Photo: Helle Biseth.

04 Freshwater

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Executive summary

Water availability for safe drinking and adequate sanitation is a significant challenge for Malawi, especially in rural areas *(well established).* A large section of the population lacks access to safe and clean water for domestic use, particularly in rural areas due to long distances to water sources, variations in rainfall distribution, and high equipment failure rates (approximately 40 per cent) of water supply infrastructure. Per capita water availability declined from 1,400 m^3/person/year in 2013 to 928 m^3/person/year in 2017 and is projected to decline to 403 m^3/person/year by 2050, placing Malawi into the water stress category. The increase in population is leading to increased demands for industry and agriculture, and this often outcompetes access to water for domestic use. The country's water situation is further compounded by unregulated water abstraction. Water in rivers, lakes, and shallow wells is of poor quality and generally does not meet the World Health Organization and Malawi Standards for potable water. While some progress continues to be made in improving access to safe water, sanitation, and hygiene (WASH), about US$97 million is needed for universal basic coverage and US$258 million for safely managed services by 2030 {4.2.1.2, 4.2.2.2, 4.2.3, 4.3.3, 4.4.7}.

Droughts, floods and cyclones are increasing in frequency, negatively impacting Malawi's water resources *(established but incomplete).* Damage caused by floods, mudslides, and flash floods is evident in some areas in Malawi. Other multiple factors affecting Malawi's freshwater resources include human activities such as mining, agriculture, and industry which lead to pollution and sedimentation of water bodies, impacting both groundwater and surface water quality. Deforestation and sedimentation from human actions have been noted to influence lake and river levels. {4.1, 4.3.4}.

Malawi's large rivers and lakes are facing heightened sediment load from land degradation, damaging freshwater ecosystems and reducing reservoir capacity *(established but incomplete).* High population densities, deforestation, high agricultural development, poor land use practices, and topography worsen conditions for soil erosion and sediment deposits into water bodies. Catchment management systems are vital for sustainable water resources management, especially as climate change increases pressure on supply and demand. The country supports basin planning, catchment rehabilitation, and management through public works and committees to support sustainable water practices. Safeguarding watersheds is crucial for water resource preservation. Integrated water resources management efforts such as the Malawi Watershed Services Improvement Project aim to restore at least 50 per cent of degraded areas in major river basins such as Shire, Linthipe, Bua, Dwangwa, North Rukuru, and Lufilya {4.2.1.2, 4.4.8}.

Transboundary waters, shared by at least two countries, account for the bulk of Malawi's freshwater inflows, including into Lake Malawi and Shire River *(well established).* The effective use and management of Malawi's shared water resources requires coordination, information and data sharing, and policy harmonisation with its neighbours. {4.4.1, 4.4.2}.

Most rural communities access drinking water through boreholes and wells. Photo: ILRI.

4.0 Introduction

Malawi is rich in water resources. These water resources include those found in lakes such as Lake Malawi and Lake Chilwa, lagoons such as Chia Lagoon and Chikukutu Lagoon, swamps and marshes such as Elephant Marsh and Vwaza Marsh, rivers that include Shire River and Ruo River, and groundwater systems. The Shire River, which flows from Lake Malawi through Lake Malombe to the Zambezi River in Mozambique, is significant for freshwater systems in Malawi; discharging about 12.5 km^3 through the basin annually (International Lake Environment Committee 2006).

While Malawi has abundant renewable water, estimated at 17.3 km^3 per year, the country faces challenges in water availability for domestic use, with decreasing per capita renewable water availability, placing the country in a water stress category (Hughes 2019). This water stress results from population growth, climate variability, and poor storage and distribution infrastructure; affecting agriculture, industry, and public health (Bronstert, Mtilatila and Vormoor 2024; Kachaje, Chisanu and Liangjun 2017).

Water in Malawi is mainly replenished through rainfall. Human activities causing pollution and deforestation harm water resources. These conditions, alongside extreme weather events, worsen water quality and often lead to disease outbreaks such as cholera (Jung *et al.* 2023). Recent heavy rainfall cycles caused by La Niña (Mloza Banda, Cornelis and Mloza Banda 2024) and cyclones (Braka *et al*. 2024) have raised groundwater levels, but also caused mudslides, flooding, and contamination of surface water, with severe economic impacts.

The economic burden of degraded water resources in flood-prone areas is significant. For example, flood damage costs in 2019 were estimated at US$57 million (Hughes 2019), affecting Malawi's capacity to meet its developmental. This situation emphasises the need for sustainable water resource management and environmental protection to ensure the availability of freshwater for future generations.

4.1 Surface water resources and quantity

Malawi's surface and groundwater resources are grouped into 17 water resources areas in which each waterwater resource area (WRA) represents one hydrological basin, as shown in Figure 4.1 and Table 4.1. These WRAs are further subdivided into 78 local sub-catchments for ease of Integrated Water Resources Management planning and implementation as required under the Water Resources Act (2013).

Heavy rainfall is the primary cause of flooding in Malawi. Photo: Horst Vogel.

