

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800

Open access books available

122,000

International authors and editors

135M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.

For more information visit www.intechopen.com



Integrated Water Resources Management - Key to Sustainable Development and Management of Water Resources: Case of Malawi

V. Chipofya¹, S. Kainja² and S. Bota²

¹University of Malawi, The Polytechnic,

²Malawi Water Partnership Secretariat,
c/o Malawi Polytechnic,

Malawi

1. Introduction

1.1 Country's location and surface area

Malawi lies between latitudes 9°S and 17°S and between longitudes 33°E and 36°E. The country's international frontiers are shared with the United Republic of Tanzania to the north and northeast, the Republic of Mozambique to the southeast, south and southwest and the Republic of Zambia to the west. It covers a geographical area of 118,484 km². Lake Malawi, the third largest freshwater lake on the African continent, takes up nearly 23.6 percent or 28,000 km² of the area. Malawi is a founding member of Southern Africa Development Community (SADC).

1.2 Population

The population of the country is estimated at 12 million, with a population density of 107 people/km². Most of the people (90 percent) live in rural areas. The main economic base of the country is agriculture with subsistence and smallholder farming being prevalent among the rural population.

1.3 Natural resources

The country has a range of natural resources which include fertile soils for agriculture, water resources, and a remarkable diversity of flora and fauna that have earned Malawi a unique habitat for bio-diversity. However, these natural resources are continuously threatened by high population densities and poverty, which have led to widespread deforestation, cultivation and settlement of marginal areas for survival. These factors highlight the challenge of balancing efforts between poverty alleviation (economic growth) and natural resources management.

1.4 Climate

The climate of Malawi is influenced by the country's geographical location. Lying northward of the sub-tropical high-pressure belt, the country is affected by south-easterly winds for about six months of the year. The dominant wind system influencing the country's climate is the position of the Inter-Tropical Convergence Zone (ITCZ), which oscillates north and south bringing with it the changes in seasons as it moves (see Figure 1). Thus, when there is strengthening of the south easterlies towards the ITCZ, which normally lies over the Central Region of the country, increases in cloud cover occur resulting in rainfall. Local topography also determines climatic conditions. Due to the diverse topography that Malawi has and the great range in altitude between locations, climatic conditions may be complex. Variations between wet and dry places and between hot and cold areas are therefore not uncommon due to this characteristic.

Temperature

The period between May and August is generally characterised by low temperatures and relative humidity. With the advance of the rainy season in about October until January, temperatures are usually high and humidity also increases. A greater part of the country enjoys favourable and tolerable temperatures especially on the plateau areas, which register moderately low temperatures as compared with the Lakeshore and the Lower Shire Valley. The mean maximum July temperature for a larger part of the west Mzimba plains, the Central Region plateau and the area extending from the southern boundary of the Thyolo escarpment to Lake Chilwa and beyond to Namwera is between 22.5° and 25° with an approximate range of between 10° to 12.5°. During this time, the high plateau areas of the Nyika, Viphya, Dedza, Zomba and Mulanje may record mean maximum temperatures of between 12.5° and 15°C with a range of about 5° to 10°C. Along the Lakeshore and in the Lower Shire Valley, mean maximum July temperatures are usually higher than 35°C.

Rainfall

A number of rainfall measuring stations exist in the country and are run by the Department of Meteorological Services as well as others including the Department of Forestry, Ministry of Agriculture, Department of Parks and Wildlife, Ministry of Irrigation and Water Development and the private sector. The direction of the prevailing winds has an important influence on the amount of rainfall received. For instance, the tangential incidence of the south-easterly winds on the western shores of Lake Malawi brings with it high rainfall around these areas. However, if the direction of the winds is parallel to the orientation of the shore, this results in no or little rainfall. The highest rainfall in the country occurs around the area north of Karonga Boma with intensities of higher than 2,050mm as well as around Nkhata Bay, Nkhotakota, Zomba and the south-eastern corner of the country in Thyolo and Mulanje. A steep southerly gradient of rainfall intensity is evident from Mwangulukulu, which rises again upon approaching the Nyika Plateau.

March is the wettest month in the year. Similarly, the great diversity of topography in Malawi sees those areas on the windward side receiving much higher rainfall than those on the leeward side, with Nkhata Bay receiving mean annual rainfall of above 1,850mm and Mzimba having only around 820mm to 1,030mm. The lowest rainfall is received in areas of low altitude such as in the Lower Shire Valley where the mean annual rainfall is below 820mm.

2. Enabling environment

2.1 Legislative provisions for water management

The need for sustainable development and management of water resources in Malawi is underscored by the existing policy guidelines, institutional arrangements and regulatory framework. These regulatory instruments are aimed at safeguarding the ecologically fragile and sensitive receiving water courses where the water, further downstream is used by people for washing clothes and bathing, or irrigating crops which may be eaten raw (Carl Bro International, 1995).

A number of water management policies and legislations have been enacted in the country. The policies and legislations have been regulatory in nature. The Water Resources Act (1969) and its subsidiary Water Resources (Pollution Control) Regulations provide the main regulatory framework for water resources management. On the other hand, Water Works Act (1995) is the main authority that established water supply and water borne sanitation delivery services. There is a high degree of policy harmonization and collaboration amongst institutions dealing with water and environmental sanitation in Malawi (Chipofya et al., 2009).

The National Water Policy (NWP) (2005) ensures water of acceptable quality for all needs in Malawi.

The National Sanitation Policy (NSP) (2008) stipulates the need to improve delivery of improved sanitation services.

Further to the above policy framework relating to water pollution control, the Malawi Government launched the Malawi Growth and Development Strategy (MGDS) in 2007. The MGDS is the overarching operational medium term strategy for Malawi designed to attain the nation's Vision 2020 (1995).

One of the nine priority areas in the MGDS is Irrigation and Water Development. Under this priority area is a sub-theme for conservation of the natural resource base and in particular water supply and sanitation.

In addition, formalized national effluent standards exist in Malawi (MBS, 2005). The main policing agent to ensure compliance is the Department of Environmental Affairs in the Ministry of Natural Resources, Energy and Environment.

Malawi, as a member state of the United Nations (UN), is also obliged to meet the UN Millennium Development Goals (MDGs) www.un.org/millenniumgoals/ (accessed 09.02.2010). Goal number seven in the MDGs relates to ensuring environmental sustainability by 2015.

2.2 National development strategies and implications for water resources management

Malawi's strategy on Water Resources Management is aimed at improving water resources conservation and storage through flow regulation, promotion of small and medium to large dams, and exploitation of ground water to meet the country's target of poverty reduction.

The Malawi Vision 2020, a national long-term Development Perspective, articulates the aspirations of Malawians and the development prospects of the country up to the year 2020.

This document, among other things, showcases the threats to the country's water resources and the environment, and also offers solutions for long-term protection and utilization. The vision recognizes that water is a limited and essential resource that is sometimes taken for granted particularly among the urban dwellers. In the rural areas of Malawi, however, people are confronted directly by its elusive nature as they are vulnerable to the ravaging cycles of drought and floods, and the slowly degrading resource base.

Malawi's long-term development goals embedded in the Vision 2020 have been translated into implementable medium term strategies through Malawi Development and Growth Strategy (MDGS). The MDGS recognizes the importance of water and assumes that there will be adequate water resources as seen in the following economic growth priorities:

Agriculture is the backbone of the economy contributing 63.7 percent of the total income of the rural people, 36 percent of GDP, 87 percent of total employment and supplying more than 65 percent of the manufacturing sector's raw materials. Agriculture has been prioritized as one of the high growth sectors in the economy's growth strategy. Increased agriculture production will be achieved through increased use of water using irrigation farming for both smallholder and commercial farming and increased use of fertilizers. If not well managed, the down side of this growth strategy would be drastic reduction in quantity and quality of water for use by other development uses due to increased water demand and increased water pollution by fertilizers and agrochemicals. This would threaten long-term sustainable economic growth.

Agro-processing is another priority area in the medium term. Also earmarked for growth is industrial processing. Adoption of more intensive production and processing methods will lead to production of large quantities of solid and liquid waste and discharges that have the potential to pollute both surface and ground water resources.

The economic growth strategy will require increasing usage of electricity which is currently mostly coming from hydroelectric sources. There are plans to rehabilitate the old hydropower generation stations and develop new ones in potential rivers such as Songwe, North Rukuru, South Rukuru and Ruo rivers. Sustenance of power generation will require maintaining steady flows in the rivers which entails proper management of the water resources upstream of the stations.

Malawi is working towards reducing by half, in the short term, the number of people without access to clean water and good sanitation, and providing good water and sanitation to every Malawian by 2025. Currently, only about 65 percent of the people have access to safe water. As the population grows, attainment of this objective entails nearly doubling the current efforts of supplying clean water in all areas of the country (urban, peri-urban, and rural).

