Rationale: This indicator seeks to measure policy implementation in relation to managing people and their actions so as to discourage undesirable behavior and encourage desirable ones. The three basic mechanisms to achieve this are command-and-control policies (regulations), incentives/disincentives (economic instruments) and education and public involvement (ILEC 2005). In addition, knowing the

degree of regulation enforcement as well as the effectiveness of economic instruments and education/awareness programs informs decision-makers on the approaches that are working and those that are not and this leads to improvement of the system, ultimately improving the sustainability of lake and basin resources.

Key Sectors: Environment, water, fisheries, agriculture (land resources conservation and development), irrigation and forestry.

Sub-indicators/measures:

- 1) Compliance with regulations (Target: very high compliance i.e. 100%).
- 2) Effectiveness of economic instruments (Target: very high effectiveness i.e. 5).
- 3) Public education and involvement concerning 1 and 2 above. (Target: very high levels of education and involvement i.e. 5).

Computation:

- 1) For command-and-control policies, obtain compliance rates from key informants in the relevant sectors. Average the rates for each sector and for all the sectors to obtain the score for the measure.
- 2) For incentives/disincentives effectiveness, obtain rates from key informants and average them to obtain a score for the measure.
- 3) For public education and involvement, obtain rates from key informants and average them to obtain a score for the measure.
- 4) Average the scores from steps 1, 2, and 3 above.

Data Sources: Relevant ministries/departments, M&E Framework for ENRM data, and local community institutions.

Indicator Source: TWAP – Modified in this study.

Indicator 5. Integration of Water Issues in Economic Development

Rationale: The economy of Malawi and the livelihoods of the population are dependent on the environment and water resources are at the center 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 the lake 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.

Key Areas: The Malawi Growth and Development Strategy, MGDS (the country's overarching strategy for development) and the National Strategy for Sustainable Development, NSSD which sets out an agenda of actions the nation needs to take to achieve sustainable development.

Sub-indicator/measure: Integration of water issues in the two strategies (Target: water issues integrated in both strategies).

Computation: A rate of 5 is assigned to the strategy that clearly integrates water issues and a rate of 1 to the strategy that doesn't. Average the scores.

Data Sources: MGDS and NSSD.

Indicator Source: This study.

Limitations: Doesn't show how water issues are actually integrated in the relevant sectors.

Indicator 6. Implementation of IWRM/WE Plan

Rationale: Existence of a national IWRM plan is a significant first step in moving towards integrated management of water resources including lakes. However, there is need to move a step further to see how effective its implementation is. The plan outlines projects/activities to be carried out to achieve the objectives of the National Water policy. Keeping track of the effectiveness of the implementation of the IWRM plan will give an indication of whether the goals the plan seeks to address are met and guide improvement.

Key Sectors: Water and sanitation.

Sub-indicator/Measure: Ratio of completed projects to planned projects (Target: all planned projects completed).

Computation: Obtain a ratio of IWRM projects/activities completed to projects/activities planned and assign an equivalent score.

Indicator Source: This study.

Data Sources: IWRM/WE plan and associated programs and projects, MoWDI.

Indicator 7. Role in trans-boundary issues

Rationale: Lake Malawi is transboundary and for management to be effective and efficient there is need for explicit recognition of the need for a cooperative approach in the policies. This paves the way for actual cooperation and provides guidance on how to cooperate.

Key Sectors: Environment, water, fisheries and forestry.

Sub-indicators/Measures:

- 1) Explicit recognition in the policies of the need for transboundary cooperation with riparian/neighboring countries (Target: explicit recognition exists).
- 2) Existence of guidelines on transboundary matters (Target: guidelines exist).

Computation:

- 1) A rate of 5 is assigned to the policy that explicitly recognizes the need for transboundary cooperation and a rate of 1 to the policy that doesn't. Obtain an average for the sectors.
- 2) A rate of 5 is assigned if guidelines on transboundary cooperation exist and a rate of 1 if none exists.
- 3) Average the scores from steps 1 and 2.

Data Sources: Departments of Foreign Affairs, Water Resources, Fisheries and any other relevant authorities.

Indicator Source: TWAP – modified in this study.

Limitations: Does not show extent of transboundary cooperation.

4.1.2. Findings

Indicator 1. Lake Related Sectoral Policies

Data and information for this indicator were obtained through a review of existing policies in the key sectors. All the seven key sectors have a national-level policy in place. This indicator is rated very strong (5) and Table 4.2 below summarizes the findings.

Table 4.2. Results for Indicator 1 (Lake Related Sectoral Policies)

Measure	Target	Findings & data/information source	Rate	Contribution to indicator score	Indicator score
Existence of national-level policies in key sectors	5	Policies exist in all key sectors (document review)	5	100%	5

Indicator 2. Relevance of Lake Related Sectoral Policies

Information was obtained from a review of policies, strategies and plans in the sectors. The fisheries policy (GoM 2012) stipulates that it seeks to coordinate and collaborate with other sectors and to provide guidance to all stakeholders in the implementation and provision of fisheries services and interventions. However, it falls short of highlighting the roles that these stakeholders are expected to play.

The National Irrigation Policy and Development Strategy (GoM 2000) provides for stakeholder involvement and thoroughly details out their roles. The stakeholders include sector ministries and Government Departments and Institutions, farming communities, the private sector, NGOs and donors. Some sensitive areas are not specifically addressed e.g. water resources buffer zones, and quality of drainage from irrigation schemes. It was not surprising to find that drainage quality for example, is also not monitored.

The National Sanitation Policy 2008 (GoM 2008b) reasonably addresses all the important areas in the sector. It also thoroughly highlights the important roles to be played and explicitly assigns responsibility to the players. These roles include service provision, education and awareness raising, inspection, monitoring and regulation.

The Agriculture Sector Wide Approach (ASWAp) and other strategies in the agriculture sector tackle most of the important issues (GoM 2010b). Commitment in the control of agricultural chemicals is there, with more focus on promotion of safe and efficient use of fertilizer and analysis of pesticide residue in food crops.

Similarly, forestry policies highlight key stakeholders as Government (i.e. Forestry Department headquarters plus centralised research and training institutions, and key line agencies in agriculture, wildlife, environment, etc., at central level, District, Town and City Assemblies, including District Forestry Offices, and their linkages with traditional authorities), private sector (profit-oriented forest-based industry, estate owners and small-scale enterprises) and civil society (NGOs, community-based groups and smallholders) (GoM 2001). However, academia is not explicitly included in the stated stakeholders

The policies have provision for stakeholder participation and generally, many of them highlighted the key stakeholders and the roles they are expected to play. However, some of the documents (e.g. ASWAp), noted that some roles and responsibilities are still unclear and this, together with weak implementation arrangements and inflexibility among stakeholders hamper coordination effectiveness. Table 4.3 provides the findings for the first sub-indicator and table 4.4 provides overall results for the indicator.

Table 4.3 Commitment to Protection of Sensitive Areas

Sector	Sensitive Areas	Score	Average for Sector
Environment	Water bodies	5	5
	Forests	5	
	Land	5	
	Air	5	
	Sanitation	5	
Water	Wetlands (marshes & swamps) & estuaries	5	3
	Lagoons	1	
Fisheries	Breeding sites	5	5
	Zones of importance for endemic fish	5	
Agriculture	Fragile & marginal areas	5	5
	Control of agricultural chemicals	5	
Irrigation	Water use efficiency	5	3
	Control of agricultural chemicals	5	
	Drainage quality	1	
	Buffer zone observance	1	
Forestry	Watershed protection	5	5
	Habitat & biodiversity protection	5	
Sanitation	Wastewater management	5	5
	Solid waste management	5	
	Hazardous waste management	5	
Total score for all sectors			4.43

Table 4.4 Results for Indicator 2 (Relevance of Lake Related Sectoral Policies)

Measure	Target	Findings & data/information source	Rate	Contribution to indicator score	Indicator score
Commitment to protection of sensitive areas	Commitment exists	Sector policies address sensitive areas (document review)	4.43	33.3%	4.62
Provision for stakeholder involvement	Provision exists	Policies provide for stakeholder involvement (document review)	5	33.3%	
Clearly stated roles of stakeholders	Stakeholders roles stated	Most policies state stakeholder roles except fisheries (document review)	4.43	33.3%	

Indicator 3. Commitment to Integrated Management of Water Resources

The water sector is the relevant sector in this case and a review of documents in the sector provided the data/information for the indicator. The concepts of decentralization and local participation form the basis of the National Water Policy and IWRM principles are explicitly promoted. The country formulated an IWRM/WE plan for the period 2008-2012 to act as a road map in addressing water related issues. The need for lake basin management however, is not explicitly recognized either in the policy or the IWRM/WE Plan and it is only assumed that lake issues are encompassed in the broad water resources management agenda. However, evidence shows that this is not the case, as the Lake Malawi Basin for example, is not holistically managed. Also, the lake-basin connectedness is not on the minds of many stakeholders associated with water resources management. Table 4.5 summarizes the results.

Table 4.5. Results for Indicator 3 (Commitment to Integrated Management of Water Resources)

Measure	Target	Findings & data/information source	Rate	Contribution to indicator score	Indicator score
Existence of IWRM plan	Plan exists	Plan exists (document review)	5	50%	3
Recognition of the need for lake basin management in water policy or IWRM plan	The need for lake basin management is recognized	Explicit recognition is absent (document review & key informants)	1	50%	

Indicator 4. Policy Implementation

Overall, key informants from all the six sectors relevant to the indicator rated regulations compliance rate as moderate. Compliance of regulations in the fisheries sector is provided as an average for both small- and large-scale fisherfolk. Large-scale fisherfolk are generally more compliant with the regulations. Notable are the regulations requiring fishing vessel registration and the prohibition of some fishing methods and commercial fishing without a license. In all these, they were rated very high. Their compliance is however poor on following prescriptions on size of fish caught, retained or traded concerning which they were rated low. Small-scale

fisherfolk are generally less compliant on all the regulations with their specific average rating of 2.5, compared to the 4.17 of large-scale fisherfolk. Key informants in the sector pointed out that generally, compliance depends on area, with some areas being more compliant than others. Effectiveness of economic instruments was also rated moderate on average.

Utilization of incentives or disincentives is not much. From the findings, incentives are more applied than disincentives. Examples of incentives in place include a “matching grant” to scheme irrigation farmers wherein Government provides support to schemes that demonstrate capability to meet a substantial proportion of the operational costs; provision of farm input to some farmers implementing some agricultural practices; and, tax wavers on boat engine importations. Disincentives based on the polluter pays principle are yet to be applied. Awareness of some of these incentives is low e.g. 65% of the fisherfolk surveyed were unaware of the tax waver on engine importations. Table 4.6 provides details of the ratings of sub-indicator 3, *level of public education and involvement on regulations and economic instruments*. Table 4.7 summarizes the overall findings of the indicator.

Table 4.6. Level of Public Education and Involvement on Regulations and Economic Instruments

Sector	Sub-indicator 3					Average score for all sectors
	Level of public education on CAC Policies (average)	Level of public involvement on CAC policies (average)	Level of public education in economic instruments (average)	Level of public involvement in economic instruments (average)	Sector average	
Environment	3	4	3	3	3.25	3
Water	2	2	-	-	2	
Forestry	4.33	4	-	-	4.17	
Fisheries	3.89	3	2.5	3	3.1	
Agriculture	N/A	N/A	3.33	3.67	3.5	
Irrigation	N/A	N/A	2	2	2	

– means that the key informants could not provide a rating for that aspect and N/A is an abbreviation for ‘not applicable’

Table 4.7. Results for Indicator 4 (Policy Implementation)

Measure	Target	Findings & data/information source		Rate	Contribution to indicator score	Indicator score
Compliance rate for command-and-control mechanisms	100%	Overall compliance	moderate (key informants)	3.1	33.33%	3.18
Effectiveness of existing incentives/disincentives	Very high	Overall effectiveness	moderate (key informants)	3.44	33.33%	
Level of public education and involvement	Very high	Overall leves(key informants)	moderate	3	33.33%	

Indicator 5. Integration of Water Issues in Economic Development

The Malawi Growth and Development Strategy (MGDS) is a medium-term development strategy that forms the country's overarching framework for development. The MGDS II, for the period 2011-2016, has six thematic areas as follows: Sustainable Economic Growth; Social Development; Social Support and Disaster Risk Management; Infrastructure Development; Governance; and Gender and Capacity Development. From these, nine key priority areas (KPAs) are derived as follows: Agriculture and Food Security; Energy, Industrial Development, Mining and Tourism; Transport Infrastructure and Nsanje World Inland Port; Education, Science and Technology; Public Health, Sanitation, Malaria and HIV and AIDS Management; Integrated Rural Development; Green Belt Irrigation and Water Development; Child Development, Youth Development and Empowerment; and, Climate Change, Natural Resources and Environmental Management. The MGDS addresses environmental issues fairly well. The Sustainable Economic Growth thematic area has nine sub-themes, most of which are related to natural resource management including water resources and the Lake Malawi Basin is an important factor in the attainment of the aspired sustainable economic growth. Within these, agriculture, mining, natural resources and environmental management, industry, trade, integrated rural development, and tourism are the KPAs. Water issues are tackled under the "natural resources and environmental

management sub-theme. In particular, under this sub-theme, the ecosystem services provided by forests such as catchment conservation are acknowledged. Also, the role of lakes and rivers in agriculture/food security, tourist attraction, navigation, and overall economic growth is acknowledged.

The National Strategy for Sustainable Development, NSSD (2004) was developed to guide the country in the implementation of the World Summit on Sustainable Development (WSSD) commitments. It details out the country's priority areas for environmental management and socio-economic development for the next 10 to 15 years. Water related issues are addressed throughout the documents as relevant but specifically, under the poverty reduction theme and 'protecting and managing the natural resource base' theme. Table 4.8 summarizes the findings.

Table 4.8. Results for Indicator 5 (Integration of Water Issues in Economic Development)

Measure	Target	Findings data/information source	& Rating	Contribution to indicator score	Indicator score
Integration of water issues in MGDS	Water issues integrated	Water issues are integrated (MGDS)	5	50%	5
Integration of water issues in NSSD	Water issues integrated	Water issues are integrated (NSSD)	5	50%	

Indicator 6. Implementation of IWRM/WE Plan

The IWRM/WE Plan for the 2008-2012 period outlined strategic projects/activities that were to be carried out. This study sought to check how implementation of the plan fared. It proved difficult to obtain clear information concerning the 13 specific projects outlined in the plan. It was understood that implementation of the projects was subject to availability of funds and support from both within and without the country which turned out to be the major challenge. As a result, these projects were not executed as detailed out in the plan, but some of the important components therein were integrated into the National Water Development Programme I and II,

the Shire River Basin Management Programme, and a few others. In the overall assessment of the effectiveness of IWRM implementation, considering that the IWRM approach seeks to attain a balance between water for livelihoods and water for nature, answers were sought to the following research questions: Did the implemented projects; (1) take into account all users; (2) utilize decentralized structures; (3) recognize women's role and improved their access to water; (4) empower poor people, helped reduce poverty, improved livelihoods and promote economic growth; and, (5) collectively work towards maintaining the resource base. Key informants and documents review were the sources of data/information for this indicator. The findings regarding these research questions are as follows;

Is IWRM Taking into Account All Users?

The country has given priority to improving access to water in the rural areas. Some programs and projects in the water and water related sectors are trying to integrate users in both the planning and implementation stages. The Southern African Development Community (SADC) Regional Water Sector Programme, supported by Danish International Development Agency (DANIDA) implemented IWRM Demonstration Projects in some countries in the region. The projects piloted an integrated water services approach called Local-level IWRM in which meeting multiple domestic and productive water needs of communities is given the highest priority. The approach focuses on water resources management at the lowest appropriate levels, participation of users, involvement of women, and financial and environmental sustainability (van Koppen et al. 2009). The demonstration project in Malawi called, "IWRM and Rural Livelihoods Project in Dzimphutsi Area", blended dam construction, irrigation scheme development, fish pond rehabilitation, hygiene and sanitation, water point protection and capacity building. However, with regards water resources management in general, integration of multiple uses and users as dictated by local conditions is still a challenge. Challenges include policy conflict among sectors in some cases and insufficient capacity at the local government level.

Is IWRM Utilizing Decentralized Structures?

Generally, implementation is following the Traditional Authority Structures at the local government level (District Councils, DCs). Where appropriate, Water Users Associations

(WUAs) have been established. The WUAs comprise of local users and they are given the responsibility to manage the water resources. The National Water Act (GoM 2013) requires the establishment of Catchment Management Committees (CMCs) in all river basins to be responsible for catchment management and they are required to advise the Water Resources Authority (WRA) on water resources conservation, among others. These were not yet established at the time of the study.

Is IWRM Recognizing Women's Role and Improving Their Access To Water?

Women's role is increasingly being recognized in natural resources management in the country. Women's participation in water and water related sectors (e.g. forestry and agriculture) is currently generally high. Group records data this study obtained from 18 local community institutions indicated average women membership of 62.5% while the average percentage of women in leadership positions was 52%, spanning a range of 30 to 80%. Women participation in the management of local community natural resources is high because, among others, the women have felt the impact of deforestation at the household level more than men (i.e. women are the ones walking longer distances to fetch firewood and water).

Generally, access to potable water is good. Malawi's MDGs target for 2015 is 74% and 2010 reports indicated the country had reached about 80% access (GoM 2010, WHO & UNICEF 2010). The survey checked whether or not this achievement is reflected in the Lake Malawi Basin, consisting of several important river basins. Respondents were asked to indicate their main source of drinking water. Categories considered safe sources in this study are piped supply, manual pump well and rainwater, and as Figure 4.1 shows, 85% have access to potable water. This quite reflects what the country had reported earlier. Important to note, however, is that this study does not account for disrupted water supply that may be due to infrastructure breakdowns, drought or other events. Thus, actual year-round access may be lower than reported here.

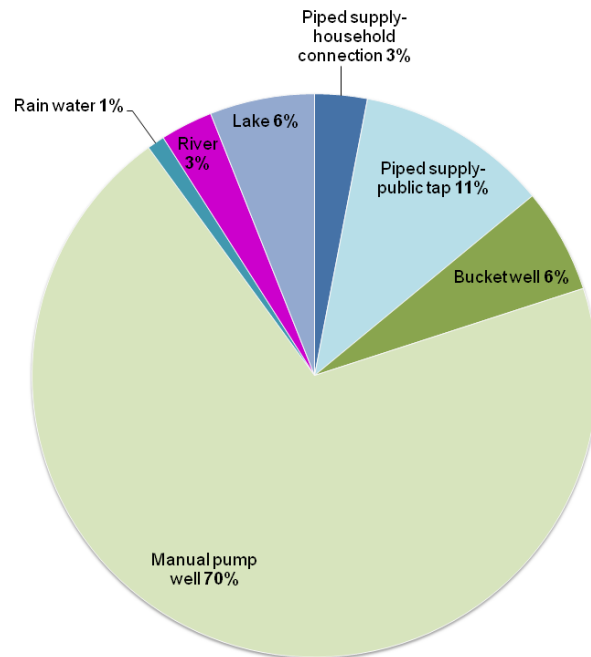


Figure 4.1. Access to Potable Water in the Lake Malawi Basin

Is IWRM Empowering Poor people, Helping Reduce Poverty, Improving livelihoods and Promoting Economic Growth?

Most of the recent projects in the water sector have a livelihoods component and are designed to address a variety of needs e.g. linking dam development projects to irrigation schemes, fish ponds etc. Meeting multiple domestic and productive water needs is given the highest priority in the SADC-IWRM demonstration projects in the Local-Level IWRM approach. In this approach, poor people's multiple water needs and their priorities are the starting point of the planning and design of new infrastructure or rehabilitation and sustainable management of institutions (van Koppen et al., 2009). This has proven to be a better approach from the experiences of the demonstration projects.

Is IWRM Collectively Working Towards Maintaining the Resource Base?

Maintaining the resource base entails managing the catchments in a way that ensures sustainability of all dependent ecosystems. This includes protecting catchments from degradation,

rehabilitating degraded catchments, maintaining natural habitats etc. To some extent, some of these activities are integrated within the activities of the local management committees e.g. irrigation farmers implementing river bank protection activities, and communities maintaining local forests. However, much of the catchment management is still fragmented, with the forestry sector playing a major role. The CMCs would be better placed in managing catchments in a way that ensures sustainability of the resource base. Current challenges include hiccups in decentralizing catchment management. IWRM is currently following the decentralization structures where the local government plays a central role. Many river catchments however cut across two or more districts, posing challenges to IWRM implementation.

Overall, implementation of IWRM is not strongly in line with the IWRM/WE Plan. It is somewhat haphazard depending on availability of resources. Even though some aspects of the plan are incorporated into other programs or projects, their effectiveness is limited. Key informants rated the overall IWRM implementation as moderate. Based on these findings, and the ratings key informants gave for the general implementation of IWRM, this indicator is given a moderate rating (3).

Indicator 7. Role in Trans-Boundary Issues

Malawi is a signatory to many environmental conventions including the SADC Protocols on Shared Water Courses, Convention on Wetlands of International Significance, Convention on the Conservation of Migratory Species of Wild Animals and Convention on Biological Diversity, which are of particular relevance to the Lake Malawi Basin. The country is thus expected to adhere to internationally accepted principles in the management of its natural resources. The various national policies acknowledge this requirement. For example, the NEP calls for cooperation with neighboring states to enhance sustainable management of fisheries, and forests, national parks and wildlife reserves that lie on international borders. Similarly, the Water Policy promotes international cooperation in the management of trans-boundary waters without compromising the country's sovereignty. Political issues are handled by politicians, while water experts in riparian countries liaise on water issues. EAD is the coordinating body on international matters. Guidelines on transboundary matters exist. The Foreign Policy (GoM 2010a) provides

general guidance while the sector policies provide guidance on aspects pertinent the sectors. This indicator is given a very high rating (5).

Summary of the Performance of the Policies Pillar

Overall, the policy pillar has a high rating (4.11) and Table 4.9 summarizes the results.

Table 4.9. Summary of the Performance of the Policies Pillar

Indicator	Score	Overall Pillar score
Lake related sectoral policies	5	4.11
Relevance of lake related sectoral policies	4.62	
Commitment to integrated management of water resources	3	
Policy Implementation	3.18	
Integration of water issues in economic development	5	
Implementation of IWRM/WE Plan	3	
Role in transboundary issues	5	

4.1.3. Discussion on the Policies Pillar

National-level policies in the key sectors are in place as the findings show. These have also shown very high relevance as they provide for stakeholder involvement, exhibit commitment to the protection of sensitive areas, and define stakeholder roles. It can be said that the policies provide a good foundation for the other aspects of lake basin management such as institutions, rules and incentives. A major weakness in the policies, especially those in the water sector is the lack of explicit acknowledgement of the importance of managing lake basins holistically and consequently the policies fail to properly address lake basin specific needs. While integrated

management of watersheds is mentioned in the policies, the significance of lakes is absent. It may be considered that lake issues are covered within overall water resources management since the country is implementing IWRM. However, considering the three unique characteristics of lakes and their management implications, there is a considerably significant risk of water resources management approaches losing focus on important lake basin issues, as findings in the other pillars show. Acknowledging the importance of managing lakes together with their basins would bring to light often ignored cross-sectoral issues that require cross-sectoral cooperation to ensure better management for sustainable use of lake and basin resources. While Malawi is implementing IWRM, more needs to be done with regards to integrated management of water resources. Another policy challenge is to ensure harmonisation of the sectoral policies as some conflict exists e.g. recommended buffer zones for water bodies, and allocation of developmental activities on sensitive areas (pertaining to land planning issues).

The moderate rating by key informants on policy implementation shows that having relevant policies in place does not guarantee highly effective implementation. All aspects considered (i.e. compliance with regulations, effectiveness of incentives/disincentives and level of public education and involvement regarding regulations and incentives/disincentives) were rated moderate. In the fisheries sector for instance, while large-scale fisherfolk's compliance is generally high, their compliance with regulations prescribing size of fish caught is low. Small-scale fisherfolk on the other hand are generally less compliant with all the regulations. Ensuring compliance requires regular monitoring and inspection. It also requires stakeholder engagement. These activities require substantial resources i.e. human, equipment and finances. According to the key informants, areas with active stakeholder participation tend to have higher compliance rate than areas where stakeholder participation is weak. The degree of stakeholder participation in an area depends on several factors one of which is the power dynamics in that area and more on this is discussed in section 4.3 under participation pillar. Findings show inadequate resource availability to the sectors details of which are discussed under participation pillar (section 4.3) and finance pillar (section 4.6). Enforcement of fisheries regulations on small-scale fisherfolk is very challenging. According to key informants about 90% of fish landings from Lake Malawi are by small-scale fisherfolk. This highlights the importance of stakeholder involvement as the Department of Fisheries alone cannot enforce regulations on such a large number of fisherfolk. In other issues, the low compliance is a result of the socio-economic system's failure to provide

alternatives. For example, ensuring compliance with the regulation prohibiting the cutting, taking, felling, destroying, uprooting, collecting and removing forest produce from a forest reserve, customary land, public land and protected forest area is challenging since one of the factors leading to deforestation, the top forestry issue in Malawi, is the lack of affordable energy alternatives in the country.