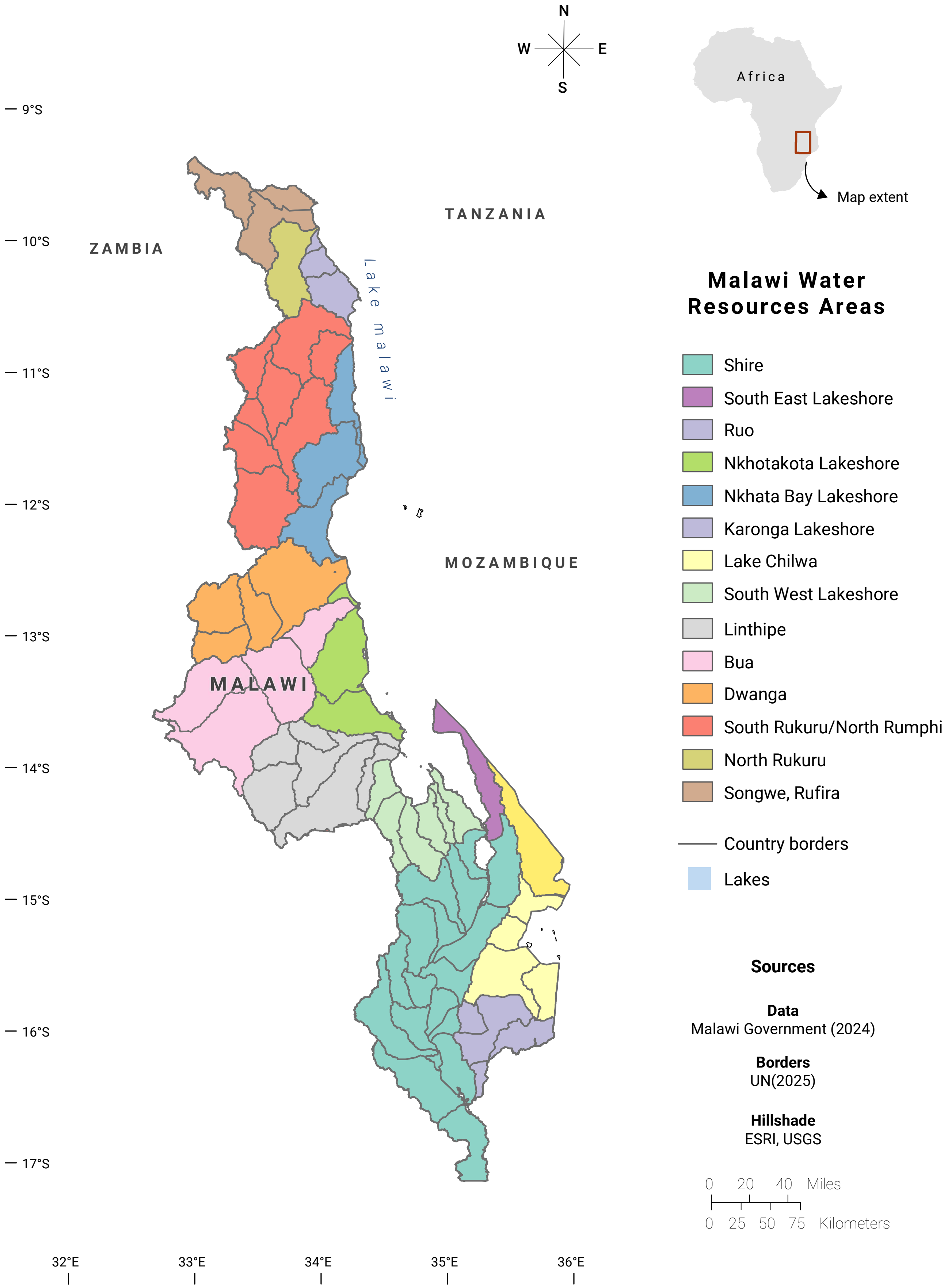

Figure 4.1: Water Resources Areas in Malawi

Table 4.1: Water Resources Area sizes, categories and its location

Water Resource Areas	Region	Area (km2)	Water Resources Units
1. Shire	Southern and Central	18,945	16
2. Lake Chilwa	Southern and Central	4,567	4
3. South West Lakeshore	South	4,998	5
10. South East Lakeshore	South	1,659	1
11. Lake Chuita	South	2,443	1
14. Ruo	South	3,519	4
4. Linthipe	Central	8,885	6
5. Bua	Central	10,658	4
15. Nkhotakota Lakeshore	Central	4,819	3
6. Dwangwa	Northern and Central	7,751	4
7. South Rukuru, North Rumphi	Northern	12,719	7
8. North Rukuru	Northern	2,088	1
9. Songwe, Lufira	Northern	3,730	2
12. Lakoma Island	Northern	17	1
13. Chizumulu Island	Northern	3	1
16. Nkhata Bay Lakeshore	Northern and Central	5,533	3
17. Karonga Lakeshore	Northern	1,945	3

4.1.1 Lakes

In Malawi, surface water resources consist primarily of lakes, rivers and reservoirs, with Lake Malawi, the third largest lake in Africa, holding most of the country's surface water. The country's hydrology is shaped by major rivers such as the Shire, North Rukuru, South Rukuru, North Rumphi, Songwe, Linthipe, Dwangwa, Ruo, and Bua. Except for the Shire and Ruo, most of the rivers drain into Lake Malawi and support the country's agriculture, fisheries, energy, and domestic water supply.

The Lake Malawi system is the most prominent hydrological feature in the country. Bounded by Malawi, Mozambique and Tanzania, Lake Malawi is 560 km long and averages around 50 km in width (Johnson and Davis, 1989). The surface area of Lake Malawi ranges between 28,750-30,800 km^2, and a volume of approximately 7,725 km^3 (Drayton 1980; 1984). The Shire River drains out of the lake. On average, the Shire River flow rate fluctuates around 450 – 500 m^3/s, which helps to regulate Lake Malawi's water levels (Chisala and Kansake 2003) Figure 4.2 shows the lake level trends (1900 – 2024) as measured at Kamuzu Barrage (Liwonde). The other major lakes in Malawi include Lake Chilwa, Lake Malombe, Lake Chiuta, and Lake Kazuni, the areas and volumes of which are described in Table 4.2.

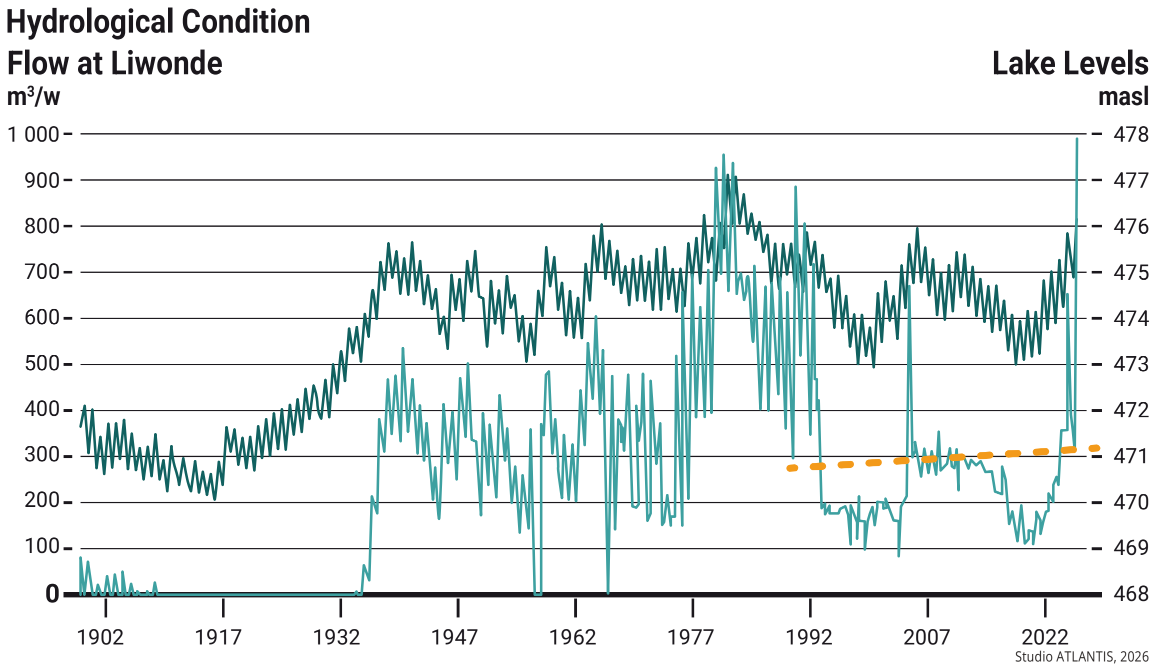

Figure 4.2: Malawi Lake Levels and Shire River water flow regime measured at Liwonde barrage (Nkwanda *et al.* 2021).

Table 4.2: Other Lakes in Malawi

Lake	Area (km²)	Volume (km³)	Location (Districts)
Chilwa	683	1.8	Machinga, Phalombe and Zomba.
Malombe	303	1.013	Mangochi
Chiuta	60	0.225	Machinga
Chia Lagoon	20	-	Nkhotakota
Kazuni	4.6	-	Mzimba and Rumphi
Chiwondo and Mlare	2.17	-	Karonga

4.1.2 Rivers

The country's surface water quantity is also held in highly extensive river systems. The main river systems in Malawi include Shire, Linthipe, Bua, Songwe, Dwangwa, Ruo, North Rukuru, South Rukuru, North Rumphi, Mwanza, and Wankulumadzi, which also have numerous annual and perennial tributaries. Most of these rivers (the Songwe, Linthipe, Bua, Dwangwa, North Rukuru and the South Rukuru) drain their water into Lake Malawi with inflows of about 360 m^3/s (Republic of Malawi 2015). As the Shire River flows out of Lake Malawi into the southern region, it is joined by two major tributaries, Ruo and Mwanza Rivers, which greatly influence water quantities in the Shire River, particularly in Lower Shire. Like the lakes, the quantity of surface water resources in rivers is highly dependent on the availability of rainfall, which sustains runoff. In these rivers, surface water resources are more abundant during the rainy season than during the dry season. Additionally, the quantity of surface water in Malawi is predominantly influenced by various other factors, the key being climate change and anthropogenic activities. Anthropogenic activities have significantly impacted the environment and altered natural processes and ecosystems. In Malawi, the key anthropogenic activities having significant impacts on water resources include agriculture, urbanisation, and construction, which bring immense land use changes, waste, and pollution.