The planned development of the Zambezi Waterway is envisaged to bring economic growth to the country through reduced transport costs and increased tourist activities. For this massive economic undertaking to be sustained and bear the required fruits in the medium and long term, water resources management to maintain a steady flow rate in the Shire River will be a requirement. Water pollution control will be critical as well as trans-boundary issues.

Mining and Tourism sectors are also earmarked as priority economic growth areas. Mining operations require substantial amounts of water which results into effluent and solid waste

that can degrade the quality of water available down stream. Tourism on the other hand, is heavily concentrated along the lakeshore areas, necessitating provision of good sanitation. Health risks along the lake such as threat of contracting bilharzia or malaria both of which are water related diseases could be detrimental to the industry if not addressed adequately.

The development of aquaculture involves increased use of fishponds for fish production and depends on clean and uncontaminated water quality. Plans to intensify fish production in lakes, dams, rivers and fishponds are dependent upon availability of adequate clean water.

The Malawi Growth and Development agenda is essentially an agenda to use more and more water. Sustainable development for Malawi calls for adoption of an integrated water resources management strategy if the water crisis projected to occur in 2025 is to be avoided.

Implementation of strategies identified in the MGDS will also enable Malawi to achieve internationally set targets such as the Millennium Development Goals (MDGs). All these documents contain goals and targets that among other things aim at reducing substantially the number of people living in poverty, improving access to the basic human needs (enough food, basic education and basic health care) and sustainable management of the environment.

The core problem facing the water sector is the challenge of maintaining a balance between exploitation of water resources for social economic development and sustainable management of the resources. Achievement of the twin objectives is possible through integrated water resource management.

2.3 Key challenges for the water sector

Water resource management challenges can be grouped into two categories namely: those associated with natural systems and those associated with human systems. Natural systems challenges constitute floods and drought mitigation. Both challenges are caused by climate change and climate variability which in turn is exacerbated by global warming. Malawi faces frequent floods of which the more recent ones occurred in the 1991/1992 and 1994/1995 rain seasons. In addition, there are increasing frequencies of floods especially along the lakeshore and Shire River system. Floods cause a lot of damage to property and loss of lives of many people every year. The current response to flooding is however, reactive. There are no mitigation or adaptation measures yet in place.

Human systems that have been established to address a number of water and water-related challenges are not functioning effectively, resulting in concerns such as poor catchment management, low capacity for IWRM/WE implementation, poor stakeholder coordination, poor information management systems, low maintenance of water delivery systems, and water quality degradation. Some human systems failures are associated with cross-cutting concerns, such as HIV/AIDS and Gender, which impact on water resource management.

2.4 Water sector reform process

Prior to the 1980s, the water sector received relatively little investment in infrastructure development or water resources management. In the 1980s, mainly as a result of the international water supply and sanitation decade initiative, more attention was given to the

water sector which resulted in a substantial increase in investment in the sector. More water points were provided through boreholes, shallow wells and gravity-fed piped water supply schemes in rural areas. In cities and towns, improved access was made through investments by Water Boards and District Water Supply Fund (DWSF).

The water sector services study of 1993/94 analyzed the water sector and identified weaknesses such as lack of coherent policy framework, weak legal instruments, inappropriate institutional arrangements, lack of capacity, and inappropriate strategies for service provision. These findings culminated in the development of the first phase of the National Water Development Project, hereafter referred to as NWDP (I), which was seen as a vehicle towards implementing the water policy and other recommendations in the study. The main objective of the project was to support the implementation of the 1994 policy to ensure adequate and safe water supply, provision of water infrastructure, and protection and management of water resources. The main outputs of NWDP (I) were:

- Creation of the 3 Regional Water Boards;
- Completion of 6 water resource management and development studies relating to Lake Malawi and other major rivers and catchment areas;
- Construction of a dam and water supply systems in the Municipality of Zomba and 17 other towns;
- Development of a district-based community managed approach to rural water and sanitation;
- Construction of 500 boreholes and 2 gravity piped water supply schemes; and
- Capacity building in the Ministry of Irrigation and Water Development and the five Water Boards (NRWB, CRWB, SRWB, BWB and LWB) through the provision of training, equipment and technical assistance.

The implementation of the NWDP (I) brought about some improvements in the water supply and sanitation delivery and water resources management. However, some short falls still remain. NWDP (II) has therefore been developed to address the shortcomings of NWDP (I). This phase will build on the experiences and achievements of the first phase, consolidate the sector institutions, improve on water resources management and accelerate the provision of water and sanitation services to the communities in a sustainable manner. The objective of NWDP (II) is to improve water resources management and increase access to sustainable water supply and sanitation services for the people living in cities, towns and villages. Its main components are:

- Urban water supply and sanitation in Blantyre and Lilongwe Water Boards;
- Town water supply and sanitation in the three regional water boards;
- Rural water supply and sanitation in District Assemblies; and
- Water resources management.

3. Water resource situation in Malawi

3.1 Spatial and seasonal distribution of surface water

Malawi has a good network of river systems and is rich in surface water resources. Some of the water systems are shared with neighbouring countries of Tanzania and Mozambique, and on wider scale form part of the Zambezi River Basin. Most (93.2 percent) of Malawi's

territorial area is in the Zambezi Basin and 86.1 percent of her population live in the Basin. However, a lot of imbalances exist in the spatial and seasonal distribution of surface water. Relatively few areas have abundant water resources available throughout the year, with most areas experiencing seasonal fluctuations or perpetual year to year water scarcity with pronounced shortages during the dry months of the year. Most rivers dry up by July, with the exception of those flowing from high altitude rainfall areas of Nyika and Viphya plateaux, the Kirk Mountain Ranges, Zomba Plateau and Mulanje Mountain. This situation of unreliable dry season flows has been exacerbated by deforestation and land use malpractices which, together with improper and in some cases unwarranted usage of heavy agrochemicals and unchecked disposal of domestic and industrial wastes and allied effluent matter, have substantially deteriorated the surface water resources. These have particularly occurred in headwaters, escarpments, and mountainous catchment areas which are, in normal circumstances, supposed to exist as protected land.

The drainage system of Malawi has been divided into 17 Water Resources Areas (WRA) and each WRA represents one basin. The WRAs are sub-divided into 78 Water Resources Units. Lake Malawi stores the bulk of the renewable surface water resources. The Shire is the largest river and it is the only outlet of Lake Malawi, while all the other major rivers drain into Lake Malawi or Shire River. A few of these major rivers drain into Lake Chilwa which is not part of the Lake Malawi catchment and therefore not part of the Zambezi River Basin. The Shire flows into the Zambezi in Mozambique.

Droughts and floods are recurrent in Malawi. The impact of climate change and variability strongly influences the occurrence and distribution of floods and droughts. The late start of the 2005/2006 rainfall season and inadequate rainfall during the season resulted in a dwindling of water resources. This was clearly evident in surface water resources as many rivers have had lower flows in the past water year. Even the lake levels have experienced a significant drop. For example, the mean lake level for October 2006 was 474.65 m.a.s.l. for October 2004. In the case of flooding, areas that are flood prone in Malawi include the Lower Shire Valley, lakeshore areas of Lake Malawi, Lake Chilwa and Lake Malombe. Of particular significance is flooding in the Lower Shire, which creates both national and regional problems since the river flows into Zambezi in neighbouring Mozambique.

3.2 Water resources availability and distribution

Malawi is a water stressed country with total renewable water resources per capita of less than 1400m³. With such low per capita, Malawi is worse of than Botswana and Namibia, countries which have large areas of desert and are traditionally believed to be water stressed.

a. Surface Water Resources

Malawi, in view of the large lake, high plateau and rugged relief, has a distinct climate. The country experiences good rainfall from November to April. The mean annual rainfall is 1,037mm. The rainfall distribution for the country is also varied according to altitude as shown in Table 1 below.

The mean monthly temperature ranges from 10° to 16°C in the highlands, 16° to 26°C in the plateau areas, 20° to 29°C along the lakeshore, 21° to 30°C in the Lower Shire Valley.

Range (mm)	Area (Km ²)	Percentage Proportion
650 - 1,000	59,464km ²	63.1
1,000 - 1,200	16,095	17.1
> 1,200	18,717	19.8

Table 1. Rainfall Distribution

The mean annual pan evaporation ranges from 1,500 – 2,000mm in the plateau areas and is highest (2,000 – 2,300mm) along lakeshore and Shire Valley. Lake Malawi stores the bulk of the renewable surface water resources with an average of 90Km³ of live storage (that can flow out of the Shire River). This lake, which is the third largest in Africa, has a surface area of 28,760 km² and an estimated total volume of water of 7,725 x 10⁹m³ with a mean level of 474 m.a.s.l. It is the most important water resource for Malawi and plays a vital role in the socio-economic development of the country. The Shire River itself transits an annual average of about 18 Km³ (500 to 600 m³/s) into Mozambique. The annual surface water resources yields on land are about 13 Km³ and predominantly drain into Lake Malawi and the Shire River. However, more than 90 percent of this runoff occurs in rainy season, particularly from December to April every year.

