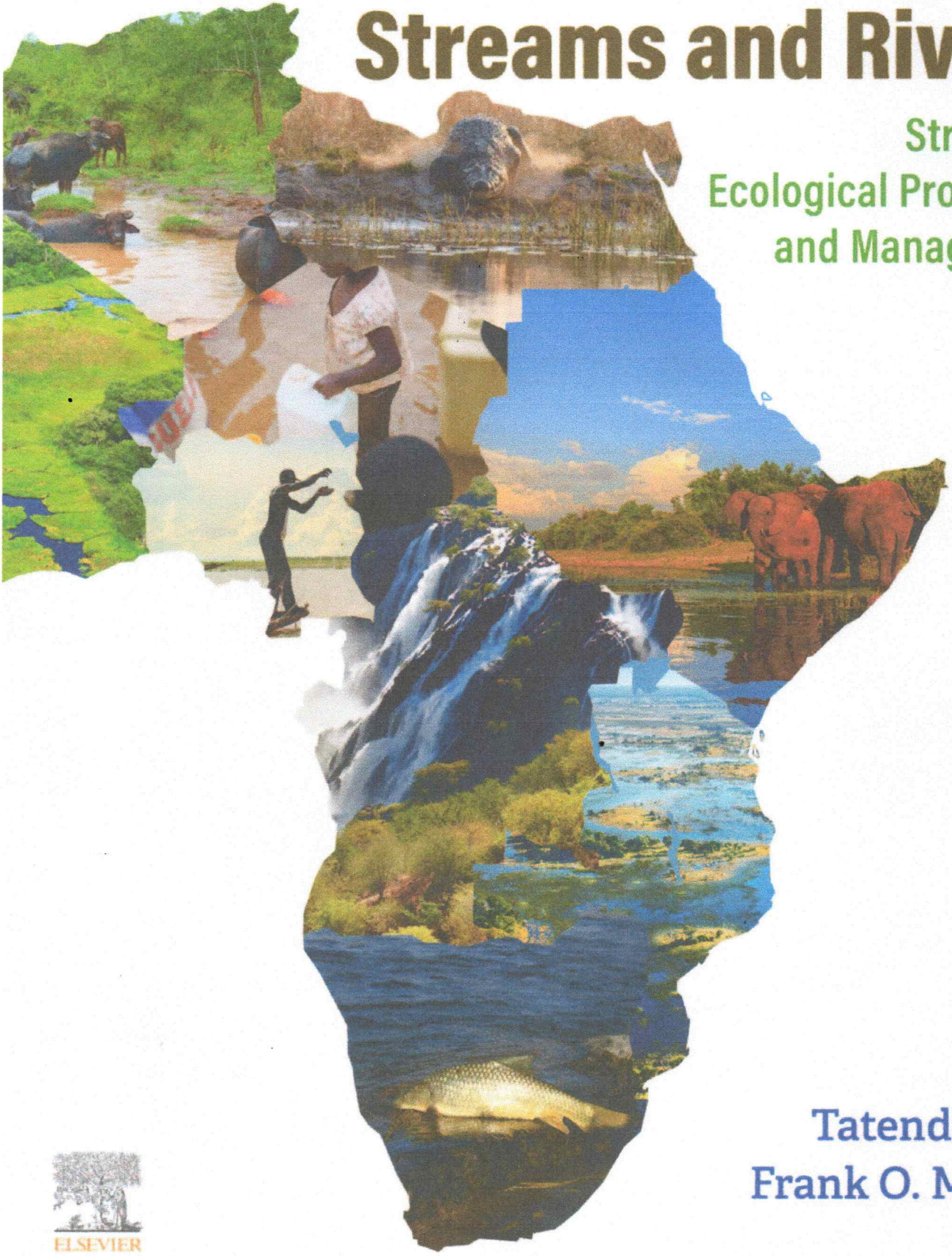
Afrotropical Streams and Rivers

Structure, Ecological Processes and Management



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Structure, Ecological Processes and Management

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Dedication

This book is dedicated to our spouses, Mwazvita Tapiwa Beatrice Dalu and Hyline Nyatichi Nyangweso, and our sons and daughters.
We thank them for their support and patience and for reminding us that there was more to life than the long hours spent on this book.

Chapter 21

Management and governance of African rivers

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Introduction

Over the years, there has been an outcry over the decline in ecosystem services (ES) that watersheds and rivers provide (Costanza et al., 1997; Kremen, 2005; De Groot et al., 2012; Ferreira et al., 2023; Masese and Dalu, 2024, Chapter 1). This situation has been witnessed in different parts of the world where dramatic declines in ES have posed serious challenges to watershed and river basin conservation (Kulindwa, 2005). While the capacity of watersheds and rivers to provide ES has become erratic, and sometimes increasing arithmetically, watershed and river basin degradation has been increasing exponentially (Brauman et al., 2014), necessitating the need for effective management and governance structures.

Africa is endowed with extensive river basins that offer a wide variety of ES for inland and coastal communities (Dube et al., 2024, Chapter 2; O'Brien et al., 2024, Chapter 3; Mwaijengo et al., 2024, Chapter 4; Muvundja et al., 2024, Chapter 5; Dalu et al., 2024a,b, Chapters 6 and 7). The continent has many valuable large rivers, including the Congo, Limpopo, Niger, Nile, Okavango, Orange, Senegal, Volta, and Zambezi whose waters and catchments are habitats for endemic and threatened species of aquatic flora and fauna. Most of these river basins have socio-economic and cultural importance not only at the local, regional and national levels but also at the global scale. They support small-scale and large-scale agriculture, commercial and artisanal fisheries, livestock production and range management, industrial growth, hydropower development and biodiversity.

Unfortunately, the sustainability and well-being of these rivers and their basins face several challenges, including depletion of water resources through excessive abstractions, land use change, barriers to flow and connectivity caused by dams and weirs, failure to invest adequately in river protection, restoration and monitoring, and unsustainable financing of investments in water supply and sanitation (see Mpopetsi et al., 2024, Chapter 25; McClain and Masese, 2024, Chapter 28). The management and governance structures already in place also seem to be inadequate and ineffective. These threats and inadequacies impinge on the sustainable management of rivers, escalating competing demands for basic water supply and sanitation, food security, economic development and river-related ES.

In this chapter, we provide an overview of the status of African river basins, existing policy and legal frameworks, and institutional structures established to facilitate their management and governance. The chapter also explores the challenges that have been experienced in the management and governance of river basins in Africa and we propose strategies for their effective management and governance.

Management and governance of river basins

River basins are the geographic areas contained within the watershed limits of a system of streams and rivers converging towards a common point, generally the sea or sometimes an inland water body such as a wetland or lake (Molle, 2017).

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Gleick and McCaffrey (1993) define a river basin as "the land area that contributes water to a river system." River basins form intricate networks of rivers and their tributaries that are vital components of Earth's hydrological cycle. The topography of the landscape defines the boundaries of a river basin, forming a natural hydrographic unit. This consideration encapsulates the fundamental hydrological aspect of river basins, emphasizing the interconnectedness of water flow and highlighting the need for a holistic approach to managing these intricate systems.

River basin management (RBM) involves the coordinated and integrated planning, development, and conservation of water resources within a specific geographical area. It includes the development (e.g., infrastructure projects), protection (e.g., environmental protection) and restoration (e.g., natural flow regime) of rivers through activities such as monitoring, analyses, allocation, development and conservation that aim to achieve a certain desired state of ecological status (Pahl-Wostl, 2009). This comprehensive approach recognizes the interdependence of various factors, such as land use, water quality, and socio-economic activities, within the confines of a river basin. RBM involves balancing competing demands for water, ranging from municipal supply, agricultural irrigation, and industrial use to maintaining ecosystem health. The allocation of water resources is a complex task that requires careful consideration of the diverse needs of stakeholders. The Brisbane Declaration (2007) emphasizes the importance of managing water to meet both human and ecological needs and advocates for an inclusive and equitable approach to water allocation. RBM encourages the active participation of stakeholders, fostering a sense of shared responsibility for the sustainable use of water resources. Sustainable management aims to optimize water use while maintaining the ecological integrity of river basins (Gleick, 2003). Although not always clearly differentiated and sometimes used interchangeably, RBM is part of river basin governance, which is a much broader concept that would include legal and institutional mechanisms.

River basin governance is defined as the range of political, social, economic and administrative structures and institutions that are in place to develop and manage water resources and the delivery of water services in a river basin (UNDP, 2004). Many of the processes and institutions are defined by the central government, and function within the existing governance framework of the country. Good river basin governance is based on principles of equity, efficiency, participation, decentralization, integration, transparency and accountability (Plummer and Slaymaker, 2007). The concept of governance can be applied at different scales, ranging from individual countries and individual institutions and subsectors within them to international contexts involving two or more countries (Cowater International, 2008). Effective governance is essential, especially in the context of transboundary river basins that traverse multiple political boundaries. The collaborative and inclusive nature of governance is crucial for addressing the complex challenges associated with shared water resources.

The establishment of River Basin Organizations (RBOs) is a common governance strategy for sustainable development and management of transboundary river basins, promoting regional cooperation and shared benefits. These organizations bring together riparian countries and stakeholders to facilitate joint decision-making and coordination. Wolf et al. (2003) highlight the importance of cooperative frameworks in transboundary river basins, emphasizing the need for diplomacy and negotiation to prevent conflicts over water resources. Furthermore, river basin governance extends beyond formal institutions to include the active involvement of local communities and nongovernmental organizations (NGOs). These stakeholders contribute valuable knowledge and perspectives, enhancing the overall effectiveness and legitimacy of governance structures.

Understanding the intricate nature of river basins involves recognizing their hydrological boundaries, the importance of integrated water resources management (IWRM) and the need for effective governance structures, especially in transboundary contexts. As human populations grow, climates change, and water demands increase, the importance of holistic approaches to RBM and governance becomes increasingly evident.

Scales of river basin management and governance

Africa is endowed with diverse ecosystems and extensive river systems, but at the same time faces the intricate challenge of managing and governing them effectively. The complexities of ecological, social, and economic factors necessitate a multi-scale approach to RBM and governance. Recognizing the importance of multi-scale approaches is crucial for ensuring the sustainable use of water resources within these intricate landscapes.

Local scale: Community-based river basin management

At the local scale, community-based RBM initiatives play a fundamental role in addressing the specific needs and challenges faced by communities residing within a given basin. Local stakeholders, including residents, farmers, and businesses, often possess valuable traditional knowledge about rivers and their resources. In many African contexts,

community-based management emphasizes the active participation of local communities in decision-making processes, reflecting the principle of subsidiarity.