4.1.3 Reservoirs

Malawi has numerous artificial reservoirs that have been constructed for hydropower generation, urban and rural water supply, and irrigation. Hydropower generation reservoirs are located on the Shire River at Nkula A and B, Tedzani and Kapichila, and on the Wovwe River. Planned hydropower generation reservoirs include Mpatamanga on Shire River, Lower Fufu, and Songwe rivers. The main drinking water supply reservoirs include Kamuzu Dam I and II on Lilongwe River, Mpira, Mulunguzi, Lunyangwa, and Mudi with a total storage of over 43 million cubic metres. In addition to these major reservoirs there are over 700 small reservoirs in Malawi that were primarily developed for irrigation with a storage capacity of approximately 64 million cubic metres (Food and Agriculture Organization (FAO) 2006).

Deforestation, unsustainable agriculture practices that cause soil erosion, urbanisation, and climate change are some of the major factors affecting the functionality and sustainability of these reservoirs. For example, Mwimba Reservoir in Kasungu, whose original design volume is 89,200 m^3, declined by 18.2 per cent over a 5-year period to a volume of 72,966 m3 (Kumambala *et al.* 2025). Policy conflicts also have contributed to reduced functionality and capacity of reservoirs. For example, Chiwembe and Chimwankhunda Dams have completely silted due to conversion of its catchment from forestry to urban housing and commercial development (MBC online 2022). Similarly, conflicting policies and strategies between the Departments of Forestry and Water contributed to the reduction of water supply capacity of the Mpira Dam due to harvesting of trees in the Mpira Catchment (Times online 2015).

Climate change has significant effects on surface water quantities in Malawi. Extreme climate conditions have seen some of Malawi's perennial rivers drying up or increased water flow and levels in both rivers and lakes. For instance, due to increased rainfall, Lake Malawi water levels have increased significantly, reaching the second-recorded highest-level of 475.7 metres above sea level in the 2023/2024 hydrological cycle and the third highest level (475.03 meters above sea level) was recorded during the 2020/2021 hydrological year. The highest, 477.22 meters above sea level, was recorded in 1980. The impact of climate change continues to influence rainfall characteristics. Studies predict a wide range of changes in annual rainfall, evapotranspiration, surface runoff, and water yield in many rivers and lakes in Malawi by the 2050s. These predicted changes include a -5.4 per cent to +24.6 per cent variation in annual rainfall and a -7.5 per cent to over +50 per cent change in annual surface runoff and water yield, with notable regional differences (Adhikari and Nejadhashemi 2016). These changes are expected to greatly impact surface water quantities in Malawi.

4.1.3 Land use change impacts

Land use changes, particularly the conversion of natural forests to agricultural land, impact surface water quantities significantly. The expansion of built-up areas, agricultural land, and deforestation cause an increase in soil erosion and surface runoff in many rivers and lakes in Malawi. For instance, a study on Lake Malawi showed that deforestation led to significant changes in lake levels, with a decrease in forest cover resulting in higher lake levels during drought periods (Calder 1995). A similar study which was carried out in the Rivirivi River basin, one of the major tributaries of the Shire River, indicated that the 65 per cent reduction in the forest cover from 1992 to 2008 increased high flow index by 16 per cent and the number of zero-flow days (Chimtengo *et al*. 2014).

4.1.4 Sediment impacts

Sediment issues are quite evident in many catchments across Malawi. Soils which are constantly being eroded from agricultural, built up, and deforested areas tend to reduce the volume of river channels, reservoirs, and lakes, consequently impacting the volume of water. Higher sediment concentrations, loads, and yields are observed in densely settled catchments with extensive agricultural activity, while lower values are found in small, steep catchments with a high proportion of intact forest. Fuelled by climatic and hydrological changes, riverbed siltation is quite visible in areas such as Nkhotakota lakeshore, the Shire Valley, central Karonga, Central Region Plateau, and most rivers that flow into Lakes Chilwa and Malawi. Lyons *et al.* (2011) observed that Lake Malawi has experienced significant lake-level fluctuations which are marked by changes in sediment patterns, with coarse-grained sediment and organic matter flux increasing when precipitation and runoff are high.

4.2 Surface water quality

Surface water is abstracted directly from rivers, lakes, and dams for domestic, industrial, and agricultural use. Surface water also serves critical ecosystem functions such as supporting aquatic biodiversity and productivity, tourism, and culture. Good surface water quality that meets national and international standards is necessary for sustaining human health, supporting ecological functions, and for utilisation as an input to industrial, domestic, and agricultural uses. There is very little information on the parameters that are used to assess the suitability of surface water for irrigation and to monitor water contamination by agrochemicals, largely because there are no standards provided for such purposes in the country.

Surface water quality from rivers, lakes and shallow wells has been shown to be poor and generally exceeding World Health Organization (WHO) guidelines and Malawi Standards (MS) for potable water (Mweta *et. al*. 2022; Table 4.3). Water quality monitoring for pesticide residuals is also absent in all major rivers even though the Government of Malawi acknowledges that pollution of waterbodies, air, soil, and food due to improper handling, storage, and disposal of pesticides is of high concern (Government of Malawi 2010).

Table 4.3 provides a summary of the state of water quality in selected surface water environments in Malawi.

Table 4.3: Table summarising surface water quality results for various water bodies.

Water Quality Parameter	Water Body							
	Limit	Malawi	Chilwa	Malombe	Likangala	Lilongwe	Mudi	Shire
SRP (mgl/L)	0.02	0.15-0.86	NA	0.01	NA	NA		
Phosphate (mg/L)	10	5.89-7.95	2.95	6.9	1.5-10.7	148	0.5-5.6	15.5-23.6
TDS (mg/L)	450-1000	500	1921	1240-1500	50-273	60	153-560	
Nitrate (mg/L)	50	50	17.8	3.9-7.9	12.4	75	83-136	<0.1
Turbidity (NTU)	<25	25	141	19.6-21.5	97.7	10-1158	12.6-1016	42-59
pH	6.5-9.5	6.5-9.0	8.6	7.4-7.6		6.7	7.7-8.5	
Electrical conductivity (μs/cm)	<3500	3500	15000	165.3	864	400	155-568	<200
Faecal coliform (cfu/100ml)	0	0-21000	1015	77	14739	20408	640-3360	96.149
Fluoride (mg/L)	1.5	2.0	40-42		2.1	NA		
Sulphate (mg/L)	400	5.7	2.9	0.63	1.94-11.6	NA	5-88.5	4.4
Sodium (mg/L)	200	80	328.4	14.4	20.2	24.3	NA	6.4
Potassium (mg/L)	10	6.4	12.4	245	3.1	NA	NA	15

Surface water quality varies in time and space. In Blantyre, Chiradzulu, and Mulanje districts in southern Malawi, Pritchard *et al.* (2007) showed that total coliform (TC) and faecal coliform (FC) values in the wet season (February and April 2006) were much higher than those in the dry season (August and October 2005). Chikabvumbwa *et al.* (2021) showed substantial water quality deterioration in Upper Lilongwe River (Figure 4.3), which was attributed to increased sewage effluents and surface runoff from non-point sources such as agricultural land, grazing land, settlements, urban areas, and point source such as industry. Similar water quality trends observed in the Upper Lilongwe River catchment were noted in various other rivers (Pullanikkatil *et al.* 2016).