Malawi, though with the largest riparian area of 65.9 percent, contributes only 42 percent of the total inflow into the lake, much less than Tanzania which, with only a riparian area of 27.2 percent, contributes about half of the inflow into the lake. This entails that Malawi needs the compliments of other riparian countries when managing and developing the lake resources. Table 2 gives the inland runoff contribution to the lake from three riparian countries of Malawi, Mozambique and Tanzania. This, therefore, calls for closer bilateral cooperation among these riparian countries.

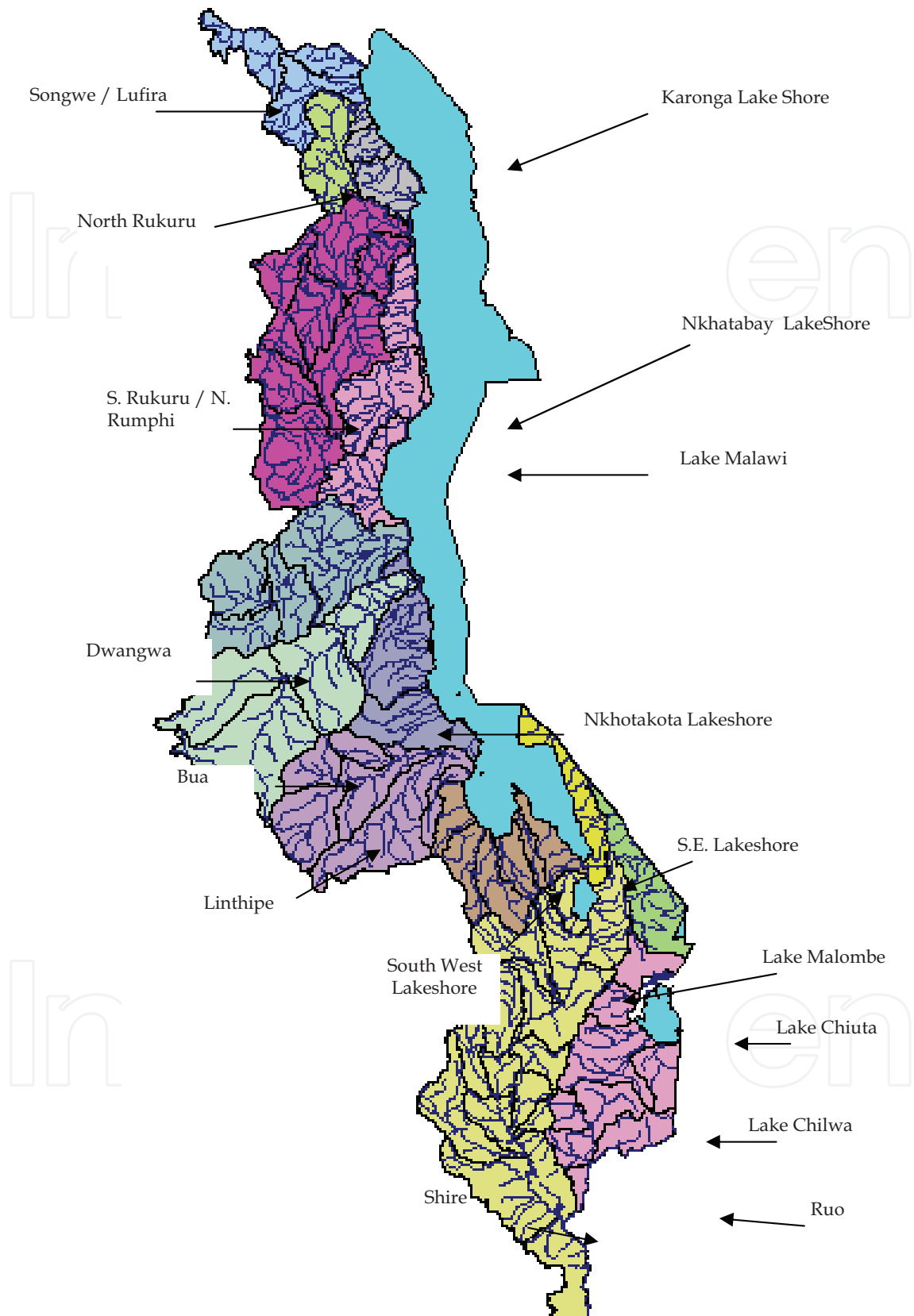
	Malawi	Tanzania	Mozambique	Total
Catchment area of lake km ²	64 372	26 600	6 768	97 740
Flow (m ³ / s)	391	486	41	918
Percentage area (%)	65.9	27.2	6.9	100
Percentage flow (%)	42.6	52.9	4.5	100

Source: Ministry of Water Development

Table 2. Contribution of Run-off water to Lake Malawi

Major rivers are the Shire, Bua, Linthipe, Songwe, North Rukuru, South Rukuru, Dwangwa and Ruo. The Shire is the largest river and is the only outlet of Lake Malawi, while all the other major rivers drain into Lake Malawi or Shire River. The major catchment areas are as shown in Figure1.

The major rivers are perennial, but due to the seasonality of rainfall, most of the smaller rivers have ephemeral flow. The mean annual runoff works out to 588m³/s or 18,480 x 10⁶m³. The mean annual runoff over the land area of the whole country is 196mm (i.e. an equivalent of 588 m³/s), and this constitutes 19 Percent of the mean annual rainfall. Details of rainfall and runoff for each WRA are shown in Table 3.



Source: Ministry of Water Development

Fig. 1. Malawi Water Resources Catchments

River Basin	Catchment Area Km ²	Rainfall Mm	Runoff		Percentage Runoff
			mm	M ³ /s	
Shire	18,945	902	137	82	15.2
Lake Chilwa	4,981	1,053	213	34	20.2
South West Lakeshore	4,958	851	169	27	19.9
Linthipe	8,641	964	151	41	15.7
Bua	10,654	1,032	103	35	10.0
Dwangwa	7,768	902	109	27	12.1
South Rukuru	11,993	873	115	44	13.2
North Rumphu	712	1,530	674	15	44.1
North Rukuru	2,091	970	252	17	26.0
Lufira	1,790	1,391	244	14	17.5
Songwe	1,890	1,601	327	20	20.4
South East Lake Shore	1,540	887	201	10	22.7
Lake Chiuta	2,462	1,135	247	19	21.8
Likoma Island	18.7	1,121	280	-	-
Chisumulo Island	3.3	1,121	280	-	-
Ruo	3,494	1,373	538	60	39.2
Nkhotakota Lakeshore	4,949	1,399	260	41	18.6
Nkhata Bay Lakeshore	5,458	1,438	461	80	32.1
Karonga Lakeshore	1,928	1,208	361	22	35.1
TOTAL	94,276	1,037	196	588	18.9

Source: Ministry of Water Development

Table 3. River Basins of Malawi: Mean Annual Rainfall and Runoff

Other important surface water resources include Lake Chilwa with a surface area of 683 km², Lake Malombe with 303 km², and Lake Chiuta with 60 km². Small lakes, lagoons and marshes include Lake Kazuni, Chia Lagoon, Chiwondo Lagoon, Elephant Marsh, Ndindi Marsh and Vwaza Marsh. Details are outlined in Table 4.

Reservoir	Surface Area (Km ²)	Location as per District
Lake Malawi	28,750	Covers Karonga, Rumphu, Nkhatabay, Nkhotakota, Salima, Dedza & Mangochi
Lake Chilwa	683	Zomba & Phalombe
Lake Malombe	303	Mangochi
Lake Chiuta	60	Machinga
Lake Kazuni*	-	Rumphu & Mzimba
Chia Lagoon	22	Nkhaota kota
Chiwondo Lagoon	-	Karonga
Elephant Marsh*	-	Chikwawa & Nsanje
Ndindi Marsh*	-	Nsanje
Vwaza Marsh*	-	Rumphu

Source: Ministry of Water Development * Surface area not known

Table 4. Major Natural Reservoirs and Marshes in Malawi

b. Reservoirs

In Malawi, water resources utilisation is heavily dependent on run-of-the-river schemes. Although there is great potential and need for dams, no major storage dams have been constructed. However, there are about 700 small to medium dams that have been constructed with reservoir capacities ranging from a few cubic metres to about 5 million cubic metres. The total storage of these dams is estimated at about 100 million cubic metres or 0.1km³.