Water issues are given substantial attention in the MGDS II and the NSSD. However, as observed regarding policy implementation, there is need to ensure water issues receive due attention in the strategies and action plans of all sectors. Sectors need to internalize the stress they exert on water resources (e.g. stress from infrastructural development, agriculture, and industry) and take appropriate measures.

IWRM implementation in Malawi so far has been a mixed bag of success stories and challenges. Overall, there is notable evidence on the ground of improved water resources management although it is difficult to attribute that entirely to IWRM implementation (since water issues cross-cut several sectors). These improvements are in better integration of multiple uses of water resources in some cases, training of water professionals in IWRM and water related areas, increasing stakeholder awareness, and improved participation of local communities, women and other stakeholders. Challenges include slow decentralization (some required institutions such as the NWRA and CMCs were not operational at the time of the study), insufficient resources, and lack of monitoring of policy implementation. These are affecting the capacity of institutions and coordination of activities across sectors.

The policies commit to international cooperation where relevant. While technical staff are able to work together across borders, some political issues hinder progress on matters of trans-boundary lake basin management. For instance, the Draft Convention on Lake Malawi/Niassa/Nyasa and its Basin (2003) is not yet into force and the proposed Lake Malawi/Niassa/Nyasa Basin Commission is not yet established. In addition, as it is discussed under information pillar (Section 4.5), information sharing with neighboring countries is low.

4.2.4. Conclusion

The various national level policies address most of the important issues. The problem is on implementation. On-the-ground evidence of many of the issues outlined in the policies (such as trans-boundary cooperation, and cross-sectoral coordination) was hard to come by and in many cases absent. There is need to translate these policies into on-the-ground reality. While the issues that need attention on the practical level may be overwhelming, consistent innovative approaches that make use of current strengths and opportunities may result in progress at whatever pace practical that is steady and sustainable.

4.2. Assessment of the Institutions Pillar

4.2.1. Indicator Details

The overall goal for the pillar is to have effective institutions with strong capacity.

Indicator 1. Existence of a Lead Institution on Lake Basin Management

Rationale: Institutions administer the laws and sometimes develop policies, rules and incentives for management of resources and are therefore at the center of lake basin management (ILEC 2005). A lake basin management organization would play an important role in managing lake and basin resources. However, it may not be necessary to establish a new lake basin management organization. Existing sectoral institutional arrangements may be effective if proper coordinating mechanisms and a leading institution exist.

Key Sectors: Water and environment.

Sub-indicator/Measure: Existence of a mandated lead institution in lake basin management (Target: lead institution exists).

Computation: A rate of 5 is assigned if a mandated lead institution in lake basin management exists and a rate of 1 if it doesn't.

Data Sources: EAD and Department of Water Resources.

Indicator Source: TWAP – modified in this study.

Limitation: Does not measure effectiveness of the lead institution.

Indicator 2. Coordination among Sectoral Institutions

Rationale: Lake basin resources are diverse and cut across many sectors. This indicator follows up on indicator 1, *existence of a lead institution on lake basin management* and checks the degree of coordination/cooperation among relevant sectoral institutions on lake basin issues. Coordination of plans and activities carried out by the sectors related to lake basin management is important to ensure that these activities share the common goal of managing and developing the lake basin sustainably and that conflicting goals are well managed and synergies harnessed.

Key Sectors: Environment, water, fisheries, agriculture (land resources conservation and development), irrigation, forestry, and sanitation

Sub-indicators/Measures:

- 1) Existence of coordination mechanisms among institutions. Average for national and district levels. (Target: coordination mechanisms exist).
- 2) Degree/adequacy of coordination at national level (Target: very high).
- 3) Degree/adequacy of coordination at district level (Target: very high).

Computation:

- 1) A rate of 5 is assigned if coordination mechanisms exist in the sectoral institutions and a rate of 1 if none exist.
- 2) For degree/adequacy of coordination at national level a rate is assigned based on the average obtained from ratings by key informants in the relevant institutions.

- 3) For degree/adequacy of coordination at district level a rate is assigned based on the average obtained from ratings by key informants in the relevant institutions.
- 4) Average the scores from steps 1, 2, and 3 above.

Data Sources: Relevant ministries/departments, survey and site observations.

Indicator Source: TWAP – modified in this study.

Indicator 3. Capacity Development in Lake Basin Management Related Areas

Rationale: Officers responsible for water resources and lake basin management need to have the capacity to ably carry out their duties. Specialized training in IWRM and other related fields at professional level would capacitate them to implement integrated approaches in their activities.

Key Sectors: Water, agriculture (land resources conservation and development), irrigation, fisheries, forestry and environment

Sub-indicators/Measures:

- 1) Existence of training programs within the institutional arrangement (Target: training programs exist).
- 2) Percentage of technical/professional staff who have received high level education (Bachelor's, Master's or PhD) in the past 10 years (about the period countries have been actively implementing IWRM since the earth summit call in 2002). (Target: high i.e. $\geq 61\%$)
- 3) Percentage of trained officers in 2 above retained (Target: very high).

Computation:

- 1) A rate of 5 is assigned to the sector with commitment to provision of staff training in lake basin management related programs and a rate of 1 to the sector without. Average the rates of all the sectors.
- 2) Average percentage of technical and professional staff who have received training in the past 10 years for the relevant sectors in relation to target.

- 3) Average percentage of trained staff retained in the relevant sectors.
- 4) Average the scores from steps 1, 2 and 3 above.

Data Sources: Relevant ministries/departments.

Indicator Source: This study.

Indicator 4. Local Community Resource Management

Rationale: Malawi is promoting community management of resources under its decentralization policy. This indicator seeks to monitor existence of local community resource management structures in the lake basin and the level of community resource management. In addition to the institution aspect, this indicator also measures an aspect of participation and data collected can be used to give an indication of the level of involvement of local communities.

Key Sectors: Fisheries, agriculture, and forestry (corresponding to the major lake basin user communities).

Sub-indicators/Measures:

- 1) Existence of local community resource management institutions (Target: local community management institutions exist).
- 2) Capacity development of local community institutions (Target: all local institutions have received adequate training in group management and other related areas).
- 3) Level of actual local community involvement in the management of local natural resources from the perception of sector institutions (Target: very high).
- 4) Level of actual local community involvement in the management of local natural resources from the perception of local community institutions (Target: very high).

Computation:

- 1) A rate of 5 is assigned to the sector with local community resource management institutions in place and a rate of 1 to the sector without. Obtain an average for the sectors.
- 2) Assign a rate based on the following;

- a. Percentage of sampled local institutions' leaders that have received training, equated to a rate.
 - b. Adequacy of the training received as rated by the local institutions' leaders.
 - c. Average the scores from steps a, and b above.
- 3) Obtain rating from key informants in the relevant institutions on the following:
 - a. Level of local community institutions' participation in the planning of management/development activities for local resources.
 - b. Level of local community institutions' participation in decision-making concerning local resources management/development activities
 - c. Average the scores from steps a, and b above.
- 4) Obtain an average rate from surveyed local community institutions on the following:
 - a. Level of involvement in planning of activities/projects concerning local resources
 - b. Level of involvement in decision-making concerning local resources
 - c. Average the scores from steps a, and b above.
- 5) Add up the scores from steps 1, 2, 3, and 4 above

Data Sources: Relevant ministries/departments and local communities.

Indicator Source: TWAP – modified in this study.

Indicator 5. Coordination between Local Community Institutions and Relevant Sectoral Institutions

Rationale: The sustainable management of local resources requires proper coordination between local community institutions and the relevant sectoral institutions. Among others, this coordination ensures that local natural resource management is in line with national goals and that local concerns are incorporated by the sectoral institutions. This indicator seeks to check the existence of coordination mechanisms between local community institutions and relevant institutions, and the degree of coordination.

Key Sectors: Fisheries, agriculture, and forestry (corresponding to the major lake basin user communities).

Sub-indicator/Measures:

- 1) Existence of coordination mechanisms between local communities and relevant institutions (Target: coordination mechanisms exist)
- 2) Degree of coordination between local communities and relevant sectoral institutions from the perspective of sector institutions (Target: very high)
- 3) Degree of coordination between local communities and relevant sectoral institutions from the perspective of local community institutions (Target: very high)

Computation:

- 1) A rate of 5 is assigned to a sector for existence of coordination mechanisms between its local community institutions and the sector institutions and a rate of 1 for non-existence. Obtain an average for the sectors.
- 2) An average rate is obtained from the ratings provided by key informants regarding degree of coordination between local communities and their institutions.
- 3) An average rate is obtained from the ratings provided by leaders of local community institutions regarding degree of coordination between their institutions and sectoral institutions.
- 4) Average the scores from steps 1, 2 and 3 above.

Data Sources: Relevant ministries/departments and local communities.

Indicator Source: This study.

Indicator 6. Degree of Cooperation in Trans-boundary Issues

Rationale: One of the unique characteristics of lakes is the integrating nature, which implies that whatever a lake receives, it disseminates throughout the whole volume. The trans-boundary nature of Lake Malawi implies that activities done in one riparian country will have an impact on the whole lake. As Malawi works towards trans-boundary cooperation, there is need to monitor

the extent of involvement of the responsible institution in trans-boundary issues. This will give an indication on how trans-boundary issues affect the sustainability of the lake basin.

Key Sectors: Water, fisheries, forestry and environment

Sub-indicator/Measure: Adequacy of cooperation with riparian countries (Target: very high).

Computation: An average rate is obtained from the ratings provided by key informants.

Data Sources: The institution(s) responsible for trans-boundary issues

Indicator Source: TWAP – modified in this study

Limitations: This indicator only measures degree of international involvement as perceived by the institutions and not based on the actual involvement done. As data availability and collection feasibility improves, this indicator will need to be revised.

4.2.2. Findings

Indicator 1. Existence of a Lead Institution in Lake Basin Management

The Ministry responsible for water affairs has authority over the management and development of water resources and sanitation in the country. The Water Resources Act (GoM 2013) establishes a National Water Resources Authority (NWRA) with mandate to coordinate and harmonize activities pertaining to water resources management and development. Among others, the NWRA is responsible for managing and protecting water catchments, gathering and maintaining information on water resources, liaising with relevant stakeholders on water resources issues, and has powers to designate a defined area as a catchment area, and establishment of Catchment Management Committees (CMCs). The Water Resources Act requires the establishment of CMCs in all river basins to be responsible for catchment management and they are required to advise the NWRA on water resources conservation, among others. These have not yet been established. However, at the time of the study, an ongoing Shire

River Basin Management Program (focusing on the outlet of Lake Malawi), was in the process of establishing CMCs within the Shire River Basin. The expectation, according to key informants was that establishment of CMCs will eventually expand to all river basins in the country. This indicator is given an overall rating of very high (5) since a lead institution exists.

Indicator 2. Coordination among Sectoral Institutions

Data/information from key informants, document review and survey was utilized. A mechanism for coordination among sectoral institutions at district level is in place i.e. the District Executive Committee (DEC) at the District Council (DC) level. Regarding coordination at national level however, key informants noted that a mechanism as relevant as the DEC does not exist and sectors at that level operate in isolation. The sub-indicator, *existence of coordination mechanisms*, is thus rated moderate (3). On average, key informants rated the *degree/adequacy of coordination at national level* moderate-to-high (3.8). However, other key informants expressed concern that coordination at national level is inadequate. The agriculture sector observed that there has been some cases where other sectors involve it at later stages of implementation, after they encounter challenges. Overall, this sub-indicator is rated moderate (3). Key informants rated *degree/adequacy of coordination at district level* high (4.2). However, low levels of coordination/cooperation at district levels with regards implementation of activities were observed during the survey. There was a lack of coordination/cooperation among local community institutions in the three sectors surveyed (agriculture, forestry and fisheries). Based on the survey, this aspect was rated low (2) as there is very little coordination/cooperation among these local institutions, mainly depending on the interest of the traditional leader. Such coordination/cooperation, based on the current management mechanisms, is supposed to be initiated by the sector institutions (considering their institutional procedures). Therefore, *degree of coordination at district level* was rated moderate (3.1). Overall, this indicator is rated moderate (3).

Indicator 3. Capacity Development in Lake Basin Management Related Areas

Information from key informants was utilized. The institutions have arrangements for staff training programs. These include long-term courses such as post-graduate courses and short-term courses such as refresher courses, seminars etc. Table 4.10 summarizes the findings.

Table 4.10. Results for Indicator 3 (Capacity Development in Lake Basin Management Related Areas)

Measure	Target	Findings & data/information source	Rate	Contribution to indicator score	Indicator score
Existence of training programs	Training program exist	Exist	5	33.3%	4
Percentage of technical/professional staff who have received high level education in the past 10 years	High i.e. $\geq 61\%$	23.6% which is 38.69% closer to target (average for the sectors obtained from data provided by key informants)	2	33.3%	
Percentage of trained staff retained	Very high	84% (average for the sectors obtained from data provided by key informants)	5	33.3%	

Indicator 4. Local Community Resource Management

Data/information from key informants and questionnaire survey were utilized. Local community institutions are in place and have the responsibility of managing their local resources e.g. forests, farmland and fish landing beaches.

Among the survey respondents were 58 leaders from the 18 local community institutions surveyed. With regards *capacity development of local community institutions*, the leaders were asked whether they have received some kind of training on group management and other related areas or not, since their groups were formed. About half (48.3%) responded that they have and this is a moderate rating (3). Those who responded that they had received some kind of training

were further asked to rate the adequacy of the training received. Their weighted average rating is moderate, 3.2 (i.e. 22.2% rated low, 37% rated moderate, 37% rated high and 3.7% rated very high). The average rating for this sub-indicator is 3.1, moderate.

On the *level of local community involvement in the management of local natural resources as rated by sector institutions*, on average, involvement in planning was rated 4.1 while involvement in decision-making was rated 3.9. The overall score for this sub-indicator is high (4). Local communities rated the *level of local community involvement in the management of local natural resources* as moderate to high for both planning (3.66) and decision-making (3.84).

Table 4.11. Results for Indicator 4 (Local Community Resource Management)

Measure	Target	Findings & data/information source	Rate	Contribution to indicator score	Indicator score
Existence of local community resource management institutions	Local community institutions exist	Local community institutions exist (survey)	5	25%	4
Capacity development of local community institutions	All local institutions have received adequate training	About half of the leaders have received some kind of training and on average, the training received is moderate	3.1	25%	
Level of local community involvement in the management of local natural resources (perception of sector institutions)	Very high	Overall, involvement in planning was rated high while involvement in decision-making was rated moderate to high (key informants)	4	25%	
Level of local community involvement in the management of local natural resources (perception of local communities)	Very high	Overall, involvement in both planning and decision-making was rated moderate to high (survey respondents)	3.75	25%	

Indicator 5. Coordination between Local Community Institutions and Relevant Sectoral Institutions

Key informants and the survey provided the data/information required for this indicator. Mechanisms are there for local community and relevant sectoral institutions to coordinate. These include meetings, and direct links to sectoral district offices through public extension officers or the District Council structures following traditional authority. *Existence of coordination mechanisms between local communities and relevant institutions* is thus rated very high (5).

Concerning the degree of coordination with local communities, both key informants and leaders of local community institutions rated the current coordination as moderate (3.5 and 3.43, respectively). Overall, this indicator scored high (4).

Indicator 6. Degree of Cooperation in Transboundary Issues

Key informants were the source of information required for this indicator. The water sector has been cooperating with the riparian countries. Notable was the cooperation with Tanzania on the Songwe River Program (Songwe is an important tributary of lake Malawi on the borders of the two countries). Generally, the degree of cooperation was rated high (4). At the time of the study, the fisheries sector was in the process of signing a Memorandum of Understanding (MOU) with Mozambique on aquaculture, fisheries training (i.e. Mozambican officers can be trained at the Malawi Fisheries College), inspection, data sharing and several other areas. Not much cooperation was being done with Tanzania with regards fisheries but there had been cooperation through several projects. Generally, collaboration with Mozambique is advanced than with Tanzania. The degree of cooperation was rated high (4) with Mozambique and very low (1) with Tanzania, resulting in an average of low (2.5). In the forestry sector, there has been some cooperation with regards forests that lie on international borders, but it has been low. The sector thus rated the degree of cooperation as low (2). Overall, the indicator is rated low to moderate (2.8)

Summary of the Performance of the Institutions Pillar

Overall, the institutions pillar has a moderate-to-high rating (3.8) and Table 4.12 summarizes the results.

Table 4.12. Summary of the Performance of the Institutions Pillar

Indicator	Score	Overall Pillar score
Existence of a lead institution in lake basin management	5	3.8
Coordination among sectoral institutions	3	
Capacity development in lake basin management related areas	4	
Local community resource management	4	
Coordination between local community institutions and relevant sectoral institutions	4	
Degree of involvement in trans-boundary issues	2.8	

4.2.3. Discussion of the Institutions Pillar

Institutions are central to lake basin management since they implement the various measures for management (e.g. administering laws, providing a forum for involving stakeholders, and gathering and storing knowledge). Since lake basin management cuts across many sectors, users and uses, it is important to have a lead institution in the management of lake basin resources that would facilitate coordination/cooperation and foster a common agenda. Such responsibility currently lies with the Department of Water Resources. What is required is to ensure the Department is vibrant and capable of coordinating lake basin efforts i.e. raising awareness among sectoral institutions and all key stakeholders on the importance and vulnerability of lakes and ensuring that lake basin issues are adequately incorporated not only in the various relevant policies but also in the implementation of interventions. This also entails that it is important for the Government to ensure that the Department has sufficient resources for the task e.g. human and other resources.

On the ground, coordination/cooperation is generally not good as some key informants highlighted and as observed in the survey. Cross-sectoral or coordinated planning and implementation is rare, and where it is done, it is often not long-term. In most cases, such cross-

sectoral coordination/cooperation occurs during implementation of a specific project that requires and provides for that. Once the project is completed, the coordination/cooperation ceases. This resounds the concern that cross-sectoral coordination/cooperation is a practice not yet embedded in the operations of the various sectoral institutions relevant to water resources management. As such, it is not reflected in their action plans and therefore not budgeted for in their regular activities, outside externally funded projects. As it will be discussed under the participation pillar, it was observed that cross-sectoral coordination/cooperation among local community institutions is missing. This is worrying as cross-sectoral coordination is essential in lake basin management. The inadequate cross-sectoral coordination is attributed to insufficient resources (human and material) for coordination. At the time of the study, many of the institutions were understaffed. Another challenge informants pointed out is the natural dominance of sectoral priorities that needs to be overcome to ensure that sectoral priorities are not pursued at the expense of overall sustainability of the lake basin. These institutional challenges are also affecting trans-boundary cooperation, an area requiring attention.

Though commitment to provision of staff training is there, on average, a low percentage of technical/professional staff have received high level education in the past 10 years. According to key informants, this has been mainly because of lack of resources to execute the training programs. Many of the officers who have furthered their education have done so out of their own personal initiative in seeking external sources of sponsorship. The water sector is a notable exception with approximately 70% of its staff having undergone further education during the period in question. In addition to personal staff initiatives, the sector has benefitted from the WaterNet training program on IWRM. WaterNet is a regional capacity building network (SADC and East African Community (EAC) region) in water resources management, consisting of several university departments, and research and training institutes. The training program has helped improve capacity in IWRM as several officers have undergone training and are expected to be pioneers in the planning and implementation of IWRM. Staff retention rate in the sector is also high at 70%. Interestingly, retention of the trained staff is very high across the sectors, at an average of 84%. The overall very high retention rate was said to be due to promotion opportunities, efforts to improve working conditions (e.g. office space and equipment), and the higher job security associated with civil service. For those that have left, key informants speculated that better remuneration elsewhere, and loss of motivation (e.g. where good work is

not rewarded) may be the reasons. Some informants suggested that basing promotions on actual work performance would be better than basing them on length of service.

In general, key informants rate the *level of local community involvement in the management of natural resources* slightly higher (4) than local community institutions themselves rate it (3.75). Involvement in planning and decision-making varies depending on the vibrancy of the local community institution and the opportunities available to them that facilitate participation. For instance, at the time of the survey, the Department of Forestry had just finished implementing a program known as “Improved Forest Management for Sustainable Livelihoods Programme, (IFMSLP)” which focused on 16 forest reserves across the country. The program assisted the Department a lot in involving communities in co-management of forestry resources. As a result, local community institutions display high levels of involvement compared to areas outside the project. For the project areas, key informants rated their involvement as very high (5) in both planning and decision-making while the non-project areas were rated low (2) in both. The NEP promotes local community involvement as it stipulates under *Cross-Sectoral Policy Objectives, Principles and Strategies* that, “local communities whose livelihoods depend on natural resources shall take a leading role in identifying, planning and implementation of community based natural resources management (CBNRM) activities and appropriate legal and institutional frameworks shall be facilitated to ensure that local communities take responsibility for and benefit from sustainable management of natural resources” (GoM 2004 p. 11).

The moderate rating for *degree of coordination between local communities and relevant sectoral institutions* by both sectoral institutions and local communities indicates an area requiring attention. In most cases, extension staff facilitate this coordination by being a link between sectoral institutions and local community institutions. However, many survey respondents commented that frequency of extension services has declined recently, consequently reducing the frequency of interaction between local community institutions, and the extension staff/sectoral institutions. Inadequate resources was the reason key informants provided (details are discussed under the finance pillar). It is important to ensure extension services are maintained, not only for coordination purposes, but for overall better lake basin management.

4.2.4. Conclusion

The institutions pillar is rated moderate to strong (3.8). Existence of a lead institution in lake basin management, capacity development in lake basin management related areas, local community resource management and coordination between local community institutions and relevant sectoral institutions are institutional strengths. Major challenges are inadequate coordination across sectors (both among sectoral institutions and among local community institutions) and low to moderate degree of transboundary cooperation.

4.3. Assessment of the Participation Pillar

This section is based on the accepted version of the following article: Chidammodzi C.L. and Muhandiki V.S. (2015). Determination of the Status of Stakeholder Participation in the Management of Lake Malawi Basin through Application of Integrated Lake Basin Management (ILBM). Lakes and Reservoirs: Research and Management, 20: 166–181, which has been published in final form at <http://onlinelibrary.wiley.com/doi/10.1111/lre.12097/abstract> .

4.3.1. Determination of the Status of Stakeholder Participation in the Management of Lake Malawi Basin through Application of Integrated Lake Basin Management (ILBM)

Abstract

Lake Malawi is the southernmost of the Great Rift Valley Lakes of Africa and boasts the world's greatest freshwater fish biodiversity. Together with its basin, the lake provides a lot of benefits to the Malawi Nation. Settlements, agriculture and fishing are some of the major uses of the lake basin, making community involvement a necessary component of its management. Through key

informant interviews, questionnaire survey, document review and site observations, this study demonstrates the applicability of the ILBM framework in the Lake Malawi Basin in regard to stakeholder participation. The main objective was to assess the participation of stakeholders, especially local communities, in the management of the lake basin. The framework applied is discussed. Our findings show strong to very strong stakeholder participation with notable high levels of awareness and women's involvement. Enhancing the understanding of the complex nature of lake basin issues especially concerning the linkages between the water body and the basin is an area that requires attention.

4.3.2. Introduction

The wide range of ecosystem services offered by lakes and their basins result in a wide range of uses and users. Effective management of lake basins requires the integration of approaches across all the uses and users and this makes lake basin management complex. Chances of achieving sustainable management of a lake basin are higher when the respective stakeholders fully understand and appreciate their respective roles in relation to the issues in the lake basin (ILEC 2005; World Bank 2005; ILEC 2007, Muhandiki et al. 2014). Stakeholder participation therefore, becomes a necessary component of effective management that leads to sustainable use of lake basins.

There are varying definitions of stakeholder or public participation in literature reflecting the various aspects of focus. The commonalities, however, are that public participation is a process or practice of involving those potentially affected by or interested in a decision. The International Association for Public Participation defines 'public participation' as a means to involve those who are affected by a decision in the decision-making process (IAP2 2007). Rowe et al. (2004, p.88-89) have a more expanded definition as follows, "Public participation may be loosely defined as the practice of consulting and involving members of the public in the agenda-setting, decision-making, and policy-forming activities of the organizations or institutions responsible for such functions." In this paper, we define public participation as a process of involving affected or interested stakeholders in the planning, decision-making and policy-forming activities. It should be noted that the terms 'public/stakeholder participation', 'public/stakeholder involvement' and 'public/stakeholder engagement' are used interchangeably.

There are various benefits of involving stakeholders in lake basin management including: aiding to foster a better understanding of the implications of lake basin issues and thus garnering support for better management (i.e. a greater acceptance of rules for allocating resources, etc.); increased chances of incorporating local knowledge into decision-making; reduced cost of regulation enforcement; increased chances of attracting political interest in lake basin management; promotion of sustainability of management plans since the public's interest in implementation of a management plan is generally longer than the time span of government officials, and can promote broader inclusion of marginalized groups (GoM 2004; ILEC 2005; World Bank 2005).