Communities are encouraged to collect rainwater for future use. Photo: Horst Vogel

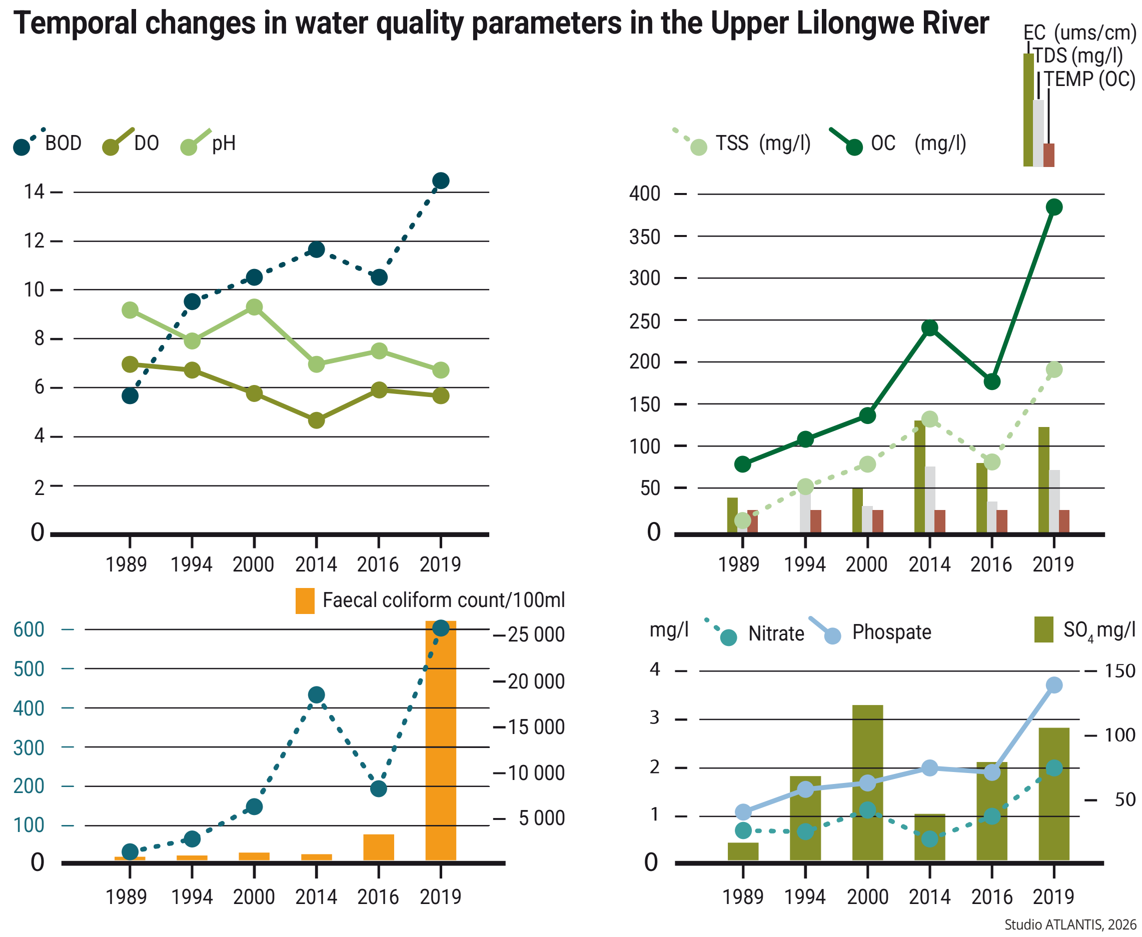

Figure 4.3: Temporal changes in water quality parameters in the Upper Lilongwe River (Nkwanda *et al.* 2021)

Urban rivers are prone to pollution from city and industrial waste, while rural rivers are mainly affected by non-point agricultural contaminants. Spatial changes in water quality have been observed along the shores of Lake Malawi where residents depend on nearshore water for drinking, cooking, and bathing. At 15 m from the shoreline, *E. coli* concentrations dropped by between 0.3 to 17 per cent of shoreline values. Tyner *et al.* (2018) reported that 90 per cent of water samples from the Lake exceeded the WHO drinking water standard of 0 colony forming unit (CFU)/100 ml. Microbial contamination of lake waters affects the quality of fish if it is not properly handled after harvesting and processing. FISH (2018) showed that improperly handled fish stored in the boat keel where the fish was in contact with inshore water had higher levels of total coliforms, *E. coli* and *Salmonella* compared with fish stored in containers. This suggests that poor lake water quality has implications for fish quality and food safety in addition to the negative impacts of the consumption of contaminated water on human health.

Pesticide and herbicide use in Malawi has generally shown an increasing trend since 2010, especially in crop production like sugarcane, tea, macadamia, and horticulture. The emergence of fall armyworm in maize and rising labour costs in small-scale agriculture has also resulted in increased use of pesticides and herbicides, respectively. Pesticide residues can contaminate surface and groundwater, affecting the quality of water for human consumption and the environment. Several studies have noted the growing trend in the use of agro-chemicals and their negative impacts on surface water quality in rivers in Malawi (Kamwala 2024; Kanyika-Mbewe *et al.* 2020; Kasambala *et al.* 2018).

Deforestation and poor agricultural practices increase runoff and soil erosion, leading to elevated levels of total suspended solids and nutrients in river discharge. This in turn leads to increased sediment and nutrient loading in Malawi's lakes (Kingdon *et al.* 1999). The use of fertiliser and indiscriminate disposal of metal products contributes to pollution. Rivers that flow through urban spaces such as Lilongwe, Likangala, Mudi, and Limbe show elevated concentrations of pollutants that are attributed to the effluent discharge from industries and wastewater leakages from sewer systems due to poorly functioning or non-existent wastewater treatment plants and poor enforcement of pollution control and wastewater management measures by authorities.

The Malawi Agenda 2063 puts emphasis on the development of irrigation infrastructure to reduce dependence on rain-fed subsistence agriculture and enhance agricultural productivity through efficient, sustainable, and reliable irrigation. Surface water quality in rivers and lakes must be evaluated for its suitability for irrigation and aquaculture. Wanda *et al.* (2014) reported high salinity in sampled shallow wells in Mzimba district, which made water unusable for irrigation. Surface water quality assessments for selected rivers (Balaka and Chagoma 2022; Jamu *et al*. 2012; Kingdon *et al.* 1999) indicate that river quality is heavily impacts fisheries productivity, especially for species such as *Opsaridium microlepis* (mpasa), *Barbus sp,* and *Enteromius sp* that require riverine environment to spawn.

There is a need to intensify the implementation of long-term integrated water resource management activities to restore and sustain the provisioning and regulating functions of watersheds, ensuring the sustainable availability of good quality water for multiple uses in Malawi. The Watershed Services Improvement Project is one such effort to address integrated water resources management (IWRM). The main aim of the project is to increase the adoption of sustainable landscape management practices and improve watershed services in targeted watersheds of the Shire River Basin, Linthipe, Bua, Dwangwa, North Rukuru, and Lufilya basins, with a target of restoring at least 50 per cent of degraded landscapes in priority catchments.

4.3 Groundwater resources and quantity

Groundwater is an essential resource for over 60 per cent of the country's population who rely on it for domestic and industrial use. Although groundwater overreliance is very prominent in rural areas, due to increased informal settlements in the country's urban areas, groundwater is also becoming one of the major sources of water supply in various urban dwellings. This has led to an increase in water abstraction points from approximately 38,000 in 2012 to 85,327 by 2022 (Kalin *et al.* 2022).

The quantity of groundwater varies across the country. In general, Malawi's geological characteristics consisting of consolidated sedimentary rock, unconsolidated sedimentary rock overlaying weathered basement, and weathered basement overlaying fractured basement. Important rock formations for groundwater as described in Table 4.4.

Table 4.4: Aquifer groups in Malawi

Aquifer Group	Description	General effect on Water Quality	Key Processes
Consolidated sedimentary rock	Consolidated sedimentary rocks of various compositions including sandstones, marls, limestones, siltstones, shales, and conglomerates. Groundwater is transmitted via fissures, fractures, joints, and intergranular pore spaces.	Quality improvement; acts as a natural filter	Denser, less permeable rocks (like shale or sandstone) slow water movement, filtering out suspended solids and allowing time for some chemical attenuation. However, certain rock types can introduce dissolved minerals like calcium, magnesium, or iron, increasing hardness.
Unconsolidated sedimentary rock overlaying weathered basement	All unconsolidated sediments including sands, gravels, lacustrine sediments, colluvium, alluvium, and fluvial sediments. Groundwater is transmitted via intergranular pore spaces. Name indicates that all sediments are generally deposited onto weathered basement aquifers at variable sediment depths.	Variable quality; often high turbidity.	The high porosity and permeability of materials like sand and gravel allow water to flow quickly, making the aquifer vulnerable to surface contamination (e.g., agricultural runoff, septic systems).
Weathered basement overlaying fractured basement	Weathered basement overlying fractured basement at variable depths. Groundwater is stored and transmitted via intergranular pore spaces in the weathered zone, and mainly transmitted via fractures, fissures and joints in the fractured zone.	Introduction of specific minerals	Chemical weathering of the original granite or other basement rock can introduce elements like iron, manganese, or even trace amounts of heavy metals into the water as minerals dissolve.