There are a total of 749 impoundments in the country, the majority (over 60 percent) of which are in South Rukuru and Ruo River basins. Most of these dams were constructed in the 1950's mainly to supply drinking water for livestock. The dams that can be classified as large dams in Malawi have mainly been developed by water boards for urban water supply. These include Lunyangwa Dam in Mzuzu, Chitete Dam in Kasungu, Kamuzu I and II Dams in Malingunde (Lilongwe), Mpira Dam in Ntcheu, Mulunguzi Dam in Zomba, Mudi and Chimwankhunda Dams in Blantyre, Chilingali Dam in Nkhotakota, and Lifupa Dam in Kasungu, as detailed in Table 5.

Water Resources Area	Number of Dams	Remarks
Shire	62	Most in Blantyre
Lake Chilwa	31	Most in Thondwe area
South West Lakeshore	8	
Linthipe	33	
Bua	38	
Dwangwa	50	
South Rukuru/North Rumphu	274	
North Rukuru	2	
Songwe / Lufira	3	
South East lakeshore	1	
Lake Chiuta	2	
Likoma Island	0	
Chizumulo Island	0	
Ruo	215	
Nkhotakota Lakeshore	9	
NKhata-bay Lakeshore	21	Almost all in Luweya/Limphasa area
Karonga Lakeshore	0	
Total	749	

Source: Ministry of Water Development

Table 5. Distribution of Dams per River Basin

c) Groundwater Resources

Evaluation and development of groundwater resources have been primarily for drinking water supply for both rural and urban areas. The construction of boreholes and hand-dug wells, which started in the 1930's, can be considered to be the beginning of the utilisation of groundwater resources in Malawi. Basically there are two types of aquifer

systems in the country namely the extensive but low yielding weathered basement aquifer of the plateau area, and the high yielding alluvial aquifer of the lake shore plains and the Lower Shire Valley. The weathered zone is best developed over the plateau areas where it is commonly 15 – 30 metres thick and even thicker. The average yield in the weathered zone of the basement complex lies in the range of 1 - 2 litres per second.

The alluvial aquifers are fluvial and lacustrine in nature, and are highly variable in character both in vertical sequence and lateral extent. They occur in several basins which, apart from Lake Chilwa areas, are all located along the rift valley floor: Karonga Lake Shore, Salima - Nkhotakota Lake Shore, Upper Shire Valley and the Lower Shire Valley. Most lithological records from boreholes give little detailed information about the successions. The overall impression is that clays usually dominate the sequence although in many localities there is significant thickness of poorly sorted sands. The sedimentary environments likely to produce the highest groundwater yields are buried river channels and littoral zones of the lake shore where the deposits are usually coarse grained and well sorted. The Lake Chilwa Basin is different from the other alluvial areas in that it is perched on the eastern side of the rift valley. The lithological logs of boreholes located in this area suggest that much of the succession is clay. In the alluvial aquifers yields up to more than 20 litres per second have been obtained.

According to National Water Resources Master Plan, estimates of recharge have been made by the analysis of flow hydrographs, groundwater level fluctuations, flownets and catchment water balances. The results vary considerably. On the basis of the river hydrographs, the annual recharge is estimated as 15 to 80mm to weathered basement aquifers and 3 to 80mm to alluvial aquifers. In the alluvial aquifers, the recharge will also occur by seepage from the river beds where these are significantly permeable. On the basis of 15mm, the recharge over the country works out to $1,414 \times 10^6 \text{m}^3$ per year.

3.3 Water resource utilisation

Consumptive and Non-consumptive Uses of Water

Water resources in Malawi are mainly used in water supply and sanitation, agriculture, irrigation, industry, energy (hydropower), transport (navigation), fisheries, and bio-diversity. The utilization of the resources can be categorised into two groups - consumptive and non-consumptive uses. The consumptive uses include water supply and sanitation, irrigation and industry while the non-consumptive uses include hydropower, fisheries, wildlife, bio-diversity, recreation and tourism. The Malawi government has made some tremendous efforts in developing its water resources and these include the ones shown in Table 6.

Uses	Amount (m ³ /s)	Remarks
Irrigation	32	Consumptive use
Hydropower	185	Non consumptive use
Water Supply	3	Consumptive
Industrial and others	1	Consumptive
Total	221	

Table 6. Consumptive and Non-consumptive Uses of Water

Domestic Water Uses

The goal of the Sector is to provide clean water and adequate sanitation to the total population in the long run, and to achieve coverage of 84 percent by 2010 in the medium term. Currently, more than 65 percent of the country's population has access to safe drinking water. Access to potable water is higher in the urban than rural areas with 85 percent and 45 percent of the population respectively. Nearly all the residents of the two cities of Blantyre and Lilongwe have access to Municipal water supply.

The Government has over the years invested in water supply. Over 27,000 boreholes, more than 79 rural gravity-fed piped water supply schemes, and 55 municipal and peri-urban water supply schemes have been constructed over the years. These systems altogether provide access to potable water to about 65 percent of the country's population. Boreholes, shallow wells and gravity-fed piped water supply schemes predominantly serve rural communities. The gravity-fed schemes have over 10,000 tap points serving more than 1,200,000 people. The installation of these schemes started way back in 1965. The sources of these schemes are rivers from forest reserves. In the past, the catchment areas of the schemes were un-encroached with good water qualities hence most of these schemes do not have treatment facilities. At present it is only Mpira/Balata scheme which has water treatment facility.

These schemes or water points are designed to provide at least 27 liters per capita per day within a walking distance of less than 500 metres. The provision of these services were originally the responsibility of government, but over the years there has been some involvement of non-governmental organizations (NGOs) and the private sector in the provision of water services especially in the rural areas. The provision of urban water supply services is done by the five Water Boards namely Blantyre Water Board (BWB), Lilongwe Water Board (LWB) and Regional Water Boards (Northern, Southern and Central).

Over the years, Improved Community Water Points (ICWP) have been installed throughout the country. According to the Ministry of Irrigation and Water Development, one is said to be accessible to safe drinking water if a functional ICWP exists within 500 metres of one's home. Recommended maximum number of people using one water point is 250 for borehole and 120 for standpipe.

A big proportion of the country's rural population is without access to potable water. Table 7 shows availability of water supply facilities to rural people in 13 selected districts in the country. The picture is expected to be the same for the rest of the country. Average proportion of the rural population of the 13 districts without access to potable water is 34 percent. The average is expected to be more or less the same for the rest of the country. In other words, the current coverage of potable water supply in the country is about 65 percent which may go as low as 40 percent due to non-functionality of the facilities at any one time. However, Government's target is 84 percent coverage by 2010, according to the Malawi Poverty Reduction Strategy Paper. It can be concluded that this target may not be achieved at all.

The traditional sources of water supply in Malawi are open hand-dug wells usually dug in flood plains or *dambos*, open surface water bodies (rivers, lakes or dams). Access to safe water defined as water piped into the dwelling, public tap, a borehole or protected well, or spring located whether on the premises or less than half a kilometre from the premises) is limited.

District	Rural Population	No. of ICWP	Functionality Ratio (%)	Population Without Access	
				No	%Age
Balaka	277,721	1,588	76	56,156	25
Chikwawa	328,336	1,404	49	179,427	56
Chiradzulu	230,202	1,139	77	51,552	22
Lilongwe	876,476	2,928	63	455,210	52
Machinga	338,899	2,121	59	125,396	37
Mulanje	404,739	2,866	52	146,880	36
Mwanza	128,057	789	72	41,140	32
Mzimba	480,242	4,670	72	104,889	22
Nkhata Bay	138,390	1,229	64	3,668	3
Phalombe	217,729	1,637	46	88,438	41
Salima	219,730	1,148	78	66,541	30
Thyolo	437,361	1,271	83	241,141	55
Zomba	460,538	3,332	61	142,146	37

Source: Malawi Rural Improved Community Water Point Inventory Draft Report, 2004

Table 7. Availability of Water Facilities or ICWP

It is estimated that up to 30 percent of the facilities are out of order at any given time. In total, some six million rural residents are exposed to health risk caused by lack of potable water hence become vulnerable to water borne diseases. Coverage would be higher if fewer systems were non-operative, malfunctioning or dried out as a result of extended drought episodes.

Great variations in service provision occur at district level. Approximately 65 percent of the population of Rumphi district have convenient access to safe water, while less than five percent of the population of Ntchisi and Mwanza districts are adequately served. Levels of access in Ntchisi District would rise if the acceptable distance between dwelling and water point is increased to one kilometre. This, however, is not the case in Mwanza District where only 4.9 percent of the population have access to safe water within one kilometre from a safe facility such as a borehole in rural areas and a public tap in urban.