At the local-scale, RBM involves the implementation of sustainable water use practices, watershed restoration projects, and the development of small-scale infrastructure to meet local water needs. The involvement of communities fosters a sense of ownership and responsibility, leading to more effective and culturally sensitive water resources management. For example, the Water User Associations (WUAs) in many countries in Africa, such as Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mali, Niger, South Africa, Senegal, Tanzania and Zimbabwe (Aarnoudse et al., 2018) provide a practical model for formal community-based RBM. These associations empower local users to collectively manage streams and rivers and make decisions about water allocation based on the needs of each user and the environment (Saleth and Dinar, 2004). Other examples of informal community-led initiatives and cultural practices aimed at the conservation of water sources, such as forests, also abound across Africa. For example, in East Africa, the Swahili Kayas are meant to protect forests and water sources, in addition to their use for cultural activities. The Maasai community of East Africa also practice the conservation of forests which were sources of streams and rivers that they depended on for watering their livestock.

Subnational/regional scale: River basin authorities

At the subnational or regional scale, the establishment of river basin authorities becomes essential for coordinating efforts across different administrative and hydrographic units within a country. River basin authorities serve as intermediaries between local communities and national governments, facilitating the development and implementation of basin-wide management plans. These authorities often have jurisdiction over multiple catchments and are responsible for integrating diverse perspectives and interests. By taking a more expansive view of the river basin, they can address issues related to water quality and quantity, water allocation, infrastructure development, and land use planning that transcend local boundaries.

The Murray-Darling Basin Authority in Australia is a good example of subnational river basin governance. Formed to manage the Murray-Darling Basin, the authority coordinates water allocation, environmental protection, and infrastructure development across multiple states, demonstrating the effectiveness of a regional approach to RBM. Similarly, Kenya is divided into six River Basin Authorities that transcend several counties defined by the geographic boundaries of major river basins and landscapes.

National scale: Centralized river basin governance

At the national scale, centralized river basin governance involves the creation of overarching institutions responsible for the management of water resources across the entire country. National governments play a crucial role in formulating policies, regulations, and strategies that guide RBM and governance. These policies often aim to balance the needs of various sectors, such as agriculture, industry, and urban areas, while ensuring environmental sustainability.

Examples of national RBM and governance institutions, departments or parastatals include the Water Resources Authority (WRA) in Kenya, the National Water Resources Authority (NWRA) in Nigeria, the Water and Sanitation Agency (WASA) in Ghana, the Water and Sanitation Ministry (MinWaterCongo) in the Democratic Republic of Congo, Ministry of Water, Irrigation, and Energy (MOWIE) in Ethiopia, Department of Water and Sanitation (DWS) in South Africa and the Directorate of Water Resources Management in Uganda. These institutions and/or departments formulate and implement policies for water resources management (WRM) in their respective countries and coordinate water-related activities across different regions of the country. They are also responsible for developing and implementing policies related to water use, quality, and infrastructure development at the national level.

Transboundary scale: International cooperation

Many river basins cross international borders, necessitating transboundary management and governance structures to address shared challenges and conflicts over water resources. Transboundary RBM and governance requires collaboration and coordination among riparian countries to develop joint management plans and governance structures to prevent disputes over water allocation.

The Orange-Senqu River Basin Commission (ORASECOM) in southern Africa and the Niger Basin Authority (NBA) in West Africa are examples of successful transboundary RBM and governance structures in Africa. ORASECOM operates in the Orange River basin that is shared by South Africa, Lesotho, Namibia and Botswana (ORASECOM, 2021). The commission focuses on transboundary cooperation to address issues such as water allocation, infrastructure development, and environmental protection (ORASECOM, 2021). Similarly, the NBA involves nine member countries, working

together to address issues related to water management, agriculture and sustainable development in West Africa. The authority facilitates collaboration and information exchange to ensure the equitable utilization of the shared water resources of River Niger (Niger Basin Authority, 2021). Another international organization in Africa is the Nile Basin Initiative (NBI), which is a cooperative partnership among Nile River Basin countries, including Burundi, the Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania and Uganda. It aims to promote sustainable development and management of the Nile River water resources.

International scale: Global cooperation and partnerships

On the international scale, global cooperation and partnerships are essential for addressing overarching challenges and promoting sustainable development of transboundary river basins. Agreements such as the United Nations Watercourses Convention (UNWC) provides a framework for addressing the rights and responsibilities of countries sharing river basins, emphasizing equitable and reasonable utilization of shared water resources (McCaffrey and Sinjela, 1998).

The United Nations Economic Commission for Africa (UNECA) contributes to the international discourse on water governance in Africa. UNECA engages in research and advocacy, supporting the development of policies and strategies that promote sustainable water management across the continent (UNECA, 2021). Recognizing the importance of multi-scale approaches is essential for addressing the complex and interconnected challenges associated with river basins. Effective RBM requires a combination of community engagement, regional coordination, national policies, and international cooperation to ensure the sustainable use of water resources for current and future generations. Embracing a multi-scale perspective enhances the resilience and adaptability of river basin governance frameworks, fostering a holistic and inclusive approach to water resources management.

Management issues in Africa's river basins

While African rivers offer immense opportunities for economic development and societal well-being, they also face significant challenges that require careful and sustainable management. Human population growth and urbanization result in increased demand for water, often leading to overextraction and depletion of water resources. Water scarcity increasingly poses the greatest threat to agricultural productivity and water-dependent industries (Arnell et al., 2019). Water pollution from agricultural runoff, urbanization and other human activities further diminish the utility of available water resources. Climate change exacerbates these issues, causing irregular rainfall patterns, prolonged droughts, and more intense floods, further stressing river ecosystems. Additionally, transboundary rivers face the risk of disputes over water allocation and use.

Considering the challenges that African rivers and their basins face, focus is increasingly placed on the role management and governance can play in reversing the negative trends. Thus, an appreciation of the threats and challenges that have implications for the management and governance of African rivers is necessary. The major threats to African rivers have been extensively discussed in Chapter 26 (Malapane et al., 2024). They include land-use and land cover changes, pollution from domestic and industrial wastewater, solid and liquid wastes from urban areas and industries, pesticides and agrochemicals, agricultural expansion and intensification and the resulting soil erosion, sedimentation, and nutrient loading, introduced and invasive species, the construction of barriers such as dams and weirs, over-abstraction of water from rivers, climate change and variability, among others (see Shelton et al., 2024, Chapter 24). Most of these threats are pervasive and must be addressed to preserve the ecological integrity of rivers and ecosystem services used by people of the continent. Here we highlight some of the issues that have not been covered in Chapter 25 (Mpopetsi et al., 2024) and Chapter 26 (Malapane et al., 2024) but should be considered during planning for effective management of Africa's river basins.

Transboundary nature of water resources

Africa's major river basins are transboundary and account for nearly 90% of the continents surface water resources. However, there are gaps in the agreements and cooperation within river basins is uneven. This makes implementation of management options difficult, including in some of the most heavily used transboundary rivers. Major transboundary rivers such the Niger, Nile and Zambezi serve countries with large human populations, which creates opportunities for conflicts and overexploitation of water resources.

In Eastern Africa, the Nile River Basin, which includes the Lake Victoria basin is the largest transboundary river basin in Africa. Consequently, there are many challenges to water use and allocation that warrant effective management and governance. Irrigation schemes in Sudan and Egypt rely exclusively on the waters of the Nile River and are, therefore,

apprehensive of the actions of upstream states notably Ethiopia, Kenya, Uganda, Tanzania, Rwanda and Burundi. The source of contention is the asymmetrical water needs and allocation which was enshrined in the Sudan–Egypt treaty of 1959 (Abtew and Dessu, 2018). All the riparian countries in the Nile basin have agricultural-based economies and thus irrigation is the cornerstone of food security (Abtew and Melesse, 2014). The Nile Basin Initiative (NBI) and the Lake Victoria Basin Commission (LVBC) play important roles in promoting cooperation for sustainable management of water resources in the basin. West Africa has 25 transboundary watercourses and only 6 are under agreed management and regulation. The situation is compounded by the fact that 20 water courses lack strategic RBM instruments. Unregistered rules and the asymmetrical variations associated with watercourses warranted the introduction of the IWRM principles to set equitable water-sharing protocols and promote environmental flows (eflows) (McClain and Masese, 2024, Chapter 28). The Southern African Development Community (SADC) region has 13 major transboundary river basins whose management faces a number of challenges, including varying levels of economic development and priorities among the member states (O'Brien et al., 2024, Chapter 3). Furthermore, the multi-lateral and bilateral agreements on shared water resources in the SADC is hampered by regional hydropolitics where economic power dynamics favour South Africa, as in the case of the Orange-Senqu basin.

Apart from transboundary surface water resources, many aquifers in Africa are also transboundary. However, studies on groundwater are very limited. Similarly, most organizations, treaties and international water laws only consider surface water bodies with limited attention given to groundwater. Despite limited data on groundwater resources and transboundary aquifers in Africa, groundwater is a major source for many communities, towns, and cities across the continent. Excessive use of groundwater can deplete aquifers and reduce the amount in streams and rivers. Excessive abstraction of groundwater can also be a source of conflicts in transboundary aquifers, necessitating the need for water allocation and sharing arrangements. Thus, sustainable management of groundwater resources should pay particular attention to problems posed by the vulnerability of aquifers to pollution, and the need to ensure the development, utilization, and protection of groundwater resources in the context of international cooperation and lessening the magnitude of water use conflicts.

Inadequate monitoring

Effective RBM relies on accurate and up-to-date information about water quality, quantity, and ecosystem health. Unfortunately, many African countries face challenges in establishing comprehensive monitoring networks, leading to limited data availability. Many African countries rely on physicochemical water quality parameters to assess the status or ecological health of streams and rivers. However, water quality monitoring is often discontinuous, and cannot provide an overall condition of the system. The use of biological indicators is preferable, but many countries in Africa have not developed national criteria for regular biomonitoring of streams and rivers. Only South Africa has a national biomonitoring program for streams and rivers. The lack of biomonitoring programs and regular assessment of streams and rivers hinders informed decision-making, making it difficult for authorities to assess the status of rivers and implement targeted interventions (UNEP, 2018).