Source: Kalin *et al.* 2022; Mapoma *et al.* 2017b.

The Hydrogeology and Groundwater Quality Atlas of Malawi estimates that the country's groundwater volumes range from 96,656 to 1,108,340 million cubic metres. The total recharge into all aquifer units' ranges between 1,031 and 7,731 million cubic metres per year. (Kalin *et al.* 2022)

Groundwater quantity in Malawi suffers unsustainable withdrawal rates, especially near urban areas where the resource is not just for domestic uses but also for small-scale industries. Climate change, which has altered rainfall and evaporation rates, is also reducing groundwater recharge in many areas across the country, consequently impacting the overall quantity. The recharge is also greatly impeded in areas where natural vegetation has been cleared due to settlement expansion, agriculture, and deforestation, as areas cleared of vegetation tend to experience high runoff rates and reduced infiltration.

4.4 Groundwater quality

An assessment of the status of groundwater quality in Malawi is important because a large majority of rural Malawians depend on groundwater from boreholes and shallow wells for household use (Holm *et al*. 2018; Mapoma *et al.* 2017a; Mapoma *et al.* 2016). Groundwater is also increasingly becoming an important source for irrigation due to low and seasonal availability of surface water and the availability of low-cost solar-powered irrigation systems (Wamalwa 2024; Kamwamba-Mtethiwa 2016).

Groundwater quality is influenced by anthropogenic and geogenic processes. Anthropogenic processes include leaching of agricultural and industrial effluents into the soil, as well as microbial contamination of groundwater due to pit latrine loading (Table 4.5). The anthropogenic impacts of groundwater pollution are higher in unconfined alluvium aquifers and prone to ionic contamination by surface waters. Geogenic processes lead to elevated ionic concentrations such as salinity, fluoride, iron, sulphate and chlorides. Nyirenda *et al.* (2015) raised concerns on the turbidity of groundwater in the Lakeshore districts of Salima and Nkhotakota due to both anthropogenic and geogenic processes. It is inferred that various human activities can be used to map the variations in the quality of groundwater in an area (Mapoma *et al.* 2017a) which may assist in identifying solutions.

Table 4.5: Calculated pit latrine loading trends in the Nkhata Bay lakeshore area (Water Resource Area 16 (Source: Kalin *et al*. 2022)

	Population					**Projection**	**Latrine fecal sludge**	**Cumulative Sludge loading**
	Calculated Number of Latrine users							
Water Resource Unit	Year 2011-2012	Year 2013-2014	Year 2015-2016	Year 2017-2018	Year 2019-2020	Year 2021-2022	Total Volume over 10-year period (Litres)	Estimated Total Loading (Metric tonnes faecal sludge 2012-2022
16E	87,951	89,274	96,109	101,005	104,240	99,721	312,281,733	374,738
16F	115,717	121,587	128,837	137,024	141,586	139,274	423,373,438	508,048
16G	58,740	56,980	58,466	59,616	59,923	59,660	190,827,595	228,993
WRA 16	262,408	267,841	283,412	297,645	305,749	298,655	926,482,766	1,111,779

Table 4.5 illustrates that the generation of faecal sludge is increasing over the years, yet on-site sanitation is dominant in Malawi. Sewer systems are limited to small portions of high-income areas, with over 90 per cent of residents in informal settlements relying on on-site sanitation, primarily pit latrines. Some of the faecal sludge is transported to city wastewater treatment plants for co-treatment with wastewater, but these facilities often receive only a fraction of the total collected sludge. The majority of faecal sludge bypasses formal treatment systems, often ending up in the environment. This may contribute to the public health burden in the country.

Banda *et al*. (2024) show that anthropogenic activities have resulted in elevated nitrate concentrations in ground water in the Lake Malawi basin which cannot be traced to geogenic processes (Figure 4.4). The observed elevated groundwater nitrate concentrations highlight the widespread human impact of extensive fertiliser use, surge in pit latrines, and septic tank systems on groundwater quality.

The high-water ionic concentrations in Lake Chilwa; particularly the high salinity, total dissolved solids (TDS) and sodium concentrations in the bases; are influenced by geological lacustrine deposits. These high ionic concentrations relative to surface water strongly indicate the need to develop surface water sources with low TDS and salinity for potable water in the basin. Monjerezi and Ngongondo (2012) reported that the presence of highly mineralised groundwater in the Lower Shire rendered groundwater resources in large areas unsuitable for domestic and irrigation purposes. Good quality groundwater is found in the Karoo basalts, Precambrian basement complex, and their derived sediment found in their vicinity and away from the saline groundwater zones (Monjerezi *et al*. 2012).

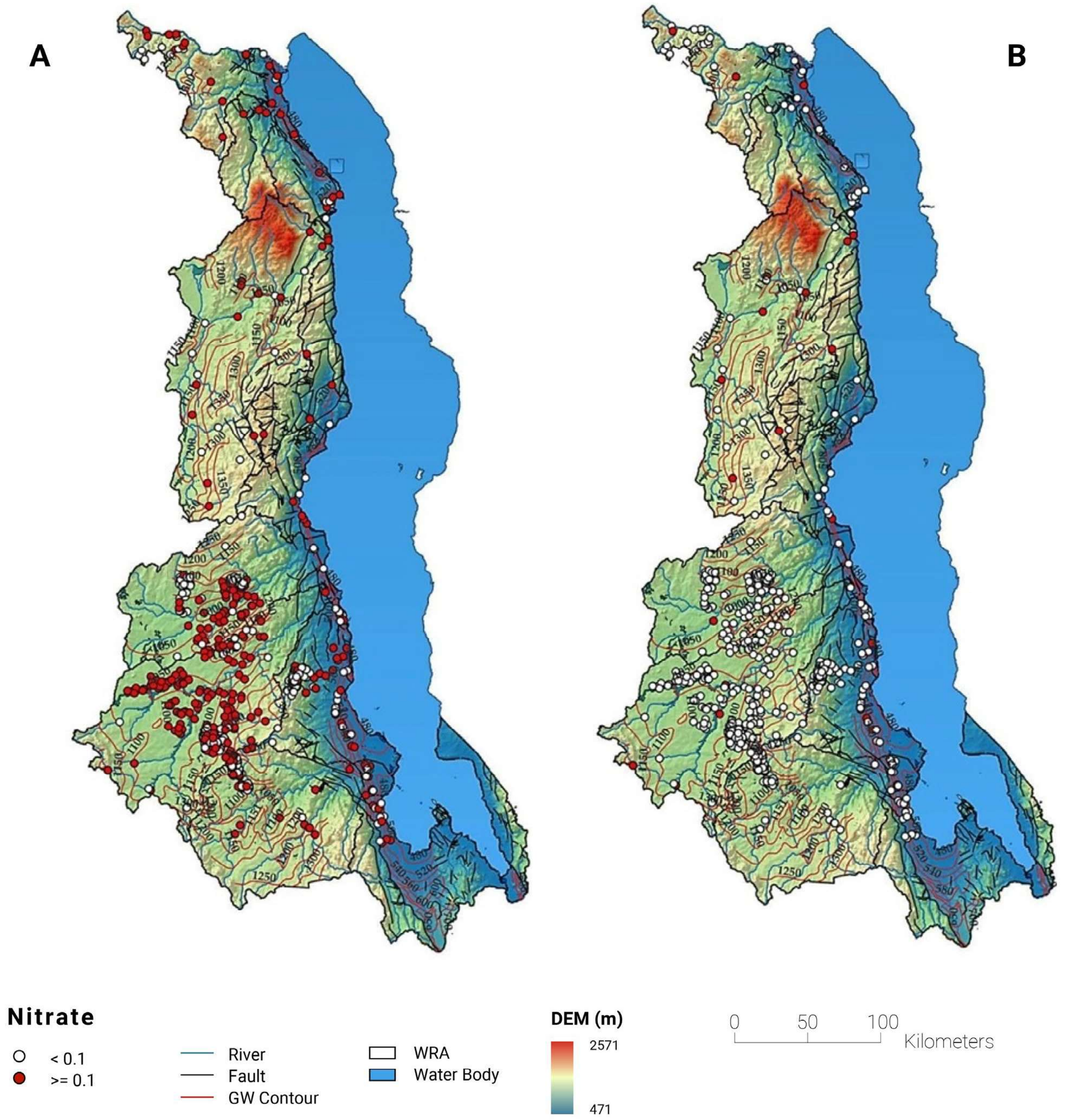

Figure 4.4: Spatial distribution of nitrate concentrations in groundwater across the LMB. (a) shows general distribution of measurable nitrate and (b) shows measurable nitrate concentration projecting potential (Banda *et al.* 2024).

4.5 Water resources availability and access

Although Malawi is rich in water, water availability and access are shaped by many factors such as climate, geography, technology, and socio-economy.

Lake Malawi, which spans close to a fifth of the country's area and supports a variety of needs, from drinking water to agriculture and hydropower generation, is the largest and most crucial source of surface water resources. Lake Malawi, which spans close to a fifth of the country's area and supports a variety of needs, from drinking water to agriculture and hydropower generation, is the largest and most crucial source of surface water resources. Rivers, particularly the Shire River, further contribute to the country's surface water reserves. Many rivers are seasonal and affected by rainfall patterns. In the rural communities where piped water systems from surface water bodies are less accessible, groundwater sources are the most important. Groundwater availability in Malawi also varies depending on geological as well as climatic factors.

In addition to the geological differences, rainfall patterns in Malawi are highly seasonal, with most precipitation occurring between November and April, leading to variations in surface water levels and recharge rates for aquifers. The commonly observed rain-bearing systems in Malawi include the Inter-Tropical Convergence Zone (ITCZ), the Congo air mass, easterly waves, and tropical cyclones (Government of Malawi 2023). According to Kelly *et al.* (2020), rainfall in Malawi ranges from 700 to 2400 mm, with a mean annual rainfall of 1095 mm. The distribution of rainfall also varies based on topography and proximity to Lake Malawi. Because of these variations, therefore, seasonal reliance on rain makes Malawi vulnerable to droughts, which periodically limit water availability for agriculture, drinking, and other uses, as both surface and groundwater decline.

In line with the United Nations Sustainable Development Goal 6.1, Malawi seeks to increase water accessibility for all by 2030 through the expansion of water points infrastructure. At the national level in 2020, 70 per cent of the population in Malawi had at least basic access to improved water supply services (having an improved water source within a round trip walking distance of 30 minutes), and 22 per cent had access to limited services (improved source at a distance of more than 30 minutes round trip). In contrast, nearly 6 per cent of households lack access to improved water sources, while 2.2 per cent draw their water directly from surface water (WHO and UNICEF 2021).

Although significant strides have been made to increase water accessibility, it is noted that this apparent significant improvement is suppressed by the high equipment failure rates of water supply infrastructure. About 26 per cent of handpumps on boreholes were observed to be non-functional in 2016 (Mkandawire *et al.* 2020). A later mapping of water points in rural Malawi in 2020 further showed that only 60 per cent were functional (Sanitation and Water for All 2022), indicating a worsening of equipment failure. The non-functional state of boreholes has mostly been attributed to old equipment, catchment deterioration, neglect, lack of spare parts and inadequate community-based water management structures. As a result of this unfortunate state, women and children shoulder the burden of poor access to water services as they often walk long distances to collect water.

4.6 Competition for water

Even though Malawi has vast freshwater resources, the country often experiences chronic water shortages in some parts due to disparities in water distribution. The main competing uses of freshwater in Malawi include domestic use for public water supply and sanitation, hydropower generation schemes, irrigation and navigation.

Agriculture is the major water consumer in the country through irrigation, with plans for greater use through the Green Belt Initiative in Malawi which aims to expand irrigation to 485,000 hectares by 2035 (Government of Malawi 2011). Table 4.6 shows a summary of current water use projections to 2035, with agricultural use ratio expected to increase from 77 per cent in 2010 to 86 per cent in 2035 (Malawi, Ministry of Agriculture, Irrigation and Water Development 2012).

Table 4.6: Composition of Water Demand in Malawi, 2010 and 2035 (Malawi, Ministry of Agriculture, Irrigation and Water Development 2012)

	Percent of National Demand (Annual average basis)	
Component	**Demand Component 2010**	**Demand Component 2035**
Domestic	16	8
Arable Agriculture (irrigation)	77	86
Livestock Agriculture	2	1
Commercial	2	2
Institutional	1	1
Mining	>1	1
Unaccounted for Water (UFW)	2	2

Hydropower generation competes with irrigation demands, affecting energy and food security, while industrial activities, such as mining, compete with environmental flows and ecosystem needs.

Despite the abundant water resources in Malawi, per capita water allocation seems to be on the decline. Based on the report by Worldometers (2018) on Malawi's water resources, by 2017 water resources allocation per capita was estimated at 928 m^3/person/year, a decline from the 1400 m^3/person/year in 2013. Figure 4.5 shows that, since 1962, per capita water allocation continues to decline. Based on this trend, per capita allocation may have declined to 403 m^3 by 2025. Due to increased population growth, municipal, agricultural, and industrial usage has drastically increased. For instance, Figure 4.6 shows that water allocation for the agricultural sector increased from 0.809 billion cubic meters in 1994 to 1.166 billion cubic meters by 2005. Within the same period, industrial usage increased from 0.032 billion cubic meters to 0.0477 billion cubic meters, while municipal water allocation increased from 0.095 billion cubic meters to 0.1431 billion cubic meters. Despite these trends, the historical data from 1992 to 2015 shows a decline in number of people with no access to safer drinking water, from 5,412,132 to 1,674,388 (Figure 4.7), a development which can be attributed to massive water abstraction points which have since been constructed across Malawi especially in rural communities (WHO and UNICEF 2021).

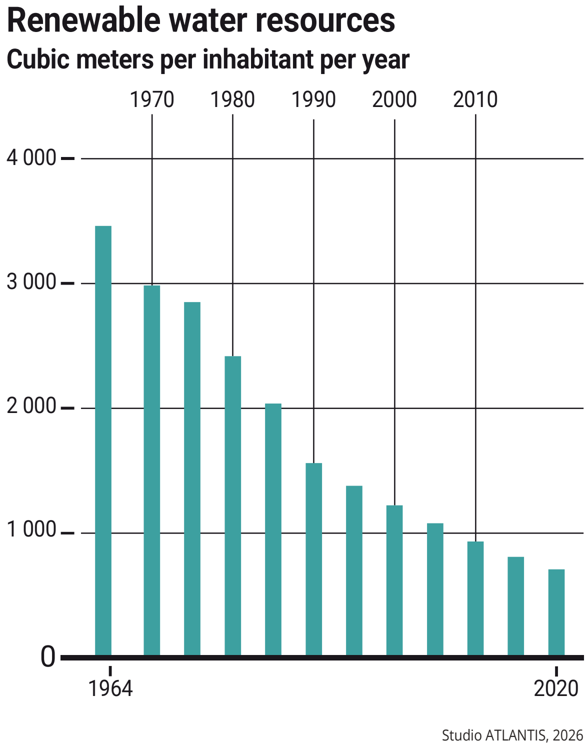

Figure 4.5: Renewable water resources per capita in Malawi (Worldometers 2018).