The rapid urbanization is of increasing concern. The urban growth rate is currently estimated at 6.1 percent nationally, and 10.6 percent for the northern city of Mzuzu. Between 50 percent and 80 percent of urban and semi-urban residents are accommodated in "traditional housing", according to the National Water Resources Master Plan of 1986. These people normally constitute the poorest sector of the urban population. Growth rates of some peri-urban communities around Lilongwe have been estimated to be as high as 15 percent per annum. Population increase could therefore add a further 1.5 to 2.2 million to the number of people without safe water by the year 2010.

Hydropower Generation

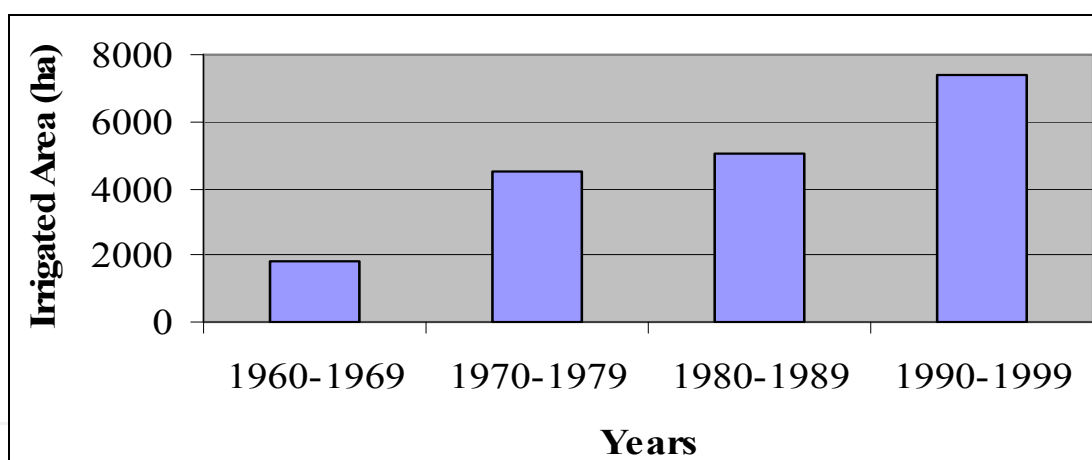
Demand for water for hydropower generation continues to be high. Though it is not a consumptive use, large amounts are allocated for power generation in the Shire and in the Northern Region. In the Shire River, hydropower plants of about 200MW generation based on a minimum flow of 170 m³/s were developed after the construction of Kamuzu Barrage at Liwonde, in 1965. However, this design flow was based on the assumption of steady Lake

Malawi levels of 474.00 m.a.s.l and the existence of a regulating dam at Kholombidzo, some 180km downstream of the lake outlet. This hydropower accounts for the production of more than 98 percent of the total electricity consumed in Malawi. Although a small percentage (3-4 percent) of the country's energy needs, it is the primary source of energy driving the economic and industrial infrastructure and services.

Agriculture

Agriculture is the mainstay of the country's economy. The sector contributes about 36 percent of the Gross Domestic Product (GDP), 87 percent of total employment, supplies more than 65 percent of the manufacturing sector's raw materials, provides 64 percent of the total income of the rural people, and contributes more than 90 percent of the foreign exchange earnings. It is the main livelihood of the majority of rural people, who account for more than 85 percent of the current estimated 12 - 13 million people.

Agriculture is the largest consumer of water in the country. About 70,000 hectares of land in Malawi have been developed for irrigation mostly for sugar and on a small scale for smallholder rice schemes and tobacco estates. Of this, more than 20,000 hectares are being used for commercial farming in the Lower Shire Valley and the lakeshore. Irrigation, demand accounts for about 20 to 25m³/s. However, a further 50,000 hectares are under traditional cultivation. Investment in irrigation has also been on the increase in an effort to boost agricultural production.



Source: NSoER 2002

Fig. 2. Smallholder Irrigation Scheme

Fisheries

Malawi's water resources have a major role in fisheries development, wildlife and biodiversity promotion and conservation. Major water resources of Lake Malawi and the Shire River remain the major habitant areas for fisheries, wildlife and biodiversity promotion and conservation. The unique relationship between the Upper Shire River and the southern end of the lake is an ideal and very important ecosystem for fish breeding and development. The Shire River also acts as a natural system for disposal of background effluent. There are also a number of investments on tourism and recreational industries in the form of permanent structures and settlements which have been established at the waterfront along the lake shore and the Shire River banks

Transport and Navigation

Lake Malawi and the Shire River play a vital role in the transport system of the country. The Lake provides the cheapest means of transportation through navigation and forms a very important component of the northern corridor transport network between Malawi and Tanzania. It brings about integration of transport systems of Malawi, Mozambique and Tanzania. To promote the water transport, a number of facilities such as ships, boats, harbours and ports have been built. An estimated amount of 180,000 tons of cargo and 300,000 passengers are handled annually.

Tourism and Settlements

The water resources are also important for permanent settlements and for the tourism industry in the country. The Lake Malawi Shire/River system is a particular attraction to tourists and the shores are dotted with settlements and recreational facilities such as hotels, motels, and cottages. Tourism is important in boosting the country's economic development as a source of foreign exchange earnings.

Environment

Environment is recognised as a legitimate water user. National Water Policy has allocated a minimum of eight percent of water to the environment. This is much lower allocation than provisions made by other African countries such as South Africa and Kenya who have allocated 30 percent for environmental flows. There is need to revisit the proportion of water allocated to environment flows.

3.4 Water resource issues

Water resources are increasingly threatened by a number of factors such as prevalent water scarcity, water resources degradation and pollution, over exploitation, and conflict of interest emerging out of lack of integrated water resources development and management, and rapid population growth. These greatly reduce the availability of water for multi-purpose usage.

a. Issues on Water Resource Availability

Water Resources Scarcity

Most rivers run dry by July, with the exception of those flowing from high altitude-rainfall areas of Nyika and Viphya plateaux, the Kirk Mountain Ranges, Zomba Plateau and Mulanje Mountain. This situation of unreliable dry season flows has been exacerbated by deforestation and land use malpractices.

These have particularly occurred in headwaters, escarpment and mountainous catchment areas, which are in normal circumstances, supposed to exist as protected land. This existing situation has led to the flashy nature of surface runoff without significant recharge of the aquifers, thereby greatly diminishing the base flows in the water resource basins.

Water Resources Degradation

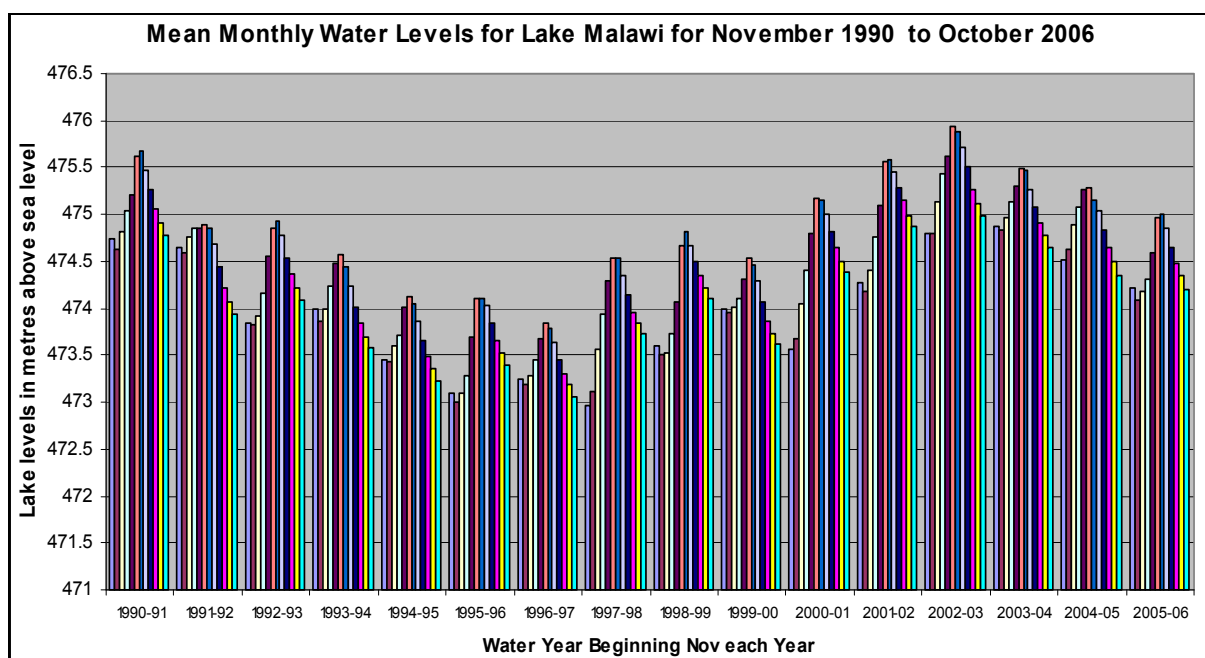
The degradation of catchment areas including marginal lands due to population pressure, deforestation and poor agricultural practices have facilitated the development of soil erosion leading to serious sedimentation or siltation problems. The rapid increase in population

densities and the growth of industries have inevitably worsened the already existing problems on the demand for land and all other natural resources. This has led to the encroachment of marginal and water catchment areas. Poor land management practices with resultant erosion of the soil have led to siltation of rivers and reservoirs causing serious water quality problems downstream and inundation of river channels as a result of increased surface runoff. Inundation of the river channels causes flooding of rivers resulting into the destruction of crops, people's houses and property as well as loss of life. This is mostly occurring in low-lying areas of the lake shore plains such as Karonga, Salima-Nkhotakota, Bwanje Valley, and Lower Shire Valley.