To contribute meaningfully to lake basin management, people are often organized into stakeholders groups such as NGOs, farmers, fisherfolk, businessmen etc. Exclusion of some stakeholder groups from key decisions can lead to serious problems if their livelihoods are affected (Agrawal & Gibson 1999; ILEC 2005; World Bank 2005). The Lake Malawi Basin runs across most of the country, is largely rural and agriculture is the main occupation. Over 80% of the population obtain their livelihoods from the agricultural sector, including fisheries and forestry (GoM 2012). Furthermore, agriculture contributes about 30% of the Gross Domestic Product (GDP) and 80% export revenue (McConnell et al. 2007; GoM 2014) and the majority of farmers are small-holders. In this respect, the major uses of the lake basin are settlements, agriculture, fishing, craftworks and as a source of fuelwood. Community involvement is therefore important.

This study thus focused on the participation of farmers, fisherfolk, local forestry management groups (henceforth referred to as local forestry managers) and to a lesser extent, other stakeholders like NGOs and the private sector in the management of the lake basin. This paper assesses stakeholder participation within the context of co-management arrangements. We adopt the definition of co-management by OECD (1997, p.174) as “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”. In Malawi, farmers, fisherfolk and local forestry managers are usually organized into local groups or clubs. These are farmers clubs, Beach Village Committees (BVCs) and Local Forestry Organizations (LFOs), respectively. These constitute what we refer to as “local community institutions” in this paper. These

institutions participate in several activities including the formulation of management plans for natural resources in their area, formulation of regulations concerning resource management and utilization, promotion of farming techniques that work (through managing demonstration plots, or playing the role of lead farmers, etc.), and enforcement of regulations. The participation is in varying degrees, depending on the experience and vibrancy of the institution. The survey we conducted focused on these institutions, in addition to interviewing basin dwellers not belonging to any group but whose main activities/occupation fall under these categories of institutions. In this paper, we use the terms “farmers”, “fisherfolk” and “local forestry managers” to refer to the major users of the lake and basin under co-management arrangements.

This paper is part of a broader study focusing on the assessment of the management of the Lake Malawi Basin. To this end, Chidammodzi and Muhandiki (2015) proposed an ILBM based indicator framework for assessing the Lake Malawi Basin. The paper utilizes the proposed indicators for the participation pillar in assessing the status of stakeholder participation in the management of the lake basin. Through this study, we demonstrate applicability of the proposed framework in regard to the participation pillar. Therefore, the objective of this paper is to determine the status of stakeholder participation in the Lake Malawi Basin through pilot application of the indicators proposed by Chidammodzi and Muhandiki (2015). Although the focus of the paper is stakeholder participation, aspects from the other pillars of ILBM have been considered wherever necessary because participation is only one part of the framework.

4.3.3. Indicator Details (Indicator Framework Applied)

This section presents the ‘participation pillar’ part of the proposed ILBM framework. The overall goal for this pillar is to promote public participation and stakeholder involvement in lake basin management.

Indicator 1. Existence of Education/awareness Programs

Rationale: Existence of education/awareness programs in natural resources management in key sectors is a crucial first step in raising awareness and gaining support for issues affecting the lake and basin. This shows willingness of the institutions to increase awareness. ILEC (2005 p. xii) states that “Simply raising awareness among resource users is one of the most effective and

easiest policies to implement. People will often modify a behaviour if they learn it has a negative effect on others”.

Key sectors: Fisheries, agriculture, irrigation, forestry, water, sanitation, environment, and education.

Sub-indicators/measures:

- 1) Existence of education/awareness programs in key sectors (Target: programs in place).
- 2) Inclusion of environmental aspects in primary/secondary school curricula (Target: environmental aspects included in curricula).

Computation:

- 1) A rate of 5 is assigned to the sector that has at least one education/awareness program in place and a rate of 1 to the sector that doesn't have any. An average rate of the sectors is obtained.
- 2) A rate of 5 is assigned if environmental aspects are included in the curricula of at least one education level, (either primary or secondary school) and a rate of 1 if not included.
- 3) Average the scores in steps 1 and 2 above.

Data sources: Relevant ministries/departments and local communities.

Limitations: Does not address effectiveness of the awareness programs.

Indicator 2. Awareness Level on Lake Basin Issues among Basin Population

Rationale: There is need to monitor the level of information that lake basin dwellers have on lake basin issues. This will give an indication of the effectiveness of the existing education/awareness programs and will guide appropriate action.

Key sectors: Fisheries, agriculture, and forestry (representing the major uses and users), water and environment.

Sub-indicators/measures:

- 1) Level of information on forestry and other environmental issues in the basin population [farmers, fisherfolk and forestry managers (Target: very high)].
- 2) Level of information on good agricultural practices among farmers (Target: very high).
- 3) Level of information on fisheries issues among fisherfolk (Target: very high).

Computation:

- 1) Average level of information of all respondents on forestry and other environmental issues, equated to a rate.
- 2) Average level of information of farmers on good agricultural practices, equated to a rate.
- 3) Average level of information of fisherfolk on fisheries issues, equated to a rate.
- 4) Average the scores in steps 1, 2 and 3 above.

Data sources: Relevant ministries/departments and questionnaire survey.

Limitations: Only assesses levels of information on farming, fisheries, forestry and environmental issues. Other aspects that may also be important may not be reflected.

Indicator 3. Level of Participation within Local Community Institutions

Rationale: Active participation of a greater number of the members is necessary for local community institutions to be vibrant and sustainable. This indicator seeks to measure the level of participation within local community institutions. Documentation of member participation in activities would enable evaluation and the resulting lessons on successes and failures in approaches would improve efforts to harness the contribution of stakeholder participation.

Key sectors: Fisheries, agriculture and forestry.

Sub-indicator/measure: Percentage of members participating in regular activities (Target: very high participation).

Computation: Percentage of members that participate in regular activities, equated to a rate (average for all local institutions surveyed).

Data sources: Survey and review of local community institutions' records.

Indicator 4. Gender Distribution in Local Community Institutions

Rationale: One of the Dublin Principles emphasizes the importance of involving women at all levels of water resources management. However, there is need to ensure that as women 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 one of the objectives of the National Gender Policy (GoM 2008a). In addition, the policy, under the governance and human rights theme, lobbies for the appointment of 50% women to decision-making positions. This indicator seeks to measure in local community institutions, the distribution of gender, women's representation in leadership positions, and whether women actively participate in regular activities besides being members.

Key sectors: Fisheries, agriculture, and forestry.

Sub-indicators/measures:

- 1) Gender distribution in the membership [Target: Not set, optimum distribution may vary depending on nature of activity (e.g. fishing is male dominated), area etc. This measure is only collecting the baseline].
- 2) Representation of women in leadership positions (Target: 50% - National Gender Policy, GoM 2008a).
- 3) Women participating in regular activities as a percentage of all women members (Target: Very high participation).

Computation:

- 1) Proportion of males and females in the local institutions (average percentages for all institutions surveyed). This measure is not included in the overall assessment since it is only establishing a baseline.
- 2) Average percentage of women in leadership positions.
- 3) Average percentage of women participating in local institutions' regular activities.
- 4) Average the scores in steps 2 and 3 above. Equate to a rate.

Data sources: Survey and review of local community institutions' records.

Indicator 5. Youth Representation in Local Community Institutions

Rationale: The youth represent the future of water resources management. Their active involvement will help ensure a sustainable future since values of integrated water resources management will be imparted to them early on in life. This indicator adopts the National Youth Policy definition of youth as all young people, female and male, from the age of 14 to 25 years. Among others, the policy encourages the youth to conserve the environment. Another aspect is whether the involvement of youths actually motivates them to participate or not. If their participation is high, they may be an important element for vibrancy and sustainability of local community institutions and implementation of management plans.

Key sectors: Fisheries, agriculture, and forestry.

Sub-indicators/measures:

- 1) Youth representation as a percentage of all members (Target: not set, establishing a baseline).
- 2) Youth participation in regular activities as a percentage of all youth members (Target: not set).

Computation:

- 1) Average percentage of youths in the membership of the surveyed institutions.

- 2) Average percentage of youths participating in regular activities.

This indicator is not scored.

Data sources: Survey and review of local community institutions' records.

Indicator 6. The Role of Traditional Authorities/Leaders in Local Community Institutions

Rationale: The creation of a local body to manage natural resources involves power sharing between the elected body and the traditional authorities/leaders (henceforth referred to as traditional leaders). It has been observed that this power play determines the effectiveness of the elected body which consequently affects the management of the natural resource (FAO 2009, unpublished forest management working paper FM/40). Njaya (2007) observed that success of governance arrangements in co-management processes depends on how local leaders are involved since they symbolize power and authority in the society. 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). Traditional leader in this case refers to Village Headmen, Group Village Headmen and Traditional Authorities.

Key sectors: Fisheries, agriculture, and forestry.

Sub-indicators/measures:

- 1) Involvement of traditional leaders in local community institutions (Target: 100% of local institutions involve their traditional leaders).
- 2) Existence of clear rules or guidelines regarding traditional leaders' roles and power sharing mechanisms between the traditional leaders and local community institutions' leadership (Target: clear rules or guidelines exist).

Computation:

- 1) Average percentage of local community institutions that involve traditional leaders, equated to a rate.

- 2) A rate of 5 is assigned if clear rules or guidelines regarding power sharing between traditional leaders and elected leadership of local institutions exist and a rate of 1 if not.
- 3) Average the scores in steps 1 and 2 above.

Data sources: Relevant ministries/departments, local institutions.

Limitations: Does not address the effectiveness of existing mechanisms for involving traditional leaders in safeguarding against traditional leaders' autocracy.

Indicator 7. Clear Relationship between Livelihoods of Local Communities and Water Resources Management

Rationale: Livelihoods of many catchment dwellers directly depend on the natural resources around them (e.g. farming, fishing, charcoal/firewood sales, timber related craft-persons, other artisans, etc.). There is need for a clear connection between lake basin management related activities done by the people and their livelihoods (ILEC 2005; World Bank 2005). For example, adoption of better farming practices increases yield, and protection of forests may bar charcoal/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 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. This would promote participation and enhance commitment.

Key sectors: Water, forestry and environment.

Sub-indicators/measures:

- 1) Explicit support of the livelihoods of local communities in the policies/plans of the key sectors (Target: policies/plans of all the 3 key sectors provide explicit support).

- 2) Average income of lake basin dwellers as a proxy measure of the effectiveness of policy implementation (Target: not set).

Computation:

- 1) A rate of 5 is assigned to the sector whose policies/plans provide explicit support to the livelihoods of local communities in natural resources management activities/projects implemented at local community level and a rate of 1 to the sector that doesn't (average for the sectors).
- 2) Average income of basin dwellers, equated to a rate.
- 3) Average the scores in steps 1 and 2 above.

Data sources: Departments of Water Resources, Forestry and Environmental Affairs, and local communities.

Indicator 8. Stakeholder Involvement (other than sectoral Government institutions & local communities)

Rationale: Monitoring the participation of other stakeholders (i.e. NGOs, private sector, faith based organizations etc.) and their area and mode of participation will inform policy makers on how they can enhance the positive impacts and maximize the benefits of their participation. This will also ensure players share a common vision.

Key sectors: Fisheries, agriculture, irrigation, forestry, water, sanitation, and environment.

Sub-indicators/measures:

- 1) Documented evidence of stakeholder involvement, other than sectoral Government institutions & local communities (Target: stakeholders are involved).
- 2) Effectiveness of stakeholder involvement from the perspective of sectoral institutions (Target: very high).

- 3) Effectiveness of stakeholder involvement from the perspective of stakeholders (Target: very high).

Computation:

- 1) A rate of 5 is assigned to the sector with evidence of stakeholder involvement and a rate of 1 is assigned to the sector with no stakeholder involvement. Average the scores of the sectors.
- 2) Effectiveness of stakeholder involvement as rated by various stakeholders, i.e. NGOs, the private sector, faith based organizations, etc.
- 3) Effectiveness of stakeholder involvement as rated by sectoral institutions.
- 4) Average the scores in steps 1, 2 and 3 above.

Data sources: Relevant ministries/departments, NGOs, private sector etc.

4.3.4. Findings

Indicator 1. Existence of Education/Awareness Programs

Data from key informants and survey were utilised. Education/awareness programs in the sectors exist. These include community awareness raising programs, demonstration woodlots and orchards in primary schools, radio/TV programs, awareness messages through the print media, etc. Some of the Departments (e.g. Department of Forestry) have publicity units responsible for publishing newsletters, distributed to other sector institutions and local communities. This sub-indicator is given a rating of very strong (5). The primary school curriculum includes some simple environmental aspects, but key informants bemoaned the weak coordination between the natural resources sector and the Ministry of Education which affects the prioritization and depth of the messages included. This sub-indicator too is rated very strong since environmental aspects are included in the curricula. Overall, this indicator is rated very strong (5).

Indicator 2. Awareness Level on Lake Basin Issues among Basin Population

Respondents were asked to rate their level of information on forestry and other environmental issues (all respondents), good agricultural practices (farmers only), and fisheries issues (fisherfolk only). On forestry and other environmental issues, the majority (71%) rated their level of information as moderate, high and very high (Figure 4.2). The weighted rate of all the responses is 3.11 which is 62.2% closer to the target of 5, resulting in a final rate for the sub-indicator of 4 (high). Regarding good agricultural practices, 79.9% rated their levels within moderate to very high (Figure 4.3). The weighted rate of all the respondents is 3.41 which is 68.2% closer to the target giving a final rate for the sub-indicator as 4 (high). Figure 4.4 shows how fisherfolk rated themselves. The weighted rate is 3.41 indicating a 68.2% proximity to target which gives the sub-indicator a rating of 4 (high). The overall rate for the indicator is 4 (high) and Table 4.13 summarizes the results.

In addition, respondents were asked several questions to further ascertain their awareness level. These were on regulations, the soil erosion problem and lake-basin connection. Table 4.14 summarizes the findings and as shown, the awareness is generally high. Notable is the low awareness among fisherfolk concerning the duty waiver incentive on boat engine importations. Awareness on lake-basin connection is also low among all the respondents.

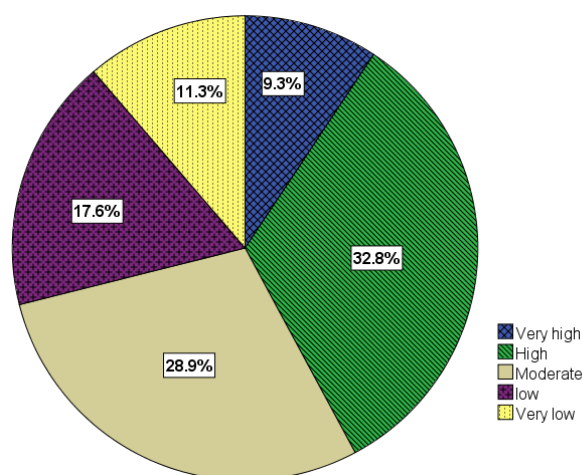


Fig. 4.2. Level of information on forestry and other environmental issues

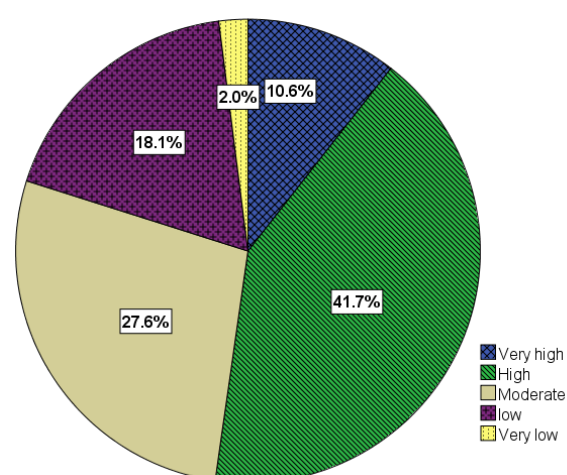


Fig. 4.3. Level of information on good agricultural practices

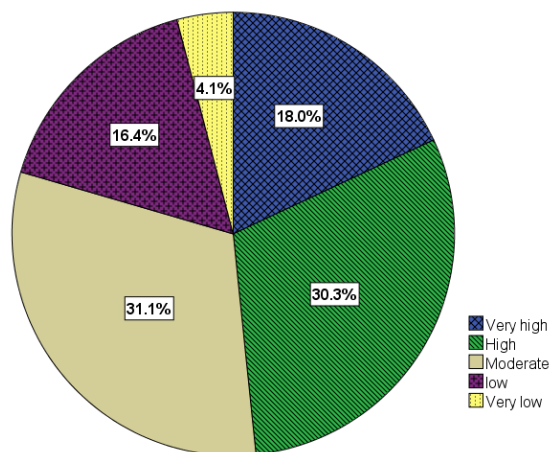


Fig. 4.4. Level of information on fisheries issues

Table 4.13. Results for Indicator 2 (Awareness Level)

Measure	Target	Findings & data/information source	Rating	Contribution to indicator score	Indicator Score
Level of information on good agricultural practices	5	3.41(survey)	4	33.3%	4
Level of information on forestry management	5	3.11 (survey)	4	33.3%	
Level of information on fisheries management	5	3.41(survey)	4	33.3%	

Table 4.14. Awareness of Several Lake Basin Issues among Basin Population

Question	n*	Yes (%)	No (%)	I don't know (%)
Do you know that it is prohibited to cultivate crops in forest reserves and protected areas unless under license? (farmers & forestry managers)	387	98.4	1.6	N/A
Do you know that it is prohibited to graze livestock in forest reserves and protected areas unless under license? (farmers & forestry managers)	386	94.3	5.7	N/A
Do you know that it is prohibited to clear land for settlement and any purpose whatsoever in forest reserves and protected areas unless under license? (all groups)	511	93.2	6.8	N/A
Do you know that commercial fishing without a license is prohibited? (fisherfolk)	128	95.3	4.7	N/A
Do you know that there are close seasons when fishing for some fish species is not allowed? (fisherfolk)	127	100%	0	N/A
Do you know that you can enjoy a duty waiver when you import boat engines? (fisherfolk)	124	35.5	64.5	N/A
Some reports say that soils of Malawi are being eroded at a faster a rate. Do you agree? (all groups)	508	92.3	7.7	N/A
Do you think farming and other activities that you do at home and in your community (e.g. vegetation clearing, setting up bush fires etc.) affect the lake in any way?	498	45.4	38.8	15.9
Is Lake Malawi important to you?	387	97.9%	2.1%	N/A

*n is number of respondents

Cross tabulations were run on the variables to see if there are any relationships. A chi-square test was performed to examine the relation between level of information on forestry and other environmental issues, and group. The relation between these variables was significant χ^2 (8, N = 505) = 128.99, $p < 0.01$. There are significant differences among the groups and the majority of the fisherfolk (68.3%) have very low to low levels of information. A chi-square test between level of information on forestry and other environmental issues, and gender showed that women

have higher levels of information as compared to men [χ^2 (4, N = 505) = 17.29, $p < 0.01$]. Also, a chi-square test between awareness of the soil erosion problem and group showed that farmers are most aware of the soil erosion problem while fisherfolk are the least aware [χ^2 (2, N = 508) = 13.49, $p < 0.01$]. Furthermore, awareness of lake basin connection is higher among those who are aware of the soil erosion problem [χ^2 (2, N = 494) = 8.74, $p < 0.05$].

Indicator 3. Level of Participation within Local Community Institutions

Information provided by 18 local community institutions (10 farmer groups, 6 forestry management groups and 2 fisherfolk groups) was utilised. Generally, there is an active participation of members in local community institutions with an average of 80% for all the surveyed groups. This indicator has a high rating (4).

Indicator 4. Gender Distribution in Local Community Institutions

With the exception of fisherfolk institutions, women generally dominate the membership of local community institutions. Their representation in leadership is very high and they exhibited a high participation in regular activities. The overall rating for this indicator is high (4.15) as Table 4.12 shows.

Table 4.15. Results for Indicator 4 (Gender Distribution in Local Community Institutions)

Measure	Target	Findings & data/information source	Rating	Contribution to indicator score	Indicator Score
Gender distribution in the membership	N/A	62.5% female (survey)	N/A	0	4.5
Representation of women in leadership positions	50%	52.4% (survey)	5	50%	
Women participation in regular activities	100%	77.6% (survey)	4	50%	

Indicator 5. Youth Representation in Local Community Institutions

There is a generally low representation of youths in the membership of the local community institutions (23%). However, their participation in regular activities is high (71.7%). This indicator is currently not scored and will only monitor the trend of youth representation and participation.

Indicator 6. The role of Traditional Leaders in Local Community Institutions

Traditional leaders are involved in most of the local community institutions surveyed (88.9% i.e. 16 out of 18), resulting in a rating of 5 for this sub-indicator. Rules/guidelines regarding traditional leaders' roles and power sharing mechanisms exist. The Local Government Act (GoM 1998), provides overall guidance and local communities develop by-laws and a constitution to govern their institutions during establishment in which such issues are sometimes addressed. This sub-indicator is also rated 5. The overall rating for the indicator is very high (5).

Indicator 7. Clear Relationship between Livelihoods of Local Communities and Water Resources Management

Policies in all the relevant sectors provide explicit support. The National Forestry Programme (NFP) highlights the link between forest degradation and poverty and states its goal as to achieve “sustainable management of forest goods and services for improved and equitable livelihoods” (GoM 2001, p.11). Similarly, the NEP (GoM 2004, p.7), has “Improve capacity for local level management of natural resources for sustainable livelihoods including conservation and sustainable use and management of biodiversity” as one of the strategies for achieving its poverty alleviation objective. The National Water Policy has similar statements. This sub-indicator is thus given a very high rating (5). Data for the second measure (average income of

basin dwellers) was not collected during the survey, as such, this measure was not assessed. The overall rating for this indicator is very high (5).

Indicator 8. Stakeholder Involvement (other than sectoral Government institutions & local basin communities)

Stakeholders are involved in all the key sectors. As indicated earlier, information for measures 2 and 3, on effectiveness of stakeholder involvement was not collected, as such, this indicator is assessed based on the first measure only and has a rating of very high (5). However, coordination/cooperation was indicated to be weak by the key informants.

Overall Performance of the Participation Pillar

The participation pillar has an overall score of 4.64 which is a high-to-very high rating. Indicator 5 (youth representation in local community institutions) was not included in the overall assessment since it is currently only monitoring the trend as earlier indicated. Based on the applied framework, the results show that the participation aspect of ILBM in the management of the Lake Malawi Basin is strong to very strong. Table 4.16 provides a summary.

Table 4.16. Performance of the Participation Pillar

Indicator	Score	Overall Pillar Score
Existence of education/awareness programs	5.0	4.64
Awareness level	4	
Level of participation within local community institutions	4	
Gender distribution in local community institutions	4.5	
Youth representation in local community institutions	N/A	
The role of traditional leaders in local community institutions	5	
Clear relationship between livelihoods of local communities & water resources management	5	
Stakeholder involvement	5	

4.3.5. Discussion

Existence of Education/awareness Programs and Awareness Level on Lake Basin Issues among Basin Population

The generally high level of awareness on lake basin issues observed may indicate that the existing education/awareness programs are effective. It should be noted that the awareness level was mainly based on how the respondents perceive their level of awareness. The low levels of awareness among fisherfolk concerning the duty waiver incentive and general environmental issues, as well as among all respondents regarding lake basin connection, signal that more needs to be done. Worth mentioning here is that on average, key informants under the policies pillar, gave a moderate rating (3) regarding level of education and public involvement (in regulations and incentives/disincentives) with the lowest (2.0) and highest (4.1) ratings coming from the Departments of Water Resources and Forestry, respectively. The low awareness on the duty waiver incentive on boat engine importations is not surprising considering that the Fisheries Department (under the policies pillar) rated the level of public education on existing incentives as low (2.0).

Current lake basin management in Malawi is on a sector-to-sector basis and coordination/cooperation across sectors is minimal despite the acknowledgement of the need for such by the various policies. As a result, sectoral activities are often implemented in an isolated manner. Lack of resources to involve key stakeholders and high vacancy rates in many Government institutions are partly responsible for the weak coordination/cooperation among lake related sectoral institutions (according to key informants and the Malawi Sector Performance Report 2011, for the Irrigation, Water and Sanitation sector, unpublished). The fragmented management is evident at the local level, despite the Decentralization Policy's call for integration of Governmental Agencies into one administrative unit at the district level through, inter alia, composite budgeting and provision of funds for the decentralized services. Although local community institutions exist in the sectors, there is no interaction among them and whatever actions they implement, they do so in isolation. This shows that cross-sectoral local level integration still has several strides to make. Many respondents were of the opinion that their activities in the basin do not affect the lake, unaware of the lake basin connection. The need for lake basin management approaches to also consider the connectedness of activities by various stakeholder groups cannot be more underscored. Accordingly, it is important to work on improving the understanding of these stakeholders on how their various activities interrelate. One way would be to ensure that district development plans reflect the interconnectedness, as these are formulated at the local level (District Council). There is also need to send out targeted messages to the various groups as appropriate and to work on enhancing the depth of the messages (i.e. as each of the groups pursues their sectoral interests, they should be aware of and appreciate the interconnectedness of activities and interests of different groups, and how all that concern and affect them). Where appropriate, the community institutions should be encouraged to cooperate in the activities that cut across sectors (like river bank protection), regardless of the sector under which they operate. Before actions can be developed and implemented, root causes of problems must be understood, from the small picture (local and/or sectoral) to the big picture (basin and/or cross-sectoral). Without that understanding, communities/stakeholders cannot effectively address the issues affecting them nor synergistically contribute to the sustainability of the entire lake basin.

In addition, the problems in the lake basin introduced earlier continue to be experienced (Donda et al. 2014), despite the generally high level of awareness. This may be due to a lack of

options for the communities to turn to. ILEC (2005, p.54) states “Awareness-raising or community education alone will not stop unsustainable resource exploitation by community members; several factors need to act concurrently, such as changed community values, availability of alternative behaviours, and disincentives for unsustainable activities”. For instance, 99% of the respondents rely on firewood and charcoal for their household energy needs. This gives an indication on the enormous pressure exerted on the forestry resources in the basin and underscores the need for cross-sectoral coordination (i.e. the energy sector’s role in overall lake basin management is important in this case). The importance of the lake to fisherfolk is obvious but to farmers and forestry managers, many of whom are located away from the lakeshore, it may not be so obvious. It was however interesting that 97.9% of farmers and forestry managers indicated that the lake is important to them. Their reasons were that it is a source of water and fish (for food and business), recreation and tourist attraction, lake transport, and some said although they have never been to the lake, they just like the idea that it is there. Although these stakeholders acknowledge the importance of the lake, it would be difficult for them to change some of their unsustainable behaviour like excessive cutting down of trees, if no alternatives are available to them, as this is a matter of their survival.

Level of Participation within Local Community Institutions

The local community institutions appear to be generally vibrant, from the high participation of members in regular activities. This is a strength that needs to be harnessed for overall better lake basin management. One of the ways to do this would be by emphasizing direct benefits wherever possible so that the early successes or improvements they may realize, say in their livelihoods, serve as an incentive for them to implement more challenging strategies in the quest of achieving sustainability. Where successes benefit off-site groups, innovative mechanisms need to be established that allow benefit sharing with the groups providing conservation services (e.g. payment for ecosystem services).

Gender Distribution in Local Community Institutions

Except for fisherfolk groups, women generally dominate the membership of local community institutions. Also, women have generally higher levels of information than men regarding environmental issues. In an analysis of how women's participation affects outcomes in the decentralized governance of community forests in India, Agrawal et al. (2006) found that women's participation has substantial positive effects. The positive effects are in the level of institutional effectiveness where greater involvement in women leads to control of illegal activities in local forests, and also in the outcomes in the forest where greater involvement of women improves forest regeneration. Although our study did not explore further on the benefits the high involvement of women may bring in the Lake Malawi Basin case, the findings elsewhere are at least, encouraging.

Youth Representation in Local Community Institutions

There is a generally low level of participation among the youth. One of the reasons is that many of them are busy with school since many are within school going age. Many respondents also remarked that many youths are not interested in voluntary activities as they prefer to spend their time on economically beneficial activities (this especially holds for those not in school). This emphasizes the need for linking community based lake basin management activities to livelihoods.

The Role of Traditional Authorities/Leaders in Local Community Institutions

Involvement of traditional leaders in local institutions is tricky. Malawi has experienced both successes and failures (Njaya 2007; Njaya & Donda 2011). Our findings show that traditional leaders are involved in most of the local community institutions surveyed. According to the respondents, the traditional leaders are involved as advisors in most cases, but there were also a few institutions in which the traditional leaders were holding positions. In general, these leaders provide support and encouragement to the institutions. For example, the land on which village forest areas are established is in most cases customary land provided by the traditional leaders.

They also play a role in settling disputes especially where cases are beyond the capacity of the local institutions' elected leadership. In addition, they are a key figure in local level regulation enforcement. Respondents commented that enforcement becomes easier if the local community institution and the traditional leader share similar values regarding natural resource management in their area and the traditional leader thus augments their agenda. The converse of this argument also holds in that where the values differ (i.e. the traditional leader is not in favour of management approaches for the resource), then the leader becomes a significant impediment to the local community institution's efforts.

Traditional leaders may also be key players in the integration of activities at local level. We found evidence of some sort of integration in communities whose traditional leaders have a high awareness and knowledge in various issues. In these communities, the chiefs encourage their subjects to participate in various lake basin management related activities (e.g. following better health and hygienic practices, managing village forest areas, implementing good agricultural practices, etc.). In many cases, these activities are implemented by the community as a whole. The policy implication of this finding is that awareness programs should also specifically target traditional leaders wherever necessary since it is important to ensure that these leaders are highly aware of lake basin issues and that they have correct information. Depending on the situation, it may even be better to educate or raise the awareness of the traditional leaders first before targeting their communities so that the leaders own the messages and are motivated to advocate them. Furthermore, under the information pillar, village meetings emerged the third preferred means of receiving information by the respondents, after extension officers and radio programmes. Traditional leaders are key in these village meetings, making their role in lake basin management all the more prominent. While rules or guidelines regarding the power play between traditional leaders and elected leadership of local institutions are in place, their effectiveness in safeguarding against traditional leaders' autocracy or other forms of oppression, or the phenomenon of 'elite capture' (whereby particular individuals or groups take advantage of the management situation to serve their own interests) was not determined and is thus recommended as an area requiring further research.

Clear Relationship between Livelihoods of Local Communities and Water Resources Management

National policies in the various related sectors clearly acknowledge the link between natural resources and livelihoods of the people. We also observed that many of the recent projects in the related sectors incorporate a livelihoods component, such as non-timber benefits in forestry conservation programmes e.g. bee farming for honey production. However, as indicated in the results section, we could not collect data on the average income of basin dwellers during the survey. As such, effectiveness of the implementation of this policy could not be determined.

Stakeholder Involvement (other than Government and local community institutions)

Stakeholders are involved but as indicated earlier, coordination/cooperation is weak especially with NGOs. Key informants indicated that in many cases, cooperation with NGOs is high in the initial stages when the NGOs are planning their activities but coordination/cooperation decreases once the NGOs receive funding and start implementing their activities. It was also indicated that at the local level (District Councils) there are cases whereby NGOs by-pass the District Executive Committee (DEC). DEC is a mechanism put in place to enhance cross-sectoral coordination of activities at district level. This has resulted in duplication of efforts in some instances (i.e. different players targeting same communities with similar interventions) because players were not properly directed by the DEC. This shows inefficiencies at the implementation level. Such challenges may be due to weak capacities at the district level to properly monitor activities going on and implement necessary action. This in turn may be a result of insufficient resources available to the District Councils for them to effectively carry out their mandate (the lack of sufficient resources is one of the major challenges that emerged under the finance pillar).

NGOs can play many roles that assist lake basin institutions through supplementing or complementing their efforts. This is evident in the Lake Malawi Basin as several NGOs (such as Total Land Care) are making significant contributions to local level natural resources management by raising awareness, providing technical guidance to local communities and many other efforts. However, as discussed, there is need to ensure proper guidance is provided and that efforts are well coordinated between the Government and all the other players. There have been

cases of conflict in the approaches of these various players. For instance, some NGOs offer monetary benefits to members of local community institutions for their participation in various activities which is often contradictory to the approach by Government as it is generally against offering monetary benefits due to sustainability considerations. This conflict undermines outcomes of the various management efforts in the long-term as members of local community institutions begin to expect monetary rewards for their participation. Several respondents commented that they put more effort to projects providing them direct monetary benefits and they don't see why they should sustain such efforts once the monetary benefits cease. When such projects phase out, their impact is often not sustained for long as level of interest and participation significantly drops. Besides, it weakens the willingness of local communities to participate in activities that are not offering monetary benefits. At the time of the study however, key informants indicated that there are efforts to address this issue and ensure harmonisation of approaches. Another example, according to key informants and survey respondents, is conflict in the technical advice provided by public extension workers and those of NGOs (e.g. recommended spacing for some tree species), resulting in confusion among local communities. All players need to share a common direction/vision and efforts need to be harmonised to harness synergies.

There are also efforts, at least at policy level, to encourage the involvement of the private sector in natural resource management although progress is generally slow. The Forestry Department described the involvement of the private sector in sustainable forest management as slowly increasing.

Overall performance

Overall, the participation pillar has a score of 4.64 out of 5. This means there is a high to very high participation of stakeholders, particularly local communities, in the management of the Lake Malawi Basin. We also found (under the institutions pillar), that of the leaders of the various local institutions interviewed (N = 55), 74.6% said their group is involved in planning of activities affecting them and 83.6% said they are involved in decision-making concerning the resources they manage. But as discussed, more needs to be done. World Bank (2005)

differentiates four levels of participation, in order of influence as follows: (1) information-sharing (one-way communication); (2) consultation (two-way communication); (3) collaboration (shared control over decisions and resources); and (4) empowerment (transfer of control over decisions and resources). This does not necessarily imply that a higher level is better. Stakeholder participation in the Lake Malawi Basin exhibits levels 1, 2 and to a smaller extent, 3. Looking at our definition of public participation, there is evidence of involvement of local community institutions in the lake basin, in planning and decision-making. To a smaller extent, local community institutions are involved in policy-forming activities, especially in the aspect of regulations (consultation during formulation of regulations and shared responsibility over enforcement). It is important to build on the successes by focusing on problems that are having direct impact to the basin and its population e.g. deforestation, soil erosion and overexploitation of some fish species. Although it is necessary to take a basin approach, it is also appreciated that developing basin level capacity requires time and experience. Nevertheless, it is important to get widespread involvement as early as possible. This includes working towards organizing these local institutions under a catchment framework (as is proposed in the 2013 Water Resources Act as a way of implementing IWRM) and transboundary cooperation since the lake basin is a shared resource. More so, the efforts being implemented need to be monitored so that lessons can be captured and incorporated soon enough, since engagement of stakeholders is a learning process and requires long-term commitment.

It is interesting that although our findings show high stakeholder involvement, degradation in the lake basin continues. This could be partly due to lack of alternative behaviours for the people to turn to, as earlier discussed. More importantly, it could be a result of the fragmented management that is currently the norm. As discussed, local level integration of management efforts across sectors is lacking and there is low understanding of the lake-basin-connection among basin dwellers. This results in sectors undermining efforts of other sectors. As earlier discussed, it is important to understand the root causes of the problems from the local and/or sectoral perspective to the basin and/or cross-sectoral perspective. This way, sectors would share a common vision, and direct their collective efforts towards its attainment. Cross-sectoral cooperation, both at policy and local implementation levels is therefore key for stakeholders to effectively address the issues in the lake basin and synergistically contribute to its sustainability. In addition, the inefficiencies at the local level, noted earlier, need to be addressed.

4.3.6. Conclusion

We have demonstrated the application of the proposed indicator framework for assessing the participation pillar of ILBM in the Lake Malawi Basin. We have thus assessed the status of stakeholder participation in the management of the lake basin, focusing more on local community institutions. We find that the participation pillar is strong to very strong with notable high levels of awareness and participation within community institutions. Women's representation and participation is encouraging. Improvement is needed to enhance the understanding of the complex nature of lake basin issues and to achieve integration of implementation of lake related activities at the local level, across various sectors. The results of the participation pillar should be understood, bearing in mind that they are just one part of the ILBM framework.



Fig. 4.5. Activities of the local communities (horticultural farming and community reforested forest (top), fish handling and processing (centre), and some of the survey respondents (bottom))

4.4. Assessment of the Technology Pillar

This section is based on the accepted version of the following article: Chidammodzi C.L. and Muhandiki V.S. (2016). An Indicator Framework for Assessing the Technology Aspect of Integrated Lake Basin Management for Lake Malawi Basin. Ecological Indicators, 60: 789–801, which has been published in final form at <http://www.sciencedirect.com/science/article/pii/S1470160X15004422>. First published online on September 1, 2015.

4.4.1. An Indicator Framework for Assessing the Technology Aspect of Integrated Lake Basin Management for Lake Malawi Basin

Abstract

Lake Malawi is one of the African Great Lakes and is well known for its fish biodiversity which is the greatest in the world for freshwaters. The lake basin is a valuable resource to the riparian countries. Activities associated with the derivation of the values offered by the lake basin, however, result in the generation of wastes and pollutants that also impact on the lake basin. Such anthropogenic activities within the lake basin place considerable strain on the lake system and may lead to the degradation of the lake basin. Proper application of technology can effectively supplement command-and-control measures and economic instruments for better lake basin management. Currently, no comprehensive framework exists to assess the management of the lake basin. Such a framework is necessary to guide managers and policy-makers in the formulation of management plans and strategies for the sustainable management and utilization of the lake basin. We propose an indicator framework for assessing the technology aspect of Integrated Lake Basin Management (ILBM) in the context of the Lake Malawi Basin. We further demonstrate applicability of the proposed framework through a study conducted in the Malawian side of the basin. We applied a five point Likert-type scale in our indicator assessment. Overall, our results show that the technology aspect of the management of the lake basin is weak to moderate. This threatens the sustainability of the lake especially in the areas of solid waste

management, sanitation services, pollution control and protection of wetlands and lagoons which performed from very low to moderate. The major challenges are weak institutional capacity, weak regulation enforcement, and insufficient resources.

4.4.2. Introduction

The Lake Malawi Basin is a valuable resource to the riparian countries. In Malawi, for example, it is important in many aspects including hydro-electric power generation (on its only outlet), fisheries, domestic and industrial water supply, rain-fed and irrigated agriculture, navigation, mineral resources, and tourism. Activities associated with the derivation of these values however, result in the generation of wastes and pollutants that also impact on the lake basin. Such anthropogenic activities within the lake basin place considerable strain on the lake system and may lead to the degradation of the lake basin. Examples of such strain include sedimentation and siltation of inflowing rivers and the lake resulting from soil erosion, and pollution of water bodies from industrial and municipal wastewater (ILEC, 2005; Castañeda et. al., 2011; Ngochera, 2014). The major challenges that Lake Malawi Basin is facing are: deforestation; uncontrolled bush fires; soil erosion; inorganic pollution from agricultural activities; pollution from domestic and industrial wastewater; overexploitation of some fish species; heavy extraction of water for irrigation from some rivers in the dry season; increasing mineral resource extraction; and industrialization (Bootsma and Jorgensen, 2005; Chafota et al., 2005; Jamu et al., 2011; Msilimba and Wanda, 2012; Ngochera, 2014). Many of these challenges relate with technology issues. No comprehensive framework exists to assess the management of the lake basin despite the increasing need for such a framework to guide the formulation of management plans and strategies.

Water bodies receive pollutants from various point and nonpoint sources. Point sources have well defined and easily identifiable points of origin (e.g. municipal/industrial wastewater and industrial emissions) while nonpoint sources are diffuse (e.g. fertilizers and pesticides). Technology plays an important role in water resources management and if appropriately applied, can help reduce the stress exerted upon lakes (ILEC, 2005; ILEC, 2007; Nakamura and Rast, 2011). There are several forms of lake basin management related technologies such as those developed for and applied in management options aiming at reducing stress on water bodies

and/or those aiming at reducing natural hazards, the former including sewage treatment plants, sanitation facilities, and wetland restoration, and the latter including weirs and dykes construction (ILEC, 2005; Nakamura and Rast 2011). In Japan, the implementation of the Lake Biwa Comprehensive Development Plan (1972-1997) included the construction of lakeshore embankment and a sewage treatment plant which resulted in better flood control and improved lake water quality (LBCPLCC-LBCPPC, 2003). Technological measures in themselves can provide significant environmental benefits but at the same time impose significant environmental costs. To be effective, technological measures need to be affordable and properly combined with other measures such as policies and institutional arrangements (ILEC, 2005). Proper application of technology can effectively supplement command-and-control measures and economic instruments for better lake basin management.

Management of lakes and their basins is an important part of water resources management since lakes (and reservoirs) store about 90% of the world's surface freshwater resources (ILEC, 2005). Lake basin management is a complex endeavour as it requires the integration of management approaches across all related sectors with their diverse uses and users. Nowadays, lake managers are adopting Integrated Lake Basin Management (ILBM) in their management approaches as a guide for sustainable management of lake basins (Nakamura, 2009; Pokharel and Nakamura, 2010; Sharip and Jusoh, 2010).

This paper focuses on the technology pillar and proposes an indicator framework for assessing the technology aspect of ILBM in the context of the Lake Malawi Basin. The current study is part of a broader study focusing on the assessment of the management of the Lake Malawi Basin. Moldan et al. (2012) observed that very limited experience exists with indicators that monitor environmental condition from the perspective of sustainable development, despite a growing demand from the policy side. This paper is a contribution towards addressing this concern regarding the Lake Malawi Basin. In this paper, we refine the technology indicators proposed by Chidammodzi and Muhandiki (2015) and demonstrate their applicability through a study conducted in the lake basin. It is important to recognize that the technology pillar is only one part of the overall ILBM framework, as such, the results of this study should be understood bearing the big picture in mind. Issues related to the other ILBM pillars have been discussed wherever necessary, especially regarding institutional and resource aspects.

4.4.3 Indicator Details

This pillar has nine indicators which have been further broken down into 18 sub-indicators or measures. The overall goal for the pillar is to utilize technological interventions for lake basin management where applicable. The indicators cover the aspects of water and sanitation services, point- and non-point source pollution control, solid waste management, biodiversity protection and adoption of technology. These aspects are in agreement with what other researchers have identified elsewhere. For instance, Pokharel and Nakamura (2010) identified solid waste management and pollution treatment as some of the important areas that need to be addressed as a way of strengthening the technology pillar in the management of Rupa Lake in Nepal. Access to improved sanitation, industrial pollution control, solid waste control, and non-point source control are some of the indicators identified by the Transboundary Waters Assessment Program (TWAP) as important under the technology pillar (ILEC, 2011). The indicators are presented according to the aspect they fall under.

Water and Sanitation Services

Ensuring environmental sustainability is one of the Millennium Development Goals (MDGs) and this has also been reflected in the recently proposed Sustainable Development Goals (SDGs) that the world's governments are currently negotiating (UN, 2003; UN General Assembly, 2014). Increased access to safe drinking water and basic sanitation are some of the targets to be achieved under the MDGs. It is important for basin dwellers to have access to these services.

Indicator 1. Access to Potable Water

Rationale: IWRM seeks to balance water for livelihoods and water for ecosystems. It is thus logical that basin dwellers, being custodians of the water resource, should have reasonable access to it. Access to potable water indicates efficiency of the basin's water governance, population health, and can also provide economic benefits if less time is spent on fetching water (UNEP-DHI, 2011) or if the water is utilised as an input for production (Mulwafu and Msosa, 2005;

Calow et al., 2010). This indicator seeks to check whether residents of the largely rural Lake Malawi Basin have access to potable water.

Key Sectors: Water, sanitation and health.

Sub-indicator/measure: The population proportion who use any of the following types of drinking water sources: piped water through household connection; piped water through public tap; pump well; rain water; and other protected water sources (Target: 100% - National Water Policy).

Computation: Ratio of the number of people who use piped water, pump well, rainwater or other protected water source to the total basin population, expressed as a percentage. Equate the percentage to a rate.

Data Sources: Survey, NSO reports and publications, data from the monitoring and evaluation (M&E) framework for the environment and natural resources management (ENRM) sector, Departments of Water Resources Development, and Sanitation and Hygiene.

Survey respondents were asked to select their main source of drinking water from the following options: (i) piped supply through own house connection; (ii) piped supply through public tap; (iii) bucket well ; (iv) pump well; (v) rain water; (vi) river; (vii) lake; and (viii) other sources. The sources considered potable in this study are (i), (ii), (iv) and (v).

Limitations: This indicator only checks the main source of drinking water. Issues of disrupted water supply due to infrastructure breakdowns or drought etc. are not addressed.

Indicator 2. Access to Improved Sanitation Services

Rationale: 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). The two important aspects of impact of sanitation on water bodies are nutrient load which has significant impact on lake ecosystem, and pathogen transport which ultimately impacts public health. This indicator uses the definition for ‘improved sanitation’ provided in the

2008 National Sanitation Policy for Malawi. The policy defines improved sanitation facilities as those that allow for the safe disposal of faeces to a functional receptacle, cesspit, septic tank or sewer line while providing privacy and safety to the user and safeguarding public health and the environment. This is also in line with the WHO and UNICEF's Global Water Supply and Sanitation Assessment 2000 Report.

Key Sectors: Water, sanitation and health.

Sub-indicator/measure: The population proportion with access to improved sanitation facilities (Target: 100% - National Sanitation Policy).

Computation: Ratio of the number of people in the lake basin with access to improved sanitation facilities to the total basin population, expressed as a percentage. Equate the percentage to a rate.

Data Sources: Survey, NSO reports and publications, M&E framework for ENRM sector, Departments of Water Resources, and Sanitation and Hygiene.

Survey respondents were asked to select the statement that describes the toilet situation at their house from the following: (i) there is a toilet at my house; (ii) we share a toilet with other households; (iii) we use a community/public toilet; and (iv) no toilet. Those who use a toilet were further asked to select the type of toilet they use from the following: (1) pit latrine with an impermeable floor (e.g. cemented) and a lid; (2) pit latrine with an impermeable floor without a lid; (3) pit latrine with a permeable floor and a lid; (4) pit latrine with a permeable floor without a lid; (5) ecosan toilet; (6) water closet toilet (flush toilet); and (7) others. The toilet types considered 'improved' in this study (according to WHO and UNICEF, 2000, and GoM, 2008a) are (1), (5) and (6).

Limitations: Other aspects of hygiene, beyond access to improved sanitation are not addressed (e.g. proper hand washing).

Point Source Pollution Control

As mentioned in section 1.0, pollution from domestic and industrial wastewater is one of the major challenges in the basin, making this an important area to be monitored.

Indicator 3. Degree of Point Source Pollution Control (Sewerage and Industrial)

Rationale: ILEC (2005, p. xi) states, “Impairment of a given lake use arises through overuse and/or when two or more users are in conflict”. The lake basin is utilized in many ways, some of which are in conflict e.g. water abstraction for domestic supply and discharge of wastewater, while some benefits are showing signs of overuse e.g. fishing of some fish species. The major potential sources of point pollution in Malawi are sewage treatment plants, sludge disposal (from septic tanks) in towns and unconnected parts of cities, mining and industry. In the lake basin, wastewater treatment works are only done in the cities of Lilongwe and Mzuzu, which are the main urban centres in the lake basin. The existing treatment systems are considered less effective (Msilimba and Wanda 2012). There is need to monitor the cities’ sewer line coverage, management of sludge disposal in the cities and towns, and compliance of the sewage treatment plants with effluent standards. Industries and mines also need to be monitored.

Key Sectors: Environment, sanitation (city assemblies & EAD), mining and industry.

Sub-indicators/measures:

- 1) Percentage of households in the cities of Lilongwe and Mzuzu connected to the sewer line (Target: not set).
- 2) Sewage effluent standards compliance rate of the sewage treatment plants (Target: 100%)
- 3) Sludge disposal compliance rate in the cities and towns in the basin (Target: 100%).
- 4) Compliance of industries and mines with effluent and emissions standards (Target: 100%).

Computation:

- 1) Average percentage of households connected to the sewer line in the cities of Lilongwe and Mzuzu according to the records of the respective city councils.

- 2) Average frequency of compliance with effluent standards of sewage treatment plants according to the assessment of the EAD, expressed as a percentage.
- 3) Average frequency of compliance with sludge disposal regulations in the cities of Mzuzu and Lilongwe, and the towns in the basin as assessed by the EAD both at central and district levels, expressed as a percentage.
- 4) Average frequency of compliance of industries and mines with standards as assessed by the EAD, expressed as a percentage.
- 5) Average the percentages in steps 1, 2, 3 and 4 above and equate to a rate to obtain a score for the indicator.

Data Sources: City and town councils, EAD, Ministry of Industry and Mines, M&E framework for ENRM sector, Malawi Bureau of Standards.

Limitations: The need to integrate data/information from various sources and the accuracy of reporting from the data sources.

Non-Point Source Pollution Control

Deforestation, soil erosion, uncontrolled bush fires and pollution from agricultural activities are some of the major challenges highlighted in section 1.0 that fall under this aspect.

Indicator 4. Degree of Non-Point Source Pollution Control

Rationale: Non-point sources represent a greater proportion of pollution entering rivers and lakes. Their components depend on the land uses in the catchment. Some of the main threats the lake is facing are deforestation, sub-optimal agricultural practices and biomass burning (Bootsma and Jorgensen 2005). Aspects measured by this indicator are forest cover (indicates extent of soil erosion), minimization of bush fires (indicates extent of nutrient load through atmospheric deposition) and adoption of good agricultural practices (gives an indication of soil erosion from farmland).

Key Sectors/Areas: forestry and agriculture.

Sub-indicators/measures:

- 1) Proportion of land covered by forests in Malawi as a proxy measure of the extent of soil erosion resulting from deforestation (Target: 50% - MDGs).
- 2) Reduction in hectares destroyed by bush fires as a proxy measure of atmospheric nutrient load to the lake from the basin (Target: not set).
- 3) Farm area under good agricultural practices as a proxy measure of the extent of soil erosion from farmland (Target: 100%).

Computation:

- 1) Ratio of the proportion of land covered by forests in Malawi to the target, expressed as a percentage.
- 2) Reduction in hectares destroyed by bush fires in the current period compared to the previous period of time, expressed as a percentage.
- 3) Ratio of farmland under good agricultural practices to total farmland in the basin, expressed as a percentage.
- 4) Average the scores in steps 1, 2 and 3 above and equate to a rate to obtain a score for the indicator.

Data Sources: M&E framework for ENRM sector, LRCD and Department of Forestry.

Limitations: The need to integrate data from various sources and the accuracy of reporting from the data sources.

Solid Waste Management

In addition to affecting public health, solid waste has an impact on water resources in terms of suspended solids transported to water bodies and pollution of groundwater by leachate from poorly managed landfills. These concerns have been factored into the proposed indicator.

Indicator 5. Extent of Solid Waste Management in the Cities of Lilongwe and Mzuzu

Rationale: Lilongwe and Mzuzu are the two main urban centres within the lake catchment and their waste generation is assumed to be high. The status of solid waste management in these cities needs to be monitored as it has a bearing on suspended solids and pollutants transported to the lake and leached to groundwater.

Key Sectors: Sanitation (city councils) and environment.

Sub-indicators/measures:

- 1) Waste collection rate in the two cities (Target: 100% of waste requiring collection).
- 2) Compliance of industries with industrial solid waste disposal standards in the two cities (Target: 100%).
- 3) Sanitary condition of final disposal facilities of the two cities (Target: based on the “Solid Waste Landfills: Decision-Maker’s Guide Summary” by Thurgood et al. (1998) which provides four basic sanitary landfill conditions).

Computation:

- 1) Ratio of waste actually collected to waste requiring collection, expressed as a percentage. Average for the two cities and equate to a rate.
- 2) Average frequency of compliance of industries with industrial solid waste disposal standards in the two cities, expressed as a percentage and equated to a rate.
- 3) Sanitary condition of final disposal facilities – Assign a rate based on Table 4.17.
- 4) Average the scores in steps 1, 2 and 3 above to obtain a score for the indicator.

Data Sources: City councils, EAD and Department of Sanitation.

Limitations: The need to integrate data/information from various sources and the accuracy of reporting from the data sources.

Table 4.17. Criteria for Assessing the Sanitary Condition of Final Disposal Facilities

Condition		Score		Average Score for LL *	Average Score for Mz **
		Yes	No		
Full or partial hydrogeological isolation	Leachate collection system	5	1		
	Leachate treatment system	5	1		
Formal engineering preparations	Waste disposal plan	5	1		
	Final restoration plan	5	1		
Permanent control	Trained supervision staff based at site	5	1		
Planned waste emplacement & covering	Layering & compacting	5	1		
	Daily covering	5	1		
Total Average Score for Each City					
Total Average Score for the Two Cities					

*LL – Lilongwe

**Mz - Mzuzu

Biodiversity Protection

The lake basin is habitat to a diverse range of flora and fauna, both aquatic and terrestrial. The major challenges in the basin are also a threat to biodiversity. We are proposing two indicators under this aspect.

Indicator 6. Management of Invasive Species

Rationale: Invasive species are known to disrupt ecosystems. Water hyacinth is the invasive plant of major concern that has infested the southern part of the lake and the upper Shire River.

Infestation on the Shire River has caused challenges in the generation of hydropower. Furthermore, invasive snail species detected in the lake, and the possibility of Nile Tilapia entering the lake, are emerging threats. There is need to monitor the measures in place for protecting/preventing the lake basin from new infestations and the efficacy of existing management mechanisms.

Key Sectors: Water, fisheries, forestry, environment and energy.

Sub-indicators/measures:

- 1) Existence of measures to protect/prevent the lake basin from new infestations of invasive species and manage infested areas (Target: measures in place).
- 2) Effectiveness of the mechanisms in place for the control and management of invasive species measured through direct observation of management of infested areas and potential invasion routes i.e. border crossings, airports, cross-basin waterways. (Target: very high).

Computation:

- 1) A rate of 5 is assigned if measures exist and a rate of 1 if none exists.
- 2) A rate is assigned based on results of direct observations of the management of infested areas and potential invasion routes.
- 3) Average the scores in steps 1 and 2 above.

Data Sources: M&E framework for ENRM sector and Departments of Fisheries, Forestry and Energy and/or the Electricity Supply Commission of Malawi - ESCOM.

Limitations: The need to integrate data/information from various sources.

Indicator 7. Protection and Rehabilitation of Wetlands and Lagoons

Rationale: Wetlands (marshes and swamps) and lagoons are sanctuaries for fish and provide fish breeding grounds (e.g. Chia and Chiondo lagoons along the lake) and therefore are crucial for enhancing fish reproduction and conserving biodiversity. 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). In addition, wetlands function as natural traps for sediments and nutrients and 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). Other countries such as Japan that destroyed some of their wetlands, are now learning the hard way and trying to rehabilitate degraded ones and re-establish some that were completely destroyed. There is need for policy-makers to understand the significant role played by wetlands and lagoons in the Lake Malawi Basin and avoid the mistakes made elsewhere by protecting existing ones and rehabilitating degraded ones. Besides giving an indication on the status of biodiversity, this indicator also supplements the indicator “degree of non-point source pollution control” due to the purification function that wetlands play.

Key Sectors: Water, fisheries and forestry.

Sub-indicators/measures:

- 1) Proportion of basin/littoral wetlands and lagoons protected (Target: not set).
- 2) Proportion of basin/littoral wetlands and lagoons rehabilitated (Target: very high).

Computation:

- 1) Ratio of area of wetlands and lagoons in the basin protected to total area of wetlands and lagoons in the basin, expressed as a percentage and equated to a rate.
- 2) Ratio of area of wetlands and lagoons in the basin rehabilitated to total area requiring rehabilitation, expressed as a percentage and equated to a rate.
- 3) Average the scores in steps 1 and 2 above.

Data Sources: Departments of Forestry, Water Resources, Fisheries, and National Parks and Wildlife Reserves.

Limitations: Does not address encroachment and related issues.

Adoption of Technology

Legislative regulation and management improvement are important strategies for addressing the basin challenges. Proper application of technology can effectively supplement these strategies and provide environmental benefits.

Indicator 8. Adoption of Deep Water Fishing Technologies

Rationale: Malawi 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, 2011). Monitoring the promotion and adoption of deep water fishing technologies is important to ensure sustainability of the abundant fisheries resources that the lake has.

Key Sector: Fisheries.

Sub-indicators/measures:

- 1) Ratio of small-scale fishermen adopting deep water fishing technologies to target. (The Fisheries Department is yet to set a target).
- 2) Ratio of deep water fish catch (both large- and small-scale fishing) to target (Target: Optimum harvest as informed by stock assessment. In the absence of a more recent assessment, this study uses 34,000 tons/yr [Thompson and Allison, 1997]).

Computation:

- 1) Ratio of small-scale fishermen adopting deep water fishing technologies to target, equated to a rate. (Determine the proximity-to-target).
- 2) Ratio of total deep water fish catch to the recommended optimum harvest, equated to a rate.
- 3) Average the scores in steps 1 and 2 above.

Data Sources: Department of Fisheries, M&E framework for ENRM sector.

Limitations: The accuracy of reporting from the data sources.

Indicator 9. Adoption of Other Technologies Related to Lake Basin Management

Rationale: 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, waste management, forestry/energy (i.e. deforestation due to fuel/energy needs), agriculture, pollution control and fishing (overfishing). A mix of innovative approaches to address the issues is required. Encouraging innovations in low cost technologies that utilize local resources is also important. This indicator requires key stakeholders to agree on the technologies to be promoted and be flexible enough to include additional technologies or drop technologies as appropriate.

Key Sectors: Water, sanitation, forestry, energy, agriculture/irrigation and fisheries.

Sub-indicators/measures:

- 1) Adoption rate of promoted technologies in water supply.
- 2) Adoption rate of promoted technologies in sanitation.
- 3) Adoption rate of promoted technologies in waste management.
- 4) Adoption rate of promoted technologies in pollution control.
- 5) Adoption rate of promoted technology in fisheries (e.g. aquaculture techniques).
- 6) Adoption rate of promoted technologies in agriculture.
- 7) Adoption rate of promoted technologies in energy.

Targets are not set for all the measures.

Computation: Obtain average adoption rates of key promoted technologies.

Data Sources: M&E framework for ENRM sector, and Departments of Fisheries, Sanitation and Hygiene, Forestry, Energy, and Land Resources Conservation and Development.

4.4.4. Findings

This section demonstrates on-the-ground application of the proposed indicators through a pilot study conducted in the lake basin. Important to note is that during the study, some data/information could not be accessed due to unavailability or difficulty to obtain such data/information from custodians with respect to time constraints. As such, data/information for

indicator 4 sub-indicator 2 (reduction in hectares destroyed by bush fires), indicator 6 sub-indicator 2 (effectiveness of the mechanisms in place for the control and management of invasive species), and Indicator 7 sub-indicator 2 (Proportion of basin/littoral wetlands and lagoons rehabilitated) could not be accessed. Indicator 4 and 7 were assessed based on only the sub-indicators with data/information available while indicator 6 was excluded in the overall assessment as the sub-indicator for which information is available was deemed insufficient to provide a reliable indication of the performance of the indicator.

Indicator 1. Access to Potable Water

This indicator utilized primary data from the survey. Majority (85%) of the respondents have access to potable water as Figure 4.6 shows. This indicator was rated very high (5.0).

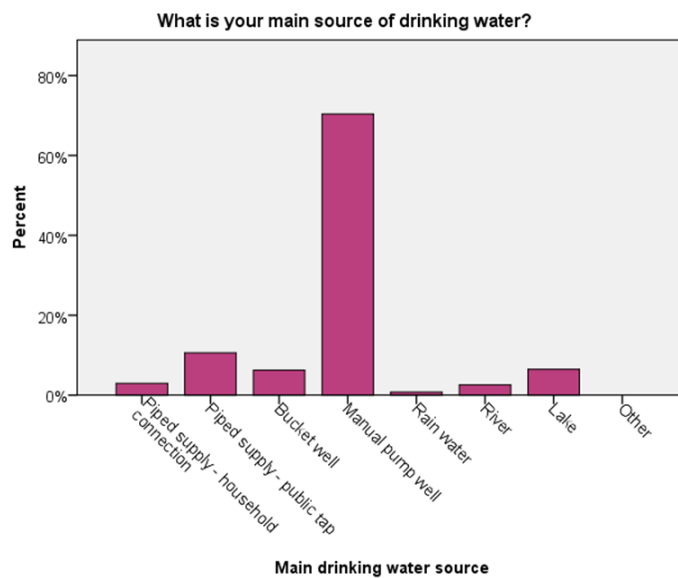


Fig. 4.6 Main drinking water source in the Lake Malawi Basin (data collected in April/May 2014)

Indicator 2. Access to Improved Sanitation Services

Primary data from the survey was utilised. Respondents with a toilet at their house were 82%, while only 4% indicated they don't use a toilet. This puts access to some form of basic sanitation at 96%. As shown in Figure 4.7, access to improved sanitation is low (23%) and this indicator is rated low (2.0). We noted that the flush toilet option was not selected by any of the respondents.

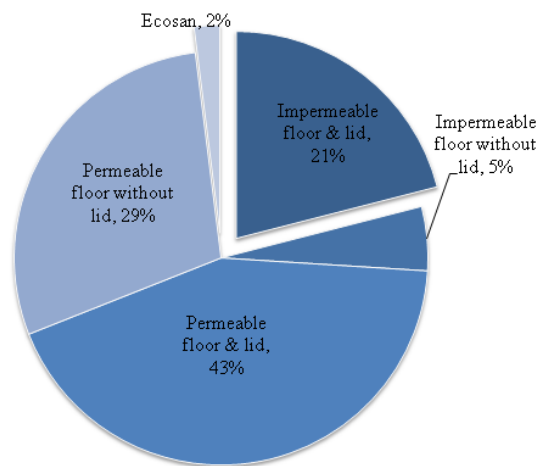


Fig. 4.7. Access to improved sanitation services in the Lake Malawi Basin (data collected in April/May 2014).

Indicator 3. Degree of Point Source Pollution Control

This indicator was evaluated based on the data and information provided by LCC, MCC and EAD through interviews. As Table 4.18 shows, the indicator score is 2.5 and we thus rated this indicator weak.

Indicator 4. Degree Non-Point Source Pollution Control

Data and information from documents review and key informant interviews were used. There was no information on *reduction in hectares destroyed by bush fires* and we consequently ignored this sub-indicator and used only the other two. Worth noting is the analysis of Archibald

et al. (2010), which utilised satellite data from 2001 to 2008 for Southern African Countries and showed that about 16% of Malawi's total area was affected by fire in the period. However, we could not find information on average annual burnt area in the period under study to provide a benchmark for our proposed framework. We have rated this indicator moderate (3.0) and Table 4.19 shows the results.

Table 4.18. Results for Indicator 3 (Degree of Point Source Pollution Control)

Measure	Target	Findings	Data/Information source	Rating	Contribution to Indicator Score	Indicator Score
Percentage of households connected to the sewer line in the cities	Not set	4.5% - average	LCC* & MCC**	1	25%	2.5
Sewage effluent standards compliance rate	100%	55% - average	EAD***	3	25%	
Sludge disposal compliance rate	100%	<60%	EAD - information available for the cities only	3	25%	
Compliance of industries & mines with standards	100%	55%	EAD & LCC	3	25%	

*LCC – Lilongwe City Council

**MCC – Mzuzu City Council

***EAD – Environmental Affairs Department

Table 4.19. Results for Indicator 4 (Degree of Non-Point Source Pollution Control)

Measure	Target	Findings	Data/information source	Rating	Contribution to Indicator Score	Indicator Score
Proportion of land covered by forests	50%	34%	FAO/FRA*, 2010	4	50%	3.0
Reduction in hectares destroyed by bush fires	Not set	Information not available		-		
Farm area under good agricultural practices	Not set	30-40%	Department of Land Resources Conservation & Development	2	50%	

*FAO/FRA - Food and Agriculture Organization/Forest Resources Assessment

Indicator 5. Extent of Solid Waste Management

We used data and information from key informant interviews (LCC, MCC and EAD) and findings from site observations. This indicator is rated very low (1.33). Table 4.20 and Figure 4.8 show the findings.

Table 4.20. Results for Indicator 5 (Extent of Solid Waste Management in the Cities of Lilongwe and Mzuzu)

Measure	Target	Findings	Data/information source	Rating	Contribution to Indicator Score	Indicator Score
Waste collection rate	100%	30% - average	LCC* & MCC**	2	33.33%	1.33
Industrial solid waste disposal compliance	100%	All waste dumped without categorization	LCC & MCC	1	33.33%	
Sanitary condition of final disposal facilities	All 4 conditions met	None of the conditions met in both cities	LCC, MCC, site observation	1	33.33%	

*LCC – Lilongwe City Council

**MCC – Mzuzu City Council



Fig. 4.8. Mzuzu City dumpsite which could not be accessed because the entrance road was blocked with waste (above), and Lilongwe City dumpsite (site observation on May 3 and May 15, 2014, respectively).

Indicator 6. Management of Invasive Species

Key informant interview findings from EAD, and the Departments of Water Resources, Forestry and Fisheries were used. We found that measures to protect/prevent the lake basin from new infestations exists (e.g. border inspections). Due to resource constraints, we could not conduct direct observations of infested areas and potential invasion routes. As a result, effectiveness of the mechanisms in place for the control and management of invasive species could not be assessed. It was deemed that the available information is not adequate to meaningfully assess this indicator and it was therefore excluded from the overall assessment.

Indicator 7. Protection and Rehabilitation of Wetlands and Lagoons

We used data and information from GoM (2011) and rates provided by key informants. We found that some wetlands and lagoons are protected under national parks and wildlife reserves (e.g. Vwaza Marsh Game Reserve). We could not find information on the wetlands and lagoons rehabilitated and this sub-indicator was not included in the indicator score. This indicator is rated moderate (3.0).

Indicator 8. Adoption of Deep Water Fishing Technologies

We used data and information from key informant interviews, reports and other documents produced by the Department of Fisheries. The ratio of small-scale fishermen adopting deep water fishing technologies to target could not be computed as the Department of Fisheries is yet to set a target. For this sub-indicator, we applied a rating of very low (1) which was provided by the key informants. According to the key informants and GoM (2014), the deep water fish catch for the year 2013 was 10,394 tons. This is 31% closer to the target of 34,000 tons/yr, resulting in a low rating (2). This indicator is rated very low (1.5).

Indicator 9 (Adoption of other Technologies)

This indicator was assessed based on key informant interviews at LRCD, DoI and Department of Fisheries. The promoted technologies have an average adoption rate of 45% and we thus rated this indicator moderate (3.0).

Summary of the Performance of the Technology Pillar

The results, as Table 4.21 shows, indicate that the technology pillar has an overall score of 2.62 which is a low to moderate rating. Indicator 6 (management of invasive species) was not included in the assessment of overall performance of the technology pillar as information collected was not adequate. Indicator 9 (adoption of other technologies related to lake basin

management) was also not included in the final assessment as targets were not set for the sub-indicators, as such it has only been used to establish the baseline. The results show that the technology aspect of the management of the Lake Malawi Basin from the perspective of ILBM is weak to moderate.

Table 4.21. Performance of the Technology Pillar

Indicator	Score	Overall Pillar Score
Access to potable water	5.00	2.62
Access to improved sanitation services	2.00	
Degree of point source pollution control	2.50	
Degree of nonpoint source pollution control	3.00	
Extent of solid waste management in the cities of Lilongwe and Mzuzu	1.33	
Management of invasive species	-	
Protection and rehabilitation of wetlands and lagoons	3.00	
Adoption of deep water fishing technology	1.50	
Adoption of other technologies	3.00	

4.4.5. Discussion

It is encouraging that our findings show 85% access to clean water among rural communities in the basin. This is within the range of what others have previously reported e.g. the 2010 MDGs Report for Malawi indicated 81% access at national level and World Bank Data shows 83% rural access for 2012 (<http://data.worldbank.org/country/malawi>). Theoretically, this is expected to contribute to poverty alleviation. In their study of several countries in southern Africa, including Malawi, van Koppen et al. (2009) observed that once water has been made accessible to communities, they tend to utilize it in their own innovative ways to improve their wellbeing e.g. engaging in small enterprises such as mat/basket weaving. We also observed that most of the

recent projects in Malawi in the water sector and water related sectors such as forestry, have a livelihoods component and are designed to address a variety of needs. For example, linking dam development projects to irrigation schemes and fish ponds, and incorporating non-timber benefits in forestry conservation and protection such as bee farming for honey production, and indigenous fruit juice/jam making. We can thus say that the country is on the right track. That being said, however, some survey respondents commented that their main drinking water source sometimes dries up in the dry months (around August to December). When this happens, they resort to unsafe sources i.e. rivers. This suggests that actual access to potable water may be lower than our findings of 85%. Attention is required in this regard to ensure sustainable year-round access. Surface water bodies are the main sources of water supply in Malawi. Exploitable ground water resources are limited as the existing aquifers are disjointed with generally low yield ranging from 0.15 to 4 litres per second (GoM, 2008c). As such, ground water resources are mainly exploited for drinking water supply for both rural and urban areas. Ground water resource in Malawi is an area requiring further study to enhance understanding of the resource. At the time of the study, the monitoring system within the Ministry of Irrigation and Water Development did not include groundwater. Calow et al., (2010) highlighted the importance of groundwater in offering reliable water supply as well as a buffer against drought in Africa. Linking water, food security and livelihoods, they argue that water availability and access are key to alleviating poverty and food security in Africa and enhance household resilience to climate variability. Earlier, Mulwafu and Msosa (2005) similarly linked access to water resources and poverty alleviation, arguing that poor people depend on water resources as a direct input for production and as a basis for health and welfare. There is need for a comprehensive assessment of ground water potential in Malawi to guide appropriate action, as the country endeavours to achieve year-round universal access to water. A lot more needs to be done to improve access to improved sanitation. While we acknowledge the efforts currently in place towards this end through various ongoing projects we observed during the study, there is need for long-term commitment on sustaining these efforts to eventually improve the sanitation situation.

The weak control of point source pollution is mainly attributed to the weak capacity of institutions that are responsible for monitoring and enforcement of regulations. Another challenge is insufficient resources. The weak capacity is due to low staffing levels in the institutions and insufficient resources and equipment. According to the unpublished Malawi

Sector Performance Report for the Irrigation, Water and Sanitation sector, for 2011, the sector had a vacancy rate of 75% out of 350 establishments and during the study, key informants confirmed this is still the case. In addition, insufficient resources hamper the extension of the existing sewerage network that is necessary to cater for the population. The major challenges for non-point source pollution control are weak coordination among sectors, especially at local level of implementation. These too are mainly attributed to the weak capacity of institutions and insufficient resources. Water, forestry, fisheries and agricultural issues inter-relate. We observed that on the local level, many farmers, fisherfolk and forestry managers do not understand how related or interdependent their activities are. The view of many was that their activities do not affect the others and vice versa. While the professionals in these sectors understand the inter-relationships and the need to coordinate and cooperate efforts, key informants lamented the weak coordination and sometimes lack of proper guidance on how to actually integrate various sectoral efforts during implementation (i.e. funding modalities and mechanisms for pooling resources). Consequently, many local level activities are implemented in an isolated manner. This results in one sector undermining the efforts of another. For instance, the agricultural sector has been promoting use of treadle pumps in irrigation. In many cases, treadle pumps have been used to irrigate crops cultivated within recommended buffer zones of water bodies, thus undermining water resources protection efforts. There is need for sustainable financial, material and human resources to be available to the sectors for them to achieve cross-sectoral coordination/cooperation at the implementation level. Clarity, regarding institutional procedures, is also needed on how sectors can practically achieve this coordination/cooperation.

Challenges leading to the very weak solid waste management may also be attributed to weak institutional capacity resulting from insufficient resources. More importantly, this may also be due to weak participation of stakeholders and communities/households in overall waste management as key informants pointed out. Both city councils indicated that they have plans to promote stakeholder participation in waste management including exploring ways of involving the private sector. It is important that they vigilantly implement their plans so that overall solid waste management may be improved as soon as feasible.

Protection of biodiversity is another area that requires more attention. Measures for protecting the lake basin from infestation of invasive species are in place e.g. border inspections

by the Departments of Immigration, and Marine Services in collaboration with the various sectors such as forestry, fisheries and water. However, the effectiveness of these measures could not be assessed, as indicated earlier. We do not know how effective the existing measures are. There are concerns of emerging invasions i.e. the threat of invasive snails (Genner et al., 2004; Michel et al., 2008; van Bocxlaer and Albrecht, 2015) and the threat of escaped Nile Tilapias from fish farms into the lake. The situation needs to be monitored and action taken as appropriate. Protection of lagoons and wetlands in the lake basin as well as the country in general is partial. Those currently under protection in the basin are the ones within national parks and wildlife reserves i.e. wetlands within Nyika National Park, Vwaza Marsh Game Reserve, Kasungu National Park and Nkhotakota Wildlife Reserve (GoM, 2011). The lake's littoral wetlands are not protected. According to GoM (2010) and key informants, most wetlands within the basin have been modified by anthropogenic activities such as farming. Thus, attention is needed in this area since wetlands and lagoons serve important biodiversity functions that are key for human wellbeing and the development of the economy as stated in the indicators rationale.

Some of the technologies being promoted that are directly/indirectly relevant to lake basin management are energy saving and more efficient cooking stoves, ecosan toilets and other improved sanitation facilities, and conservational agriculture practices. The overall adoption of technologies is moderate. We cannot say whether this is good or bad as the situation is mixed and many of these technologies have been recently introduced. The irrigation sector has performed notably well on adoption of technologies. The main technologies in use in the sector are gravity-, treadle pump-, motorized pump-, and watering can-based irrigation systems. The average technology adoption rate in the sector is 76.3 %. Out of the 43,218.6 Ha of area under irrigation in the country 56% are irrigated using gravity-, 29% using treadle pump-, 8% using motorised pump- and 7% using watering can-based systems. We consider this a sustainable approach in the Malawi context as 92% of the irrigated area is utilizing relatively low cost technologies. The Department of Irrigation Services indicated about 75% of all the adopted technologies as sustainable. However, there is need to monitor water usage and drainage to ensure the supporting water bodies are not negatively affected. Although the *adoption of deep water fishing technologies* has performed lowly, plans for its promotion exist and various efforts are underway towards this end. What is needed is to base these efforts on the proper understanding of the resource and long-term commitment in implementation.