Inadequate monitoring contributes to challenges in maintaining water quality and controlling pollution in rivers. Without a comprehensive understanding of the pollutants entering water bodies, authorities struggle to enforce effective regulations. This is particularly evident in rapidly urbanizing areas where industrial discharges and untreated sewage often degrade water quality. A study by Odume and Nkwoji (2017) highlights the urgent need for improved monitoring to address water pollution in urban rivers. Inadequate monitoring also contributes to ecosystem degradation and loss of biodiversity as changes often go unnoticed until irreversible damage occurs. The Okavango Delta, a UNESCO World Heritage Site, faces challenges due to altered river flow and climate change impacts, emphasizing the need for continuous monitoring to protect fragile ecosystems (Burg, 2007; Moses and Hambira, 2018).

For transboundary rivers, the absence of adequate monitoring systems complicates international collaboration. The Orange-Senqu River Basin Commission (ORASECOM) in southern Africa provides a good example of how a robust monitoring network supports transboundary river governance in Africa. The ORASECOM's data collection and sharing mechanisms enhance the understanding of river dynamics and inform joint decision-making among member countries.

Inadequate funding

Effective conservation, protection, and management of African rivers and their basins face substantial challenges due to limited funding. Limited funding often translates into insufficient investment in essential infrastructure for river conservation and management. For instance, the construction of monitoring stations, gauging systems, and water quality assessment facilities requires substantial financial resources. The absence of such infrastructure hampers the collection of

accurate data needed for informed decision-making. Limited funding also compromises the capacity of regulatory bodies to enforce environmental laws and monitor compliance. For instance, in the Niger Delta region, insufficient funding for environmental agencies has allowed unregulated activities such as oil spills to detrimentally impact the health of rivers, ecosystems, and communities (Oronto, 2002).

Inadequate funding poses significant challenges in combating pollution, a pressing issue for many African rivers. The lack of resources for wastewater treatment facilities and pollution control measures allows untreated effluents to flow into rivers. The Nile River, for instance, faces pollution challenges due to agricultural runoff and industrial discharges, exacerbated by limited funding for pollution abatement measures (Luo et al., 2020). Limited funding also undermines community-led conservation initiatives that play a crucial role in protecting rivers at the local scale. In the Rwenzori Mountains of Uganda, the lack of financial support for local initiatives has impeded efforts to address deforestation and soil erosion, negatively affecting river ecosystems (Nabuuma, 2019). In Kenya, many subcatchment management plans (SCMPs) for river rehabilitation and conservation developed by WRUAs are not adequately funded and mainly rely on donor funding to implement their activities (Richards and Syallow, 2018), and this hinders their effectiveness in water resources management.

African rivers are increasingly vulnerable to the impacts of climate change, including altered precipitation patterns and increased temperatures. Lack of or limited funds constrains the implementation of adaptive measures, such as the construction of resilient infrastructure and the development of climate change adaptation plans. The Limpopo River basin faces challenges in adapting to climate change due to financial constraints, impacting water availability and agricultural practices (Mukwada et al., 2020).

Limited data on river discharge

Similar to the monitoring of the ecological condition of streams and rivers in Africa, there is also inadequate data on river flows (discharge) for many rivers, including transboundary rivers. Africa is notorious for the poor quality of discharge data, which is often discontinuous, poorly recorded, and often inaccessible to the public and other users. One primary challenge impacting the quality of discharge data in African rivers lies in the limitations of data collection infrastructure. Many regions across the continent lack adequate gauging stations and monitoring equipment, resulting in sparse and incomplete datasets. Technological constraints also pose another insurmountable obstacle to acquiring high-quality discharge data. Outdated or insufficient technological infrastructure hinders the implementation of advanced measurement techniques, remote sensing, and real-time monitoring systems. This problem is compounded by insufficient human and institutional capacity in hydrological monitoring and data analysis. The lack of skilled personnel and adequate training programs hampers the ability to maintain and operate monitoring networks effectively, even when they are available. Efforts have been made to install automated gauging stations and rehabilitate colonial-era discharge monitoring stations in many rivers across the continent, but these cease to operate once the funding agency ceases operations or a funding project ends. The scarcity of monitoring stations, lack of modern infrastructure and limited human capacity compromises the accuracy and representativeness of discharge data, impeding the ability to understand the dynamic nature of river systems, including the impact of climate change (Savenije, 2010).

Another major constraint to the management of rivers is limited or lack of data sharing, even when these are available. Examples have been given where discharge data are not digitized upon collection from manual gauging stations or stuff gauges, and the hard copies used become hard to read over time because of wear and tear. This compromises data quality. In many cases, data are scattered across different agencies or countries, hindering comprehensive basin-level analysis. The lack of standardized data-sharing mechanisms and limited accessibility to existing data further exacerbates the challenges of data availability. Improved data-sharing protocols are essential for enhancing the collective understanding of river systems and fostering collaborative management strategies (Gründemann et al., 2018).

The compromised quality of discharge data on African rivers has far-reaching implications for RBM. Inaccurate data hinders the ability to assess water availability, plan for sustainable resource use, and develop effective flood mitigation strategies. As a result, the management of water resources becomes reactive rather than proactive, leading to increased vulnerability to water-related challenges such as droughts, floods, and water scarcity (Wilby et al., 2009).

Existing management and governance structures in Africa

The management of river basins has been a challenge for the African governments. According to Hassan et al. (2014), these issues include water access inequality, limited funding and manpower for managing river basins at the national and basin levels, poorly maintained water infrastructure, subpar service delivery, dwindling quality and quantity of surface water

resources, climate change impacts, low stakeholder participation and increase in conflicts among stakeholders, institutional fragmentation and conflicting sectoral policies. To address these challenges, this section reviews some of the institutional structures, policies, and legal frameworks that have been established to enhance the management and governance of river basins in the continent.

Institutional structures for the management of river basins in Africa

Sustainable RBM can be made possible by having adequate institutional frameworks at the local, regional, national, and international (transboundary) levels to balance conflicting interests over water resources. Many institutions of joint governance have offered solutions to the problems associated with shared water resources, and the institutionalization of collaboration can contribute to the development of trust. Research shows that conflict is less likely in environments where there is institutional capacity for dialogue and dispute resolution (UN-Water, 2008; World Bank, 2012a,b).

Local level

The majority of African nations have embraced participative, decentralized, and devolved approaches to natural resource management due to its advantages over top-down, centralized techniques (Meynen and Doornbos, 2002). This Community-Based Natural Resources Management approach (CBNRM) seeks to promote sustainable community development and the fair distribution of benefits derived from natural resources (Kumasi et al., 2010). Local community involvement in planning, management, and decision-making is crucial for the preservation of natural resources (Stoll-Kleemann and Welp, 2008). Depending on the degree of community involvement, this involvement can take many different forms, from low to high (Agrawal, 2001). The participation could either be through consultation, collaborative decision-making, and self-management of natural resources (Rodríguez-Martínez, 2008; Schultz et al., 2011). The integration of indigenous knowledge, property rights, and values with the management of natural resources is another goal of the CBNRM framework (Kellert et al., 2000).

Decentralized governance promotes more accountability of organizations at all levels (Crook and Manor, 1998) and more efficient local management of natural resources (Ribot, 2003). Although it is still up for debate how complete cost recovery and equitable distribution may coexist, decentralization and participation have long been pushed as ways to maximize water efficiency (Rusca et al., 2015). However, the performance of local management and governance institutions as well as the equitable distribution of resources, have been affected by several issues, including the usurpation of power by the local elite, the incomplete transfer of authority to local organizations, lack of transparency and accountability and continued conflict over access and utilization of resources (Shackleton et al., 2002; Zulu, 2009; Richards and Syallow, 2018). Some of the CBNRM organizations or structures that have been established to enhance RBM in Africa are discussed below.

Water user associations

Many countries in Africa have recognized the importance and need for community-based organizations to participate in the management of water resources at the local level. For river basins, this is achieved through the establishment of Water User Associations (WUAs). African countries with WUAs as part of decentralized water management systems at the local level include Senegal, Ghana, Burkina Faso, Niger, Mali, Tanzania, Kenya, Ethiopia, Malawi, Zimbabwe, and South Africa (Aarnoudse et al., 2018). In South Africa, the National Water Act (NWA) of 1998 created new organizational arrangements for RBM that paved the way for the creation of Catchment Management Agencies (CMAs) and Water Users Associations (WUAs) at the local level (Mutondo et al., 2011). Similarly, in 1998, Zimbabwean promulgated the Water Act and the Zimbabwe National Water Authority (ZINWA) Act. These Acts led to the creation of catchment and subcatchment councils (Water User Associations) to manage seven major river basins in the country (Mutondo et al., 2011). Likewise, Kenya has decentralized management of water resources through the implementation of the IWRM framework and the associated Dublin principles (Allouche, 2016; Manzungu and Derman, 2016). The enactment of the Water Act of 2002 (revised in 2016 and 2022), and the new constitution in 2010 acknowledged the importance of community participation in the management of natural resources. The Water Act 2002 led to the formation of Water Resources Users Associations (WRUAs) within the six drainage regions of Kenya.

In different countries, WUAs seem to be playing the same role of managing water resources at the local scale. Their key objectives include (1) the promotion of controlled and legal water use activities, (2) the promotion of good management practices that make efficient and sustainable use of water resources, (3) safeguarding of environmental flows for

downstream ecological demands and basic human needs, (4) the reduction of water use conflicts, and (5) catchment conservation to improve water quantity and quality (Richards and Syallow, 2018; Aarnoudse et al., 2018).

Formal and informal organizations

Similar to WUAs, formal and informal organizations exist in many African nations. These include government parastatal and non-governmental organizations (NGOs) that manage and conserve water resources for sustainability at the local level. In Kenya, for instance, examples of NGOs include the Tana Basin Organization (TBO) and WaterAid, while examples of government parastatals include the Tana River Development Authority (TARDA) and Kenya Water Towers Agency, which works together with local communities to manage water resources sustainably. These programs include community-led conservation activities as well as the development of infrastructure projects including dams and other water harvesting systems (Tana Basin Organization, 2021).

Indigenous knowledge

Indigenous knowledge (IK) is defined as the distinctive, traditional, and local knowledge that exists within and is generated around the specific conditions of a community that is indigenous to a specific geographic area (Greiner, 1998). The UNESCO definition of IK is, "Local and indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings." The knowledge is normally embedded in the community and is unique to a given culture, location, or society (De Guchteneire et al., 1999). The preservation of natural resources, such as land, forests and water, is currently being significantly aided by the practice of IK. Sadly, knowledge of the environment is being lost in communities all over the world, and there is an urgent need to conserve this information to assist in the development of mechanisms that will protect natural resources (Battiste, 2005).