The quality of surface water resources has substantially deteriorated due to several factors that include; inappropriate land use practices, improper and in some instances unwarranted usage of heavy agrochemical and unchecked disposal of domestic and industrial wastes and allied effluent matter. The quality of groundwater is however generally good, although isolated and sporadic occurrences of saline ground intrusion are encountered. In some areas the utilisation of ground water for water supply has been limited by the presence of high contents of parameters such as iron, fluoride, sulphate and nitrate.

A number of rural water supply schemes which the government had constructed in the early 1970's with minimal treatment facilities and relying heavily on abstracting water from protected catchments (like forest and wildlife reserves) have recently been heavily contaminated by human faecal coliforms as a result of human encroachment into these protected areas.

Non-designated dumping sites operated in line with unplanned and poor technological operational concepts that do not conform to stipulated health or any scientifically developed standards are known to lead to pollution and other detrimental effects on the water resources of the country.



Source: MoIWD

Fig. 3. Lake Malawi Trends in 1990/1991

Drought and flooding are recurrent problems in Malawi. The impact of climate change and variability strongly influences the occurrence and distribution of floods and droughts. The late start of the 2005/2006 rainfall season and inadequate rainfall during the season resulted in dwindling of water resources. This was clearly evident in surface water resources as many rivers have had lower flows in the past water year. Even the lake levels have experienced a significant drop. For example, the mean lake levels for October 2006 was 474.19 m.a.s.l. compared to 474.35 m.a.s.l. for October, 2005 and 474.65 m.a.s.l. for October 2004. The declining trend of lake levels from the peak of 2002/2003 shown in the Figure 3 below may be a reflection of the upland catchment rainfall impact.

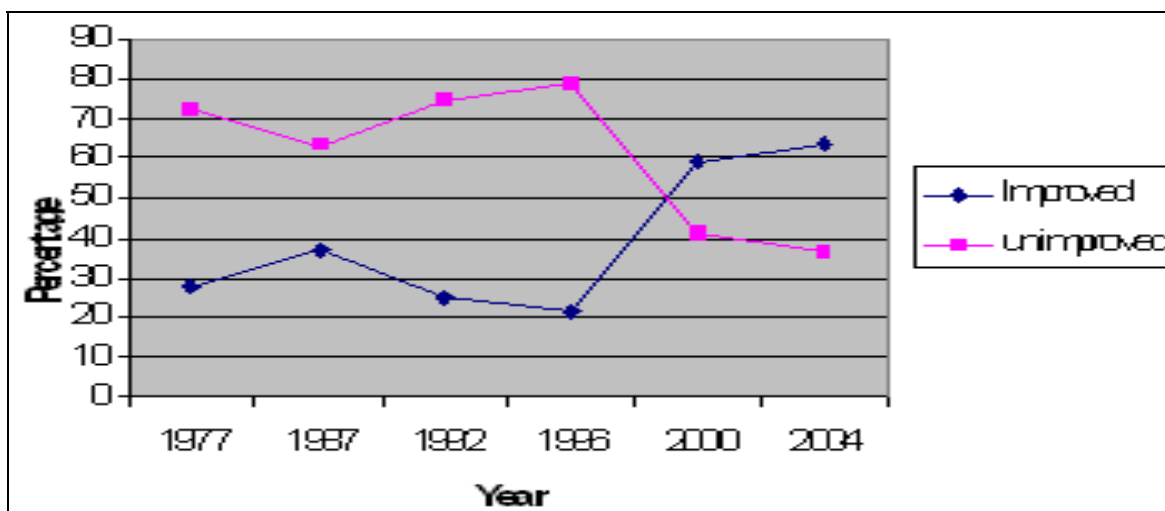
These issues are contributing to the imbalanced situation of the water resources and show the great need to check and arrest the situation if the set development goals and objectives are to be achieved. It also calls for a holistic approach in the development and management of water.

b. Issues on Water Resource Utilisation

The available water supply systems are most vulnerable to the effects of droughts and unreliable dry season flows. This is so because very few systems have reservoir storage facilities to act as back-up to the supply system which proves to be of strategic importance during low flow seasons or no-flow periods. That is to say most of the developed systems rely on run-of-the-river water supply schemes, which are heavily susceptible to the effects of hydrological droughts and seasonal fluctuations.

The water delivery services in the country, including those relying on boreholes and wells are also adversely affected by poor design values coupled with inappropriate operation and maintenance mechanisms.

The population with access to potable water drops from 65 percent to levels as low as 40 percent at anyone time due to problems of water scarcity and those affecting operation and maintenance of the delivery system. The remaining population of 35 percent access water from unprotected sources resulting in the high prevalence and upsurge of water borne or water related diseases. The trend overtime however, show a slight increase of people accessing potable water (Figure 4).



Source: National Statistical Office

Fig. 4. Safe Water Access Trends for Malawi

Even though more than 99 percent of the country's power is hydro-generated, the high tariffs still cut off majority of the population from accessing electricity. This has forced most people to depend on fuel wood thus causing uncontrolled deforestation. To satisfy these demands, there is need for a multi-sectoral administrative coordination, and enhancement of political, legal and economic co-operation initiatives that can assist in the regulation of hydrological regimes not only for Lake Malawi and the Shire River, within acceptable limits, but also for all water resources of the country as a whole.

4. Water resources management framework

Water resources management basically involves the monitoring and assessment of water quality and quantity, the development and protection of water resources, the provision of water services and ensuring that water laws are strictly adhered to by all users. In other words, water resources management may be defined as man's control over water as it passes through its natural cycle, with balanced attention to maximising economic, social and environmental benefits. The goal of sustainable IWRM is, therefore, to conserve water resources in both quality and quantity for the benefit of the present and future generations.

Pressure on water is increasing due to increase in population. Land use is intensifying causing increased land degradation and eventually degradation of the water resources. This causes an increase in demand for water and a range of potential and actual threats to the quality and quantities of water available. Also water supply and water-borne sanitation services are inadequate to meet the needs of some communities. This calls for action from water sector and water related sector organisations as well as the user communities in the proper planning, development and utilisation of water resources to achieve the maximum benefits while at the same time ensuring their sustainability.

4.1 Water policy and legislation

A number of water resources management policies and legislations have been enacted in Malawi. The policies and legislation have been regulatory, to promote conservation, equitable allocation and protection of the resources against pollution, over-exploitation, and physical degradation to establish water supply and sanitation delivery services or other water dependent services. The Water Resources Act (1969) and its subsequent amendment and subsidiary Water Resources (Pollution Control) Regulations provide the main regulatory framework for water resources management. On the other hand, Water Works Act (1995) is the main authority for establishing water supply and water borne sanitation delivery services.

The government introduced the 1994 Water Resources Management Policy and Strategies (WRMPS). This policy and its strategies, however, have been reviewed by the 1999 and 2005 Water Resources Management Policy and Strategies funded under the Natural Resources Management and Support (NATURE) programme. The introduction of the National Environmental Policy and the call for harmonisation of natural resources management policy, legislation and institutional roles, warranted the review. This provides an enabling environment that is conducive for sustainable and integrated water resources development and management.

The policies and legislation of other sectors benefiting and affecting the water field need to be in harmony with those drawn for water resources management. One of such important

Acts is the Environmental Management Act, which serves as an umbrella legislation with its aim focused on enforcing sustainable development of the natural resources. It is also important for the national water resources legislation to be in harmony with those of the neighbouring countries in the region. The signed Protocol on Shared Watercourse for the SADC region (2000) provides a framework for harmonisation of policy and legislation among the SADC and Zambezi River Basin member states.

The revision of the policy and legislation on water resources management entailed the revisiting of institutional roles of the Ministry of Irrigation and Water Development and harmonising them with other government departments and agencies involved in the water sector and other organisations whose undertakings are in any form linked to water resources management and development. This will ensure that policy and legislative reforms are documented and implemented without duplication or dormancy in any essential water environmental resources management services.