The issues we have discussed concerning the technology pillar are not isolated to this pillar alone in the ILBM framework. They are linked to the other pillars like policies, institutions, participation, information and finance. Lack of data/information was a major limitation in this study and this directly relates to the information pillar. Furthermore, information that is available is not easily accessible by interested stakeholders or the public. M&E units exist in the sector departments. The data and information that they collect is usually archived in the institutions' libraries and access is often tedious and inconvenient. In addition, the public at large is generally not aware of the existence of such libraries and the procedures for access. In 2011, Malawi developed an M&E framework for the ENRM general sector to integrate M&E of the sector. The framework defined indicators for each sector and assigned responsibility for data collection as well as frequency of reporting to the EAD, the coordinating institution for the framework. Some of the indicators in our proposed ILBM framework were adopted from this ENRM monitoring framework to align our proposed framework to the existing framework and ease data/information collection needs. It can be said that implementation of this framework has a lot of strides to make as at the time of this study, some data/information expected to be collected under this framework was not available (e.g. reduction in hectares destroyed by bush fires) despite the requirement for such data/information to be reported annually. There is need to effectively operationalise this framework and establish convenient mechanisms to improve access of information (i.e. provide online access where feasible and designate contact persons to be responsible for handling direct inquiries). It would also be beneficial to integrate knowledge generated from various programs and studies (i.e. donor funded programs implemented in the various sectors). The finance pillar is especially critical as it affects all the other five pillars and this has been demonstrated in the discussion of the technology pillar, as most of the challenges are boiling down to insufficient resources. Political leaders' role is especially important as their support to ensuring availability of sufficient resources is crucial. To better understand the big picture, it is important to look at the ILBM framework in its entirety and how the various pillars relate with one another. That way, the various interactions of the many factors at play will be better understood and key action points will be better pinpointed.

4.4.6. Conclusions

We have proposed an indicator framework for assessing the technology aspect of the integrated management of the Lake Malawi Basin. We have also demonstrated its application through a pilot study conducted in Malawi. As noted in the discussion, lack of data/information was a major limitation in this study. We find that overall, the technology aspect of the management of the lake basin is weak to moderate. This threatens the sustainability of the lake in particular and water resources in general, especially in the areas of solid waste management, sanitation services, pollution control and protection of biodiversity. This may have undesirable consequences on the wellbeing of Malawians and the economy if not properly addressed. There is need to improve capacity of institutions, enforcement of regulations and information management. Availability of sufficient resources is necessary for the mandated institutions to ably perform their duties. The support of political leaders is needed in ensuring that sufficient resources are available for the country to move towards sustainable management and utilization of the lake basin.

This framework can aid the collection of relevant data and information regarding the technology aspect of lake basin management. Such data and information would guide lake managers, policy-makers, researchers and interested parties on the areas that require attention as the country moves towards sustainable management and utilization of the lake basin. Our proposed framework comprises what we consider important elements based on our research. It serves as a starting point and it is neither exhaustive nor fixed. This framework is therefore open to further modifications as new knowledge and insights emerge.

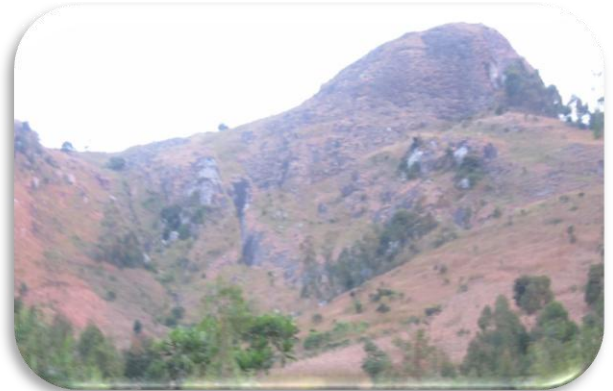


Fig 4.9. Degradation in Pictures: Deforestation of and cultivation on steep slopes (top), river bank degradation due to sand harvesting and cultivation (center and bottom left), and muddy inflow to the lake indicating soil erosion upstream (bottom right)

4.5. Assessment of the Information Pillar

4.5.1. Indicators Details

The pillar has two main goals. The first goal is 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 1 to 3 are linked to this goal. The second goal is to improve access to information by decision-makers and the public. Indicators 4 to 7 are linked to this goal.

Indicator 1. Existence of a Lake Basin Wide Monitoring and Information Collection System

Rationale: A lake wide monitoring system that collects information on lake basin issues is important for developing better lake basin management plans and tracking the changes going on in the lake basin.

Key Sector: Water.

Sub-indicator/measure: Existence of a lake basin wide monitoring and information collection system. (Target: lake basin wide monitoring and information collection system exists).

Computation: A rate of 5 is assigned if a lake basin wide monitoring and information collection system exist and a rate of 1 if it is not in place.

Data Sources: MoWDI.

Indicator Source: TWAP – modified

Limitations: Does not check effectiveness of the monitoring and information collection system.

Indicator 2. Relevance of Resident Scientific Research Institutes

Rationale: Scientific research in areas that can be applied to lake basin management is important for improving lake basin management as acquired information can be used to show the limits of lake basin resources, enlighten hard-to-see connections and provide innovative solutions to problems (ILEC 2005). If research results are not incorporated into management plans, there is a

high risk of such plans and the resulting activities failing to achieve sustainable development. Having managers define the research needs (e.g. through a formal needs analysis) can be an effective way to have research results taken up and applied in management (ILEC 2005)

Key Sectors: Environment, water, fisheries, agriculture (land resources conservation and development), irrigation, forestry, sanitation, sector research facilities, and academia.

Sub-indicators/measures:

- 1) Existence of formally defined research needs by managers (Target: research needs are formally defined).
- 2) Effectiveness of the communication between the sectors and resident scientific institutes, researchers and other stakeholders concerning the identified research needs (Target: very high).
- 3) Relevance of research focus areas to the defined needs (Target: very high).

Computation:

- 1) A rate of 5 is assigned to a sector if research needs have been formally identified and defined and a rate of 1 if they haven't. An average of the sectors is obtained.
- 2) An average rate is obtained based on information from key informants.
- 3) An average rate is obtained from the rates provided by key informants.
- 4) Average the scores from steps 1, 2 and 3 above.

Data Sources: Relevant ministries/departments, research institutes and academia.

Indicator Source: TWAP – modified in this study

Indicator 3. Utilization of Citizens/Indigenous Knowledge in Management Approaches

Rationale: 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 etc.

Key Sectors: Water, fisheries, forestry, agriculture, and environment.

Sub-indicator/measure: Degree of utilization of citizens/indigenous knowledge in management approaches.

Computation: Obtain an average from ratings by key informants.

Data Sources: Ministry of Agriculture and Departments of Water Resources, Forestry, Fisheries, Environment, research institutions/academia and other stakeholders.

Indicator Source: TWAP – modified in this study.

Limitations: Does not include the perception of citizens/indigenous people themselves.

Indicator 4. Availability of Information

Rationale: Availability of accurate information is central to lake basin management. Since lake basin ecosystems are complex and lakes take a long time to exhibit changes going on within them, information is particularly valuable to decision-makers and a long term commitment to acquisition of information is therefore necessary. The major issues concerning the lake as identified by other researchers in previous studies are in the aspects of water level fluctuations, changes in phytoplankton composition, biodiversity, fishery production, contaminants and pathogens (Bootsma & Hecky 1993, 1999, 2003; Ramlal et al. 2003; Vollmer et al. 2005; Hecky et al. 2006; Jamu et al. 2011; Donda et al. 2014). Based on these (except pathogens), this study compiled a list of 20 selected items on which availability of information was checked.

Key Sectors: Environment, water, fisheries, forestry, agriculture, sanitation and energy.

Sub-indicators/measures: Availability of information on the following aspects (the list is open to revision as necessary);

- 1) Discharge of major inflowing rivers
- 2) Water abstraction quantities from major inflowing rivers
- 3) Water abstraction quantities from the lake
- 4) Climate and weather

- 5) Nutrient load of major inflowing rivers
- 6) Atmospheric nutrient load to the lake
- 7) Nutrient concentrations of the lake
- 8) Phytoplankton species composition in the lake
- 9) Zooplankton species composition in the lake
- 10) Proportion of farm area in the lake basin under good agricultural practices
- 11) Soil erosion rates
- 12) Area under forest cover in the basin
- 13) Reduction in area destroyed by bush fires
- 14) Compliance with fisheries regulations
- 15) Sustainable fish catch
- 16) Actual fish catch
- 17) Amount of solid waste recycled
- 18) Quantities of wastewater generation in the major cities within the basin
- 19) Industrial compliance with standards and regulations
- 20) Mining compliance with standards and regulations

Computation: A rate of 5 is assigned against each item if information is available and a rate of 1 if information is not available. An average is obtained.

Data Sources: Ministries/departments responsible for environment, water, fisheries, forestry, agriculture, sanitation and energy.

Indicator Source: This study.

Limitations: Does not show whether the available information is sufficient or not.

Indicator 5. Information Access

Rationale: It is important that information that is generated informs decision-makers, researchers, other stakeholders and the general public to enhance better lake basin management. For this to happen, it is necessary that the available information is made easily accessible to all interested parties.

Key Sector: Water

Sub-indicator/measure: Existence of central information access for lake basin issues
(Target: central information access exists)

Computation: A rate of 5 is assigned for existence of a central information access and a rate of 1 for non-existence

Data Sources: MoWDI and EAD.

Indicator Source: TWAP.

Indicator 6. Utilization of Monitoring and Research Findings

Rationale: The long retention time of Lake Malawi (114years) 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 (ILEC 2005). Lake related sector institutions need to have mechanisms for capturing research findings and utilizing them (as timely as possible) in their management plans and strategies.

Key Sectors: Environment, water, sanitation, fisheries, forestry, agriculture and irrigation.

Sub-indicators/Measures;

- 1) Existence of mechanisms for capturing monitoring findings/feedback (Target: mechanisms exist).
- 2) Existence of mechanisms for capturing research findings (Target: mechanisms exist).
- 3) Utilization of monitoring and research findings in decision-making and resource management plan/strategies (Target: very high).

Computation:

- 1) A rate of 5 is assigned to a sector for existence of mechanisms for capturing monitoring findings/feedback and a rate of 1 for non-existence.

- 2) A rate of 5 is assigned to a sector for existence of mechanisms for capturing research findings and a rate of 1 for non-existence. Obtain an average for all the sectors.
- 3) An average rate is obtained from rates provided by key informants.
- 4) Average the scores in steps 1, 2 and 3 above.

Data Sources: Relevant ministries and Departments.

Indicator Source: This study.

Indicator 7. Degree of Information Sharing among Riparian Countries

Rationale: 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 their experiences so as to promote positive interventions.

Key Sectors: Water and fisheries.

Sub-indicator/Measure: Degree of information sharing (Target: very high).

Computation: An average rate is obtained from the rates provided by key informants.

Data Sources: Ministries and Departments of Water, Fisheries and Foreign Affairs.

Indicator Source: TWAP – modified in this study

4.5.2. Findings

Indicator 1. Existence of a Lake Basin Wide Monitoring and Information Collection System

This indicator utilized information from key informants and document review. There is an M&E system for the water sector but it does not specifically include issues important for the Lake Malawi Basin. There is no specific system either, for monitoring and collecting information on the Lake Malawi Basin. An M&E framework for the Environment and Natural Resources

Management (ENRM) general sector was developed in 2011 to strengthen national coordination in the flow of environmental information among stakeholders (GoM 2011a). As a harmonized M&E system for the sector, it was envisioned as providing an opportunity for systematically tracking progress and evaluating the effectiveness of interventions in the sector as well as meeting reporting requirements of conventions and protocols to which Malawi is party. The framework encompasses the following 13 sectors: forestry, fisheries, water, parks and wildlife, industry, energy, emissions, mining, sanitation and hygiene, agriculture, infrastructure, weather and climate, and land resources and settlement. The EAD is the coordinating institution for the framework. The framework defines indicators for each sector, responsible institution for data collection and frequency of reporting to the EAD. It includes indicators relevant to lake basin issues such as catchment protection, water quality monitoring, enforcement of environmental regulations, conservation of fish breeding sites and many more. However, information pertaining to the operationalization of the framework proved difficult to access and some data that were expected to be collected through the framework were unavailable (e.g. reduction in hectares destroyed by bushfires and hectares of catchment areas protected) leading to the assumption that the framework is not yet operational. This indicator is thus rated very low (1).

Indicator 2. Relevance of Resident Scientific Research Institutes

Data and information from key informants were utilized. The sectors have identified and in many cases formally defined their research needs although dissemination has not been effective. The identification has been through mechanisms such as the Forest Research Institute of Malawi (FRIM) and Malawi College of Forestry (MACOF) for the forestry sector, stakeholder meetings, capacity needs assessment, etc. This sub-indicator is rated very high (5).

Generally, the key informants' responses showed that sectors and the academia do not have a solid culture of consulting and sharing sector needs that the academia should focus on. Except for the irrigation sector which indicated a high rate of communication between the sector and stakeholders with regards research needs, the other sectors indicated low to moderate levels of communication. The average rate for the sub-indicator is low-to-moderate (2.67).

The relevance of current research focus areas to the defined needs was rated moderate (3.17). This was not surprising, considering the common concern of the key informants that these needs are not widely shared/disseminated. Overall, the indicator is rated moderate-to-high (3.6).

Indicator 3. Utilization of Citizens/Indigenous Knowledge in Management Approaches

This indicator utilizes information provided by key informants. While existing efforts to capture citizens/indigenous knowledge through meetings, EIAs prior to project implementation etc., are acknowledged, key informants rated utilization of this knowledge in management approaches as low (with the exception of the agriculture sector in which incorporation is high). The average rate for this indicator is low (2.2), showing that the current mechanisms are not very effective.

Indicator 4. Availability of Information

The indicator utilized information from key informants and document review and Table 4.22 summarizes the findings. The findings show generally high availability of information. Some of the information is held by the various sectoral institutions. However, in many cases, the information is scanty or requires a lot of processing before it can be used.

Table 4.22. Availability of Information on Lake Basin Aspects

Issue	No.	Item	Rate	Responsible Sector/Information Sources
Lake level	1	Discharge of major inflowing rivers	5	Water Resources
	2	Water abstraction quantities from major inflowing rivers	5	Water Resources
	3	Water abstraction quantities from the lake	5	Water Resources
Phytoplankton composition & biodiversity	4	Climate and weather	5	Meteorology
	5	Nutrient load of major inflowing rivers	5	Water Resources
	6	Nutrient concentrations of the lake	5	Water Resources & research publications
	7	Atmospheric nutrient load to the lake	1	Water Resources
	8	Phytoplankton species composition in the lake	5	Fisheries & research publications
	9	Zooplankton species composition in the lake	5	Fisheries & research publications
	10	Proportion of farm area in the lake basin under good agricultural practices	5	Agriculture
	11	Soil erosion rates	5	Agriculture & research publications
	12	Area under forest cover in the basin	1	Forestry
	13	Reduction in area reduced by bush fires	1	Forestry
Fishery production	14	Compliance with fisheries regulations	5	Fisheries
	15	Sustainable fish catch	5	Fisheries
	16	Actual fish catch	5	Fisheries
Contaminants	17	Amount of solid waste recycled	1	City Councils
	18	Quantities of wastewater generation in the major cities within the basin	1	City Councils
	19	Industrial compliance with standards and regulations	5	Industry & environment
	20	Mining compliance with standards and regulations	5	Industry, mining, & environment
Average Score			4	

Indicator 5. Information Access

There is no “one-place” data/information access regarding Lake Malawi issues. In addition, although the Water Resources Department maintains a hydrological database for the country in its library, the public is generally not aware of it and accessing such information is often not easy. This indicator is rated very low (1).

Indicator 6. Utilization of Monitoring and Research Findings

This indicator is rated based on the interviews with key informants. It was found that mechanisms for capturing monitoring findings/feedback throughout implementation are not clear. This sub-indicator is thus rated very low (1). Likewise, there are no clear mechanisms in place for capturing research findings and the rating for this sub-indicator is very low (1). According to the key informants, utilization of monitoring and research findings in decision making is low (2). This indicator is therefore rated very low (1.33).

Indicator 7. Degree of Information Sharing among Riparian Countries

It was found that information is usually shared when there is a project. The shared information includes flood issues, co-management and experience sharing, boat building technologies, aquaculture, forestry issues, etc. Often times, informal networks are utilized as they are faster, escaping the bureaucracies. Overall, the degree of information sharing is given a low rating by key informants (2). This is because information sharing is usually done only during projects involving the riparian countries and it is seldom done as a regular activity within natural resources management.

Summary of the Performance of the Information Pillar

Overall, the information pillar has a low rating (2.16). Table 4.23 summarizes all indicator scores.

Table 4.23. Summary of the Performance of the Information Pillar

Indicator	Score	Overall Pillar score
Existence of a lake basin wide monitoring and information collection system	1	2.16
Relevance of resident scientific research institutes	3.6	
Citizens/indigenous knowledge input	2.2	
Availability of information	4	
Information access	1	
Utilization of monitoring and research findings	1.33	
Degree of information sharing among riparian countries	2	

4.5.3. Discussion of the Information Pillar

The overall rating for the information pillar is low (2.16). Considering the important role of information in lake basin management, this is a worrying finding. One of the specific goals of the national environmental policy is to “develop and regularly update environmental information systems to facilitate planning and decision-making at local, national and international levels.” (GoM 2004, p.4). M&E of environmental programs and activities is recognized as crucial to ensuring that national development and poverty reduction goals are achieved sustainably through the integration of environment management principles into national policy and planning processes (GoM 2011a). Early efforts in addressing the country’s data and information needs include the Malawi Environmental Monitoring Program (MEMP) implemented in two phases (Phase One, 1993-1995, and Phase two, 1996-1998). It was funded by the United States Agency

for International Development (USAID) and implemented through a partnership between the University of Arizona (UA) and Clark University (CU).

One of the two purposes of MEMP was to establish capacity within the Government of Malawi (GoM) for performing environmental monitoring and assessments of changing conditions in order to better target and shape mitigation efforts. An analysis of the situation of the Middle Shire River (the outlet of Lake Malawi) was to serve as a means of exploring the issues related to developing an information system that can assist GoM to make decisions on the environment. Ultimately, it was expected that the GoM would establish and implement a nationally representative environmental monitoring program. However, the anticipated outcome has not been realized to date.

Currently, a lake-wide M&E system does not exist (as indicated in the findings) and while the various lake related sectoral departments have M&E units that monitor aspects relevant to their interests, some lake specific issues are not monitored by any of these institutions e.g. atmospheric nutrient load to the lake. As earlier indicated, Malawi developed an M&E framework for the ENRM general sector to integrate M&E of the sector. It was expected that the ENRM M&E framework would provide an opportunity for systematically tracking progress in implementation of interventions in the sector by the multi-sectoral stakeholders relevant to the ENRM general sector. However, this is still not the case. The framework, as developed, is comprehensive and involves 13 sectors as follows; forestry, fisheries, water, parks and wildlife, industry, energy, emissions, mining, sanitation and hygiene, agriculture, land resources and settlement, infrastructure and, weather and climate. Participating sectors/institutions are to report their findings frequently to the EAD. While the individual institutions manage their own information systems, the EAD is responsible for producing aggregate data and its storage at national level. An M&E Unit within the EAD is given responsibility for developing a database for each sector and the database is supposed to be accessible to stakeholders. How this database is to be accessible is not stated. Also, the M&E Unit is expected to produce quarterly and annual national M&E reports. Frequent reporting of participating sectors to the EAD is not happening and consequently, aggregate data is not available. Likewise, the quarterly and annual M&E reports were not available at the time of the study. Challenges include insufficient human,

financial and material resources, and a lack of commitment on the part of participating sectors and weak follow-up and coordinating capacity at the EAD.

Concerning the relevance of resident scientific research institutes, although many of the sectors have formally identified and defined their research needs, dissemination of those needs to the resident scientific research institutes, researchers and other stakeholders has been very poor. The irrigation sector indicated that they utilize the National Research Council (whose mission is to promote and coordinate research, science and technology in the country), the Department of Forestry utilizes FRIM, and the Department of Fisheries indicated they collaborate with Bunda College of the Lilongwe University of Agriculture and Natural Resources. In general, however, the Departments do not make deliberate effort to share their research needs with the scientific community resulting in gaps in both the available information/knowledge versus the information/knowledge needs, and the technical skills in the staff of the sectors.

One of the goals of the NEP is to promote the use and application of local knowledge and norms that facilitate sustainable environment and natural resources management (GoM 2004). However, the findings of this study show that local knowledge is still not incorporated. Although the involvement of local communities is high as the results of the participation pillar show, incorporation of local knowledge into decision making is low. This may be mainly because mechanisms for local knowledge incorporation are not clear.

Although the findings show a high availability of information, access to that information is a significant problem. The available data/information is scanty and scattered among a web of custodians with no 'one-place' source where stakeholders and other interested parties can be guided concerning the kind of data/information that are available, and how they can be accessed. Data collection for many of the items checked in this study is not routinely conducted and a considerable amount of the available data/information is based on estimates. Some of the existing information is from research publications by various researchers which may or may not be reflected in the country's knowledge base. Furthermore, in many cases, available data is not processed for immediate use. The major problem as the findings show, is not data/information availability, rather it is access to the available data/information. It is not easy for stakeholders and interested parties to know what data/information are available, the custodian institutions, how to access them and, the procedures required as well as the time it takes for one to have the

data/information from the time of request. Similarly, access to information on Lake Malawi issues is a problem. The Lake Malawi National Park includes a Lake Malawi Museum. Museums play an important role in information sharing as they disseminate scientific and other information. The museum is undergoing some maintenance challenges and it requires to be upgraded and updated. These issues are linked with the finance pillar as managing information and maintaining a museum require availability of adequate resources.

It is important to utilize monitoring and research findings in decision-making and management interventions. This ensures that lessons learnt are put into use for sustainable resource management and utilization. Key informants cited weak linkages and bureaucracies as some of the challenges impeding the capturing and utilization of monitoring and research findings in decision-making and management plans/strategies. They said, it usually takes long for a department to officially take up issues, thus delaying implementation. Information sharing among riparian countries is also an area requiring attention. The lake basin is a trans-boundary resource and the importance of trans-boundary information sharing on lake basin issues cannot be more emphasized.

Overall, information management for lake basin issues and the entire natural resources sector is an area requiring attention. Without reliable information, institutions can be inefficient, policies can be ineffective and sometimes misleading, technology can be misapplied, and resources can be misallocated, leading to confusion among stakeholders and threatening the sustainability of natural resources (ILEC 2005). This may have adverse impact on the people's well-being and the economy. Provision of accurate information depends on well established procedures and protocols (Snel et al. 1998). MEMP recommended four areas that require attention in the development of a national Environmental Information System (EIS). These are;

- 1) *National level environmental data infrastructure* – routine collection of core national environmental data sets, adequate management to ensure easy retrieval, development of environmental data standards, and a data infrastructure that allows for proper archiving and regulated access;
- 2) *National level multidisciplinary environmental analysis* – to routinely address national environmental concerns as they emerge;

- 3) *Decision support* – to adequately link environmental information users and providers so that collection of information is in line with user demands, information is adequately disseminated to all relevant decision-makers and stakeholders, and adequate support is provided for information usage e.g. through policy and extension services; and,
- 4) *EIS oversight* - to ensure that all EIS activities are effectively coordinated and integrated.

The M&E Framework for ENRM developed in 2011 was, in a way, an effort to develop a national EIS oversight. According to MEMP findings, an EIS oversight requires the existence of a mandated institution to oversee and coordinate activities to ensure;

- 1) The routine collection of environmental data in accordance with standards and user demand;
- 2) Environmental analysis utilizes multidisciplinary expertise and is routinely conducted to satisfy user demands;
- 3) The routine assessment of environmental information needs and routine dissemination of information; and,
- 4) The routine review of environmental support to encourage the use of environmental information.

In the existing M&E framework, the institution with such mandate is the EAD. The question is why is this arrangement not working as anticipated that to date, it is still difficult to access available data/information and some data which the framework sought to generate is still not available? One of the reasons emerging from this study's findings is inadequate human, financial and material resources. As discussed in earlier sections of this thesis, most of the institutions are highly understaffed that the existing staff cannot effectively handle the burden embedded in the institution's mandate. One other reason could be lack of commitment. As Mulwfu (2010) in his examination of the impact of policy changes on water rights in Malawi pointed out, there is a lack of connection between policy and practice which in some cases results in new policies being developed even before old ones have been implemented. Loss of institution memory is also an important issue that this study picked. A lot of projects are implemented that generate a lot of information as well as provide useful lessons. These lessons are not fully utilized in subsequent interventions. For instance, the MEMP was an important initial initiative towards better information collection, management and dissemination. Experiences from its implementation are

a source of insight to any further actions regarding environmental information systems in the country. The recent M&E framework for ENRM, though tries to address some of the issues MEMP raised or recommended, falls short of making explicit effort to draw from the MEMP experiences. The MEMP is not at all mentioned in the methodology for developing the M&E framework for ENRM nor are its lessons explicitly incorporated in the entire framework. It is not surprising that it is missing in the references cited. One can say that MEMP lessons are lost despite the fact that the EAD was a key institution in both MEMP implementation and the development of the M&E framework for ENRM.

A similar observation was made by Kafumbata et al. (2014) in their study on riparian ecosystem resilience of Lake Chilwa and other lakes and the livelihoods strategies of those dependent on them. They observed that the problems these ecosystems and the people depending on them face are exacerbated by poor linkages between knowledge generation and policy level. This results in a “lack of a sustainable development concept of rational natural resource use in programmes and interventions” (p. 5). Under the MEMP, several departments received technical assistance from Clark University and University of Arizona i.e. the Department of Forestry in routine monitoring of land cover change; the Ministry of Agriculture in routine monitoring of agricultural yields and soil loss; The Department of Meteorology in routine monitoring of rainfall and rainfall energy; and, the Department of surveys in providing core spatial environmental data sets (Snel et al. 1998). In addition, the Department of Surveys received technical assistance in developing environmental data standards. It is important to pool data/information generated through the various programs implemented and ensure that knowledge once generated, is not lost. It is also important to ensure that national to local environmental information users and providers are adequately linked so that collection of environmental information reflects user demands, dissemination of environmental information to all relevant decision-makers and stakeholders is adequate, and support given for environmental information usage is adequate (Snel et al 1998).