Africa is a continent with a rich collection of IK because of its many indigenous communities. With the help of IK which has been handed down over generations, the utilization of natural resources by indigenous communities was largely sustainable. While IK is a good fit for bottom-up and decentralized approaches to natural resource management, the promotion and advancement of Western science has undermined its application and significance. Nevertheless, many communities of indigenous peoples of Africa observed, and some continue to this day, WRM practices meant to protect or conserve available water sources and resources (Borthakur and Singh, 2020; Ncube, 2022). Although the literature is limited, here we give examples that demonstrate the existence and potential of IK in water and RBM in Africa.

In South Africa, Lake Fundudzi, which is the largest natural lake in South Africa, is a sacred place for the Vha-Venda people who keep the lake and its environment spiritually clean and prohibit any developments that can blemish the spiritual upkeep of the lake (Anyumba and Nkuna, 2017). These traditional practices and beliefs have given the lake and the surrounding area a sacred status that has limited exploitation by surrounding communities for many years (Khorombi, 2007). Similarly, the traditional water harvesting, storage, and irrigation and other water-associated knowledge have allowed the indigenous communities of South Africa, such as the Xhosa people of Eastern Cape, to subsist in conditions such as arid lands and survive in drought for ages (Denison and Wotshela, 2009). In Zimbabwe, the Chibememe and Tshovani communities in the Sangwe communal lands use their IK or beliefs to manage water resources, forests, and wildlife in their locality to safeguard them for the present and future generations (Chibememe et al., 2014). They practice the concept of sacred pools, where aquatic resources are controlled to prevent the overharvesting of fish. In the Sangwe community, each sacred pool is allocated to a certain village head who is tasked with monitoring the fish stocks and informing the chief when it is ready for harvesting or when illegal harvesting has occurred (Chibememe et al., 2014).

Similar approaches to natural resources management and conservation through restricted use and sharing were practiced in other regions of the continent. In Eastern Africa, the Maasai community, who are traditionally pastoralists, practiced forest conservation aimed at protecting the sources of water (rivers) for their livestock. The Maasai mostly grazed their livestock in the semi-arid savannah lowlands where there was an ample supply of forage and limited grazing or exploiting forests in the humid uplands, which they conserved and protected as sources of water for their livestock. Due to their well-known methods of conserving soil and water, the Konso people of Ethiopia have been designated as a UNESCO World Heritage Site (UNESCO, 2010). This community works together to construct terracing and pond systems for water harvesting and soil erosion control (Behailu et al., 2016). The ponds were intricately designed and fenced to prevent or minimize debris and sediments in runoff from entering the pond (Fig. 21.1). The community uses the proverb "Living together means sharing resources" to strengthen their cohesion and togetherness (Garra, 2006). This is a lesson that can be emulated to achieve sustainability in modern management practices (Harvey and Reed, 2007).

FIGURE 21.1 Water harvesting structures of the Konso people of Ethiopia. (A) A wooden mesh to filter out debris in runoff from entering the pond, (B) a fenced pond, (C) terracing outside to prevent silt from entering the pond, and (D) a stilling basin that settles silt in runoff before entering the pond. *Adopted from Behailu et al. (2016).*

National level

All parties involved in WRM must work together to safeguard and develop river basins in a sustainable and effective manner. At the national level, centralized river basin governance entails the establishment of overarching institutions in charge of managing water resources nationwide. The creation of laws, rules, and plans that direct the governance and management of river basins is mostly the responsibility of national governments. In order to ensure environmental sustainability, these policies often aim to strike a balance between the demands of diverse sectors, including urban regions, industry and agriculture.

Examples of national RBM and governance institutions, departments or parastatals that have been established in Africa and their roles are summarized in Table 21.1. Generally, these institutions and/or departments formulate and implement policies for WRM in their respective nations and coordinate water-related activities across different regions of the country. Additionally, they are responsible for developing and implementing policies related to the development of infrastructure, water quality and usage at the national level.

Transboundary level

Many river basins cross international borders, necessitating transboundary management and governance structures to address shared challenges and conflicts over water resources. Transboundary RBM and governance requires collaboration and coordination among riparian countries to develop joint management plans and governance structures to prevent

TABLE 21.1 National institutional arrangements for river basin management in Africa.

Institution	Country	Roles
Water Resources Authority (WRA)	Kenya	Formulate and enforce standards, procedures and regulations for the management and use of water resources and flood mitigation; regulate the management and use of water resources; issue permits for water abstraction, use and recharge and enforce the conditions of those permits; collect water permit fees and water use charges; determines and sets permit and water use fees; provide information for formulation of policy on national WRM, water storage and flood control; coordinates with other regional, national and international bodies for the better regulation of the management and use of water resources; and advises the government on the management and use of water resources.
National Water Resources Authority (NWRA)	Malawi	Responsible for management, conservation, use, and control of water resources as well as regulating the rights for water use.
Federal Ministry of Water Resources	Nigeria	Formulates national water policies and develops a strategy to guide the integrated planning, management, development, use and conservation of the nation's water resources; based on the recommendations of the national council on water resources, it formulates guidelines for policy and standards for water supply and sanitation and monitor the level of service delivery and ensures regular dissemination of reports; it periodically reviews and updates national water legislation to ensure consistency with national policy; it implements development projects with multi-purpose natures including for flood and drought management that are outside the mandate of individual service delivery agencies.
Water Resources Commission (WRC)	Ghana	Regulates and manages the country's water resources and co-ordinates the related government policies.
Ministry of the Environment, Nature Conservation and Forestry (MECNE)	Democratic Republic of Congo (DRC)	Manages water resources and is responsible for urban sanitation.
Ministry of Water, Irrigation, and Energy (MoWIE)	Ethiopia	Plans, develops, protects and manages the country's water resources, as well as supervises all medium and large irrigation projects.
Department of Water and Sanitation (DWS)	South Africa	Custodian of the country's water resources and it formulates and implements policy governing the water sector.
Directorate of Water Resources Management (DWRM)	Uganda	Manages and develops the country's water resources in an integrated and sustainable manner; it ensures the adequate water supply for all social and economic needs of the present and future generations.
Ministry of Water and Irrigation (MoWI)	Tanzania	Formulates and monitors the implementation of policies and strategies for the water sector; it mobilizes funds for water projects; analyses water sector data; issues guidelines on the sustainable use of water resources and sanitation services; it organizes workshops for water sector professionals and promotes research on leading-edge technologies; it coordinates responsibilities and implements recommendations from the national water Board.

The Ministry of Water Resources Development and Management	Zimbabwe	Formulates policies to guide the systematic and integrated planning of the optimum development, utilization and protection of the country's water resources.
Ministry of Natural Resources (MINIRENA)	Rwanda	Responsible for policy formulation, strategic planning, coordination, quality assurance, monitoring, evaluation and capacity building in the water sector
The Directorate of Water Resources (DRH)	Burundi	Responsible for policy formulation, development of strategies for sustainable development of the country's water resources, development and maintenance of the country's national water Master plan and maintaining the water tariff policy for rural and urban areas.
Ministry of Water Resources and Irrigation (MWRI)	South Sudan	Responsible for water resource policy formulation, water use planning and regulations, scientific research, setting water use tariffs and protecting wetlands.
Ministry of Energy and Water Resources (MoEWR)	Somalia	Responsible for policy formulation, setting standard operation, national planning, regulation, monitoring, and technical support of regional states in relation to energy and water resources.
The Water Resources Department (WRD)	Eritrea	Oversees water resources management as well as ground and surface water allocations, irrigation and monitoring.
Ministry of Water and Sanitation (MEA)	Senegal	Responsible for WRM, drinking water supply and sanitation and agricultural water allocation; it also facilitates collaboration and communication within the water sector.
Water Resources Management Authority (WARMA)	Zambia	Regulates, manages, develops, protects, and conserves water resources for all users.
Ministry of Water Resources and Irrigation (MWRI)	Egypt	Responsible for the development, distribution and management of water resources. Also, it's responsible for collection and disposal of agricultural drainage water, monitoring and assessment of water quality of the various water sources.
The General Directorate of Hydraulics (DGH)	Morocco	Responsible for development of water resources for all uses, including major dam construction and operation.

disputes over water allocation maintain state-to-state collaboration and promote transboundary sustainable water management. Their success is a result of various stakeholders' involvement as well as government financial and political support. Table 21.2 provides an overview of transboundary institutional arrangements that have been put in place in Africa to help with RBM.

Policy and legal frameworks for the governance of rivers in Africa

A common definition of water policy is the set of laws and rules that support water management. It includes all attempts to specify the guidelines, goals, and tools used by governments to regulate how people use water, prevent contamination of water sources, and supply water to the environment. In addition to the legal and regulatory framework, it takes into account the planning for the distribution of water resources and the methods used by water managers and other stakeholders to put the framework into practice (Water Mandate, 2010). Sectoral policy's overarching goal is to provide the tools required to create an enabling environment required for sector development. From the standpoint of governance, defining the goals and procedures of policies and including all pertinent parties in the process are just as crucial as the policies themselves (McGranahan and Satterthwaite, 2006).

A key factor influencing the quality of a policy and its outcomes is how it is formulated. The two main approaches for developing policies are decentralized and centralized. In centralized systems, sectoral planning and policy formulation are coordinated and controlled by an executive-level planning body composed of senior officials from the central government's apex ministries. Although Tunisia appears to have benefited much from this strategy, insufficient demand-side input is permitted during the policy-making process (AfDB, 2011). This increases the likelihood that the policies won't be suitable or acceptable at lower levels. Moreover, this strategy misses the chance to establish policy networks with influential decision-makers within and around sector ministries, which will ultimately influence how well a policy is implemented in the long run.

Local governments and water users can participate in the policy-making process far more actively under the decentralized and participatory model. By doing so, they can significantly influence sector governance and policy more than they might in the form of centralized policy-making. Mali, with its National Sanitation Policy (AMCOW, 2008), Uganda with its National Water Action Plan (Jønch-Clausen, 2004) and Kenya, whose constitution requires that all management decisions, including the creation of pertinent policies and laws, be participatory and consultative, are example of nations that have shown the advantages of decentralized and consultation-rich policy-making.

The legislation serves as a means of integrating policies into national political and legal frameworks, defining standards for water quality, safeguarding the rights of individuals and communities to water, handling conflicts, and - perhaps most importantly - defining the obligations of sector institutions (AfDB, 2011). Effective governance of river basins can be significantly influenced by the latter function, especially considering the multitude of organizations engaged in the development and management of the water sector. Legislation that is based on the concepts of equitable and reasonable use, duty to cooperate, and dispute prevention, resolution, and compliance is crucial for transboundary RBM because it clarifies institutional roles and responsibilities across shared jurisdictions (Schulz, 2006).