4.2 Existing framework for water resources management

The water sector in Malawi comprises several levels of responsibility that range from national policy formulation through the administrative and management units down to service providers in the construction, operation and maintenance of water supply, water borne sanitation and any other water based or related fields. These levels of responsibility are assigned to different government institutions and parastatal organisations of utmost importance recognising how the MoIWD has developed over the years to lead the sector amidst many challenges to where it stands today.

4.3 Evolution of the water and sanitation sector

Water as a distinct sector in Malawi is relatively new and still developing. The process to develop a distinct sector in Malawi, like many other countries in the World, has evolved over time in response to the growing need for better management and development of water resources to meet the growing demand.

During the colonial and federal administrations there was no real effort to develop water resources for social-economic development or to meet the needs of the wider indigenous population even though 750 small dams were developed during that time. Therefore, few systems were installed in urban centres mainly to service the expatriate community. Different water related functions were therefore scattered in different Government units only as incidental activities in the line functions of those units.

After gaining independence in 1964, the new Malawi Government continued with the same institutional framework, hence despite the increased exploitation of water resources mainly for agriculture development, there was no sectoral consolidation of water related development. Similarly, these were scattered in many Government units and uncoordinated, for example, Water Resources Management and the branch of Irrigation were in the Ministry of Agriculture and Natural Resources. Ground Water Division (Boreholes) was in the Geological Survey, while Rural Water Supply was under Community Services. Some urban water supplies were functions of city/town councils under Local Government, and District Water Supplies were under the Department of Public Works.

This disintegrated approach to water related developments greatly retarded the proper management and development of water resources in Malawi due to lack of direction, coherent planning and efficient use of the human and other material resources. The outcome of this was rapid deterioration of the country's water resources and little coverage in terms of provisions of safe water to both urban and rural populations between 1964 and 1980.

In order to raise the profile of Water and Sanitation as a key ingredient of socio-economic development in the world, the United Nation introduced the water supply and sanitation decade in the 1980's. As a requirement for Malawi to benefit from this water development initiative, a Water Division was created in 1979 under the Department of Lands, Valuation and Water in the Office of the President and Cabinet. This was the first step towards the creation of distinct sector, and it brought together the hitherto scattered units of water resources, groundwater, rural water supplies, district/town water supplies, water quality and irrigation.

The profile of the new water sector was enhanced in September 1984 when the Water Division was separated from the Department of Lands and Evaluation and a fully fledged Water Department was created under the Ministry of Works. In September 1994 the Department was given full ministerial status as the Ministry of Irrigation and Water Development, and then after a functional review in 1997, the Ministry of Water Development was created. This led to clear separation of institutional roles among water boards, regional water boards, and how the Ministry would interact with various players in water resources development and management. In 2004, the Department of Irrigation was separated from the Ministry of Agriculture and Food security and rejoined the Ministry of Water Development to become what is today called the Ministry of Irrigation and water development.

5. Water resources management key challenges, opportunities & risks

A major challenge facing the IWRM in the country and world over is the understanding of IWRM concepts by the decision makers. In most cases the IWRM concepts are poorly understood in spite of the recent trends by the United Nations in recognition of the need to adopt IWRM principles for sustainable water resources management.

Important hydrological and ecological services are considered to be of marginal value and it is therefore not surprising that environmental issues continue to receive less attention from most central governments and its protection is seen by decision makers as a "green" issue promoted largely by external interest group.

Water is a necessary input for any productive activities of agriculture, forestry, industry, mining, livestock development, energy production, tourism, wildlife conservation and domestic water supply among others. Therefore, the effective integrated management of water resources and sustainable utilisation is a pre-requisite for sustaining all forms of life and fostering overall socio-economic development in Malawi.

Water availability varies considerably within Malawi. Overall it is a scarce resource, which is vulnerable to global factors such as climate change, and to regional constraints imposed by the management of trans-boundary waters. Water is also vulnerable to local and national factors such as the growing demands of urban and rural populations, increasing sectoral

demands, greater competition and potential for conflict over water, worsening water pollution, land and catchment degradation, destruction and encroachment on aquatic ecosystems, and proliferation of invasive weeds. Increasingly, environmental degradation from unsustainable land and water use patterns and other anthropogenic factors is undermining and threatening the sustainability of the water resource base itself. These challenges are likely to further exacerbate the water scarcity in the country if they remain unchecked. The challenges have been summarised as follows:

5.1 Water scarcity and droughts

There are inadequate water resources to meet demand due to increased seasonal variability in run-off, increases in population and demand for industrial production, and irrigation requirement. This problem has basically arisen as a result of droughts and unreliable dry season flows. 1991/92 – 1994/95 droughts showed the vulnerability of water supply schemes. Most of them rely on the direct run of the river which. Low availability of seasonal run-off greatly affects the hydrological demand for domestic needs, industrial production, and irrigation requirements.

There are frequent occurrences of droughts, which are initiated by the El Niño and Southern Oscillation (ENSO) phenomena. These have resulted in inadequate amounts of rainfall received, hence declining amounts of both surface and groundwater resources.

5.2 Water resources degradation

Pollution of surface and groundwater resources is a growing problem and is making water resources unavailable for use without expensive pre-treatment. Pollution is increasing from point source such as effluent discharges of industrial and domestic waste, and from non-point sources such as solid waste, silts, and agrochemicals. The following are some major causes of water resources degradation in Malawi:

a. Effluents Disposal

The disposal of effluents puts a demand on the resources either by reducing the quality of the sources of raw water, or by requiring the regulation of stream flow to provide greater dilution. At present, the demand exists only in the first category, and mostly in the urban areas, such as Blantyre, Lilongwe, Mzuzu and Zomba. Future demand is likely to increase rapidly with the growth of industrialisation and centralisation of population in the urban areas. However, the picture is far from clear and information is urgently needed. Disposal of effluents directly into Lake Malawi is especially an important issue, bringing into light the conflicting requirements of industry, fisheries and tourism.

b. Sedimentation (Siltation)

Great pressure on the land resources resulting in soil erosion and deforestation has been experienced in Malawi due to rapid population growth. Silt loads (sedimentation) in surface runoff from soil erosion lead to significant problems in down stream water quality, including increased suspended solids and turbidity, resulting in high water treatment costs and water flow problems. Since 90 percent of the people reside in rural areas and depend on rivers for water supply, chances of drinking unclean water are very high.

As indicated in case studies carried out, catchments with high deforestation rates have faced increased levels of flow discharge, which in turn have led to increased levels of turbidity and solids. High sediments loads in the rivers bring about siltation of rivers (when the gradient is low) and of water reservoirs. The silted river courses and of water reservoirs tend to have reduced capacities so that when it rains the banks may overflow, causing flooding at times; or the water erodes the bank (in order to accommodate the increased volume of run-off). The intake point for Nkula Hydro-electrical power reservoir, for instance, is frequently dredged for this reason. Sedimentation may also affect fish resources.

c. Chemical Contamination

With the reduction in fertility of agricultural land, use of agrochemicals such as fertilisers, pesticides for increased productivity becomes inevitable. However, run-off of these chemicals into water bodies can cause serious harm to human health, livestock, fish, and other aquatic environment. For example, these chemicals may result in eutrophication of the water bodies and an increase in water plants growth. This threatens fish resources growth and reproduction.

d. Catchment area encroachment

Encroachment of protected catchments, through deforestation, human settlement and cultivation of marginal lands is an issue of major concern in Malawi today. This nature of pressure exerted on the water resources brings about declining base flows, deterioration of water quality, and reduced groundwater recharged rates, increased turbidity of water in river and reservoirs and increased incidences of flood disasters.

5.3 Institutional and legal constraints

The Government's policy is to provide clean potable water to all people so as to reduce the incidence of water borne diseases and reduce the time devoted by individual to water collection. The Water Resources Act and other Acts that deal with the use of water for different purposes have been found to be inadequate in that they conflicts each other instead of complimenting one another in issues of water resources management. They also lack punitive measures against those who cause substantial water pollution by discharging effluent. The proposed implementation of institutional arrangement or other strategies mentioned in the current policy may take longer time to implement the strategies or the targets. The weakness and strength of these institutions should have been translated into policies to ensure that they have the capacity not only to implement the National Water Resources Management Policies (NWRMP), but also integrated management.

Within the new water policy and strategies, there is an increased effort on decentralisation and ensuring resources are owned and managed at a local level. The roles of the various bodies, including Village Development Committees (VDCs), area development committee (ADCs), District Coordination Teams (DCTs), district assemblies (DAs) and Catchment Management Authorities, require careful analysis to ensure co-ordinated execution. It is important to consider the appropriate entry points for organisations into rural communities to avoid duplication of services in a given area.