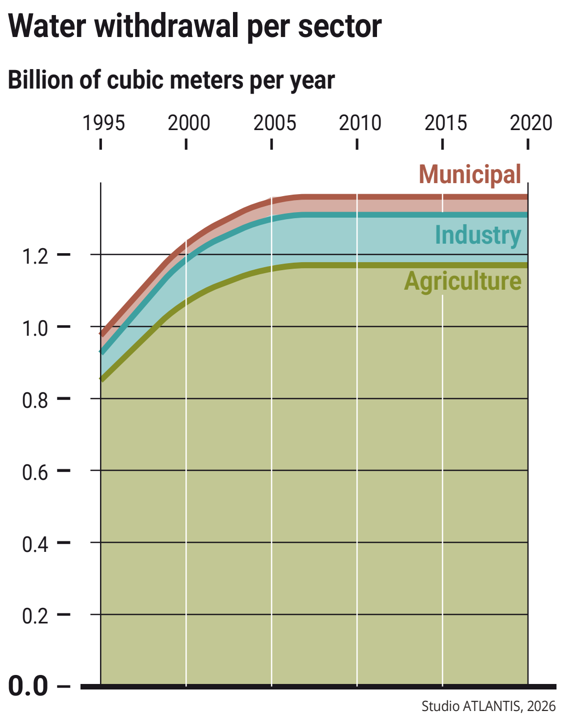

Figure 4.6: Water withdrawal per sector (Worldometers 2018)

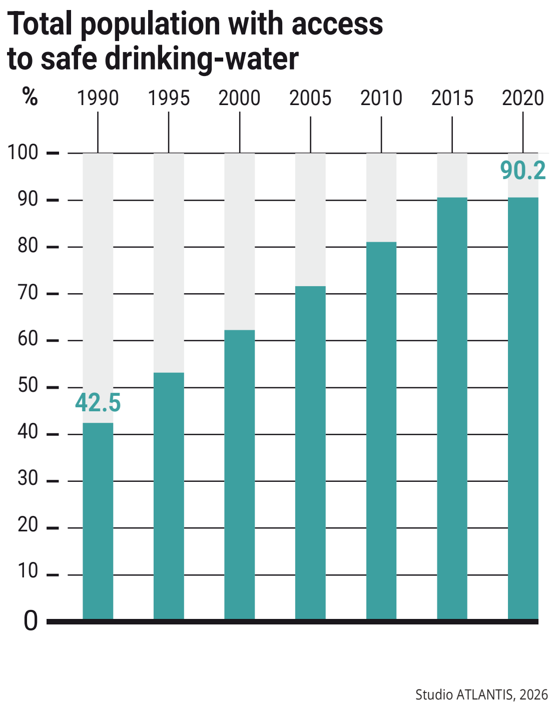

Figure 4.7: Historical data on Access to Safe drinking water (Worldometers 2018).

4.7 Extreme weather events: droughts and floods

Scientific predictions and evidence affirm that global climate change is likely to further increase exposure to multiple risks affecting the magnitude, frequency, and spatial distribution of hazardous and disastrous events (IPCC 2014). Exacerbated by catchments degradation, the impact of increased runoff or reduced water availability cannot be overemphasised. Malawi, like many other Sub-Saharan African countries, suffers the multifaceted extremities of weather events such as droughts and floods.

4.7.1 Droughts

According to Global Disaster Dataset, the numbernumber of droughts from 1979 to 2016 in Malawi was 13 (Centre for Research on the Epidemiology of Disasters (CRED) 2025) During this period, drought affected a total population of 28.7 million in Malawi. Almost all droughts in Malawi are associated with El Niño. The whole country is vulnerable to droughts, although Karonga, Salima, Zomba, and Lower Shire are known to be more drought prone areas (World Bank 2010).

Droughts seriously disrupt water availability in quantity and quality, as well as agricultural productivity in Malawi due to increased evapotranspiration and reduced water flows into water bodies. Lake Chilwa dried up in 1995 due to drought (Government of Malawi 2006). In 2016, drought conditions resulted in extensive crop failures, affecting 2.8 million people across the country. Similarly, the 2023/2024 rainfall season was marked with an El Niño induced drought, which resulted in a 22.9 per cent decline in agricultural productivity against the five-year average (Bronstert *et al.* 2024).

4.7.2 Floods

In the face of climate change, flooding events in Malawi are on the rise. The spatial distribution of floods has also increased, partly fuelled by lack of natural barriers to overland flow of water, due to forest degradation as well as the modification of natural water channels through agriculture and sedimentation processes. During the period from 1967 to 2018, Malawi experienced 36 flooding events, affecting a total population of 2.85 million in both urban and rural areas. Other major flood disasters occurred in 1997, 2001, 2003, 2006, 2015, 2019, 2022, and 2023, involving the Shire, Ruo, Dwangwa, and both South and North Rukuru Rivers (Chairuca 2019).

These flooding events have caused massive damages to both human life and infrastructure, as well as the general environment, especially in districts of Chikwawa, Nsanje, Zomba, Phalombe, Mulanje, Dedza, Nkhotakota, Nkhatabay, Rumphi, and Karonga. In addition to the usual damage of crops and houses, the 1997 floods in Malawi also damaged the Bangula-Chiromo railway line in Nsanje District (Chairuca 2019). The 2023 floods caused by Tropical Cyclone Freddy killed 676 people, displaced more than 500,000 people, and caused extensive damage to roads, bridges, and homes. In 2024, other devastating floods were recorded in Kasungu and Nkhotakota Districts, as well as all of Lake Malawi's shore areas. As a result of the Dwangwa river swelling, more than 7,000 people were displaced from the Dwangwa Catchment (Bronstert *et al.* 2024).

Apart from major flooding events, flash floods are also recorded in urban and rural communities of Blantyre, Lilongwe, Kasungu, Salima and Karonga. Most of the urban floods are a result of informal settlements along riverbanks that alter the natural waterways. Some of the very common areas where urban floods are prominent include Zolozolo and Chibavi areas in Mzuzu, Mtandire area in Lilongwe, and Machinjiri in Blantyre. In these areas, increased runoff destroys infrastructure almost yearly.

4.8 Ecosystem health

Malawi's freshwater ecosystems are fundamental to the national economy, providing fisheries, water supplies, hydropower, irrigation, and biodiversity services that sustain millions of livelihoods. Habitat loss, pollution, climate change, invasive species, and unsustainable exploitation increasingly threaten the integrity of these systems.

The decline in freshwater fish populations, especially in Lake Malawi, are symptomatic of broader ecosystem stress, which is largely due to overfishing, sedimentation, and degraded breeding habitats. The degradation of aquatic habitats reflects the breakdown of ecological processes critical to nutrient cycling, food web stability, and water purification. Additionally, urban runoff and agricultural intensification have increased nutrient and plastic loads into Lake Malawi, compounding eutrophication and raising concerns for both aquatic life and human communities.

Malawi's environmental management frameworks highlight the need for the adoption of integrated watershed and ecosystem-based approaches. Initiatives such as the National Fisheries and Aquaculture Policy and community-led wetland conservation programmes contribute to restoring ecological function and improving rural health outcomes.

4.8.1 Human health and ecological linkages

Human health in Malawi is intricately tied to freshwater ecosystem health. Over 60 per cent of total animal protein intake in the country is from fish, linking aquatic ecosystem integrity directly to nutrition security (Kalin *et al.* 2022). Polluted water sources from agricultural runoff and waste disposal elevate risks of waterborne diseases like cholera and typhoid, disproportionately affecting low-income urban and rural populations.

Sedimentation, poor sanitation, and weak waste management systems exacerbate vector-borne disease prevalence by altering aquatic habitats favourable to mosquitoes and snails that transmit malaria and schistosomiasis, respectively.

Wastewater generation is increasing in Malawi mostly due to rapid population growth, urbanisation, and industrialisation, which have resulted in treatment facilities failing to keep up with the demand. Most of the treatment facilities in Malawi are either old, non-functional, or their efficiency is greatly compromised due to numerous challenges. Inadequate wastewater management and non-functional wastewater treatment facilities have severe environmental impacts, affecting public health, ecosystems, and economic development.