Table 21.3 below summarizes some of the existing policies and legal frameworks that have been developed and enacted in some of the African countries to facilitate river basin governance.

Challenges in the management and governance of river basins in Africa

The management and governance of rivers in Africa face numerous challenges that impact the sustainable use of water resources, environmental conservation, and the well-being of human communities. The challenges range from environmental and climatic factors to socio-political and institutional issues. Here we explore some of the key challenges in the management and governance of rivers in Africa, highlighting the complexities involved and drawing insights from relevant literature.

Failures of existing institutional and legal frameworks

River basins function well and serve both ecological and economic roles if they are properly managed and governed. In Africa, however, the management and governance of river basins remain a challenge, leading to unsustainable use of the water resource and related biodiversity. National and transboundary institutions for the management and governance of river basins exist (Tables 21.1 and 21.2), but face inherent challenges. In the SADC region, civil conflicts in Mozambique and Angola, as well as liberation wars in Namibia and Zimbabwe hampered the proper functioning of the Okavango River

TABLE 21.2 Transboundary institutional arrangements for river basin management in Africa.

Commission	Year founded	River basin	Countries	Roles
Nile Basin Initiative (NBI)	1999	Nile	Egypt, Sudan, Ethiopia, Uganda, Kenya, Tanzania, Burundi, Rwanda, Democratic Republic of Congo, and Eritrea (the latter is observer)	The NBI aims to foster regional peace and security, share socioeconomic gains, and develop the river in a cooperative manner; it offers an institutional framework, a common goal, and a set of policy directives to create a foundation for cooperative action throughout the basin.
Senegal River Basin Development Organisation (OMVS)	1972	Senegal	Mali, Mauritania, and Senegal (Guinea has an observer status)	It performs all technical and economic duties assigned to it by the member states, including implementing the Senegal river convention, encouraging and coordinating development research; its water Charter (2002) presents a shared vision for managing the river sustainably.
Okavango River Basin Water Commission (OKACOM)	1994	Okavango	Angola, Botswana and Namibia	It handles policy and institutional issues pertaining to the governance of the basin; it deals with policies and practices for biodiversity conservation; creates plans for water management; deals with issues pertaining to the collection, handling, and interpretation of water-related data.
Lake Victoria Basin Commission (LVBC)	2005	Lake Victoria	Kenya, Tanzania, Uganda, Burundi, Rwanda	It coordinates the five EAC partner states' sustainable development and management of the Lake Victoria Basin.
Niger Basin Authority (NBA)	1963	Niger	Benin, Burkina Faso, Cameroon, Guinea, Côte d'Ivoire, Mali, Niger, Nigeria, Chad	It promotes collaboration among member states and guarantees the basin's integrated development, particularly in the fields of hydraulics, energy, agriculture, animal husbandry, fishing and fish farming, as well as the exploitation of forests, industry, transportation, and communications.
Lake Chad Basin Commission (LCBC)	1964	Lake Chad	Cameroon, Niger, Nigeria, CAR, Chad	It promotes the preservation of the ecosystems, regional integration, peace, security, and development in the Lake Chad region and its shared water resources.
Gambia River Basin Development Organization (OMVG)	1967	The Gambia	The Gambia, Guinea, Guinea Bissau, Senegal	It promotes the sustainable management of the common resources of the Gambia, Kayanga-Geba and Koliba-Corubal rivers.
Volta Basin Authority (VBA)	2006	Volta	Burkina Faso, Benin, Côte d'Ivoire, Ghana, Mali, Togo	It promotes stakeholder consultation in the basin; encourages the application of IWRM and the fair distribution of benefits in the region; Evaluates the planned infrastructure in the basin; it develops and implements joint projects and initiatives; contributes to the subregion's socioeconomic integration, and sustainable development, and poverty reduction.
Limpopo Watercourse Commission (LIMCOM)	2003	Limpopo	Botswana, Mozambique, South Africa and Zimbabwe	It provides recommendations and advice to the Contracting parties on management, preservation, and conservation of the Limpopo river and its tributaries.
Orange-Senqu River Commission (ORASECOM)	2000	Orange-Senqu	Botswana, Namibia, Lesotho and South Africa	It promotes the equitable and sustainable development of the Orange-Senqu river resources; it also promotes IWRM and development within the basin by providing a forum for consultation and coordination between the riparian states.
Zambezi Watercourse Commission (ZAMCOM)	2004	Zambezi	Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe	It promotes equitable and efficient management of the Zambezi river to ensure its sustainable development.

TABLE 21.3 National policies and legal frameworks for governance of river basins in Africa.

Country	Policy and legal frameworks	Aspects addressed
Kenya	Water Act, 2002 (Revised, 2016 and 2022)	Water Act, 2016 provides the governance structure for the whole water sector and aligns the water sector with the Constitution's primary objective of devolution. Water Act, 2016 is a revised version of the water Act 2002 that redefines roles and responsibilities of the main institutions.
	Constitution of Kenya, 2010	The constitution of Kenya under Article 43 economic and social rights (Republic of Kenya, 2010) guarantees every person's right to clean and safe water in adequate quantities. Moreover, in relation to the water sector, the constitution mandates water service provision to the county government. The constitution also mandates that the state encourage public participation in the management, protection and conservation of the environment under Article 69(1) (e).
	Kenya National Water Master Plan 2030	It formulates the strategy and prepares an action plan for sustainable water resources development and management for six catchment areas toward 2030.
Ethiopia	Water Resources Management Policy, 2000	It emphasizes an integrated framework for water resources development as "a rural-centred, decentralized management underpinned by a participatory approach" that shall ensure "social equity, economic efficiency, system reliability, and sustainability norms."
Uganda	Water Act, 1997	It defines the powers and functions of water authorities as the responsible entities for provision of water supply services and gives the Minister of water and environment the authority to demarcate water supply areas and appoint water authorities to provide water supply services in these areas through a notice in the Gazette.
	National Water Policy, 1999	It encourages the use of an integrated strategy to manage water resources in a way that is both most beneficial to people and sustainable.
Rwanda	Water Resources Law, 2018	It offers a precise framework for the tenets of IWRM, such as "user pays" and "polluter pays," and it addresses pollution prevention as well. Additionally, it stipulates that it is illegal to pollute water bodies by dumping, spilling, or depositing chemicals of any kind above what is safe for aquatic life or human health.
	National Policy for Water Resources Management, 2011	It is a robust framework for the management, protection and conservation of the country's water resources.
Burundi	Water Act, 2012	It focuses on a centralized approach to water resources management.
South Sudan	Water Act, 2012	It focuses on the management of water resources, regulation and the supply of water services.
Somalia	Water Act, 2012	It establishes the legal framework to support the strategy; and defines organizations, mandates, and responsibilities in the water sector.
	National Water Resource Strategy 2021–25	It provides a suite of strategies, objectives, and actions for the water sector for the 2021–25 period.
Eritrea	Water Resources Law, 2010	Its goals are to protect and enhance Eritrea's water resources; and to encourage and coordinate all institutional efforts in accordance with recognized international standards and procedures in order to accomplish sustainable socioeconomic development and ecological stability.

Djibouti	National Water Master Plan, 2006	Introduced to improve the sanitation sector and the water supply in the country.
	National Water Resources Plan, 2004	It emphasizes stakeholder participation and an integrated approach to managing water resources.
Tanzania	National Water Policy, 2002 (Revised, 2023)	The national water policy 2002, version 2023s principal goal is to guarantee the most economical, efficient, sustainable, and equitable development and use of water resources for the benefit of all.
	Water Resources Management Act, 2009	It provides the institutional and legal framework for the sustainable management and development of water resources. It describes in detail the fundamentals of managing water resources as well as the prevention and control of water pollution.
	Water Supply and Sanitation Act, 2019	It provides the legal framework and policies for urban, peri-urban and rural water sanitation and hygiene, service delivery and regulation. It defines the institutions responsible for the management of water and sanitation services both in urban and rural areas.
South Africa	National Water Act, 1998 (Revised to National Water Amendment Act, 2014)	It ensures the equitable and sustainable management, conservation, development, protection, and control of South Africa's water resources for the benefit of all people.
Zimbabwe	Water Act, 1998 (Revised, 2003)	It provides for the management and conservation of water resources in Zimbabwe.
Malawi	Water resources Act, 1969 (revised, 2013	It provides for the acquisition and regulation of water use rights and management and conservation of water resources.
	National Water Policy, 2005	It covers every facet of managing water resources, including their development and delivery of services in line with regional and global trends as well as the sustainable development goals.
Ghana	Water Resources Commission Act, 1996	It establishes the water resources commission, outlines its membership and its responsibilities for managing and controlling water resources in Ghana.
	National Water Policy, 2007	It focuses on achieving sustainable development, management and use of Ghana's water resources to improve health and livelihoods, and reduce vulnerability while assuring good governance for present and future generations.
Burkina Faso	Water Act, 2001	It recognizes the importance of clean water, decent toilets and good hygiene.
Nigeria	Water Resources Act, 2004	It encourages the best possible planning, development, and utilization of Nigeria's water resources.
	National Water Resources Policy, 2016	It aims to protect the integrity of the country's freshwater ecosystems while facilitating and enhancing sustainable access to safe and sufficient water to meet the cultural and socioeconomic needs of all Nigerians in a way that will improve public health and food security, and reduce poverty.
Senegal	Water Code, 1981	It establishes water as a public good to be equitably distributed between different uses with prioritization for domestic consumption. Also, it contains clauses on water ownership, authorization and control required to exploit water resources and the costs associated with water withdrawal.
Egypt	Water Resources and Irrigation Law, 1984 (Revised, 2021)	It aims to set up efficient systems for irrigation, drainage, water distribution, and administration.

Basin Water Commission (OKACOM), and the Zambezi Watercourse Commission (ZAMCOM). Similarly, the effects of apartheid in South Africa hampered the Limpopo Watercourse Commission (LIMCOM) and Orange-Senqu River Commission (ORASECOM). Generally, civil wars and other strives negatively impacted operations of RBM across Africa, including the Congo Basin (IMF, 2015), Lake Chad Basin (UNDP, 2022) and the Niger River Basin (Brown et al., 2022).

Since the institutions are charged with running the legal frameworks, it means the implementation of the governance regimes and regulatory systems also become ineffective or are not adequately implemented to ensure sustainable management and exploitation of the resources of the basins. Conflicts over water access rights are also common in the Nile basin (Ngamdu, 2015), often due to severe droughts, biased water agreements made during the colonial era, disparities in the level of economic and infrastructural development in the 10 riparian countries, as well as differences in religious and political systems across the countries sharing the resource (Ngamdu, 2015). Amicable resolution of these challenges is hampered by the inadequate human and financial capacity of relevant institutions such as the Nile Basin Initiative (Ngamdu, 2015).

While the construction of dams along river courses often helps in flood control during episodes of extreme flooding, these also lead to shrinking water resources, occasioning frequent conflicts (Ngamdu, 2015), especially in endorheic basins such as Lake Chad. Generally, flooding in river basins is a significant challenge in Africa because institutions of governance lack reliable data on the severity and frequency of occurrence of floods (Abbas et al., 2016; Mercado et al., 2020). Therefore, accurate prediction models cannot be developed (Mercado et al., 2020). Implementation of integrated flood risk management that builds resilience among communities at all levels is difficult because of a limited understanding of the potential risks and consequences of extreme flooding and, the lack of technological capacity to design relevant structures for flood control (Abbas et al., 2016), and weak institutional, governance and policy frameworks (Verweij et al., 2021). Similarly, flood management strategies are not integrated with social, cultural, physical and political factors, as well as ecosystem services (Abbas et al., 2016; Vitale, 2023).

Failure of institutional and legal frameworks to serve effectively in the sustainable management of river basins and sustainable exploitation of water and aquatic resources is due to ineffective capacity to enforce the regulations, due to diverse factors. Corruption among staff and associated stake-holders compromises the ability to enforce existing regulations (IMF, 2015). Lack of sufficient human resources and expertise also creates critical lapses in the enforcement of the regulations. Generally, most transboundary rivers are managed by River Basin Organizations (RBOs), but well-managed river basins like the Rhine and Danube have RBOs managed by a secretariat and expert working groups (EWGs) (Schmeier, 2010), comprising of personnel specialized in certain area, and so deal with certain issues of critical importance in the basin. This advice on specific issues, helping management take technical decisions of optimal impact. An RBO may have several EWGs, such as the implementation of the European Union's (EU) Water Framework Directive (WFD), flood protection and accidental water pollution of the International Commission for the Protection of the Elbe River (Schmeier, 2010). Although better-organized RBOs in Africa such as the Lake Victoria Basin Commission have EWGs, most like the Lake Chad Basin Commission (LCBC), Lake Tanganyika Authority (LTA), Niger Basin Authority (NBA), Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS), Volta Basin Authority (VBA) and Zambezi Watercourse Commission (ZAMCOM) lack such groups (Schmeier, 2010). This is mainly due to limited expertise and capacity development on critical and technical issues of basins. Proper management of the river basins, is therefore imperilled, due to a lack of regular updates or reconstitution of the membership of the EWGs, to cope with the changing or emerging needs and challenges of specific basins.

Emerging issues

Different river basins on the continent face challenges related to climate change with varying degrees of severity (Dalu et al., 2024, Chapter 29). While freshwater is an important resource for domestic, industrial as well as environmental use, it is also a finite resource, and often limiting on the continent. Although challenges related to climatic patterns are age-old, new and emerging challenges are particularly severe, because of extreme phenomena, related to climate change. One such challenge is extreme and more frequent droughts, which affect the discharge and environmental flows in basins. Related to such droughts are diseases and reduced productivity of livestock, due to mortality. Endorheic river basins such as the Okavango River (Turton, 2010) and Lake Chad basins (Pattnayak et al., 2019; Olowoyeye and Kanwar, 2023) suffer frequent episodes of drought, reducing water flows and groundwater recharge in the basins, exacerbated by environmental unfriendly activities in the watershed (Olowoyeye and Kanwar, 2023) in respective countries. This negatively impacts livelihoods, with relevant institutions such as the Okavango Basin Commission (OKACOM) and the Lake Chad Basin Commission (LCBC) being unable to adequately address these. Similarly, flooding is frequent in most of the river basins, which causes massive destruction and loss of livelihoods for residents.

In areas that face severe water scarcity, inter-basin transfer (IBT) is necessary, since water security is critical for economic development. For instance, Gauteng province, South Africa, and Lesotho rely onITBs to support economic activities. In Gauteng, such diversions are used in mines (Turton, 2010), which are critical resources for industrial growth. However, this IBT often causes shortages in the main basin, and pollution from mines which is environmentally unfriendly (Turton, 2010). These create conflicts due to access and environmental effects, resulting in environmental politics that affect the management of river basins. Furthermore, IBTs require well-developed hydraulic infrastructure to ensure the safety of the water resource being transferred and minimize wastage through leakages. In South Africa, the white communities are more endowed and have the ability to install such infrastructure, naturally benefitting from the water resource of another basin. This increases related environmental politics that hamper the proper management of river basins (Turton, 2010).

Environmental politics is indeed a serious challenge in water-scarce regions of North Africa, and negatively impacts the management of river basins. The Nile River basin, with a human population of close to 200 million people, has its upper riparian countries in East Africa and the Horn of Africa. This region currently faces considerable environmental politics, especially because of the construction of the Grand Ethiopian Renaissance Dam (GERD) by Ethiopia, which Sudan and Egypt oppose, for threatening food security and access to sufficient water (Dahir, 2020). Even before the initiation of this project, the politics of the Nile River basin was often a volatile matter because of colonial-era treaties that granted Egypt and Sudan enormous power and control over the waters of the Nile, at the expense of upstream states (Ethiopia, Eritrea, Kenya, Tanzania, Burundi) (Pemunta et al., 2021). These treaties include the Nile Treaty of 1902 (Degefu, 2003; Pemunta et al., 2021), the Nile Waters Agreement of 1929 (Salman, 2013) and the Nile Waters Agreement of 1959 (Batstone, 1959). Mistrust among riparian states due to the hegemony of Egypt created by the power it derives from these treaties, therefore, affects the ability of relevant institutions to ensure proper management of the basin. Similarly, the basin lacks a comprehensive basin-wide framework for legal, institutional, and political harmony among upstream and downstream states (Yihdego et al., 2016), and this hampers the ability of relevant institutions and instruments to effectively address access and user rights for respective states (Yihdego et al., 2016).

The SADC contains several specific principles, whose implementation or lack of, especially in transboundary water resources, increases mistrust and consequently environmental politics, which exacerbate challenges of RBM. These include respect for the sovereignty of member states in the utilization of shared watercourses; application of rules of general or customary international law, community of interest, and equitable utilization; the need to maintain a balance between economic development and environmental protection in shared watercourses systems; co-operation in joint projects and studies relevant to shared watercourse systems; commitment to sharing data among riparian states; equitable and reasonable utilization of shared watercourse systems and the need for discharge; abstraction permits for all users; and the obligation to notify all riparian about emergencies (Turton, 2010). In South Africa, these political challenges are heightened by unequal economic disparities among communities, with whites being accessible to good quality water resources (Turton, 2010). In the Okavango and Cunnene basins, environmental politics arise from the location of developments and some cities in the watershed areas, instead of along river courses and lakes. This creates challenges in implementing some of the WRM strategies that require application in the watershed (Turton, 2010).

Sustainable management of river basins also requires frequent monitoring, in order to ensure water quality remains within acceptable limits. This requires the availability and use of current, reliable and scientifically validated monitoring tools. In Kenya and some countries which have implemented water sector reforms in line with the guidelines of the Sustainable Development Goals 2015, the monitoring of water resources by regulatory authorities still remains a challenge (Nyanchaga, 2016). This hampers the planning and management of water resources, and exacerbates the degradation of river catchments, leading to a decline in the quality and quantity of water available to communities (Nyanchaga, 2016). One of the main reasons for the inadequate monitoring of water resources in river basins in Africa is the lack of suitable monitoring tools (Kaaya et al., 2015; Masese et al., 2021). While rapid bio-assessment methods (RBM) have been developed and are widely used in Europe and many countries of the SADC region (Tanzania, Namibia, Zambia, Angola and South Africa) (Dallas, 2021; Kaaya et al., 2015), Kenya and most countries of central and west Africa lack such tools.

Politics in water resources management

As a concept for effective management of water resources, IWRM was implemented in Africa through the support of donors and development partners. However, the adoption of the approach was hampered in some countries by existing political orientations and policies. In Zimbabwe, for instance, it was affected by political decisions that replaced large-scale farms with small-scale farms through a change of the land tenure system. This change saw black communities, many with no skills and capital to continue economic production on their acquired land, unable to effectively adopt sustainable

strategies for managing water resources. This created a disincentive to donors' support of IWRM in the country (Dirwai et al., 2021), leading to poor implementation of the approach. Countries that received donor support due to a favorable political environment, such as Uganda, Kenya and Tanzania, South Africa and Zambia, as well as those that had enthusiastic citizen participation like Mali and Burkina Faso implemented IWRM (Dirwai et al., 2021). This led to the development of improved water infrastructure, reform of policy and enactment of new laws which consequently guided better management of river basins and regulation of water resources and services (Dirwai et al., 2021).

Although IWRM was implemented in South Africa, different cultures among communities hampered the adoption of the management approach in many parts of the country. Poor interpretation and translation of innovations in IWRM due to political affiliations in the country also hindered effective adoption of the approach in parts of the country (Dirwai et al., 2021). Similarly, the country introduced a licensing system for IWRM. This restricted access to water resources by smallholder farmers, who were unable to pay for the licenses. Furthermore, even for those farmers able to pay for licenses, they still needed storage facilities (Dirwai et al., 2021), which blocked many more of the farmers from accessing water resources and services (Dirwai et al., 2021). This stifled proper management of river basins by the wider section of the communities. At some point, the government shifted from a local water rights system to a state-based system of water provisioning. The politics and bureaucracy associated with the new system created bottlenecks that made it harder for smallholder farmers to obtain water (Dirwai et al., 2021). Generally, a lack of political will, pragmatism and technical challenges among authorities restricted access to water resources by a large section of the community, creating a disincentive to proper management of river basins by all stakeholders.