5.4 Inadequate capacity to carry implement IWRM

Capacity building should be guided by a clear understanding of institutional roles and responsibilities in the context of decentralisation. A broad view of capacity building is required, including issues of management, human resources, skill development, organisational development, training and the mobilisation of financial resources.

The changing roles of MoIWD require new skills and competence in planning, monitoring, evaluation and regulation of water supply and sanitation services in line with the Decentralization Policy. Capacity building must be tailored to allow the officers to take on these new roles and perform them effectively. It is, however, important to identify and analyse existing capacity gaps and tailor the capacity programme to fill these gaps.

For effective implementation, sustainability and operation and maintenance of water and sanitation projects, there is need for capacity at grass root level. The basics of CBM have become institutionalized in many programmes and projects and this is having a positive impact on the maintenance of water points within communities. There is, however, need for further development to ensure the long term sustainability by improving the spare parts supply chain and the mechanism for carrying out repairs beyond the capacity of the communities and increasing the range of technology choices offered to communities.

Capacity building is not just a role for the Government. The challenge is to see how all the stakeholders can contribute to building capacity within the sector.

5.5 Standards, procedures and specifications

The provision of water and sanitation services is performed by a number of organisations and institutions. This has led to a proliferation of approaches and procedures and a lack of standardisation. Technical specifications for water and sanitation facilities are very variable and this leads to cost variations. Sometimes the bases for these cost variations are not obvious, other than the fact that the different procedures may incur different expenditures. The challenge is to see how the sector coordinates these various approaches and implement them in IWRM.

5.6 Disaster management (floods and droughts)

Currently, Malawi has a reactive approach to flood and drought disaster management. In years of excessive rains, flood disaster management is prevalent, whilst the management of food and water shortages follows the years of droughts. The country is aware of areas that are prone to floods and droughts, but as yet no mitigation measures have been instituted. Limited efforts have been made to utilise forecasting models for flood warning and early drought monitoring, but there is only very limited infrastructure activity.

In 'normal' years the water resources of Malawi are mostly seasonal causing floods during the rainy season and droughts in the dry season, yet per capita availability of water shows ample water resources for every citizen. Water resources will have to be harnessed through water harvesting and catchment rehabilitation and management.

Properly managed catchments will improve water retention on the catchment to enhance aquifer recharge and improved dry season stream flow. The challenge is to implement an integrated flood management initiative that aims at ensuring an end-to-end process of flood

management, put in place in a balanced manner, duly considering prevention and mitigation measures and the positive and negative impacts of floods. The development of the resultant national integrated flood management and drought management strategies is definitely another challenge

5.7 Shared water resources

Management of Lake Malawi, Shire -Ruo River system, Lake Chilwa, Lake Chiuta Songwe River catchments shall required cooperation between riparian countries of Tanzania and Mozambique. There is undoubtedly a challenge in luring political support to the management of the transboundary water courses. A mechanism is required to create a flat form for consultation and dialogue among affected nations.

The existence of legal instruments of shared water resources provides a favourable environment for contact and dialogue among riparian states in order to promote integrated water resources management.

5.8 HIV/AIDS

The number of deaths and the extent of human suffering caused by AIDS have assumed an unimagined order of magnitude. The consequences are now so pervasive that they constitute a substantial challenge to social and economic development in Malawi. HIV is no longer simply a public health issue but a major concern to sustainable integrated water resources development and management. It cuts across agencies, disciplines and national boundaries.

6. Summary

Malawi is water stressed country with total renewable water resources per capita of 1,400 m³. With such a low per capita, Malawi is worse of than Botswana and Namibia, countries which have large areas of desert. Within the SADC, Malawi is the second country with low per renewable water per capita, after South Africa.

Per capita of renewable water available will decline further over time due to rapidly growing population of 2.8 percent, climate change/climate vulnerability and water quality degradation (due to poor agricultural practices, poor waste management, deforestation and forest degradation). In spite of the low per capita adoption of WDM, strategies has remained low especially in agriculture sector most of the water is used.

Lake Malawi-Shire River water system, which is a strategic water resource for hydro power generation, irrigation, navigation and fisheries, is a vulnerable resource because about 53 percent of the water comes from the catchment in Tanzania. Any major water development activities within the catchment would have serious consequences of the economy of Malawi. Efforts to manage water resources more efficiently have been hampered by inadequate capacity for IWRM, unharmonised policies and laws, inadequate catchment management practices and poor coordination among stakeholders.

Water stress status of Malawi is a serious threat to development of the country and has the potential to reverse development already achieved by the nation. Water shortage will seriously affect efforts of Malawi Government to achieve Growth and Development goals

set out in MGDS because MGDS is about using more and more water for farming, tourism, industries, navigation, electric power generation and other economic activities.

The declining water situation will now become the major limiting factor towards development of the country. Water allocation among competing potential users will become critical and trade offs will have to be made in order to ensure that the scarce water resource is used in an activities that will result in maximizing benefits for the nation.

The trans-boundary nature of the water resource also mean that Malawi will need to develop very close dialogue/consultations with the neighbouring countries in order to ensure that water development in respective countries does not negatively affect the development agenda of neighbouring countries. While joint commission of cooperation exists with Mozambique, Malawi needs similar consultation mechanism with Tanzania and Zambia. Issues of common interest will be both water resources management plans in neighbouring countries but also Malawi will need to start dialogue on cross border water transfer potential from neighbouring countries to Malawi.

IWRM/WE offers an approach that can enable Malawi effectively address national and international water resource challenges by promoting integrated management of natural resources and promoting consultations of various stakeholders in water and water-related fields.

7. References

- Carl Bro International, 1995. *Sanitation Master Plan for the City of Blantyre: Existing Sanitation Situation Volume III*. Government of Malawi.
- Chipofya, V., Kainja, S., Bota, S., 2009. *Policy Harmonization and Collaboration amongst institutions – a strategy towards sustainable development, management and utilization of water resources: case of Malawi*. Desalination, Elsevier. 248, Issues 1-3, 678-683.
- Malawi Government, 1969. *Water Resources Act, Cap 73:03*, Laws of Malawi, Government of Malawi, Zomba.
- Malawi Government, 1995. *Waterworks Act, No. 17*, Laws of Malawi, Government of Malawi, Lilongwe.
- Malawi Government, 1995. *Malawi's Vision 2020*. Government of Malawi, Lilongwe, Malawi.
- Malawi Government (2003). *Strengthening of Water resources Boards Report, Annex 6*
- Malawi Government, 2005. *National Water Policy*. Ministry of Irrigation and Water Development, Government of Malawi, Lilongwe.
- Malawi Government (2006). *Ministry of Irrigation and Water Development National Strategic Plan (2006 - 2011)*.
- Ministry of Works & Supplies/UNDP (1986). *National Water Resources Master Plan, Report and Appendices: Surface Water Resources General*.
- Malawi Government, 2007. *Integrated Water Resources Management and Water Efficiency Plan*. Ministry of Irrigation and Water Development, Government of Malawi, Lilongwe, Malawi.
- Malawi Government, 2008. *National Sanitation Policy*. Ministry of Irrigation and Water Development, Government of Malawi, Lilongwe.
- Malawi Government, 2009. *Population and Housing Census*. National Statistical Office, Government of Malawi, Zomba www.un.org/millenniumgoals/



Sustainable Development - Energy, Engineering and Technologies - Manufacturing and Environment

Edited by Prof. Chaouki Ghenai

ISBN 978-953-51-0165-9

Hard cover, 264 pages

Publisher InTech

Published online 29, February, 2012

Published in print edition February, 2012

The technological advancement of our civilization has created a consumer society expanding faster than the planet's resources allow, with our resource and energy needs rising exponentially in the past century. Securing the future of the human race will require an improved understanding of the environment as well as of technological solutions, mindsets and behaviors in line with modes of development that the ecosphere of our planet can support. Some experts see the only solution in a global deflation of the currently unsustainable exploitation of resources. However, sustainable development offers an approach that would be practical to fuse with the managerial strategies and assessment tools for policy and decision makers at the regional planning level. Environmentalists, architects, engineers, policy makers and economists will have to work together in order to ensure that planning and development can meet our society's present needs without compromising the security of future generations.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

V. Chipofya, S. Kainja and S. Bota (2012). Integrated Water Resources Management - Key to Sustainable Development and Management of Water Resources: Case of Malawi, Sustainable Development - Energy, Engineering and Technologies - Manufacturing and Environment, Prof. Chaouki Ghenai (Ed.), ISBN: 978-953-51-0165-9, InTech, Available from: <http://www.intechopen.com/books/sustainable-development-energy-engineering-and-technologies-manufacturing-and-environment/integrated-water-resources-management-key-to-sustainable-development-and-management-of-water-resourc>

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen