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STATE OF AFRICA'S ENVIRONMENT 2024

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URBAN WATER POVERTY

DISEASE BURDEN

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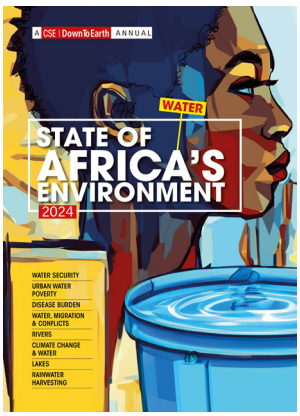

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FOREWORD

THE WATER-POVERTY NEXUS IN AFRICA

"Half the work of a sick peasantry goes to feed the worms that make them sick"

ACCESS TO water is not just a fundamental human right but also a trigger for chronic poverty. Water is vital for creating a sustainable economy. Both natural and anthropogenic changes can affect the local hydrological regime and affect the economy dependent on that regime adversely. Deforestation in ecologically fragile environments, for example, can lead to substantial changes in the hydrological regime. Rural people need water for a variety of uses ranging from domestic use, livestock use, small-scale irrigation, home-based processing activities and other artisanal and industrial applications. Though substantial investments are being made in exploiting river and groundwater resources to support large-scale irrigation systems and supply of water to urban centres, these systems have rarely reached out to poor rural people living in degraded or low quality rural lands who need water-based interventions to restore their rural ecology and get out of their "poverty trap".

Large-scale water development systems have also often led to inefficient and inequitable distribution of water resources and forced displacement of the poor. One of the biggest environmental challenges that developing countries face in the coming decades is to balance their increasing demand with the diminishing availability of water. Increases in population coupled with the ongoing processes of industrialisation, urbanisation and agricultural modernisation are, on one hand, leading to an ever increasing demand for water and, on the other, a decreased supply of freshwater, especially in the absence of effective mechanisms to regulate pollution.

The future scenario is one characterised by overexploitation of water resources, decreased accessibility to clean water, and increased competition for and potential of conflict over water resources. Africa is the world's second driest continent, after Australia and also the most water-stressed one. Sub-Saharan Africa was the world's most water-stressed region between 2020 and 2021, found a survey published in the *Lancet Planetary Health* journal in November 2022. Nearly 36 per cent of the people surveyed in the region were water insecure, according to the report. Across Africa, the incidences of violence over water resources increased by around 34 per cent during 2022-23. There were at least 71 such incidents recorded in 2023 compared to 53 in 2022, according to the Pacific Institute. In 2023, Africa reported the highest number of water-related conflicts and disputes since 2019. Major institutional, policy and technological initiatives are, therefore, required to ensure an efficient, socially equitable and environmentally sustainable management of water resources.

There is only one source of fresh water and that is precipitation, whether it is in the form of snow that makes glaciers or rain which ultimately flows down as streams and rivers and recharges the groundwater. A major reason for the growing overexploitation of water resources is the current stress on river water and groundwater to the neglect of rainwater and floodwater, the availability of which is far greater. If all water use was to be met from rivers and groundwater

systems, riverine ecosystems and groundwater resources will come under extreme stress, as is already being noticed across the continent. Countries, particularly in Africa, use only a small part of its water endowment. Two major discontinuities have emerged worldwide in water management since the 19th century. One, the State has emerged as the major provider of water replacing communities and households as the primary units for provision and management of water. Two, there has been growing reliance on the use of surface and groundwater, while the earlier reliance on rainwater and floodwater has declined, even though rainwater and floodwater are available in much greater abundance than river water or groundwater. Theoretically, the potential of water harvesting in meeting household needs is enormous. Even in an arid area with an annual rainfall level of only 100 mm, one hectare of land can theoretically capture as much as one million litres of water. As there is a synergy between population density and rainfall levels, less land is required in more densely populated areas to capture the same amount of rainwater. And in such areas, there is usually more built-up area like roof-tops which have improved runoff efficiency.

Rainwater harvesting can not only provide a source of water to increase water supplies but also involve the public in water management, making water management everybody's business.

It will also reduce the current demand on government institutions to meet water needs, reduce the need for government subsidies, and help everyone to internalise the full costs of their water requirements, thus encouraging the public to be more conserving in its water demand. And in rural areas water harvesting will also be an integral part of an integrated programme for sustainable development of land and water resources on a watershed basis whose objective is to improve total biomass output. Water harvesting and integrated land-water management is not new to the Africa continent, or to many other parts of the developing world. The art and science of "collecting water where it falls" is ancient but this "dying wisdom" needs to be revived to meet modern freshwater needs adequately, equitably and sustainably and modernised with inputs from science and technology.

In human terms, rainwater harvesting means making water everybody's business. Every household becomes involved both in the provision of water and in the protection of water sources. It means making water the subject of a people's movement, re-establishing the relationship between people and their environment and turning water into a sacred element of nature. It means the empowerment of urban and rural communities to manage their own affairs with the state playing a critical supportive role and the civil society playing a critical role in encouraging equity and sustainability in the use of water. It means a role for everybody with respect to water.

Local water management and rainwater harvesting constitute the key organising activity to initiate the restoration of the ecological and economic base of villages dependent on a biomass economy. However, this demands a fundamental change in water management

Local water management and rainwater harvesting constitute the key organising activity to initiate the restoration of the ecological and economic base of villages dependent on a biomass economy. However, this demands a fundamental change in water management strategies

strategies. Community control and participation is essential for any strategy that seeks to use and manage local water resources. But this participation is not possible unless a community-based institutional framework for natural resource governance is developed.

There are experiences that demonstrate how communities across the continent have used water harvesting to engineer ecological regeneration, which in turn has led to building sustainable local economies. These successful community-based resource management experiences establish the critical role of water conservation in poverty eradication. These experiences are testimony to the potential of generating economic wealth and well-being from rainwater harvesting. What is also remarkable is the short time it takes to transform a poverty stricken, destitute and ecologically-devastated village to a relatively rich and green village. This wealth can be used to create more wealth by regularly investing in resource management, thus, leading to a cyclical system of sustainable growth. The community also begins to see a stake in the good management of its natural resource base as it benefits from its development.

The Africa Water Vision 2025, that guides the continent in its water sector collective policy, notes, "This interdependence between water availability and development is exemplified by the link between water and poverty. Due to poverty, access to adequate water and sanitation is low in Africa. Yet due to the inadequate access to safe water and sanitation, there is a high incidence of communicable diseases that reduce vitality and economic productivity on the continent. In effect, 'half the work of a sick peasantry goes to feed the worms that make them sick'."

The theme of this edition of "The State of Africa's Environment" is water. It makes a compelling case for putting water at the centre of Africa's overall development. From poverty to conflicts to high disease burden, this report has looked at the continent's development through the lens of water. ■

WATER SECURITY

HIGHPOINTS

Water security is not just about how much natural water a country has but also **how well the resources are managed.**

All African nations are water insecure hosting **22% of the world's critically water insecure population.**

Local shallow aquifers in Africa represent over 60% of the groundwater resource, and 255 million people in poverty live above them.

Sub-Saharan Africa is world's most water-stressed region; **36% people reported to be "water insecure".**

PHOTOGRAPH COURTESY: UNICEF

WATERSCAPES

Abundant natural water availability does not necessarily ensure water security

HOW DOES a day start in Africa's most water-endowed country? A citizen of the Democratic Republic of Congo (DRC, or Congo) wakes up early to start the routine of looking for a water source. If lucky, s/he can find it within six-seven kilometres of residence. This daily trudge is for 10-15 litres of water for a family of six-seven members. In Congo, woman family members are in-charge of water collection and management, besides other household chores. According to an estimate of the World Bank done in 2014, a primary school girl in Congo spent 15 per cent of her time fetching water. A secondary school girl spared 16 per cent of her time for the same. It means a Congolese woman spends a sixth of her life searching and securing water.

The water sources are usually unprotected creeks, rivers, springs, dug wells, roadside puddles or stagnant pools of accumulated water from unidentified sources. Over 90 per cent of the country's rural population depends on springs for drinking water. Unprotected wells are another big source of water, while dependence on groundwater is prominent in cities like Kinshasa,

Lubumbashi and Matadi.

The search for water sets in a vicious cycle that results in high infant and neo-natal mortality in the country. The collected unsafe water is first used for drinking and cooking purposes, leaving nothing for ablution or any other hygiene purposes. So, people practice open defecations – only 20 per cent people in Congo have access to a basic toilet – that contaminate the waterbodies from where they source water for drinking and cooking purposes. Unsafe water and lack of safe sanitation cause deadly diseases like diarrhœa and cholera. The World Health Organization (WHO) declared the cholera outbreak of 2023 in Congo with 52,400 cases and 462 deaths as one of the largest outbreaks in the world. That year, Congo accounted for 80 per cent of all cholera cases in West and Central Africa. The outbreak continued in 2024 (as of April), aggravated by floods that hit the country in February, termed as the worst in 60 years. The floods contaminated thousands of waterbodies across the country.

The burden of waterborne diseases weighs heavily on the people of Congo – it has one of highest rates of maternal, neonatal (dying before 28 days of life) and child (dying before the fifth year of birth) mortality in the world. According to estimates by the United Nations Inter-agency Group for Child Mortality Estimation for 2020, the child mortality rate in the Congo is 100 deaths per 1,000 live births. So, 10 per cent of children born today would not make it to their fifth birthday. Maternal mortality ratio is at 547 deaths for every 100,000 live births; and neonatal rate is 27 per 1,000 live births. Like other countries in the world, Congo has committed to meet the Sustainable Development Goals (SDGs) by 2030, under which it has to bring down maternal mortality ratio to fewer than 70 deaths per 100,000 live births and neonatal mortality to 12 per 1,000 live births. Lack of safe drinking water and sanitation also means high burden of

Congo's water scarcity is paradoxical. The United Nations Environment Programme (UNEP) terms Congo as the "Africa's water-rich" country. The World Bank estimates that Congo has over 50 per cent of Africa's surface water reserves

malnutrition among children. According to UNICEF, "chronic malnutrition affects 43 per cent of children between 0 and 5 years of age throughout the country." The Africa Development Bank's "The Africa Water Vision for 2025" says: "In effect, half the work of a sick peasantry goes to feed the worms that make them sick."

Congo's water scarcity is paradoxical. The United Nations Environment Programme (UNEP) terms Congo as the "Africa's water-rich" country. The World Bank estimates that Congo has over 50 per cent of Africa's surface water reserves and approximately one-quarter of the continent's water resources. According to Food and Agriculture Organization of the United Nations (FAO) and UNEP data, river networks cover over 20,000 km and lakes and rivers (86,080 km^2) account for approximately 3.5 per cent of Congo's land area. The Congo River Basin – Africa's largest river by volume having a consistent flow throughout the year - covers 98 per cent of the country.

Despite this overwhelming natural endowment of water, in comparison to Sub-Saharan Africa's average 50 per cent population having access to safe drinking water, Congo's situation looks grim. Nearly three-fourths of Congo's 70 million citizens don't have access to safe drinking water. According GIZ, the German development agency, "only 24 per cent of people in Congo have access to affordable drinking water (the country is one of the poorest in the world and 'an estimated 74.6 per cent of Congolese people lived on less than $2.15 a day in 2023')." Surface water use for drinking, and irrigation purposes is negligible. According to FAO's country profile, "Less than 10 per cent of the population relies on surface water for drinking and while the agricultural sector employs 71 per cent of the population, irrigation is not a significant source of demand. Irrigation potential ranges between 4 to 7 million hectares, but it is estimated that only 6,800 ha are regularly irrigated, predominantly for sugar cane and rice cultivation." Going by the country's National Strategic Development Plan (2017-2021), Congo should have eliminated open defecation and provided 100 per cent access to basic sanitation by 2021, besides giving 65

WATER INSECURITY: THE GLOBAL AND AFRICAN CHALLENGE

African nations account for nearly half of the 114 "water insecure" nations in the world. At global level, 3 of the 5 most critically water insecure nations are in Africa. These are – Eritrea, Sudan and Ethiopia. All 54 countries in Africa continent are "water insecure" or these countries account for nearly half of the 114 "water insecure" nations in the world according to the most recent assessment on global water security released by the United Nations University Institute for Water Environment and Health (UNU INWEH).

National water security score

20 45 64

Of the **114** countries identified as "water insecure" globally, every 2nd water-insecure country is located in Africa.

54 countries in Africa continent are "water insecure". Key drivers of water insecurity include: Population growth, Climate change & Pollution

24% of African nations, or 13 countries, are categorised as "critically insecure." These are: Eritrea, Sudan, Ethiopia, Djibouti, Somalia, Liberia, Libya, Madagascar, South Sudan, Niger, Sierra Leone , Chad and Comoros

Globally, **3** of the 5 most critically water-insecure countries are in Africa: Eritrea, Sudan, and Ethiopia. Eritrea is the 2nd most critically water-insecure nation in the world, followed by Sudan and Ethiopia

Source: Global assessment on water security, 2023,United Nations University Institute for Water Environment and Health (UNU INWEH)

ISLAND'S DISTRESS CALL

AS A visitor, Zanzibar offers an amazing holiday experience with golden sandy beaches, plush hotels and superb cuisine, all supported by very welcoming local hosts. However, as you delve deeper into the island's day-to-day functioning, the first thing that hits you is the overabundant use of bottled water wherever you go. For a long time, Zanzibar, one of the driest areas in the world, has been facing some very basic water, sanitation and hygiene (WASH) challenges. A large part of the archipelago is experiencing an acute freshwater shortage due to the deterioration of water infrastructure and the effects of climate change.

According to the Zanzibar Water Authority, 200 million litres of fresh water are needed per day for the entire population, but only about 50 per cent of that is actually available. While tourists resort to drinking bottled water at $10 per bottle, the local populace, who cannot afford such heavy expenditure, must undergo the drudgery of collecting drinking water, often spending 2 to 7 hours a day and travelling long distances to collect barely enough water for the whole family.

Similar to other developing economies, water scarcity largely affects women and children, who end up walking for miles to obtain this vital resource, which is quite time-consuming and deprives the children of their education. To make matters worse, the water collected after such hardships is often contaminated. Several studies point to contamination of drinking water by excessive mineral presence (high salinity) or faecal bacteria, especially during times of flooding. As a consequence, Zanzibar has increased vulnerability to waterborne diseases such as cholera and dysentery. One of Zanzibar's most acute problems over the years has been the spread of cholera due to unsafe drinking water and poor hygiene and sanitation. Projects to monitor water quality and bulk chlorination of stored water have been implemented; however, even today the safest water is bottled water, which is expensive and has to be transported to the island from the mainland.

The Ministry of Health Social Welfare Elderly and Children Zanzibar (MoHSWEGC-Z), along with several international agencies like United States' national public health agency Centers for Disease Control and Prevention (CDC) and United Nations Children's Fund (UNICEF), among others, has been engaged over the last decade in implementing water and sanitation facilities on the island. However, the challenges have not been completely eliminated. For example, CDC has developed a programme to improve drinking water quality and support ongoing monitoring, establish sustainable public health interventions and long-lasting WASH improvements in Zanzibar that will also prevent cholera. The initiative, which is a collaboration between CDC, UNICEF, the MoHSWEGC-Z Environmental Health Unit (EHU) and the Zanzibar Water Authority (ZAWA), is working on improving water quality through the monitoring of water distributed by ZAWA through the piped water network system that exists on the island. However, although parts of Zanzibar are covered with a piped water network, not all parts of the system are chlorinated to ensure the water is safe to use.

The initiative has been able to provide intelligent and timely data to address non-functioning treatment tanks,

PHOTOGRAPH: ISTOCK

potential pipeline breaks and staffing challenges. This, in turn, has allowed ZAWA to take corrective actions and improve the water being supplied to cholera-endemic areas. This piped network and water quality monitoring system supports the second pillar of the cholera elimination plan while building capacity and improving Zanzibar's access to safe water. Another project which is proving successful and showing positive results is related to bulk chlorination of water at source and is being implemented by CDC along with UNICEF and EHU.

Launched in January 2021, the project treats water stored in large storage tanks (greater than or equal to 1,000 litres) in five districts of Zanzibar that are considered cholera hotspots. The bulk chlorination project improves water quality by chlorinating water at the point of collection, where households go to collect water. Activities have included mapping over 1,000 water vendors and institutions, such as schools and healthcare facilities that store water in bulk, as well as distributing chlorine tablets and training nearly 500 vendors and institutions on how to use them properly. These vendors and institutions primarily use groundwater sources, such as boreholes to fill their tanks.

In March 2022, the Ministry of Water, Energy and Minerals unveiled a comprehensive water investment plan for Zanzibar to be implemented between 2022 and 2027, supporting the implementation of the Zanzibar Development Vision 2050 towards achieving a blue economy. The main objectives of the plan are to promote investment in the sector, strengthen governance and enhance the capacity of various stakeholders through mobilisation of resources, ultimately ensuring optimal water supply across Zanzibar.

The current ground reality remains challenging until the new reforms are put in place. The island still faces water shortages in several villages and there are multiple reports of the presence of coliform bacteria, organic matter and ammonia in the groundwater. As the government starts to implement the necessary WASH infrastructure, there is an urgent need for educating and training the communities on the benefits and usage of the same. For example, waste management facilities are insufficient, leading to untreated discharges into the sea, exacerbating contamination and raising concerns about seafood safety. Solid waste management is inadequate, with only 45 per cent of the daily 200 tonnes reaching dumping sites. Poor public awareness and limited garbage collection capacity compound these challenges, demanding urgent attention to establish proper waste treatment facilities. However, bulk chlorination and improving the piped water supply are not the only means to address the scale of drinking water scarcity faced by Zanzibar. Another possibility is mitigating contamination in the first place through efficient treatment of wastewater.

Zanzibar has a population of approximately 1.9 million. The average annual water usage per person is about 36 cubic metres. It is estimated that 80 per cent of this water becomes wastewater. Consequently, Zanzibar produces around 34 million cubic metres of wastewater each year. However, less than 1 per cent of this wastewater is treated.

per cent population access to safe drinking water supply. "At this rate, it is highly unlikely that the Democratic Republic of Congo will be able to achieve the SDG 6, which calls for universal access to water and sanitation by 2030," wrote Saroj Kumar Jha, the Global Director for the World Bank Group's Water Global Practice (GP), in a blog post on the Bank's website.

THE AFRICAN SYNDROME

Continent Africa suffers from the Congo syndrome: lack of access to water despite abundance of it. The State of Africa's Environment 2023, published by the Delhi-based think tank Centre for Science and Environment and fortnightly magazine *Down To Earth*, reported, "With 17 rivers, over 160 lakes and vast wetlands, Africa is endowed with abundant water resources. While the Nile is largely regarded as the world's longest river (some estimates also peg the Amazon as the longest), Lake Victoria is the second largest in the world." Using various studies, the above report said, "Africa's aquifers hold 0.66 million km^2 of water. This is more than 100 times the annual renewable freshwater resources stored in dams and rivers." According to an assessment of UNEP, Africa's renewable water resources average 3,930 km^3, which is just less than 9 per cent of the global total. Africa's wetlands cover approximately 1 per cent of the continent's total surface area, the above assessment said. "Groundwater water sources were estimated at 660,000 km^2, which is 100 times more compared to the surface waters of the region," said a research paper by Joan Nyika of the Department of Geoscience and the Environment, Technical University of Kenya, Nairobi and published on *Springer Link*.

WATER RESOURCES OF AFRICA/RIVERS AND LAKES

The continent has 17 rivers, over 160 lakes and vast wetlands

Source: "Water Resources in Africa under Global Change: Monitoring Surface Waters from Space", *Surveys in Geophysics,* 2023

The World Bank's latest report titled "The Hidden Wealth of Nations: The Economics of Groundwater in Times of Climate Change" said: "In Sub-Saharan Africa, untapped groundwater irrigation potential could be key to improving food security and poverty reduction. Little land is irrigated there, but local shallow aquifers represent over 60 per cent of the groundwater resource, and 255 million people in poverty live above them." Water withdrawal is very low at 3.8 per cent for both rainfall and internal renewable resources in Africa except for northern African countries with 18.6 per cent for rainfall and 152.6 per cent internal renewable resources.

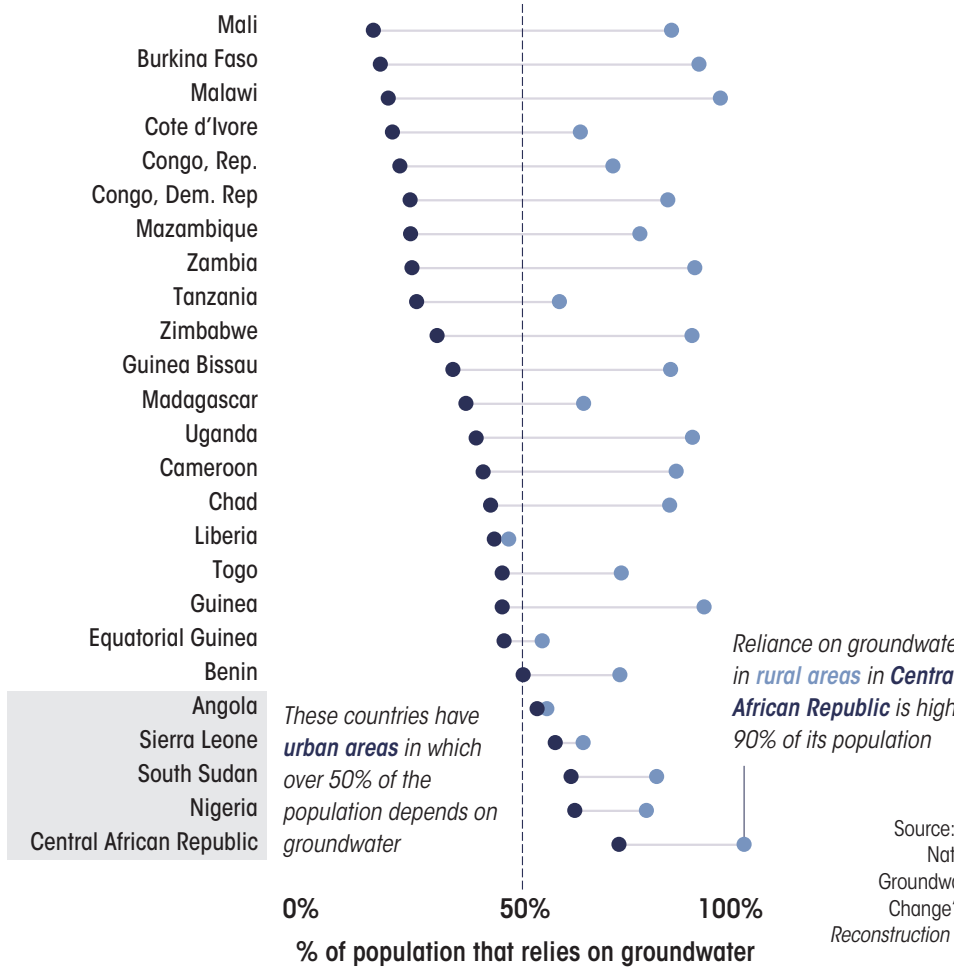
Africa is the world's second driest continent, after Australia and also the most water-stressed one. Sub-Saharan Africa was the world's most water-stressed region between 2020 and 2021, found a survey published in the *Lancet Planetary Health* journal in November 2022. Nearly 36 per cent of the people surveyed in the region were water insecure, according to the report. Overall, some 14.2 per cent of the respondents were water stressed; while countries in Sub-Saharan Africa, such as Cameroon (63.9 per cent) and Ethiopia (45 per cent), experienced the highest rates of water insecurity, those in Asia, like China (3.6 per cent), experienced the least.

Some 436 million adults of the 3 billion people surveyed across 31 low-and middle-income countries across four regions in Sub-Saharan Africa were water insecure in 2020-21, showed the findings, adding that 21 countries in the region Sub-Saharan Africa accommodated the most

WATER PORTFOLIO

Percentage of urban and rural populations relying on groundwater for their water supply

Reliance on groundwater is common on rural areas
Some urban areas are also heavily reliant on this resource

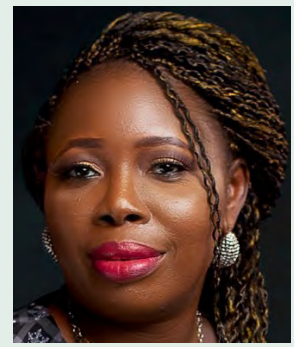


Source: "The Hidden Wealth of Nations: The Economics of Groundwater in Times of Climate Change", *International Bank for Reconstruction and Development / The World Bank*, 2023

WATER SECURITY LEVELS ARE LOW IN AFRICA

Worrying insights from UN's first-ever assessment of water security in Africa

GRACE OLUWASANYA AND DUMINDA PERERA



WHEN IT comes to water security – a reliable, good supply of safe water – just 29 African countries have made some progress over the past three to five years. Twenty-five have made none. This data comes out of the UN's first-ever assessment of water security in Africa. Published by the UN University's Canada-based Institute for Water, Environment and Health, the assessment used 10 indicators to quantify water security in Africa's 54 countries. Such an assessment had been done before in the Asia-Pacific region, but never for Africa.

The UN's concept of water security encompasses various needs and conditions. These include: water for drinking, economic activity, ecosystems, governance, financing, and political stability. Water security, therefore, is not just about how much natural water a country has but also how well the resource is managed. The assessment is limited by very poor data on some issues – such as access to drinking water or sanitation. It nevertheless offers some preliminary, but obvious, conclusions.

Overall levels of water security in Africa are low. Not a single country, let alone a sub-region, is at the highest "model" stage of water security. The top five countries – Egypt, Botswana, Mauritius, Gabon, and Tunisia — are at best at a "modest" (just above average) stage of water security. Without water security, people are exposed to environmental and health risks, increased susceptibility to water-related disasters and lack water for economic and social use. The assessment team hopes that as this quantitative tool develops, it will help generate targeted policy recommendations and inform decision-making and public-private investments toward achieving water security in Africa.

KEY FINDINGS

The assessment introduced five stages of water security: Emerging (a score of 0 – 45), slight (45 – 60), modest (60 – 75), effective (75 — 90), and model (90 – 100). Except for Egypt, all countries scored below 70. Only 13 of 54 countries were found to have a "modest" level of water security. Somalia, Chad and Niger appear to be the three least water-secure countries in Africa. Over a third of the 54 countries had "emerging" level water security, representing a large gap to be closed to reach an acceptable level. These countries are home to half a billion people. The situation doesn't appear to be improving very quickly. Between 2015 and 2020, the continent as a whole progressed only by 1.1 per cent based on the indicators.

EXAMINING THE INDICATORS

Here is an overview of how countries fared on each indicator.

Access to drinking water: Access to "at least basic" drinking water services ranged from 37 per cent of the population in the Central African Republic to 99 per cent in Egypt. Regionally it ranged from 62 per cent in central Africa to 92 per cent in north Africa. Africa's average basic drinking water service is 71 per cent. This leaves behind about 29 per cent of the total population, or more than 353 million people.

"At least basic" means access to improved water sources – such as piped water, protected hand-dug wells and springs. These either need to be "safely managed" (accessible on premises, available when needed, and free from contamination) or can be collected in a trip of 30 minutes or less.

Access to sanitation: Access to sanitation – meaning access to, and use of, sanitation facilities and services – was broadly similar at the regional level. There's an average of 60 per cent access to limited sanitation. This means at least 40 per cent of the total population (483 million people) are left behind.

A few countries – Seychelles and most countries in north Africa – have reached, or nearly reached, 100 per cent. The most challenged countries are Chad and Ethiopia.

Access to hygiene facilities: This indicator refers to access to practices like hand washing. The greatest access was found in north Africa (67 per cent), the least access was in west Africa. Liberia was the lowest in the region with less than 10% access. Chad and the Central African Republic suffer from the highest number of deaths from diarrhoea, an indicator of ineffective hygiene practices.

Per capita water availability: The amount of water available per person was highest in central Africa, with the Republic of Congo considered Africa's most water-rich country. At the other end of the spectrum, half of the countries in north Africa appeared to be absolutely water scarce. Water availability has recently declined in west, central and southern Africa. This was most notable in Cote d'Ivoire, Cameroon, Somalia, Mozambique and Malawi.

Water use efficiency: This indicator assesses the economic and social value. The score is a sum of efficiencies – a measure of how well a country uses the water it has in its economy. On this basis, water use efficiency appears to be lowest in north Africa (with Somalia lowest at the national level) and highest in central Africa (with Angola highest at a national level).

Water storage infrastructure: Water storage in large dams, measured in volume (m^3) per capita, is deemed best in the southern Africa, worst in east Africa. South Africa, with over 25 per cent of all large dams in Africa, is outscored by Ghana, Zimbabwe, and Zambia, likely due to just one mega reservoir in those countries. Half of all countries score very low, reflecting the continent's low level of water storage development. Only Ethiopia and Namibia have increased their storage over recent years.

Wastewater treatment: Scores are highest in north African countries, lowest in east and west Africa, where 12 countries in each region treat less than 5 per cent of wastewater. No country treats more than 75 per cent. Only Tunisia, Egypt and Lesotho treat over 50 per cent of wastewater.

Water governance: Governance takes into account the various users and uses of water with the aim of promoting positive social, economic, and environmental impacts. This includes the transboundary level. Water governance appears to be most advanced in north and southern Africa and least advanced in central Africa. Nationally, Ghana reported reaching 86 per cent of integrated water resource management implementation in just two years – a significant improvement. Liberia, Guinea-Bissau, and Comoros are the lowest-performing countries.

Disaster risk: Disaster risk is a measure of the potential loss of life, injury, or destroyed or damaged assets, which could occur to an ecosystem, or a community in a specific period of time. North Africa appears to be the least risky sub-region (it has less exposure or high ability to adapt), with Egypt the least risky country. West Africa was the riskiest. Some 49 of 54 African countries have seen increased disaster risk scores over five recent years.

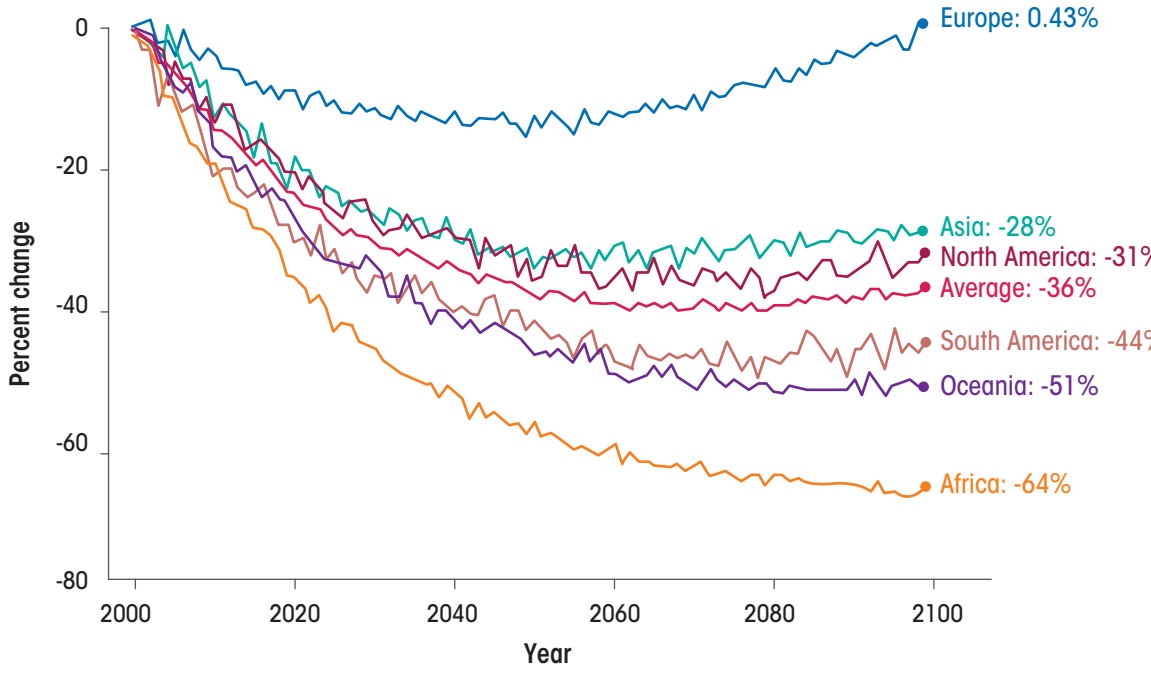
Water dependency on neighbouring nations and water resources variability: Egypt stands out as Africa's most water-dependent country. It relies on the Nile river which flows through 10 countries – Tanzania, Uganda, Rwanda, Burundi, Democratic Republic of Congo, Kenya, Ethiopia, Eritrea, South Sudan, and Sudan – before reaching Egypt. And the southern Africa sub-region has a wide disparity in the available water per year.

Preparing for the future: Our paper calls for a pioneering effort to create global standards for water security measurement data and assessment. Some critical components of water security simply cannot be assessed without good data. For example, it's not possible to estimate the percentage of the African population that will have access to safely managed drinking water services or safely managed sanitation by 2030, a key UN Sustainable Development Goal. Our water security assessment tool is a work in progress, guided by a goal of an influential and nationally-owned tool used by all African countries and that it helps generate targeted policy recommendations and inform decision-making and public-private investments in Africa.

(Grace Oluwasanya is Research Lead for Water, Climate and Gender, Institute for Water, Environment and Health (UNU-INWEH), United Nations University. Duminda Perera is Senior Researcher: Hydrology and Water Resources, UNU-INWEH)

water-stressed population in 2021. The study, led by Sera Young, an anthropologist with the Institute for Policy Research, revealed the first snapshot of global experiences with water insecurity. The researchers were also able to pinpoint which socio-demographic groups experienced the highest rates of water insecurity. They used the Individual Water Insecurity Experiences (IWISE) scale, which they developed to measure individual experiences with access, use, and stability (reliability) of water, to grade the degrees of water insecurity. They asked questions such as how often participants worried about not having enough water, how often they were unable to wash their hands, or how often they changed what they ate because of water shortage. They found that people with lower levels of income and those residing on the outskirts of cities were more prone to water insecurity. For example, those living in city suburbs or

AFRICA IS EXPECTED TO EXPERIENCE THE MOST SIGNIFICANT DECLINE IN PER CAPITA RENEWABLE WATER RESOURCES BY 2100



Note: RCP = Representative Concentration Pathway. The estimation is based on global downscaled precipitation projections from the National Aeronautical Space Administration and population data from the International Institute for Applied Systems Analysis
Source: "Water for Shared Prosperity", *World Bank,* 2024

outskirts of Burkina Faso had lower IWISE scores than city residents. Those living in rural areas in Senegal, Congo (Brazzaville), Gabon and Ethiopia shared the same experience.

The UN-led "Global Water Security 2023 Assessment", released during the UN 2023 Water Conference, found that all African nations were "water insecure" accounting for nearly half of the 114 such nations in the world. Three of the five "critically water insecure" countries in the world are in Africa - Eritrea, Sudan and Ethiopia. Africa accounts for 22 per cent of the world's critically water insecure population. Around 6.3 billion people (or 78 per cent of the world's population) live in countries experiencing critical water insecurity or general water insecurity. Of this, 4.3 billion reside in the Asia-Pacific, followed by Africa (1.4 billion), Americas (415 million people) and 65 million in Europe. In African continent, 13 African countries have been assessed to be in the critically insecure category.

Water security refers to the availability of sufficient quantities of water of acceptable quality to meet the needs of humans and ecosystems. The global water security assessment is based on 10 critical parameters, including drinking water, sanitation, good health, water quality, water availability and value, water governance, human safety, economic safety, and water resource stability. Countries classified as "critically water insecure" face severe challenges in achieving water security across seven of these 10 components. These challenges include low levels of access to safely managed drinking water and sanitation services (Components 1 and 2), high WASH-attributed mortality (Component 3), poor water quality (Component 4), low water value (Component 6), weak water governance (Component 7), and unstable water resources characterised by high inter-annual variability and low storage capacity (Component 10). The assessment assessed countries on a total score of 100. In Africa, 13 countries scored 40 or less. This means these fall under the "critically insecure category". They are: Eritrea (29), Sudan (30), Ethiopia (31), Djibouti (32), Somalia (35), Liberia (36), Libya, Madagascar and South Sudan (37), Niger and Sierra Leone (38), Chad (39), and Comoros (40). Forty-one countries in Africa or 76 per cent of countries in the continent are classified as "water insecure" with a score ranging

from 41 to 58.

The UN assessment pointed to alarming situation: In 2022, 2.2 billion people lacked access to safely managed drinking water services, while 3.5 billion lacked access to safely managed sanitation. Furthermore, disparities persisted across regions, with rural areas bearing the brunt of inadequate access. Low-income countries, in particular, have seen regression in access to safe drinking water, with an additional 197 million people lacking access since 2000. Eight out of 10 people who didn't have access to at least basic drinking water and sanitation services lived in rural areas and little progress had been made in closing the rural-urban access gap in low-income countries over the last two decades.

