Chrispin Kowenje · Andreas Haarstrick · Timothy Biswick · Gideon Ajeagah · Stephen Ojwach · Oluwatoyin A. Odeku · Gnon Baba *Editors*

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Foreword

Water resources in Africa, like any other part of the globe, are under pressure because of the number of natural and anthropogenic factors. A number of efforts have been done, through international/regional initiatives, to help nations to plan, develop and manage water resources and ensure sustainability of water use, build climate resilience and strengthen integrated water resources management. What has been a missing factor in most, if not all, of these initiatives is the exploration of tapping into Africa's wide range of traditional practices and knowledge systems that have been applied (with success) on the continent to preserve Africa's natural habitat for centuries.

Water resources are transboundary in nature and therefore the management approach must be universal. Water supports fora and fauna as well as lives and livelihoods of vast numbers of people across wide catchment areas and national boundaries. The depletion and degradation of these resources have the potential to adversely affect the ecosystem, social fabrics, political relations and socio-economic development. Access to clean fresh water is critical in addressing sustainable development challenges, which will get worse with the increasing water demands across all social, economic and environmental sectors. The effects of climate change that is putting more pressure on water quality and availability exacerbate the situation. These conditions are increasingly putting businesses, governments, communities and the environment at risk.

Scarcity of fresh clean water affects more than 40% of people across the globe with more countries experiencing water stress due to rapid population growth, high urbanisation rates and expansion of agricultural and industrial activities. The dwindling drinking water supplies are negatively affecting all continents where increasing drought and desertification is making the situation worse. Provision of food and nutrition security, of affordable human health and well-being, and of support infrastructure across the environmental as well as social-economic sectors depend on the availability, affordability of and proper management of clean water resources.

Ensuring availability and sustainable management of water is inherent in the sixth Sustainable Development Goals (SDG) and is closely linked with other SDGs. If SDG 6 is "badly tracked", this will hinder the progress in realising the rest of UN Agenda

2030. Water security is also inherent in one of the priority areas of Africa Agenda 2063s first-ten year's implementation plan. It is worth noting that issues of water resources management and security are reflected across the six pillars of Africa's Agenda 2063. In essence, water security and management are issues that cut across a variety of targets of both UN and Africa's Agenda 2030 and 2063, respectively, as well as other regional and international development agenda.

This book, which aims to document, preserve and scientifically interpret the African indigenous knowledge/practices on water resources management, has come out at the opportune moment to offer insight into the relevance of and infuse the traditional knowledge and practices to modern approaches on sustainable water resources management. The book covers a wide range of traditional practices that include: (i) water harvesting; (ii) water transportation; (iii) water storage and conservation; (iv) water treatments; (v) myths and folk stories about water management or conservation; (vi) water resource management systems and (vii) soil-water-forest conservation/management systems sub-topics. The findings in this book, however, demonstrated that the knowledge application is not limited to only these categories.

The unique nature of this book resides in the fact that it seeks to preserve the African indigenous practices and knowledge system that has been handed over, undocumented, from generation to generation. This book puts into light the fact that marrying traditional practices with conventional scientific understanding has a potential to shape the future of African's, and indeed for the rest of the world, water resources management into a sustainable system that is crucial for food and ecological security, political stability and socio-economic development.

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Preface

A safe and sustainable water supply plays an important role in public health and the well-being of society. From ancient times, all global human settlements and major cities developed in places with access to water. According to the UNDP 2016 report, the concerted efforts of national governments, the international community, civil society and the private sector helped achieving the Milennium Development Goals (MDGs) target of halving the proportion of people who lack access to improved sources of water by the year 2015. However, realising the need for a more sustainable path to reduce poverty, in 2015 the United Nations came up with the Sustainable Development Goals (SDGs). Of interest is SDG 6, which aims at ensuring availability and sustainable management of water and sanitation for all by the year 2030. In the African continent, communities have for centuries practised various traditional and indigenous methods of water resource collection and management suitable for their needs. This book seeks to document these indigenous practices with the aim of providing scientific evidence to support their use in the African continent.

Target 6.8 of the SDG 6 reinforces the involvement of local communities in the water resources management. Specifically, SDG item 4 target 4.7 recognises the resilience that springs from and encourages the preservation and dissemination of indigenous and cultural knowledge. The African continent has partially preserved its natural habitat for centuries and this is the knowledge this work seeks to imbue with current scientific understanding. The traditional practices are categorised as: (i) water harvesting, (ii) water transportation, (iii) water storage and conservation, (iv) water treatments, (v) myths and folk stories about water management or conservation, (vi) water resource management systems and (vii) soil-water-forest conservation/management systems sub-topics.

Most of the work presented in this book are primary data, collected during the Covid-19 pandemic period of 2020. Interviews, discussions and observations were conducted to gain an understanding of the historical background of the water system, administration and operational rules, informal constraints, resources contribution for the initial investment and their views towards modern development of water systems. This book aims to document, preserve and scientifically interpret the African foreknowledge on water resources management. In line with SDG 15.5, which aims

to protect the biodiversity and natural habitats, this book, therefore, offers insight into the relevance of the traditional knowledge and practices to modern approaches on sustainable water management.

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About This Book

The book addresses the situation of water and wastewater management in Africa from present angle, underpinned by selected case studies. The publication of this book will also be the start of a book series that in more detail critically reviews, discusses and analyses the water and wastewater situation and management in different regions and countries worldwide. Further, the book provides a useful resource for scientists, researchers and practitioners dealing with water and wastewater management. The book also takes a comparative look at traditional methods of water management in Africa that have guaranteed water supply for centuries, in many cases integrating sustainability considerations. In line with SDG 15.5, which aims to protect the biodiversity and natural habitats, this book, therefore, offers insight into the relevance of the traditional knowledge and practices to modern approaches on sustainable water management.

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Chrispin Kowenje studied Chemistry at BSc and MSc levels from Egerton University—Kenya (1990–1998) and received his doctorate in 2006 in the field of Chemistry of Materials at State University of New York at Binghamton University-USA. Since 2017, he is an Associate Professor of Chemistry at Maseno University. His teaching and research cover manipulating and applying the chemistry of zeolites, clays and other natural materials for waste, domestic and drinking water treatments. He contributes to pollution remedial measures. In addition, Chrispin involves himself in optimising bioenergy especially biodiesel, bioethanol and biogas production processes. Prof. Kowenje has been a chairperson to Africa Future Earth committee (2019–2022), a member of the review board to global Future Earth organisation (2020–2022) and member to Future Talent Council (2020). He has keen interest in how research scientists promote the attainment of Sustainable Development Goals.

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Timothy Biswick studied Chemistry and Mathematics at the University of Malawi (1993–1997) and received his doctorate in Materials Chemistry at the University of Cambridge (2006) specialising in organic-inorganic hybrid materials for various applications. Thereafter, he was a postdoctoral research fellow at the Centre for Intelligent Nano-Bio Materials in Seoul, Korea (2007–2008). Since 2008 he has been working in the Department of Chemistry at the University of Malawi. His teaching covers the general area of inorganic chemistry, and his research is centred on the design and synthesis of inorganic for environmental remediation. He is currently the Coordinator of the DAAD exceed-Swindon project for the Sub Saharan Africa region.

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Gnon Baba is a Full Professor in organic chemistry and environmental sciences. He obtained his doctorate in University of Rennes 1 in organic chemistry in 1994 and he obtained his state doctorate in 2002 in University of Cocody at Abidjan (Ivory Coast). He was recruited as a teacher-researcher in the University of Lomé in 1996. From November 2007 to September 2018, he was the Dean of the Faculty of Science and Technology of University of Kara. Since 2019 he is the Director of the University Agency of Francophonie (AUF) in Togo. He is the author of over 80 scientific publications and collective works. He is the coordinator of Sub-Saharan Africa EXCEED-SWINDON network in 2019 and 2020 and is President of the West African Water, Environment, Energy and Mines Network (WAWEEMN) of the West African Chemical Society (WACS). Gnon Baba is head of the Laboratory.

Part I
Introduction

Chapter 1
Sub-Saharan Africa's Way of Water Management

Andreas Haarstrick and Chrispin Kowenje

1.1 Introduction

From early times to the present Anthropocene world, water has been an important medium for human civilisation in terms of tradition, religion, economy, technology, and society. Many religious communities for ritual purification or baptism use water. In nature and research, water is used both as a solvent and as a transport medium.

The proverbial power or effect of water is subject to a certain dualism. On the one hand, when tamed, water presents itself as a life-enhancing medium, providing useful forms of energy and ensuring the survival of entire natural life forms up to and including human civilisations. On the other hand, water can also create hazards, such as floods, tsunamis, storms, and landslides. Likewise, water shortages can be devastating, leading from droughts to famines to climatic changes that, not least, alter and endanger ecological diversity. How we treat and manage our water resources depends on the desires of human society and on each individual. If this is done in a common sense, responsible and sustainable manner, many conflicts in the political, health and economic areas can be avoided. The magic formula is "security through sustainability".

Up to 70% of the earth's surface is covered by water. Then, how is water scarcity possible? Well, one must know that 97.5% of all the water on earth is seawater, which is not suitable for direct human consumption. Here we have to realise that both population numbers and temperatures are steadily rising, which means that the little fresh water available in reservoirs is under severe stress. Another point concerning freshwater is that, according to UNESCO-IHP (2017), about ¾ of all new jobs worldwide are related to water.

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Global freshwater demand is expected to increase by 55% by 2050. Much of the water is still used in agriculture, meaning more than 70% of the Worldwide water reserve. Because of the global population explosion, food production will increase by 69% by 2035. The same increased demand applies to the extraction of water for conversion into electrical energy. This development makes it clear once again, that there will certainly be a global water crisis if intelligent measures for the sustainable use of drinking water resources are not introduced as soon as possible. The former prime minister of Norway, Bruntland, defined sustainability; (i) activities where the needs of the present generation are met without compromising the needs of future generations and (ii) equitable spatially and temporally distribution of the resources. Although the central role that water occupies in sustainable development is recognized, water-related services remain far too low on the scales of public perception and of governmental priorities. As a result, water, which ordinarily should be a common good, often becomes a limiting factor, rather than an enabler to social welfare, economic development, and healthy ecosystems.

In 2016, the world embraced the Sustainable Development Goals (SDGs). In the SGDs, unlike in MDGs, the issues of water management were specifically itemized and prioritized in Goals 6 and 14 but with linkages and interactive effects to several other goals. The scientific community, through the Future Earth forum (Future Earth, 2013), intends not to miss the targets again as was the case with MDGs by collapsing the many SDGs into three broad areas of (a) **dynamic planet** (environment, water quality, etc.) for better understanding of drivers, interactions and processes in water issues, and anticipation of global thresholds and risks, (b) **global sustainable development** (water management, communications, awareness, etc.) for deeper understanding of ecosystem functions and services, and (c) **transformations towards sustainability** (waste management, eco-psychology, etc.) for sustainable integration of emerging technologies and economic development pathways in human development.

To secure and sustainably manage the water resources, multi-disciplinarily in training is recommended. Arguably, such numerated multilayered challenges facing sustainable water management do not lend themselves to narrow disciplines. Broadly, the experts need to be able to identify pollutants and prevent pollution and contaminations, advocate for good water resource governance, push for green revolution in afforestation and enhancement of carbon credits, develop early warning systems such as the utilization of modern (hydro-) meteorological station data, and integrate indigenous or traditional knowledge into early warning systems. Water security plays a pivotal role in human development and in attainment of the SDGs to an extent that of the 17 SDG goals about 9 are water related nexus. According to Britt Crow-Miller et al. (2016), achieving water security in urban environments is important as cities already shelter more than half of the world's population and accordingly the highest concentration of socio-economic activities. In addition, the knowledge of renewable energy and clean alternative energy sources is encouraged. Primarily, collaboration among water management players and effective communication of scientific findings are key to offering sound, secure and sustainable water management systems.

Good water governance and water resource management encompass many elements, but essentially include effective, responsive, and accountable government institutions that respond to change, openness and transparency that provide information to stakeholders and give citizens and communities a voice and role in decision-making; this is the framework of an inclusive political and economic system. The importance of having a transparent, universal, and neutral platform for government and citizen groups to mobilise available resources and seek alternative ways to ensure improved water and sanitation management has been demonstrated, as well as the importance of complementing local government support.

1.2 The Sub-Saharan Africa Situation

In Sub-Saharan Africa, population, and economic growth, as well as periodic and chronic water scarcity, pose major challenges to Sub-Saharan Africa's path to development and prosperity. The lack of water management infrastructure, both in terms of storage and supply, as well as in improving drinking water supply and sanitation, are crucial factors responsible for poverty, which is hardly changing. Climate change processes that negatively affect rainfall and temperature trends threaten water availability, agricultural productivity, and ecosystem balance in almost all regions of sub-Saharan Africa. Against this backdrop and the increasing demand for water, there are additional constraints that pose significant challenges to improving water resource management. Lack of human and infrastructural capacity, persistent poverty, discrimination, and inequalities in access to drinking water and sanitation, and inadequate and unsustainable financing of water resource management and services are some of the challenges to sustainable water management.

Adapting traditional knowledge to meet today's water resources management is a major challenge for people all over the world in general and Africa in particular. Over the centuries, dry land dwellers (desertification) in the Northern part of Africa have overcome this challenge through traditional methods of water harvesting and management, which have ensured long-term sustainability of water resources through demand management and adequate resource replenishment. In general, these methodologies despite being effective and cost-efficient are either in decline or have been completely abandoned. Water Challenges are unique in their dependency on relatively scarce available water—this scarcity exists on a gradient ranging from mild in dry sub-humid areas to extreme in hyper-arid areas (or deserts), and adversely impacts the land include all terrestrial regions where the production of crops, forage, wood, and other ecosystem services are limited by water. There are quite profound impacts on how the human societies based in water scarcity areas relate to their environment and balance the tradeoffs in land and water use. Over the millennia, dryland societies thriving in these settings have adopted sustainable and equitable approaches for managing their water as well as other natural resources. Today, water management in arid areas is under a serious paradigm shift in the face of new challenges that pre-empt the proper exploitation of this vital natural resource.

In semi-arid regions of Africa, where rainfall is scanty, many water management systems were developed to provide irrigation water for agricultural through the centuries ago. To overcome the water scarcity in these regions traditional water management systems were locally developed. These practices traditionally used by local people made the best possible use of the scarce water resources and difficult conditions created by the aridity of the climate. Socio-economic and environmental aspects of these methods are assessed. In this book, it will be discussed why some water management systems are still being applicable.

Some of East Africa and much of West Africa fall within the humid tropics, where abundant water resources are available. There too, despite this availability, numerous water-related problems exist. More than half of the African population has neither safe drinking water nor sanitation. As in the drier areas of sub-Saharan Africa, irrigation is largely neglected and a significant potential for expansion of water usage is becoming more preoccupying.

The situation in southern Africa is, in many respects, similar to that of North Africa. Water is in limited supply in most countries of the sub-region. Most watersheds are already tapped by large-scale abstraction schemes, and plans are under way to tap the remaining ones. Botswana and Namibia have already reached their internal water-supply limits. The same applies to Zimbabwe, where a water-shortage alarm was issued when the lack of water throughout the country had become critical. Despite a major operation to drill boreholes all over the country, the rural areas, where most of Zimbabwe's 10 million people live, were badly affected. Crop production was slashed by the failure of the rains in the summer growing season, and energy was in critically short supply because of the lowest rainfall in the river catchment. Water stress is particularly important in South Africa because of the size of its population and economy. Key policy options are similar to those of North Africa and include demand-side management, the decentralization and adaptation to sustainable water management rules.

The most important issue to use traditional method is to understand how we can adapt and integrate indigenous water management practices into modern technologies of water resources systems successfully. Since ages, people across different regions of Africa, have experienced either excess or scarce water due to varied rainfall and land topography. Yet, they have managed to irrigate their agricultural fields using localized water harvesting methods. Their traditional communal ways, though less popular, are still in use and more efficient.

There are many other methods too that are practiced in various combinations. These methods have been around for hundreds of years, and with a lot of areas suffering from water scarcity, it may be time to revisit some other traditional methods to help innovate new ways of revival. This book explores the possibility of incorporating traditional water management experiences into modern water management. Modern systems are deemed to replace the traditional ones in search of sustainable services. In fact, the dynamism of management, which is influenced by various factors, including technology, climate change, population growth, and education level of the people in charge, requires flexible systems that are adaptable to different situations. However, striving to achieve sustainability by introducing new technologies

and ignoring the existing local knowledge is of no use to the people who dominantly depend on traditional practices. The communities, which have long-served traditional management systems, are not easily willing to work with the imported techniques if they have not been involved in the development of those systems, or if their social components are interpreted wrongly or even ignored. In such cases, traditional people prefer to remain observers rather than become involved as real participators. In consequence, modern water systems are used while the services are operational, but the communities return to unimproved sources after the services break down. Development of advanced technologies and new approaches to sustain systems is worthwhile to accept; yet blending them with traditional knowledge that exists in target areas can make them more valuable for the intended purpose. Thus, successful management practices should be investigated before introducing new technologies and management styles, since endeavors that ignore the local conditions are unlikely to succeed.

The idea of describing traditional knowledge is a cumulative body of knowledge, know-how practices, and representations maintained and developed by peoples with extended histories of interaction with the natural environment. The sustainability of water supply and sanitation has become a special concern of the developing countries and international donors. Since the decade of International Drinking Water and Sanitation (1981–1990), several approaches have been used in the sector to bring in sustainable services. Shifting from top-down to a bottom-up approach, the introduction of participatory approaches, vowing to community participation, provoking community management, and advertising community financing are ways to increase the sustainability of the systems. The fundamental issues that motivate this study are (a) the need for service sustainability of water supply and sanitation, (b) lack of integration of modern management approaches with the local situation, and (c) the disparity of sustainability of the modern and the traditional systems. Various reasons can be mentioned for the failure of modern schemes in the study areas, including financial, environmental, technical, and social aspects.

1.3 The Future of Water-Secure Sub-Saharan Africa—Which Path is the Right One?

The question of the right path does not have just one answer or solution. Several factors play a role here, ranging from political, economic, sociological, and technological to ecological and climatic factors. Africa is a large continent with correspondingly diverse climatic, ecological, ethnic, and political differences and traditional ways of life. This, of course, makes it not easy and not always possible to find the right one way or the one right solution to an efficient, sustainable, and secure water supply and management for the future. As diverse as the conditions described are, it is therefore important that the African countries—and here with a special focus on the countries south of the Sahara—find a stable consensus for unified action.

One thing is obvious: the climate will change, the population will grow, and water scarcity will increase or even worsen. In addition, here, in particular, governments have a responsibility to act collectively. Definitely, there is no more time for long discussions; action must be taken. Not only Africa, but also all other continents are no longer able to preventively cope with the increasing water crisis, but only reactively. The decisive factor is the advancing, unstoppable climate change. The world will not succeed in stopping global warming by plus 1.5 to 2 degrees; huge efforts would have to be made immediately to switch from fossil fuels to renewable energy sources but there is no longer enough time. This has impressively been stated in the IPCC's World Climate Report (2021).

The far climate impacts will become even more pronounced in the coming decades (IPCC report 2021). But perhaps small local/regional solutions can buffer the worst effects. This may also be the case in sub-Saharan Africa. For this to happen, governments must consistently monitor the situation in their countries—as has happened in the first steps, for example, in Ghana, Kenya, Botswana, and South Africa—and establish regulations and sanctions that will lead to long-term security of water supply. This also includes the continuous improvement of water infrastructure measures and the securing of freshwater resources. This will require financial efforts, which are not always given and therefore several good concepts (also long-term effective) are to be worked out, whose realization is brought on the way over for national budgets and international aid funds. When it comes to the question of costs, a lot can be saved with the idea of reaching the goal with small local/regional projects and relying on technologies that are uncomplicated, robust but easily repairable and based on solid scientific foundations and recent findings. Perhaps a symbiosis with local traditional methods (indigenous knowledge) can create synergy effects that increase the likelihood of success of local/regional projects and are also able to reduce costs.—But once again, governments must act, and this does not mean just drawing up pages of regulations and rules, including sanctions, but action must create realities; water security must become visible. It should also be noted that not only the securing and sustainability of freshwater resources must be an issue, but also the treatment and processing of wastewater for reuse in industry, agriculture, and households. It is mandatory that all concepts for securing the water supply in the future must also include the reuse of treated wastewater. This is so to speak in extended form part of the "water resource management".

The symbiosis with traditional, indigenous knowledge and methods has already been mentioned above. But what can be understood by indigenous knowledge?—Indigenous knowledge or indigenous technical knowledge are facts to those who consider them a way of knowing or viewing the world. Some of it is belief and a lot of it is folk wisdom or common sense. Indigenous knowledge systems are learned ways of knowing and viewing the world. They have evolved from very many years of experience and trial and error problem solving by groups of people working to overcome the challenges they face in their local environments, drawing on the resources available to them.—Part of what we know today indicates that the first anatomically modern humans appeared in the southern part of the African continent. There is ample evidence that sorghum, millet, rice, yam, oil palm, as well as cattle

were domesticated in the area between the Sahara and the equator about 9000 years ago (Haverkort et al., 2002).

Traditionally, water has been managed from and since that time for two main purposes, agriculture, and domestic consumption. Water sources ranged from direct precipitation to water from drains, rivers, streams, and seeps. Underground water sources were also tapped. The water collected in this way was used to meet domestic needs as well as for watering livestock, agriculture, and irrigation. Available literature indicates that more innovative indigenous water management techniques have been developed in climatically arid areas and in mountainous regions of Africa (Reij, 1990).

For agricultural purposes, traditional African farmers developed techniques such as building terraces, pit systems, drainage ditches, and small earthen dams to conserve soil and water. Virtually all on-farm water management techniques known about here are examples of low external inputs combined with the use of locally available resources. While retaining water, some of the techniques also provide effective protection against soil erosion and loss of soil fertility. Johda (1990) gives the term "ethno-engineering" to these techniques. This involves the collection and concentration of runoff and rainwater to improve crop production and make it more reliable, which Reij (1988) also describe in their article. In wetter regions, these techniques have been combined as needed with other techniques such as crop rotation, shifting cultivation, mixed cropping, manure application, and protection of nitrogen-fixing crops. In countries with rainfall of 500 mm or more, the focus tends to be on in situ moisture conservation techniques. These included agroforestry practices that prevented soil erosion and resulted in sustained retention of moisture in the soil (Olokesusi, 2006). Traditional irrigation systems based on surface water originated in Africa and most of them are based on the shaduf or shadouf system, which originated on the Nile River in Egypt many centuries ago. The technique usually consists of a long, tapered, nearly horizontal pole mounted like a seesaw (New Encyclopedia Britannica Macropaedia, Vol. IX, 1994) and has been modified in different parts of the continent to suit sociocultural and environmental characteristics (Olokesusi, 2006).

In most African countries, surface water is considered a common good. All community members have equal rights to access and use water for drinking, washing, livestock, cooking and irrigated agriculture. Rainwater (from roof-tops) collection and micro-catchments like small dams, cisterns, or water holes, for domestic use has always been practiced. Water hygiene plays an essential role here. In many African societies, the household forbids anyone to use their own cup to draw water from the communal water pot. Rather, a vessel is attached to the pot from which all members of the household are expected to draw water into their own drinking vessels. In arid and semi-arid areas, the clay pots used are often buried on the grounds rather than in the rooms to provide a cooling effect. Locally processed shea butter is often added to the bottom of the pots before water collected from roofs, streams, or rivers is poured into the pots. Attempts to disinfect the collected water or keep it potable vary culturally. In southwestern Nigeria, for example, Adenopus breviflorus or tagiri is commonly placed next to the household clay water pot during the dry season to

ward off evil spirits and "germs" that cause measles. The fruit of Adenopus breviflorus is commonly used in folk medicine in West Africa as a medicinal plant to treat measles, indigestion, and as a wound antiseptic (e.g., umbilical cord wound), while livestock farmers use it to treat Newcastle disease and coccidiosis in various livestock species, especially poultry. The Uhabiri Ossah clan of the Igbo in the Umuahia area of southeastern Nigeria seeks to improve the taste of water for human consumption and achieve a kind of disinfection by exposing the clay water pot to the hot smoke of Uhokiriho seeds. For this purpose, the seeds are thrown into the burning firewood of the traditional cooking stove while the water pot is placed on top (Olokesusi, 2006).