Msilimba and Wanda (2012) noted that in Malawi wastewater treatment works are only done in major cities of Blantyre (city) at Blantyre (district), Soche, and Limbe (smaller regions and neighbourhoods); Lilongwe (city) at Kauma (village); Zomba (city) at Chikanda (village), and Mzuzu (city) at Moyale. The practice of wastewater reuse is at a smaller scale and is mainly used for washing cars, irrigating pastures, cooling boilers, and watering lawns. The bulk of wastewater is disposed of directly into water bodies. Only 10 to 15 per cent of wastewater generated in the country is connected to sewage systems (World Bank 2021).

Even in cases where treatment is done, the efficiency levels are very low. Wastewater treatment plants in Blantyre and Lilongwe exhibit varying levels of efficiency in removing organic pollutants. The removal efficiency for Chemical Oxygen Demand (COD) ranges from 49 to 74 per cent. For Biochemical Oxygen Demand (BOD), primary treatment achieves removal efficiencies of 20 to 40 per cent, while trickling filters can remove up to 84 per cent. For Total Suspended Solids (TSS), primary treatment eliminates 40 to 60 per cent (Chipofya *et al.* 2010).

Environmental health in Malawi is directly linked to the condition of freshwater systems, land use patterns, and increasing anthropogenic pressures. The country's environmental health landscape reflects complex interactions between population growth, poor waste management, water pollution, air quality decline, and climate variability, all of which increase vulnerability to disease and reduce resilience across communities.

The World Health Organization (2025) Environmental Health Scorecard for Malawi ranked the country's overall health at 46/100, with particular weaknesses in water and sanitation services, exposure to household air pollution, and waste management capacity. Air pollution and waterborne diseases remain major public health challenges, with unsafe water, poor sanitation, and inadequate hygiene (WASH) estimated to contribute significantly to diarrheal diseases, cholera outbreaks, and malnutrition. Recurrent floods, droughts, and increased temperature fluctuations further heighten Malawi's vulnerability by amplifying risks of malaria, schistosomiasis, and vector-borne diseases.

Sanitation in Malawi remains a critical pillar of public health and environmental integrity. As of 2025, only about half of Malawians had access to basic sanitation, with rural areas underserved. In urban centres, informal settlements often lack improved toilets and proper faecal sludge management systems, making them major risk zones during flooding events (World Health Organization 2025).

The ministry responsible for water affairs and partner organisations are implementing programs to promote Community-Led Total Sanitation (CLTS) and to expand urban faecal sludge treatment capacity. Initiatives such as decentralised waste treatment, composting toilets, and public-private partnerships in waste collection are being piloted in Blantyre and Mzuzu cities to improve urban sanitation efficiency. Additionally, international support through the National Sanitation and Hygiene Investment Plan and WASH in Health Care Facilities Initiative aims to provide safe, sustainable sanitation systems targeting schools, markets, and hospitals.

To achieve Sustainable Development Goal 6, it is estimated that Malawi needs US$97 million to build and maintain universal basic coverage and an additional US$258 million to build and maintain safely managed services each year up to 2030 (UNICEF 2023).

4.9 Transboundary water resources

Most of Malawi's surface water resources and much of its groundwater resources are shared with neighbouring countries. It is therefore important to recognise international water sharing agreements in resource use and planning. Lake Malawi and its catchment clearly show the magnitude of these shared water resources (Table 4.7) and importantly, the discharge from Lake Malawi through the Shire River is a major tributary to the Zambezi River, the basin of which is shared by eight countries and managed through the Zambezi Watercourse Commission (ZAMCOM). The Songwe River basin is shared with Tanzania and is central to bilateral cooperation efforts between Malawi and Tanzania through the Songwe River Basin Development Programme. The cooperation focuses on flood control, agriculture, and improved water supply, benefitting communities on both sides of the border.

The Lake Chilwa system is also shared with Mozambique. Inflows into Lake Chilwa originate from the eastern slopes of the Shire Highlands, the Zomba Plateau and the northern slopes of the Mulanje Massif. Jamu *et al.* (2012) and Rivett *et al.* (2020) indicate that, in the past, lake Chilwa used to dry naturally over a 15 to 20-year period. The lake has not completely dried out in the last 20 years. Another notable transboundary water resource is the Ruo river basin. Although just a tributary of the Shire River, the Ruo River, which partly borders Malawi and Mozambique, requires cooperation between the two countries to mitigate flood risks and support sustainable agriculture in surrounding areas. The groundwater resources also found within the named transboundary water resources are also managed as transboundary, with the Shire Basin transboundary aquifer being the largest.

Table 4.7: International contributions of run-off water to Lake Malawi

Variable	Malawi	Tanzania	Mozambique	Total
Catchment area of the lake (km2)	64,372	26,600	6,768	97,740
Flow (m3/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 Agriculture, Irrigation and Water Development 2016

4.10 Indigenous and local knowledge for the management of water resources

Indigenous and Local Knowledge plays an important role in water resource management as it is based on principles of conservation, stewardship, and equity. Indigenous and local people have been managing their water resources for a long time, over which they have developed sustainable practices. Their knowledge is based on their relationship with nature, and they view water as a living entity and a habitat to their ancestral spirits. Traditionally, tree species such as *Faidherbia albida* (Winter Thorn; Msangu), *Syzygium cordatum* (Waterberry; Mkungu, Nyowe), *Trichilia emetica* (Mahogany), *Acacia xanthophloea* (Fever tree), *Rauvolfia caffra* (Quinine, Mwimbi), *Khaya anthotheca* (mmbawa), *Ficus sycomorus* (Fig, mkhuyu) and *Combretum* species have been used to stabilize river banks.

4.11 Catchment management

Catchment management activities in Malawi involve the strategic planning and implementation of activities to manage the water resources within designated Water Resources Areas and Water Resources Units. Catchment management aims to balance water needs for agriculture, domestic use, and ecosystem health while addressing challenges like climate change, deforestation, and land degradation.

Although various catchment management activities are implemented by various stakeholders, their actions are guided by National Guidelines on Integrated Catchment Management and Rural Infrastructural (Government of Malawi 2015). Catchment management activities are strongly linked to national policy. For example, the Water Resources Act of 2013 provides for the management, conservation, use, and control of water resources, including the management of watersheds through Catchment Management Committees (CMCs). The Environmental Management Act of 2017 also aims to enhance environmental management and protection.

The Shire River Basin has been the focus of most basin planning and watershed management initiatives. This is mainly due to its size and importance for energy, water, and food security, and the basin's hot spot status for natural disasters, natural resources degradation, and soil erosion (Calow 2021). The Malawi Watershed Services Improvement Project (MWASIP) targets degraded watersheds in the Linthipe, Bua, and Dwangwa basins in the central region, and the North Rukuru and Lufilya basins in the north with a target of restoring 50 per cent of degraded landscapes in priority catchments.

Various international and local organisations promote food or cash-transfer programmes linked to watershed management interventions. For example, the Food for Asset (FFA) programme in Malawi has a core focus on watershed rehabilitation and management, targeting degraded catchments in eight southern districts of Chikwawa, Nsanje, Blantyre, Phalombe, Zomba, Machinga, Mangochi and Balaka. The districts are climate-vulnerable and chronically food-insecure.

Public works have been used since the mid-1990s for a variety of purposes. The Malawi Social Action Fund–MASAF (1998–2019) included a significant public works component implemented. Although not directly focusing on catchment management, the public works programme included tree planting, agriculture and irrigation activities which impacted and protected various catchments across the country. The Malawi National Social Support Programme offered a framework for different social protection initiatives that incorporates catchment management, with activities such as community forestry, tree nurseries, fishponds, climate-smart agriculture, and watershed management (Calow 2021). Watershed management has also been addressed through the Enhanced Public Works Pilot, focusing on smaller micro-catchments (typically less than 250 hectares, five per district) and includes forest restoration, gully reclamation, rehabilitation of water supply, and drainage.

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