4.5.4. Conclusion

The information aspect of the management of the Lake Malawi Basin is weak. This has implications for all other aspects of lake basin management as accurate, reliable and timely

information is crucial for better lake basin management. Improving information management in general and improving information access as well as ensuring existing knowledge is not lost but effectively applied in management and development interventions is critical.

4.6. Assessment of the Finance Pillar

4.6.1. Indicator Details

The overall goal of the finances pillar is to ensure sufficient funding for lake basin management and involve stakeholders in mobilization and management of funds.

Indicator 1. Government Funding for Lake Basin Management

Rationale: For lake basin management activities to achieve and maintain the lake basin's sustainability, there is need for long term availability of stable funds. The long flushing time (648 years) and retention time (114 years) for Lake Malawi (Bootsma & Hecky 2003) 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.

Key Sector: Water

Sub-indicators/Measures:

- 1) Sufficiency of funds allocated for lake basin management within the lead institution (Target: very high).
- 2) Sufficiency of funds available to lake related institutions as measured by the percentage of planned activities that available funds are able to finance (Target: very high)

Computation:

- 1) A rate is obtained from key informants.
- 2) An average rate is obtained from the ratings provided by key informants.
- 3) Average the scores from steps 1 and 2 above.

Data Sources: MoWDI and relevant Departments.

Indicator Source: This study

Indicator 2. International Development Funding

Rationale: The lake basin being transnational, there are activities that might need joint cooperation and joint funding by the riparian countries and sometimes, donor agencies. There is need for riparian Governments to commit some funds for such activities. The Governments are also expected to assume ownership and responsibility in implementation of the activities/projects e.g. ensure implementation capacity and good governance.

Key Sectors: Fisheries and water.

Sub-indicators/measures:

- 1) Potential of donor funding for joint riparian country projects/programs.
- 2) Government's commitment to meeting its obligations for joint project/program implementation.

Computation:

- 1) Potential of donor funding for joint projects/programs equated to a rate.
- 2) Government's commitment to meeting its obligations for project/program implementation rated based on a review of recent projects and information from key informants (Target: very high)
- 3) Average the scores in steps 1 and 2 above.

Data Sources: Relevant Ministries and Departments, and project implementation reports.

Indicator Source: TWAP-modified in this study.

Indicator 3. Local Retention of Revenue Collected Locally

Rationale: It is also important that a substantial proportion of funds generated locally is retained for local use. This would help stakeholders and the public to appreciate the importance of the funds and would also enhance compliance.

Key Sectors: Water, fisheries and forestry.

Sub-indicator/measure: Extent to which revenue collected locally is retained for local use. (Target: sectors promote and practice local retention of revenue).

Computation: A rate of 5 is assigned to the sector practicing local retention of revenue and a rate of 1 to the sector that is not. An average for the sectors is obtained.

Data Sources: Relevant Ministries and Departments and, local community institutions.

Indicator Source: TWAP – modified in this study

4.6.2. Findings

Indicator 1. Government Funding for Lake Basin Management Institutions

There are no funds within the water sector specifically allocated for lake basin management and this sub-indicator is thus rated very low (1). At the time of the study, sector institutions had been very inadequately funded. On average, the sectors indicated that available funds in the fiscal year were able to finance 24.2% of the activities in their annual work plans. Sufficiency of available funds is thus rated low (2). The overall score for the indicator is 1.5.

Indicator 2. International Development Funding

Document review and key informants provided information for this indicator. When there is need for cooperation i.e. a joint project, the potential of obtaining funds from donors is high. This sub-indicator is rated 4. The commitment of Government in meeting its obligations is rated moderate, based on experience from recent projects and key informants comments. For example, the Performance Assessment Report for the GEF/SADC Lake Malawi/Nyasa Biodiversity

Conservation Project (1994-2000) rated the borrower's (Government) performance as unsatisfactory because interest and ownership was uneven (World Bank 2001), and the implementation and status report for the Shire River Basin Management Program Phase I (2012-2018) Project's risk rating for institutional capacity for implementation and sustainability was high while the political and governance risk rating was substantial (Waalewijn 2015). This indicator is rated moderate (3.5).

Indicator 3. Local Retention of Revenue

The water and fisheries sectors were not providing for local retention of revenue at the time of the study because the law in support of that was not yet enacted. The forestry sector however, in the areas where IFMSLP was implemented, some proportion of local revenue was being retained for local use. This indicator is rated low (2.3).

Summary of the Performance of the Finance Pillar

The finance pillar is rated low (2.43). Table 4.24 summarizes the results.

Table 4.24. Summary of the Performance of the Finance Pillar

Indicator	Score	Overall Pillar score
Government funding for lake basin management	1.5	2.43
International development funding	3.5	
Local retention of revenue	2.3	

4.6.3. Discussion of the Finance Pillar

The Governmental fiscal year under which this study was conducted was deemed the worst by key informants in terms of institutional funding. Funds for lake basin management related activities are highly inadequate as the results show. In part, this is because the need for the holistic management of lake basins is not explicitly acknowledged in the water policies and consequently, attention on lake basins is inadequate. Government also needs to be committed in ensuring effective implementation of interventions, whether implementation is through regular institutional operations or externally funded projects/programs. Key informants pointed out that the success of many of their activities is not only dependent on availability of funds but also on the timely availability of those funds. This is because the nature of some activities requires availability of adequate resources at a particular period (e.g. some agricultural/irrigation interventions and enforcement of closed season for fishing). Unavailability of resources for such activities dents many other related follow-up activities. Unstable flow of resources negatively affects the operations of the institutions and results in the loss of cumulative benefits that would have been gained had a stable flow of resources been sustained.

The NEP, under *economic incentives for sustainable environmental management* (section 3.2 f), states “Government departments and local communities shall have the right to revenue generated from sustainable utilization of natural resources on public and customary lands in order to provide positive incentives and self-finance for such continued use” (GoM 2004, p. 8). The efforts underway to provide for local retention of funds are a move in the right direction. The Forestry Department is leading in this respect where local communities involved in the IFMSLP retain a proportion of the revenue generated locally. It is yet to be seen what the outcomes from this approach will be.

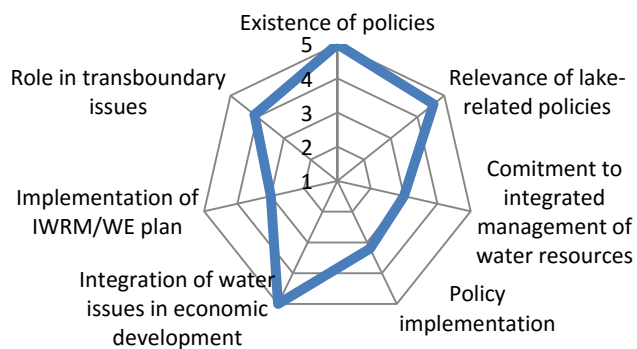
Overall, a lot more needs to be done to ensure stable availability of adequate resources for lake basin management as this aspect affects all the other pillars of governance. As an example, survey respondents were asked to indicate their preferred means of receiving information, ranked in order of priority. Extension officers were the most preferred means, followed by radio programs and village meetings. Their reasons for preferring extension officers included that their physical presence makes interaction and transfer of information, skills and techniques very effective. Extension officers are able to provide demonstrations (learning by

doing), and respond to questions and provide clarifications right away. Interestingly, extension officers also play a key role in village meetings, in collaboration with traditional leaders. The traditional leaders mobilize their communities while the extension officers deliver the messages, be it on sanitation and hygiene, good agricultural practices, management of public water points, forestry management, or fisheries issues. A lot of resources are required for the operations of extension officers i.e. their training, transportation means, message delivery materials and equipment etc. In the fiscal year under which data/information for this study were collected was deemed the worst, in terms of institutional funding, as earlier indicated. Among the coping mechanisms these institutions employed were significant reductions in extension services provided and monitoring activities. The effect was almost immediate as complaints on the reduced frequency of contact with extension officers kept popping up from survey respondents. These are the people representing the majority of the users of lake basin resources. They need information and skills transfer. The demand is there but the institutions responsible for the supply are incapacitated by severe resource constraints. In the long run, the impact on the lake basin may have adverse effects on the entire nation. It cannot be further underscored that availability of adequate and stable resources for lake basin management related activities is crucial and the Government needs to play a leading role in resource provision.

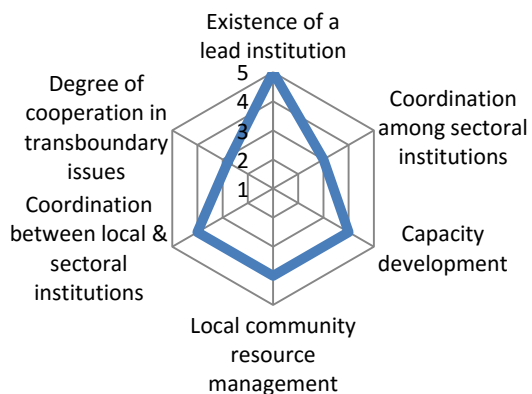
4.6.4. Conclusion

The finance pillar is weak with an overall rating of 2.43. The insufficient funding for overall lake basin management reflected in all the lake related sectors puts the lake basin and the dependent economy and well-being of Malawians at considerable risk. Improvement is required to ensure that resources necessary for sustainable lake basin management are available and effectively utilized. While ongoing efforts to involve stakeholders in mobilization and management of funds are appreciated, a lot more needs to be done.

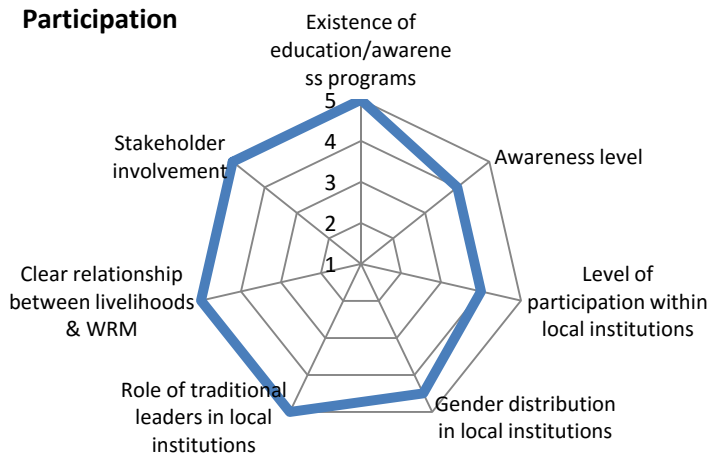
Policies Pillar



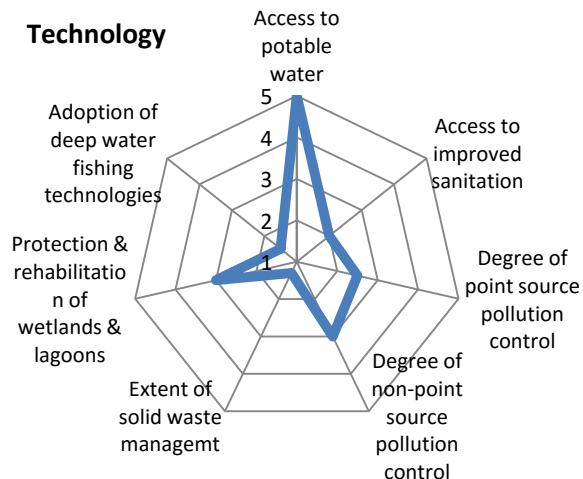
Institutions



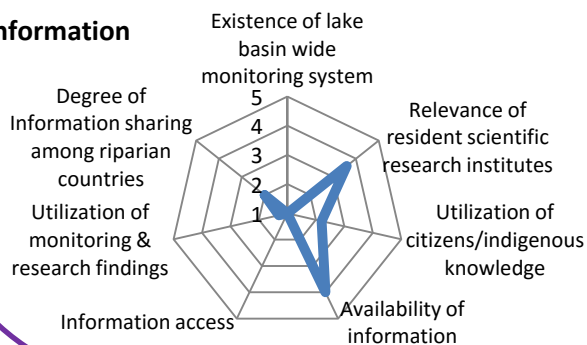
Participation



Technology



Information



Finance

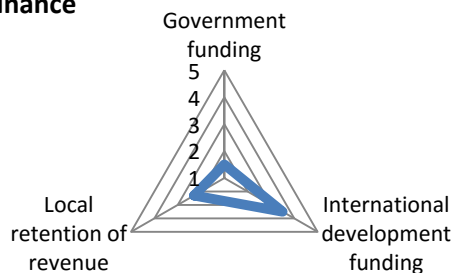


Fig. 4.10. Graphical representation of the performance of the pillars

4.7. REFERENCES

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CHAPTER 5 SYNTHESIS OF FINDINGS

This chapter discusses the findings from a holistic perspective i.e. in consideration of all the six pillars of ILBM. Section 5.1 discusses the status of the Lake Malawi Basin from the viewpoint of ILBM. Through a SWOT analysis, section 5.2 presents the internal and external factors surrounding the management of the lake basin. Section 5.3 ties everything together and aims to demonstrate the interactions between the socio-economic subsystem (represented by the indicator performance) and the ecological subsystem (represented by the ecosystem services provided by the lake basin) and identify critical points requiring attention. Section 5.4 discusses the implications of the findings.

5.1 Status of the Management of Lake Malawi Basin from ILBM Lens

Chapter 4 presented the findings and how each indicator and ILBM pillar performed. This section provides a quick holistic discussion of the findings. Overall, the management of the Lake Malawi Basin is rated moderate with an average score of 3.27. The pillar performance is somewhat split into two distinct rating groups, low and high. Two pillars fall in the high rating, the participation pillar, which is the strongest with a score of 4.62, followed by the policies pillar (4.11). The institutions pillar scored moderate-to-high (3.8). Three pillars fall in the low rating. The technology pillar (2.62) which scored low-to-moderate, followed by the finance pillar (2.3) and finally the information pillar which is the weakest (2.16). Figure 5.1 provides an overview picture of the status of the Lake Malawi Basin.

As the results show, the information, finance and technology pillars require more attention than the other three pillars. The finance pillar affects all the other pillars as adequate resources (both human and material) are required for all the other pillars to perform well. For instance, indicators under the technology pillar mainly address implementation issues such as access to sanitation services, degree of pollution control and protection of biodiversity. Implementation is strongly affected by the information available and accessible, the policies in place, capacity of the institutions responsible for implementation, the stakeholders involved and

the technological options available. All these require availability of adequate resources. The weak-to-moderate performance of the technology pillar, which is mainly representing on-the-ground reality, shows that having adequate and relevant policies in place does not guarantee effective implementation. Adequate resources and reliable information that is easily accessible are essential elements that drive institutions to effectively implement policies. Resources and information are necessary to ensure that policies are relevant, institutions are adequately operational, relevant stakeholders are meaningfully engaged, technology is appropriately applied, and that management ensures sustainability of the lake basin. Unfortunately, these two pillars are the weakest. This may partly be the reason why overall performance of the management of the lake basin is not that good since information and science as well as finance are fundamental as they affect everything. Promotion of scientific research, enhancing information management and ensuring availability of adequate and stable resources for lake basin management issues is important.

ILBM Pillar	Indicator Performance								
Policies	Lake related sectoral policies	Relevance of lake related sectoral policies	Commitment to integrated management of water resources		Policy implementation	Integration of water issues in economic development	Implementation of IWRM/WE plan	Role in trans-boundary issues	
Institutions	Existence of a lead institution on lake basin management	Coordination among sectoral institutions	Capacity development in lake basin management related areas		Local community resource management	Coordination between local community institutions & relevant sectoral institutions		Degree of cooperation in trans-boundary issues	
Participation	Existence of education/ awareness programs		Awareness level	Level of participation within local community institutions	Gender distribution in local community institutions	Role of traditional authorities/leaders in local community institutions	Clear relationship between livelihoods of local communities & water resources management	Stakeholder involvement	
Technology	Access to potable water	Access to improved sanitation services		Degree of point source pollution control	Degree of non-point source pollution control	Extent of solid waste management	Protection & rehabilitation of wetlands and lagoons	Adoption of deep water fishing technology	
Information	Existence of a lake basin wide monitoring & information collection system		Relevance of resident scientific research institutes	Utilization of citizens/indigenous knowledge in management approaches		Availability of information	Information access	Utilization of monitoring & research findings	Degree of information among riparian countries
Finance	Government funding for lake basin management institutions				International development funding			Local retention of revenue	

Fig. 5.1 Status of the management of Lake Malawi Basin from ILBM lens

Very weak	Weak	Weak to moderate	Moderate	Moderate to strong	Strong	Strong to very strong	Very strong
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5.2. SWOT Analysis of Findings

The strengths, weaknesses, opportunities and threats (SWOT) analysis was done in consideration of the pillar performance. The analysis enables the performance of each indicator and its associated sub-indicators to be presented in the four SWOT categories and thus enhances understanding. The analysis reinforces the indicator findings by picking up the underlying issues that emerged in the discussion of the findings and highlighting them in bullet form in the SWOT table. Table 5.1 shows the strengths, weaknesses, opportunities and threats identified.

The analysis revealed several important strengths within the lake basin system that can contribute to better lake basin management as the table shows. Considerable weaknesses were also identified that threaten the sustainability of the system. These need to be addressed and turned into strengths so that the situation can improve. Several opportunities were identified which need to be taken advantage of in the management of the lake basin. However, some fundamental weaknesses in the system need to be addressed first before the identified opportunities can be fully utilized i.e. before the information available in scientific literature and in local institutions can be effectively utilized, overall information management needs to be improved. Finally, climate change is an important threat to the system considering that the lake is especially sensitive to climatic changes due to its large surface area. Climate change therefore needs to be monitored and appropriate mitigation and adaptation measures need to be developed and implemented to enhance resilience. As discussed under the participation pillar, provision of affordable alternative energy sources should not be ignored as the impact of the current energy demand on forestry resources and overall water resources management is significant.

Table 5.1. SWOT Analysis

Strengths	Weaknesses
1. Existence of lake related sectoral policies to support sustainable lake basin management	1. Lack of recognition of the need for holistic lake basin management in water policies
2. Relevance of the lake related sectoral policies	2. Low access to improved sanitation services
3. Integration of water issues in economic development strategies	3. Very low proportions of city population connected to the sewer line
4. Established institutional set up – i.e. existence of a lead institution & other relevant institutions at national, regional and district levels and local community institutions in various related sectors	4. Very weak solid waste management
5. Capacity development in lake basin management related areas	5. Inadequate protection of wetlands & lagoons
6. Existence of education/awareness programs	6. Inadequate cross-sectoral coordination/cooperation & fragmented implementation of interventions (e.g. catchment management)
7. Existence of local community resource management institutions	7. Weak trans-boundary cooperation
8. High level of awareness among stakeholders on some lake basin issues	8. Slow adoption of good agricultural practices
9. Stakeholder interest (e.g. NGOs & local communities) in lake basin related issues	9. Very low compliance rate with industrial waste disposal standards
10. High level of women involvement in natural resource management	10. Very poor condition of final solid waste disposal facilities
11. Very high access to potable water	11. Very low adoption of deep water fishing technologies
12. Explicit support of the livelihoods of local communities in policies	12. Lack of lake basin wide monitoring and information collection system
13. High forest coverage	13. Weak communication between sectors and scientific institutes, researchers & other stakeholders
	14. Low utilization of indigenous knowledge

Table continues

Table 5.1 Continued

Strengths	Weaknesses
	15. Lack of a central information access point for lake basin issues 16. Unclear mechanisms for capturing monitoring and research findings 17. Low utilization of monitoring & research findings 18. Low information sharing with riparian countries 19. Lack of specific fund allocation for lake basin management coordination 20. Low local retention of revenue collected locally 21. Lack of monitoring of policy implementation 22. Some required institutions not operational (e.g. NWRA & CMCs) 23. Inadequate availability & allocation of resources (human, financial & material) to lake-related institutions 24. Weak enforcement of legislation
Opportunities	Threats
1. Availability of information in scientific literature & in institutions 2. Harnessing NGO & civil society interest & participation 3. Donor funding potential for joint riparian projects	1. Climate change & climate variability 2. Inadequate affordable alternative energy sources

5.3. Subsystem Interactions in the Lake Malawi Basin System

The study employed the causal loop diagram (CLD) technique to complement the SWOT analysis in synthesizing the findings. One main weakness of the SWOT analysis is that it expresses individual factors without explicitly showing how these factors influence and get influenced by one another. This makes it difficult to systematically identify the critical factors or issues upon which to focus management efforts or interventions. The systems approach as applied in this study aims to enhance the SWOT analysis by highlighting critical areas that require attention and so guide prioritization of management action. Vensim PLE software was used to draw the causal loop diagram.

The following are the steps followed in the systems approach applied;

- 1) Identification of the components of the system - This was done in Chapter 3 (Methodology) and the six ILBM pillars together with their respective indicators form the key components of the system under study, the Lake Malawi Basin.
- 2) Identification of key issues – Major weaknesses were extracted from the results of the pillar performance and the SWOT analysis and they are shown in Table 5.2.
- 3) Development of a causal loop diagram (CLD).
- 4) Identification of critical points of action and critical indicators.

Table 5.2 Major Weaknesses

Pillar	Indicator	Sub-indicator/Measure
Policies	Commitment to integrated management of water resources	Recognition of the need for lake basin management
Institutions	Degree of cooperation in trans-boundary issues	Adequacy of cooperation with neighboring countries
Technology	Access to improved sanitation services	Basin population with access to improved sanitation services
	Degree of point source pollution control	Percentage of households connected to sewer line
	Extent of solid waste management in the cities of Lilongwe & Mzuzu	Waste collection rate
		Industrial solid waste disposal standards compliance rate
		Sanitary condition of final waste disposal facilities
	Adoption of deep water fishing technology	Small-scale fisherfolk adopting deep water fishing technologies
		Deep water fish catch
Information	Lake basin wide monitoring and information collection	Lake basin wide monitoring and information collection
	Utilization of citizens/indigenous knowledge	Utilization of citizens/indigenous knowledge
	Information access	Information access
	Utilization of monitoring & research findings	Extent of utilization of monitoring & research findings
	Sharing of information among riparian countries	Degree of information sharing among riparian countries
Finance	Government funding	Sufficiency of funds to lead institution
		Sufficiency of funds to lake-related institutions
	Local retention of revenue	Local retention of revenue

Table 5.2 shows the weak areas as revealed by the results of the indicator performance. These represent the socio-economic subsystem. Out of these issues, four have been isolated as key issues considering how they are causally related to the other variables and their connection to ecosystem services in the lake basin. These are waste management, access to improved sanitation services, nutrient loading and pollution control, and protection of biodiversity (i.e. management of invasive species, protection and rehabilitation of wetlands and lagoons, and related aspects). Pollution, for instance, is an effect of many activities in the lake basin across all sectors, while biodiversity is affected by and affects fairly everything going on in the basin, whether positively or negatively. In addition, key ecosystem services provided by the lake basin (discussed in Chapter 3 section 3.3.2, *the values offered by the Lake Malawi Basin*) were isolated to represent the ecological subsystem. These ecosystem services are also reflected in the proposed vision for the Lake Malawi Basin (Chapter 3 section 3.3.2). The key issues and ecosystem services became the variables for the CLD that was developed (Figure 5.2). The CLD illustrates the relationship between the socio-economic and ecological sub-systems through interaction of the key issues and the ecosystem services and the associated feedback. As necessary, additional variables were included to clarify the causal link between variables. There are several factors with a causal effect on the selected variables. The CLD was drawn using only selected factors that are closely related to the context of this study i.e. factors that can be easily related with the indicators and sub-indicators that this study uses. The intent was to include an adequate number of key variables that enhance understanding of the interactions at play without including too many variables that would make the CLD overwhelming.