In view of climate change, these technologies are a valuable resource, but they need to be adapted to today's socio-economic and environmental conditions, and this is where modern methods and knowledge come into play. Without question, these "ethno-engineering" techniques form an important starting point for establishing future water management and coping mechanisms that allow for sustainable and climate-adapted improvements in agricultural production, thus also contributing to poverty alleviation. Regulated and sustainability-based access to water also helps to circumvent time and constraints that are important in rural communities. It would also improve personal hygiene and environmental sanitation. These developments also expand livelihood opportunities with positive environmental consequences as well since poverty and environmental degradation are mutually dependent.

With respect to future water security and returning to the question of the right way forward for Africa, the answer lies in combining traditional/indigenous (Indigineous Knowledge System IKS) and modern knowledge. Concepts based on this can generate synergistic effects, which are also based by the fact that they consider local/regional situations and socio-economic conditions. This includes decentralized solutions that can be more specific and detailed to local problems and viable sustainable solutions. But as already mentioned above, it still requires some effort and a permanent will. Unfortunately, in many places there are political obstacles and most of the water management concepts are poor. Olokesusi (2006) reports that already at a pan-African conference on water in Addis Ababa, Ethiopia, in December 2003, inadequate funding and technology were cited as the main obstacle to solving the continent's water and sanitation problems. An urgent call was made for the integration of new knowledge with IKS. At that time, it was already noted that ICS, while different from Western science-based knowledge systems, have many aspects that complement science. ICS is fundamentally local in factual information; here, science would necessarily have to conduct new studies to obtain the same information that already exists in ICS. Western science has a short-term information base to draw upon, while its indigenous counterpart has the advantage of a very long-term information base to draw upon.

In integrating the two knowledge systems, people's intellectual and traditional resource rights must be fully recognized and respected. Whenever possible, these rights should be documented and patented to the appropriate authorities. In addition, it may be helpful to consider the following (Olokesusi, 2006):

- Developing a symbiotic relationship by combining the benefits of ICS and Western knowledge systems.
- Stakeholders in the two knowledge systems should develop a partnership through Complementary action plans, participatory action research.
- The principle of co-management should guide the development and management of water resources. The "top-down" governance of science and technology should give way to this reality. This means local beneficiaries and "outside experts" working together and giving equal weight to both types of knowledge.
- Western science stakeholders should seek to verify the veracity of information from ICS stakeholders by assessing the credibility of information sources.
- Upscaling of specific ICSs could be achieved if more attention is paid to methodological approaches and if these are structured.
- For projects, the economic dimension of the approaches should be identified during appraisal.

The objective of this book is to explore the good lessons of traditional water management in the different regions of Africa to better enhance the modern technological water management practices, to sustainably activate the hydric equation in the African continent on the one hand and the global water crisis on the other hand.

References

Crow-Miller, B., Chang, H., Stoker, P., & Wentz, E. A. (2016). Facilitating collaborative urban water management through university-utility cooperation. *Sustainable Cities and Society, 27*, 475–483.

Future Earth. (2013). Future earth initial design: Report of the transition team. *Paris: International Council for Science (ICSU)*. ISBN 978-0-930357-92-4.

Haverkort, B., Millar, D., & Gonese, C. (2002). Knowledge and belief systems in sub-Saharan Africa. In B. Haverkort, K. Van't Hooft & V. Hiemstra (Eds.), *Ancient roots, new shoots: Endogenous development in practice* (pp. 137–169). Zed Books.

IPCC—Intergovernmental Panel on Climate Change. (2021). *Sixth Assessment Report*. https://www.ipcc.ch

Johda, N. S. (1990). Mountain agriculture: The search for sustainability. *Journal for Farming Systems Research Extension, 1*(1), 55–75.

Olokesusi, F. (2006). Survey of indigenous water management and coping mechanisms in Africa: Implications for knowledge and technology policy. African Technology Policy Studies Network, ATPS Special Paper Series No. 25.

Reij, C. (1988). Soil and water conservation in Yatenga, Burkina Faso. *The greening of aid: Sustainable livelihoods in practice* (74–77).

Reij, C. (1990). Indigenous soil and water conservation practices in Africa. Paper presented at the Workshop on Conservation in Africa: Indigenous Knowledge and Government Strategies, organized by the Social Science Council of New York, held in Harare, Zimbabwe, 21–27 December 1990.

The Lancet—The 2021 report of the Lancet Countdown on health and climate change: Code red for a healthy future, *398*(10311), 1619–1662.

UNESCO–IHP. (2017). *Un world water development report—The international hydrological programme*. http://ihp-wins.unesco.org/layers/geonode:unworldwaterdevelopmentreport2

Part II
Water Harvesting and Detection

Timothy Biswick

Introduction

Water is critical to all socio-economic aspects of human welfare including security, transport, energy and health. It is central to the production and preservation of a host of benefits and services for people and can play a key enabling role in strengthening the resilience of social, economic and environmental systems in the light of rapid and unpredictable changes. However, both naturally occurring conditions and processes and human activities such as climate and geography limit access to this vital resource. In Sub-Saharan Africa, and indeed the rest of the developing world, access to water is limited based on time (during droughts and dry seasons) and space (in arid areas). In addition, as population increases and agricultural and industrial activities intensify, the amount of water required by society escalates.

Over centuries, dwellers in areas with spatial or temporal water scarcity have overcome these challenges through several traditional methods of water resources management. Broadly speaking, water resources management refers to the process of planning, developing, and managing water resources, in terms of both water quantity and quality, across all water uses. It includes the institutions, infrastructure, incentives, and information systems that support and guide water management. Various methods of groundwater prospecting/detection, as well as water harvesting, have been used in various communities as a way of improving access to water resources. However, it has been noted that these methodologies despite being effective and cost-efficient are either in decline or have been completely abandoned.

This chapter discusses some of the ways rural communities in Sub-Saharan Africa have, over the years, employed to access water for their various needs. It outlines the various types of divination methods used by the Luo communities in Western Kenya

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as a means of prospecting and locating groundwater. These traditional methods are compared with modern methods in terms of success rate, reliability and cost with the aim of exploring ways of adapting and integrating the traditional methods of water prospecting into modern technologies for improved reliability and affordable cost for the rural communities. Additionally, the chapter discusses rainwater harvesting that is practised in rural areas on the outskirts of Lomé in Togo. The quality of the rain harvested water is assessed and compared with alternative sources of water in the area.

Chapter 2
Water Harvesting Practices and Consequences in South of Togo: Case of Mission TOVE and KOVIE in Maritime Region

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2.1 Introduction

In developing countries such as in Sub-Saharan Africa, water shortage is very frequent in rural areas as well as in the cities within a specified water supply infrastructure (Mun & Han, 2012). The drinkable water problem is frequently encountered with a further aggravated situation in rural areas caused by inadequate water supply infrastructures, poverty, poor water governance, and climate variability (Balogun et al., 2016). Unfortunately, during the past decade and because of climate change, many resources became scarce, such as water, and their qualities have deteriorated. So, the need for drinking water leads people in rural areas to the use of surface water, rainwater, run-off water without any pretreatment but at times apply some rudimentary technologies for water supply and rainwater harvesting. Rainwater harvesting can be defined as a deliberate collection of rainwater from a surface known as catchment and its storage in physical structures or within the soil profile (Malesu, 2006). According to Lee et al., (2012), rainwater harvesting can provide good quality water in sufficient quantities in the areas that experience urban stream depletion and water shortages. Despite its potential, this technology is underused in developing countries especially in rural areas and there are only a few organizations involved in this technology for rural communities (Sturm et al., 2009). Some factors such as low seasonal rainfall, quality of housing and construction material, and low household income, make the potential of rainwater harvesting (RWH) not fully exploited in the African countries compared to other regions like South East Asia (Mahmoud et al., 2014). Rainwater quality which is generally known to be good and frequently meet World Health Organization (WHO) guidelines, is largely dependent on the path water takes

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