Limited integration across sectors

Governance of the water sector entails the range of political, social, economic and administrative systems put in place to guide the development and management of water resources, as well as the delivery of water services across the society (UNDP, 2004). Good governance of the water sector requires equity, efficiency, participation, decentralization, integration, transparency and accountability by both Government and government agencies, private actors, the community and all stakeholders. In many countries of Africa, however, governance of the sector is often disjointed, and devoid of linkages (AfDB, 2011), and many authorities perform different roles, often with overlaps. In Kenya for instance, where policy reform and enactment of new laws to govern natural resource management have been undertaken, establishing clear legal and institutional frameworks for relevant sectors, management and governance of natural resources is largely sector-specific, with very little linkages and integration, even at the grassroots level (Ombogoh et al., 2022). While forest and water are interlinked, with forest health directly influencing water quality and quantity (Jacobs et al., 2017), forest resources are managed by the Kenya Forest Service (KFS), while the Water Resources Authority (WRA), created by Water Act, 2016, manages water resources (Ombogoh et al., 2022).

Similarly, although the Kenya Water Towers Agency (KWTA), created in 2012 (Executive Legal Notice No. 27 of 2012) is charged with spatial planning, monitoring and rehabilitation of critical water towers, it is also involved in the conservation and sustainable management and regulation of aquatic resources in the watersheds of specific river basins (CIFOR, 2017). This role conflicts with the mandate of key institutions under the water sector, that were created in the policy and law reforms that were initiated around 1999, and peaked in 2016 (World Bank, 2016), especially since important river basins emanate from these watersheds or water towers. On the other hand, the management of marine parks and marine protected areas is under the Kenya Wildlife Service (KWS). This also extends to portions of rivers that run through national parks and game reserves. An example of this is the Mara River, which is both transboundary and flows through the Maasai Mara National Reserve in Kenya and the Serengeti National Park in Tanzania. Therefore, the conservation of portions of the river that flows through these parks is under KWS, while WRA is responsible for the portions of the river outside the parks. This is challenging since impacts exerted on the river in the upper reaches affect the health of the river downstream. Management and conservation of marine parks and marine protected areas (MPAs) is complicated by several agencies that coordinate this function. Generally, Kenya Wildlife Service is the one controlling all such protected areas (Harker et al., 2022), but the Kenya Fisheries Service (KeFS) also has a role in the management, because of fishing activities in the areas (Owuor et al., 2017). Kenya Forest Service is charged with managing mangrove forests within the parks and protected areas (Owuor et al., 2017), while tourism agencies license all activities in the parks (Harker et al., 2022). Although wildlife conservancies such as Lakes Kamnarok, Bogoria, and Kanyaboli are under County governments, KWS assists in technical support, security and developing management plans for the reserves to address pollution, habitat degradation, and poaching. For such aquatic resources, inflows are via streams, rivers and surface run-off from flooding. This requires the active involvement of WRA in the proper management and regulation of the resources upstream, and due to weak collaboration between these agencies and county government units, management of the resource is imperiled. This

is further compounded by specific statutes that empower the National Environmental Management Authority (NEMA) in the management and regulation of some wetlands in the country (LVBC, 2012).

Limited financial resources

In Africa, many governments lack adequate funding for the effective management of water resources and the development of public water infrastructure to supply all citizens with clean and safe drinking water. Financing gaps of between US$ 56 billion and US$ 66 billion exist on the continent (AfDB, 2018). Financing in the water sector is required for infrastructure and services, governance, information gathering, monitoring, regulation, forecasting, training and capacity building (EUWI-FWG, 2012). While water infrastructure and services are well financed, due to the direct social and economic benefits from water access by communities, WRM is not well financed (EUWI-FWG, 2012). This closely mirrors poor funding for aquatic biodiversity monitoring and conservation on the continent (Achieng et al., 2023). Financing of WRM generally proceeds from tariff revenues and national budgetary allocations, boosted by development assistance (support by development partners) (EUWI-FWG, 2012). This attracts the involvement of private sector financing (EUWI-FWG, 2012), especially if the size of the project is big with considerable social benefits to many citizens.

Indeed, in basins with well-developed water infrastructure for water supply like the Orange River basin, there is a reasonable level of water security, safety and reliability, since wastage is also minimized (Turton, 2010). Similarly, in countries that have implemented policy and law reforms for the water sector like Kenya, Uganda, Tanzania and South Africa, private sector financing for public water projects exists (Kigutu, 2019). The Water Sector Trust Fund of Kenya for instance, receives financing from private sector players for the development of water projects in the country. However, due to limited incentives in the relevant policy, the amounts provided so far under this arrangement are small, and repayable over short periods of about 5 years (Kigutu, 2019), yet the payback period for water infrastructure is 15 years (WFF, 2016). Also, the number of private sector financiers for the water sector is limited, mainly due to limited incentives in the relevant policy (CBK, 2017; Kigutu, 2019). Kenya and Ghana issued bonds for support to WRM, but uptake of this was negligible, mainly due to limited incentives. To overcome such challenges, countries such as South Africa created distinct institutions, like the Trans-Caledon Tunnel Authority, empowered to raise funds from local and international money markets. Similarly, Zambia created the Kafue River Hydro-Authority. These also easily raise funds from sovereign wealth funds from Chinese, Arab and Indian funds (EUWI-FWG, 2012).

Water sector financing in Kenya as stipulated in the Water Act, 2016 also involves loan guarantees from the government or a public entity or bank. The Water Sector Trust Fund (Water Fund) fits this role, with the mandate to provide conditional and unconditional grants to the County governments and to assist in financing the development of and management of water and sanitation services in marginalized and underserved areas. However, this role is currently not well played, due to limited policy incentives.

Budgetary support for the sector in Africa is generally low, with countries like Uganda and Ghana witnessing progressively declining allocations in the 2000s (EUWI-FWG, 2012). South Africa witnessed increasing budgetary support for the sector over the same period, due to several factors like a stronger economy, diverse functions under the sector such as research, support from the mining industry, strong and autonomous institutions in the sector, a stronger asset base of relevant institutions that attract commercial financing, fiscal policy that limit the role of the national treasury in the acquisition of loans by water institutions. Also, incentives provided by the National Water Act encourage private sector support for WRM.

For many countries, the support provided as official development assistance (ODA) for the water sector is critical for development, especially infrastructure development for safer, adequate and clean water supply. In South Africa, Ghana and Uganda, for instance, ODA for WRM has been on the increase, with many countries of the West (e.g., Denmark, Belgium, Germany, the UK, USA, the Netherlands) and the EU providing increasing ODA support for the sector (EUWI-FWG, 2012).

Strategies for effective management and governance of African rivers

Effective RBM at transboundary, national and local levels requires coordinated multi-stakeholder participation, good and sound policies, legal frameworks, institutional mechanisms and sustainable financing that are transparent and accountable that yields results on the ground. This section outlines strategies that should be adopted to ensure effective management and governance of river basins in Africa.

Harmonization of management and governance structures

Harmonization processes usually involve bringing together a combination of policies and initiatives aimed at the advancement of national legislative and regulatory frameworks towards relevant international best practices and alignment with regional and international protocols and agreements (Addy and Gebrewubet, 2017). The process typically aims at bringing together different national legislative, regulatory and policy frameworks by establishing a commonality of standards and requirements and eliminating major differences.

Policy harmonization and alignment at national, regional and continental levels according to Addy and Gebrewubet (2017) should include but not be limited to the signing of memoranda of understanding among partner states. To be harmonized include the adoption of regional harmonized water policy, and regional harmonized water law, agreeing on institutional framework for transboundary water resources management, and developing and agreeing on data sharing protocols. Others include developing a detailed capacity building needs assessment and preparing a capacity building plan, developing and agreeing on a monitoring and evaluation system/plan for policy implementation, identifying and agreeing on transboundary water resources monitoring stations agreeing on and establishing on regional database, and regional database centre and agreeing on WRM Centres of Excellence at African Union (AU) level. All these are aimed at bringing about more effective coordination and cooperation regarding RBM and governance in Africa.

Traditional approaches

- In ecological research, natural resource management, and evidence-based decision-making, local knowledge is crucial (Alexander et al., 2019). In most African rural communities, natural resources are vital not just as a source of food and other domestic products but also form the basis for cultural and spiritual beliefs (Ochola et al., 2010). Conservation is aided by the cultural, spiritual, and religious connections that many communities have with wild animal species and their natural habitats (Ntiamoa-Baidu, 2008).

For instance, watershed management was viewed by the Marakwet community in Kenya as a societal duty that was overseen by clan elders who controlled access and usage of the water sites. These rights were divided among various clans (Obiero et al., 2023). Cheserek (2005) states that seasonal changes in water availability were countered by changes in livestock water points, communities migrated along known routes with dependable water sources, grazing was zoned and restricted in certain areas, particularly during the rainy season, dry season wells were established, water collection points were fenced, and cultivation was not allowed upstream of rivers or 2 km from the riverbank. Elders imposed fines or penalties for any disobedience, in addition to the Marakwet's belief in gods attacking people who tampered with the purity of the water, to enforce these cultural customs.

To prevent contamination of water bodies and protect catchments, elders forbade washing near riverbanks and felling of trees, especially those seen as sacred and utilized in ceremonies. Additionally, quotas were assigned to each clan that shared a furrow in order to prevent disagreements over the exploitation of resources, and specific forest areas were set aside and guarded as shrines for cultural occasions (Obiero et al., 2023). The Ogiek community in the Mau Forest has also employed traditional methods to manage the forest and water towers in the Lake Victoria basin (Kiage, 2019). Enforcement of traditional approaches, however, requires bylaws to minimize conflict with other governmental legal and institutional structures.

Participatory approaches

Many issues in RBM are addressed by participatory techniques, such as the under-appreciation of local knowledge, the marginalization of individuals, the favoring of elite and expert viewpoints, and the use of extractive and exploitative research practices (Roque et al., 2022). In addition, several participatory approaches to water management aim to improve decision-making, democratize knowledge generation, empower participants, and contribute to the creation of new environmental futures (Roque et al., 2022). One specific illustration of a catastrophe adaptation strategy that came about as a result of a participatory planning process is the "Living with Floods" experience in Mozambique's lower Limpopo River (Spaliviero et al., 2011). Some of the participatory strategies that can be used to promote efficient river basin governance and management in Africa are outlined in Table 21.4.

Development of cost-effective monitoring tools

Throughout the Afrotropics, a number of river basins that are not part of protected conservation zones are subject to various stresses, including changes in land use, urbanization, and excessive water withdrawals that jeopardize the biological integrity of the area. In places like Africa, where traditional analysis of chemicals in water is both costly and inaccessible,

TABLE 21.4 Participatory approaches which can be used in river basin management.

Participatory approach	Objective of the approach	Expected outcomes
Participatory action research McTaggart (1991).	Center marginalized voices in the research process	Action plan from marginalized groups
Community based participatory research Wallerstein and Duran (2010).	Partnership with local communities to address water challenges	Collaboration to promote water access in communities
Photovoice Fantini (2017).	Give agency to participants using a camera or pictures	To inform policy or decision-making
Citizen science Dickinson et al. (2010).	Increase public participation in natural resources challenges through monitoring sites for ecological research	Data to inform the public (e.g., education) or decision-makers on natural resource management
Stakeholder research Eaton et al. (2021) and Reed (2008).	Engage diverse people who have a "stake" in a particular environmental management challenge for decision-making	Social learning and consensus building among different stakeholder groups for decision-making
Participatory rural appraisal Belay et al. (2013).	Give rural people agency in the research process (including viable for action) in collaborations with agencies and researchers	Center participants in research about their own community including education and opportunity to plan for action
Participatory modeling van Eeten et al. (2002), Voinov and Gaddis (2008), and Nyaki et al. (2014).	Bring diverse stakeholders from community members to decision makers to provide insights, address the tradeoffs, and come to a consensus on a model for a natural resources challenge	Model that considers diverse perspectives in a particular natural resource management challenge
Sustainable future scenarios Iwaniec et al. (2020) and Sampson et al. (2020).	Framework to co-develop positive futures considering sustainability and resilience	Future scenarios inclusive of sustainability and resilience
Participatory convergence Birthisel et al. (2020) and Lakhina et al. (2021).	Bring a diverse team of researchers and centering community needs as part of the research process	Transformational plausible solutions for complex problems

Adopted from Roque et al. (2022).

biomonitoring appear to offer a better alternative (Masese et al., 2024, Chapter 27). While such ecosystems are very dynamic and require a comprehensive multimetric index that incorporates the effects of numerous stressors across time, the same methodology offers a snapshot of ecological conditions at the time of sampling. Research employing aquatic biota, such as fish and macroinvertebrate communities, as indicators of the ecological state of streams and rivers in the Afrotropics, along with multimetric indices (such as indices of biological integrity, or IBIs), diversity, and multivariate methods, can be useful instruments for providing management information for river basins (Tampo et al., 2023). The majority of these indices are now country- or region-specific (Masese et al., 2023), thus the focus should be on developing indices that span several African countries or areas.

Training and capacity building

Building capacity at different levels is essential to improving African river basin governance and management. This should focus on building the technical expertise of water management professionals, providing training for local communities in sustainable water use practices, and fostering the development of institutions capable of implementing effective management strategies. Capacity required should develop incentives, and skills, improve governance, create enabling legal frameworks, and fair interstate power structures. Chikozho (2014) states that building capable networks and constituencies of expertise within and beyond Africa to catalyze action as well as share experiences and promote mutual learning will go a long way in increasing transboundary basin leadership and technical capacity.

The secret to success is to thoroughly analyze the underlying capacity challenges and constraints that each basin faces; to encourage coordinated and creative actions toward suitable and feasible solutions that consider the needs and priorities unique to each river basin; and to facilitate the deployment of integrated capacity building interventions that are strong

enough to address deeply ingrained systemic challenges and constraints (Chikozho, 2014). Building capacity has been widely used to improve regional economic integration and the sustainable use of transboundary waters in the Senegal and Nile basins (Sadoff et al., 2002; Falkenmark et al., 2009).

Payment for watershed services

In order to reduce the vulnerability of dependent communities and production enterprises, the promotion of Payment for Watershed Services (PWS) or Ecosystem Services (PES) is a policy option that fosters ecosystem sustainability (Weru et al., 2023). This is achieved by increasing the capacity of local communities and government authorities to conserve the river basin. The payment for watershed services are schemes that use funds internally generated from all water users as an incentive for landholders to improve their land management practices. It is a viable policy alternative to watershed management issues, and a means of addressing chronic problems such as declining water flows, deteriorating water quality, flooding (Ina et al., 2013) and funding watershed interventions.

PES has been used in Kenya's Upper Tana River basin to manage erosion, which has increased food security and income while reducing sedimentation (Firmian et al., 2011). Through the removal of invasive species from wetland ecosystems, this strategy has increased water provisioning services and reduced poverty in downstream agricultural communities in South Africa (Turpie et al., 2008). However, according to Pattanayak et al. (2010), a key challenge for PES/PWS schemes includes proving or linking benefits to the intervention.

Licensing

In order to employ licensing as a strategy for managing water demand, private landowners or prospective water users must apply for (or buy) a license or permission for any activity that affects water usage in the watershed, such as construction, diversion, or artificial recharge (UNEP-DHI Partnership, 2017). In addition to safeguarding against over-abstraction, pollution, and groundwater depletion, this technique provides revenue for sustainable water management initiatives in the watershed, such as restoration programs. It also encourages coordinated water developments within the watershed. Additionally, it makes sure that the wider range of watershed stakeholders benefit from water development efforts and helps increase public understanding of sustainable water use and environmental conservation (UNEP-DHI Partnership, 2017). Therefore, water licensing enables governments and watershed managers to monitor the amount, location, and usage of water, enforcing prompt limits as necessary (UNEP-DHI Partnership, 2017). Water allocations are regarded as being in line with sustainable use, social equality, and economic efficiency in South Africa, where IWRM is being piloted in multiple basins (Tinashe et al., 2021).

Investment in water use infrastructure

Infrastructure development is essential to enhancing a river basin's water management and services. To improve water availability and quality, investments in irrigation systems, wastewater treatment plants, and water storage facilities should be included in infrastructural development. The general well-being of people reliant on river basins, improved agricultural output, and enhanced resistance to climate change are all significantly impacted by these infrastructural investments.

Africa's water infrastructure delivery is still falling short of what is needed to meet the continent's water needs. According to the World Bank (2013), at least $30 billion more must be spent yearly to achieve Sustainable Development Goal 6—clean water and sanitation for all. The only long-term and sustainable way to secure water resources is to accelerate investments in climate-resilient water infrastructure, knowledge, and institutions, including nature-based solutions. In order to accommodate Africa's expanding population and changing consumption habits, new water systems must also be constructed (World Bank, 2012a,b). Therefore, in order to fulfill the continent's current and future needs, increased investments in water use infrastructure are desperately needed (World Bank, 2012a). This will guarantee that everyone involved sustainably gains as much as possible from the goods and services that river basins offer.

Off-channel water storage to replace damming

Despite its widespread use, damming rivers has significant negative ecological effects. A paradigm shift is required for the sustainable management of river basins, with the construction of an off-stream reservoir away from the river channel taking precedence over the construction of an in-stream reservoir through damming. Walker (2017) and March et al. (2003) state that there are a number of advantages to this kind of water withdrawal and storage. The timing of water removal from the

river may be readily controlled, and water withdrawal can also be stopped during severe storms when sediment levels in river flow are high. These benefits include creating minimal disruption of channel morphology and providing minimum water flow in the river at all times. Also, it can be less expensive to build and have greater security thus implement adequate management measures. Integration of off-channel water storage into current RBM as an alternative to damming is one of the best strategies to adopt where water storage is needed for whatever purposes within river basins in Africa.

Increased funding

For Africa to reach the UN Sustainable Development Goal targets on water and sanitation, funding must be at least three times greater. Strengthening the water investment framework and creating creative financial arrangements with the goal of diversifying financing sources (users, industries, philanthropists, domestic commercial banks) and mitigating risks will be crucial to closing the financial investment gap for water resources in Africa (OECD, 2023). Governments, international organizations, and stakeholders must prioritize and sufficiently fund the sustainable management of river basins in order to guarantee the resilience and health of African rivers. By doing this, the continent may contribute to environmental sustainability, local community well-being, and the preservation of its rivers for present and future generations.

Conclusions and way forward

For Africa to have sustained economic growth and development, effectively managed river basins are essential. Despite good progress being made at the policy and strategic levels and in the establishment of various instruments, such as the legal frameworks for RBM in the continent, there are still concerns regarding the lack of appropriate infrastructure. Some of the case studies in the chapter demonstrate the progress that is also being accomplished at the watershed level. However, governance is still a challenge. Given that most of the river basins are shared across international political borders, this means that joint management is vital, raising the issue of governance structures at different levels (e.g., transboundary, national and local levels). As a result, the many institutional and legislative components that control RBM must be connected, coherent, well-coordinated, and successfully applied. This can be achieved, for instance, through institutional collaboration, integrated planning initiatives, or consistent cross-sectoral legislation. Furthermore, a deeper comprehension of the various state and nonstate entities engaged in the various basin management steps at the various levels is required. In order to ensure their effective inclusion in RBM processes and activities, as well as to prevent the development or escalation of disagreements among them, it is crucial to understand their respective interests, positions, and power as well as the relations between them, especially across different levels.

The lack of or limited monitoring of rivers in Africa is a critical factor contributing to their mismanagement. Inadequate data availability hampers decision-making, making it challenging to address issues related to water quality, pollution control, ecosystem health, and transboundary water management. As the continent grapples with increasing pressures on its water resources, investing in robust monitoring systems becomes imperative. Strengthening monitoring capabilities will not only enhance the understanding of river dynamics but also empower authorities to implement proactive and effective measures for the sustainable management of Africa's vital waterways. This necessitates collaborative efforts at local, national, and international levels to build capacity, share data, and implement science-based strategies for the protection and preservation of African rivers.

Addressing the challenges in the quality of discharge data on African rivers is paramount for achieving effective RBM. Improved data collection infrastructure, enhanced technological capacities, standardized data-sharing protocols, and comprehensive capacity-building initiatives are essential components of a strategy to overcome these challenges. By investing in the reliability and accessibility of discharge data, African countries can empower themselves to implement evidence-based policies, promote sustainable water resource use, and better adapt to the evolving dynamics of their river basins. This concerted effort will not only enhance the resilience of ecosystems and communities but also contribute to the overall sustainable development of the continent.

Finally, the limited funding allocated to the conservation, protection, and management of African rivers poses substantial challenges to the sustainable development of these crucial water resources. Inadequate financial support inhibits the development of essential infrastructure, enforcement of environmental regulations, and implementation of pollution control measures. Moreover, it hampers community-led initiatives and adaptation efforts to address climate change impacts. To ensure the resilience and health of African rivers, it is imperative for governments, international organizations, and stakeholders to prioritize and invest in the necessary financial resources. By doing so, the continent can work towards preserving its rivers for current and future generations, fostering environmental sustainability and supporting the well-being of local communities.

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