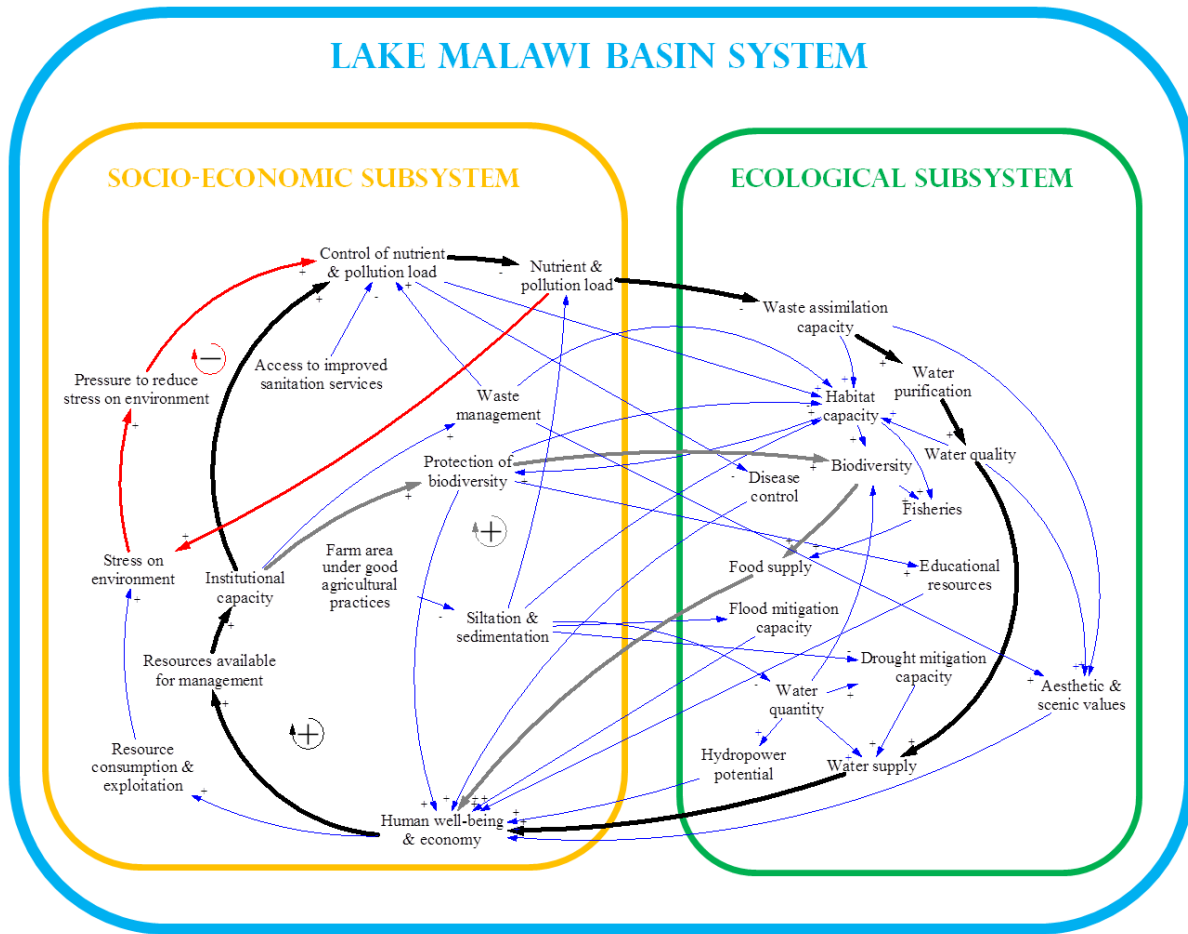


Fig. 5.2 Causal loop diagram illustrating the interaction between the socio-economic and ecological subsystems in the Lake Malawi Basin. The item at the tail of the arrow causes a change in the item at the head of the arrow. A + sign at the head of the arrow indicates that change occurs in the same direction and a – sign indicates that change occurs in the opposite direction. The \oplus or \ominus symbols indicate the direction and effect of the loop.

The CLD shows clear interaction between the two subsystems as illustrated by arrows crossing from one system to the other. For instance, nutrient and pollution load causes a cascade of effects on several ecosystem services i.e. waste assimilation and water purification, which are regulating services, and water supply, which is a resource provision service. The loop tracing this effect (shown with black arrows) moves from control of nutrient and pollution load to nutrient and pollution load, waste assimilation capacity, water purification, water quality, water supply,

human well-being and economy, resources available for management, institutional capacity and back to control of nutrient and pollution load, and has a reinforcing effect. The reinforcing effect indicates that a change in the condition of a variable leads to an amplified change when the effects are traced around the loop. In this case, a decrease in control of nutrient and pollution load (findings show low to moderate pollution control) will cause an increase in nutrient and pollution load which will cause a decrease in waste assimilation capacity. This will in turn cause a decrease in water purification capacity that will cause a decline in water quality that will eventually cause a decrease in water supply. This will cause a decline in human well-being and economy and in turn cause a decrease in resources available for management that will cause a decrease in institutional capacity. The end result will be a decrease in the control of nutrient and pollution load. Reinforcing loops make the system unstable and are associated with a high potential for either a rapid upward or downward spiral i.e. if the initial condition is bad, it will keep worsening and likewise if it is good, it will keep getting better. Lake basin management needs to take this into account to avoid continued degradation of the lake basin. In this case, **monitoring of nutrient and pollution load from both point and non-point sources is critical.** This entails keeping an eye on access to improved sanitation services, population proportion connected to the sewerage system, sludge disposal compliance, compliance of industries and mines with standards, forest cover, bush fires, agricultural practices, solid waste management and other issues as relevant. **A lake basin wide monitoring and information collection system is therefore crucial.** Equally important is the utilization of **monitoring and research** findings in management approaches and policy formulation. Coordination across sectors and meaningful stakeholder involvement are also essential. **All this requires availability of adequate and stable resources.** The issue of pollution control falls under the technology pillar but this discussion shows how it is linked with the information, policies, institutions, participation and finance pillars. This example highlights the interconnectedness of the ILBM pillars and why it is important to consider all of them (in varying degrees as appropriate) to ensure lakes are managed for sustainable use.

The CLD shows another loop, again starting from control of nutrient and pollution load, but having a balancing effect. The loop (shown with red arrows) moves from control of nutrient and pollution load to nutrient and pollution load, stress on environment, pressure to reduce stress on environment and back to control of nutrient and pollution load. This loop shows that a

decrease in control of nutrient and pollution load will cause an increase in nutrient and pollution load which will in turn cause an increase in stress on environment. This will cause an increase in pressure to reduce stress on the environment (assuming an active and well-informed network of stakeholders) and the end result will be an increase in control of nutrient and pollution load. A situation that started badly has a good ending. Self-balancing loops indicate that the situation stabilizes over time.

The complex and unpredictable nature of lake basin ecosystems is evident from the two loops discussed so far. The effect of a variable (e.g. control of nutrient and pollution load) on the system differs depending on the path it follows. It is difficult to predict what path a variable may take especially where socio-economic and ecological systems interact. It is very difficult to predict how the various stakeholders will act and react to situations in the system. Their actions are influenced by politics, economic conditions, sectoral, corporate or personal ambitions and many other factors. The ecological system itself is also very complex. This just shows that uncertainty is inherent to the system and that a holistic approach to management is essential. It is thus important to develop a common vision widely owned by most if not all relevant stakeholders. The need for a common vision was also highlighted in lessons from the management of the Lake Victoria Basin. Such a vision would guide stakeholders' choice of action or omission and decision-making as they carry out their somewhat different yet connected endeavors. The precautionary principle also becomes important in whatever interventions are to be implemented. In light of the insights emerging from the CLD, **it is important for water policies to explicitly acknowledge the need for lake basin management**. This will lay the foundation for holistic management. As findings show, explicit acknowledgement is currently missing and it may be the reason why the Department of Water Resources, which is the lead institution in lake basin issues (according to the existing institutional set up) has not managed to effectively coordinate those issues across sectors. Lake basin issues are not explicit on its agenda hence not very apparent in its programs.

There is a third loop highlighted in the CLD with gray arrows. It moves from protection of biodiversity to biodiversity, food supply, human well-being and economy, resources available for management, institutional capacity and back to protection of biodiversity. The loop has a reinforcing effect. There are more loops that can be traced in the CLD but only three have been

highlighted to demonstrate the complexity of the system. The remaining key issues (waste management and access to improved sanitation services) have not been specifically traced because they have a causal effect to pollution control and biodiversity which has been captured within the highlighted loops.

5.4. Implications of Findings

The overall moderate rating of the management of the Lake Malawi Basin indicates that there is a lot of room for improvement to move towards better management that would ensure sustainable use. It cannot be determined whether the governance situation is improving or worsening since this kind of holistic assessment for the Lake Malawi Basin is the first. The findings therefore provide a baseline on which future studies can refer to. That being said, however, there are many important insights that have emerged as discussed below;

Weak Pillars Require Much Attention

The most obvious insight is that the three pillars rated between low and moderate (information, finance and technology) require more attention than the others. Weaknesses identified under these pillars pose considerable threat to the entire lake basin system, as the CLD has shown. The broad areas requiring much attention are pollution control, biodiversity protection, lake basin wide monitoring and information collection, institutional capacity and availability of adequate and stable resources. There are a lot of issues connected to these broad areas that need to be specifically addressed if the condition is to improve as has been discussed in earlier sections of this thesis and in the following sub-sections.

A Holistic Approach to Management of the Lake Basin is Essential

This thesis has attempted to show how activities in the various lake related sectors influence one another and the whole lake basin system through cause and effect interaction as well as associated feedback. Management thus requires a holistic approach. The proposed indicator

framework reflects a holistic approach. Many of the effects from the interactions take a long time to manifest as effects of some variables may cancel the effects of other variables, and some processes take a long time to manifest change. In general, many processes exhibit delay. It is therefore important to ensure that while taking a holistic approach to management, the time factor is taken into account. This calls for long-term commitment. Responsible institutions need to have a long-term view that is reflected in their management strategies. Stakeholders need to be aware of the implications of the time factor so that it is reflected in whatever activities they carry out as they participate in lake basin management.

A holistic view also shows that the structure of the system is part of the problem (i.e. resource use inevitably results in degradation of some sort). Therefore, problems cannot be solved by simply focusing on attributing blame to a single sector or entity perceived to be responsible but rather through collaboration that is able to balance compromises. A priority management target within the ecosystem approach should be conservation of ecosystem **structure** and **functioning** in order to **maintain ecosystem services** (EsA Principle 5). In other words, as society pursues its well-being and development goals, it is essential to ensure that ecosystem viability is maintained, otherwise, there will be no resource base to support the attainment of well-being and development.

The Importance of Cooperation with Other Riparian Countries

Although the thesis did not focus on trans-boundary issues, from the discussion that ensued, it is obvious that sustainability of the lake basin cannot be ensured by only one country. All riparian countries have a role to play since their actions are connected and affect the entire lake basin system. Riparian countries need to enhance their cooperation and work towards a shared vision.

Critical Areas Requiring Attention

Broad Areas: Pollution control, biodiversity protection, promotion of scientific research, lake basin wide monitoring and information collection, institutional capacity, and availability of adequate and stable resources.

Issues connected to the broad areas that require improvement and/or monitoring: recognition of the need for lake basin management, access to improved sanitation services, population proportion connected to the sewerage system, sludge disposal compliance, regulations enforcement, compliance of industries and mines with standards, forest cover, bush fires, agricultural practices, solid waste management, adoption of deep water fishing technologies, prevention and management of invasive species, access to information, utilization of monitoring and research findings in management and policy formulation, sufficiency of funds available to lake-related institutions, trans-boundary cooperation, cross-sectoral coordination, access to sustainable energy sources, and climate change.

CHAPTER 6 CONCLUSIONS

6.1. Overall Achievement of the Research Objectives

6.1.1 Development of an Indicator-Based Tool for Monitoring and Assessing Integrated Lake Basin Management

As discussed in Chapter 3 (section 3.3.2), the tool was developed and published. This objective contributed to the development of the methodology applied in this research. The process that was involved in the development of the tool helped to put the research in context and better shape the holistic approach.

6.1.2. Determination of the Status of Management

The status of the management of the lake basin was determined through pilot application of the indicator-based monitoring and assessment tool that was developed. This has been discussed in Chapter 4 and Chapter 5. Strengths are in the aspects of stakeholder participation, policies and institutions. Information, finance and technology are the aspects found to be weak. The findings show the current status of management as moderate, putting sustainability of the lake basin at risk.

6.1.3. Identification and Analysis of Issues, Needs and Challenges through SWOT Analysis

The SWOT analysis was conducted and the issues, needs and challenges that were identified have been discussed in Chapter 5 (section 5.2). Findings show considerable strengths that can be harnessed for better lake basin management. However, there are also many weaknesses that need to be addressed as well as opportunities that can be taken advantage of to improve the situation. Threats that need to be monitored were also highlighted.

6.1.4. Identification of Critical Areas Requiring Management Attention through Systems Thinking Approach

The critical areas were identified and highlighted in Chapter 5. These fall under the following broad areas: pollution control; biodiversity protection; promotion of scientific research; lake basin wide monitoring and information collection; and, availability of adequate and stable resources.

6.2. Importance of the Study and its Findings

- 1) The study developed an indicator based framework/tool for monitoring and assessing ILBM in Lake Malawi Basin that is context specific. The framework/tool can guide the collection of relevant data/information that is useful to lake managers, policy-makers, researchers and other interested parties regarding the management of the lake basin system.
- 2) The developed framework/tool was piloted in the Lake Malawi Basin by conducting a holistic assessment of the status of lake basin governance and thus demonstrating its applicability.
- 3) The holistic assessment of lake basin governance done by the study is the first of its kind to be done in the Lake Malawi Basin and therefore the study presents useful findings that can be applied in policy and management interventions. It also provides useful baseline data/information that can be used as a reference for future studies.
- 4) The findings reveal some strengths (in the aspects of policies, institutions and stakeholder participation) that can promote better lake basin management if sustained and enhanced. Considerable weaknesses are also highlighted (in the aspects of information and science, technology, and finance) that threaten the sustainability of the lake basin system and hence require attention.

- 5) The developed indicator framework with its long-term focus, multi-perspective approach, and flexibility that allows modifications as necessary makes it a useful tool for adaptive management.

6.3. Limitations of the Research

As earlier indicated, the focus on only the Malawian side of the lake Basin is a major limitation. This was due to resource constraints (time and finances). Another major limitation is unavailability of some data/information and difficulty to obtain some data/information from custodians with respect to time constraints.

6.4. Areas for Future Research

- 1) An assessment of the entire lake basin encompassing all riparian countries is important.
- 2) Going a step further in understanding the lake basin system dynamics and developing a model for the system's behavior that can aid predictions for better planning and management.
- 3) Assessment of the power sharing dynamics among the various stakeholders (e.g. between Government institutions and local community institutions, between traditional leaders (TAs, GVHs, VHs) and elected leadership of local community institutions, between Government and other players (such as NGOs) and how these affect overall lake basin governance.

APPENDIX Sample Questionnaire

A study on the Integrated Lake Basin Management of the Lake Malawi Basin

Questionnaire for Farmers

Club Name:

District:

Questionnaire No.:

Interviewer:

Date:

Introduction

My name is Clara Chidammodzi, a doctorate student at Nagoya University in Japan. I am conducting a field survey to understand the current management status of the Lake Malawi Basin. You have been selected as one of the respondents for this survey to help me understand the situation of farming in this area. I will be grateful if you are willing to take a moment for the interview. The information you provide will be kept confidential and will not be disclosed to any person. The interview will take about 30 minutes.

Respondent Information

Name: _____

Gender: 1. Male 2. Female

Age: _____

Position in club: _____

About the Farmer's Club

I would like to start by asking you some questions about your group.

Q1 What are the objectives of your group?

Q2 As one of the members/leaders for the group, what role do you play in the group?

Q3 Are there any rules in your group?

(1) Yes

(2) No

Q4 If your answer to Q3 above is yes, who formulated the rules?

(1) The government (2) Extension officers (3) Ourselves (4) I don't know

(5) Other, please specify_____

Q5 Do you think the rules are fair?

(1) Yes, because_____

(2) No, because_____

Q6 How often do you abide by the rules of your group?

(1) Always

(2) Usually

(3) Sometimes

(4) Rarely

(5) never

Q7 In your farming activities, do you have to comply with other rules/regulations that were formulated by the Government?

(1) Yes

(2) No

Q8 If your answer to Q7 above is yes, what are the rules/regulations?

Q9 Do you think the Government formulated rules/regulations are fair?

(1) Yes, because _____

(2) No, because _____

Q10 How often do you abide by the government rules/regulations?

(1) Always (2) Usually (3) Sometimes (4) Rarely (5) never

Q11 Were you involved in the formulation of the government rules/regulations?

(1) Yes (2) No

Awareness and Participation

Q12^{1.4.3} Do you know that it is prohibited to cultivate crops in forest reserves and protected areas unless under license?

(1) Yes (2) No

Q13 If your answer to Q12 above is yes, how often do you abide by this regulation?

(1) Always (2) Usually (3) Sometimes (4) Rarely (5) never

Q14^{1.4.3} Do you know that it is prohibited to graze livestock in forest reserves and protected areas unless under license?

Q15 If your answer to Q14 above is yes, how often do you abide by this regulation?

(1) Always (2) Usually (3) Sometimes (4) Rarely (5) never

Q16^{1.4.3} Do you know that it is prohibited to clear land for settlement and any purpose whatsoever in forest reserves and protected areas unless under license?

(1) Yes (2) No

Q17 If your answer to Q16 above is yes, how often do you abide by this regulation?

(1) Always (2) Usually (3) Sometimes (4) Rarely (5) never

Q18 Malawi is currently implementing a decentralization policy. As part of that, citizens are given power to manage natural resources in their area. There are several activities and projects going on in many areas of the country about farming, forestry, environment, water supply, fisheries etc. **As a member of your village**, what activities or projects have you participated in in your area in the past two years?

Name of Project	Implementer (e.g. government, NGO by name, etc.)

Q19 What activities/projects has your **farmers club** participated in in the past two years?

Name of Project	Implementer (e.g. government, NGO by name, etc.)

Q20 The Ministries/Departments of Agriculture, Environment, Forestry, Water, Fisheries and others disseminate information about farming, environmental protection, catchment protection, forestry issues etc. By what means do you receive such information? Please, select all applicable

- (1) Extension Officers (2) Radio (3) Television
(4) Our club (5) Other clubs' members (6) Village meetings
(7) School (regular) (8) School (adult learning) (9) Posters
(10) Other, please specify _____

Q21^{5.5.2} Which of these means of receiving information are your 3 most preferred?

1st is _____ 2nd is _____ 3rd is _____

Q22^{3.2.1} Please, rate the level of information that you have about better agricultural practices (e.g. a mix of knowledge on prevention of soil erosion on farms, land conservation techniques on farm, manure making and application, appropriate fertilizer application, water conservation techniques on farm etc.)

- (1) Very low (2) Low (3) Moderate (4) High (5) Very high

Q23 Are you applying the farming information that you receive (or these techniques) on your farm(s)?

- (1) Yes (2) No

Q24 If your answer to Q23 above is yes, are you seeing any benefits?

- (1) Yes, such as _____
(2) No

Q25 Some reports say that soils of Malawi are being eroded at a faster a rate. Do you agree?

(1) Strongly disagree (2) Disagree (3) Agree (4) Strongly agree

Q26 If you agree, have you been affected by soil erosion in any way?

(1) Yes (2) No (Skip Q27, Q28 & 29)

Q27 How have you been affected by the soil erosion?

Q28 What are you doing to solve the soil erosion problem as an individual?

Q29 What are you doing to solve the soil erosion problem as a club?

Q30 What are you doing to solve the soil erosion problem as a community/village?

Q31^{3.2.2} Information about forestry issues is also being disseminated. Please, rate the level of information that you have on forestry issues (dangers of deforestation, importance of maintaining forests and woodlands, reforestation and afforestation etc.)

(1) Very low (2) Low (3) Moderate (4) High (5) Very high

Q32 Is your community applying the forestry management information that you receive?

(1) Yes (2) No

Q33 If your answer to Q32 above is yes, how is your community applying this information?

Q34 Are you seeing any benefits of applying the forestry management information in your community?

(1) Yes, such as _____

(2) No

Q35 Do you have trees on your farm?

(1) Yes

(2) No

Q36 If your answer to Q40 above is yes, of what use are the trees on your farm to you?

Q37 As an individual, are you involved in any forestry management activities in your area?

(1) Yes

(2) No

Q38 If your answer to Q43 is yes, what kinds of activities are you involved in? Please select all applicable

(1) I participate in village forestry/tree management activities

(2) I have woodlot

(3) Other, please, specify _____

Q39 Is Lake Malawi important to you?

(1) Yes

(2) No

Q40 If your answer is to Q39 above is yes, how important is the lake to you? Please, select all applicable

(1) I get fish for consumption

(2) I get fish for sale

(3) I get water

(4) I go for recreation

(5) I use lake transportation

(6) I just like the fact that the lake is there (7) Other, please specify _____

Q41 Do you think farming and other activities that you do at home and in your community affect the lake in any way e.g. vegetation clearing etc.?

(1) Yes

(2) No

Q42 If your answer to Q41 above is yes, how do you think farming affects the lake?

-
- Q43 What is the main kind of energy that you use for cooking?
- (1) Firewood (2) Charcoal (3) ESCOM supplied electricity
(4) Solar electricity (5) Paraffin (6) Other, please specify _____
(7) Any electricity (ESCOM or solar)
- Q44 Given a chance, would you like to change the kind of energy you use for cooking?
- (1) Yes (2) No
- Q45 If your answer to Q44 above is yes, what kind of energy would you prefer?
- _____ Because _____
- Q46 What kind of energy do you use for lighting?
- (1) ESCOM supplied electricity (2) Solar electricity (3) Paraffin (4) Candles
(5) Battery powered torches/bulbs (6) Other, please specify _____
(7) Any electricity (ESCOM or solar)
- Q47 Given a chance, would you like to change the kind of energy you use for lighting?
- (1) Yes (2) No
- Q48 If your answer to Q 53 above is yes, what kind of energy would you prefer?
- _____ Because _____

Water and Hygiene

Now I would like to ask you about water and hygiene.

- Q49 What is your main source of drinking water? Please choose one from the list below.
- (1) Piped supply through my own house connection
(2) Piped supply public tap

- (3) Bucket well
- (4) Manual pump well
- (5) Rain water
- (6) River
- (7) Lake
- (8) Others (please specify:_____)

Q50 Which of the following describes the toilet situation at your house? Please choose one.

- (1) There is a toilet at my house (2) We share a toilet with other households
- (3) We use a public toilet (4) No toilet

Q51 If you have a toilet at your house what type is it?

- (1) Pit latrine with an **impermeable** floor (e.g. cemented) and a lid
- (2) Pit latrine with an **impermeable** floor (e.g. cemented) without a lid
- (3) Pit latrine with a **permeable** floor (yozira) and a lid
- (4) Pit latrine with a **permeable** floor (yozira) without a lid
- (5) Ecosan toilet
- (6) Water closet toilet (flush toilet)
- (7) Others (please specify:_____)

For those Holding Leadership Positions Only

Now I would like to ask you some more questions about your club and your club's relations with other institutions.

Q52^{2.4.2} Has your group ever received training on group management (e.g. how to conduct formalized meetings, record keeping etc.)?

- (1) Yes (2) No

Q53 If your answer to Q58 above is yes, please rate the adequacy of the training received.

- (1) Very low (2) Low (3) Moderate (4) High (5) Very high

Q54^{2.4.2} Is your group involved in the **planning** of activities/projects concerning farming?

- (1) Yes (2) No

Q55^{2.4.4.a} If your answer to Q60 above is yes, what is your opinion about the level of involvement your club gets in the planning stages of projects/activities?

(1) Very low (2) Low (3) Moderate (4) High (5) Very high

Q56 Would you like to see any improvement in the way your club is involved in the planning stages of projects?

(1) Yes (2) No (skip Q63, Q64 & Q65)

Q57 If your answer to Q62 above is yes, what improvement would you like to see?

Q58 What can your group do to realize that improvement?

Q59 What can government do to realize that improvement?

Q60^{2.4.2} Is your group involved in **decision-making** of projects or issues about your activities?

(1) Yes (2) No

Q61^{2.4.4.b} If your answer to Q60 above is yes, what is your opinion about the level of involvement your group gets in decision-making of projects or issues about your activities?

(1) Very low (2) Low (3) Moderate (4) High (5) Very high

Q62 Would you like to see any improvement in the way your group is involved in the decision-making concerning project aspects that affect you?

(1) Yes (2) No

Q63 If your answer to Q62 above is yes, what improvement would you like to see?

Q64 What can your group do to realize that improvement?

Q65 What can government do to realize that improvement?

Q66 Does your group coordinate with the Office of Agriculture and extension officers?

(1) Yes

(2) No

Q67^{2.5.3} If your answer to Q66 is yes, what is your opinion on the degree of coordination between your group and the Office of Agriculture and extension officers?

(1) Very low

(2) Low

(3) Moderate

(4) High

(5) Very high

Q68 Would you like to see any improvement in the coordination between your group and the Office of Agriculture and extension officers?

(1) Yes

(2) No

Q69 If your answer to Q68 above is yes, what improvement would you like to see?

Q70 Does your group cooperate with any fishing club?

(1) Yes

(2) No

Q71 If your answer is yes to Q70 above, on what area(s) do you cooperate?

Q72 Does your group cooperate with any forestry management group?

(1) Yes

(2) No

Q73 If your answer to Q72 above is yes, on what area(s) do you cooperate?

Q74 Do traditional authorities/leaders of this area play any role in your group?

(1) Yes

(2) No

Q75 If your answer to Q80 above is yes, what roles do the traditional leaders play in your institution?

Q76^{3.6.2} Are there clear rules or guidelines regarding traditional authorities/leaders' roles and power sharing mechanisms between the traditional authorities/leaders and your club leaders?

(a) Yes

(b) No

Q77 What other comments concerning farming do you have?

Thank you very much for your cooperation!