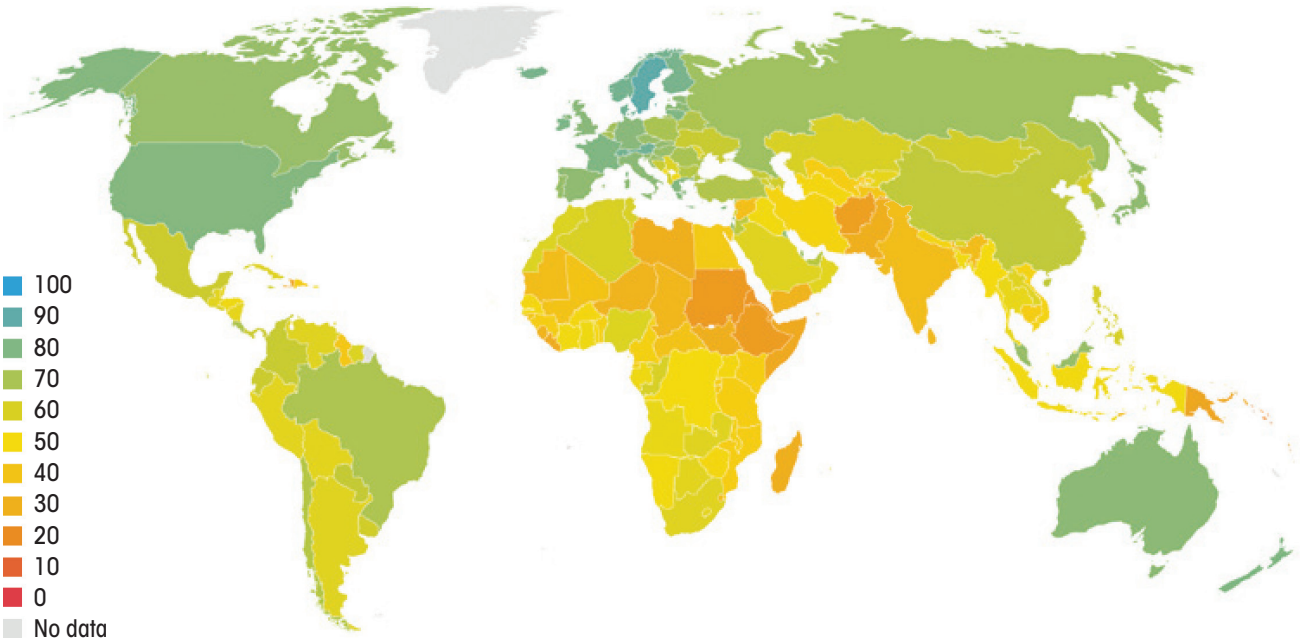
The assessment's key message is: "Abundant natural water availability does not necessarily ensure water security." "Many countries in Africa, the Asia-Pacific, and the Americas with abundant freshwater resources have high rates of WASH-attributed deaths due to limited WASH access, poor water quality and water having low economic value despite potentially high economic losses due to floods or droughts," said the study. It reasons the desperate situation with state of water, "Africa has the lowest levels of safe WASH (water, sanitation and hygiene) services worldwide, contributing to low levels of water security in the region. Almost 31 per cent (over 411 million) of people in the 54 African countries, including 33 LDCs and 6 SIDS, do not have access to a basic drinking water service. Only 201 million people (15 per cent) have access to safely managed drinking water."

Notwithstanding the fact that the continent accounts for 9 per cent of the global freshwater resources, nearly 66 per cent of Africa's total area fall under the arid or semi-arid categories. Distribution of water resources is highly skewed in Africa. Six countries account for 54 per cent of the continent's total water supply. On the other hand, 27 countries with severe water scarcity (also referred to as water poverty) share just 7 per cent of the total supply. This explains the high water scarcity condition in Sub Saharan Africa where more than half of the population don't have access to safe drinking water.

Going by a progress report of the WHO-UNICEF, Sub-Saharan Africa is the only region in the

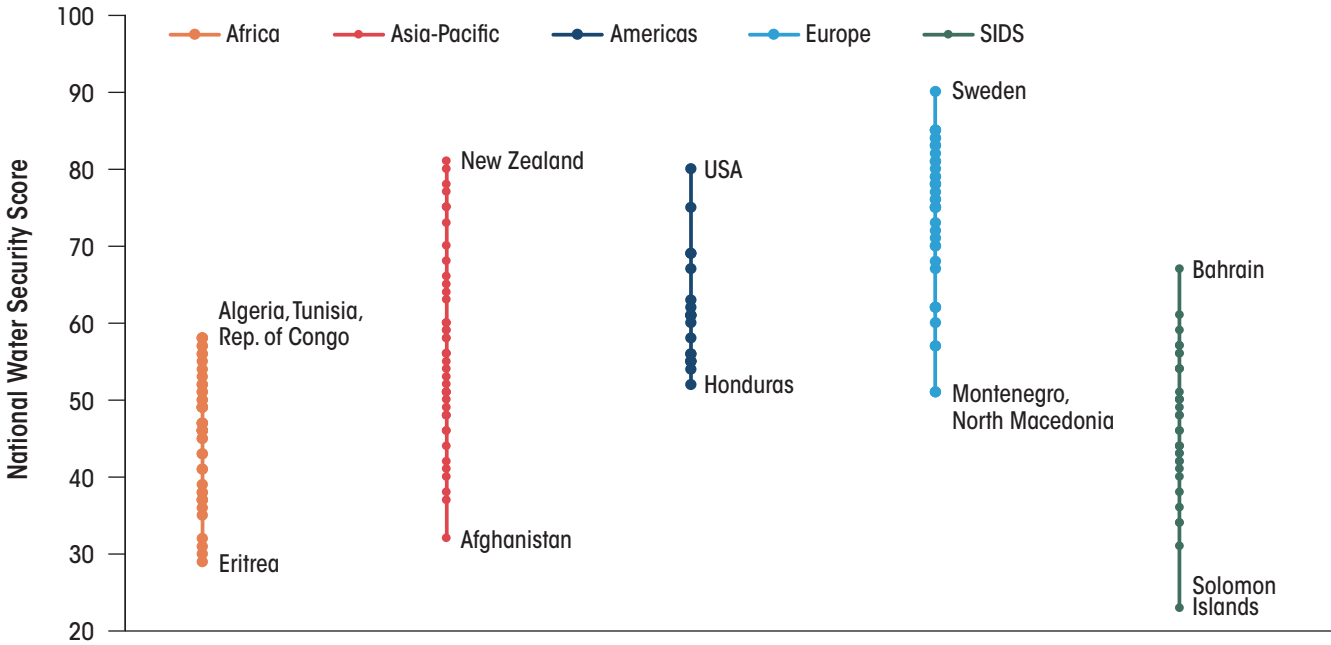
NATIONAL WATER SECURITY MAPPED GLOBALLY, BASED ON A SCORE OF 1-100

Abundant natural water availability does not necessarily ensure water security



Source: "Global Water Security 2023 Assessment", *UNU Institute for Water, Environment and Health*

NATIONAL WATER SECURITY SCORES FOR 186 COUNTRIES GROUPED IN 4 REGIONS PLUS SIDS GLOBALLY



Source: "Global Water Security 2023 Assessment", *UNU Institute for Water, Environment and Health*

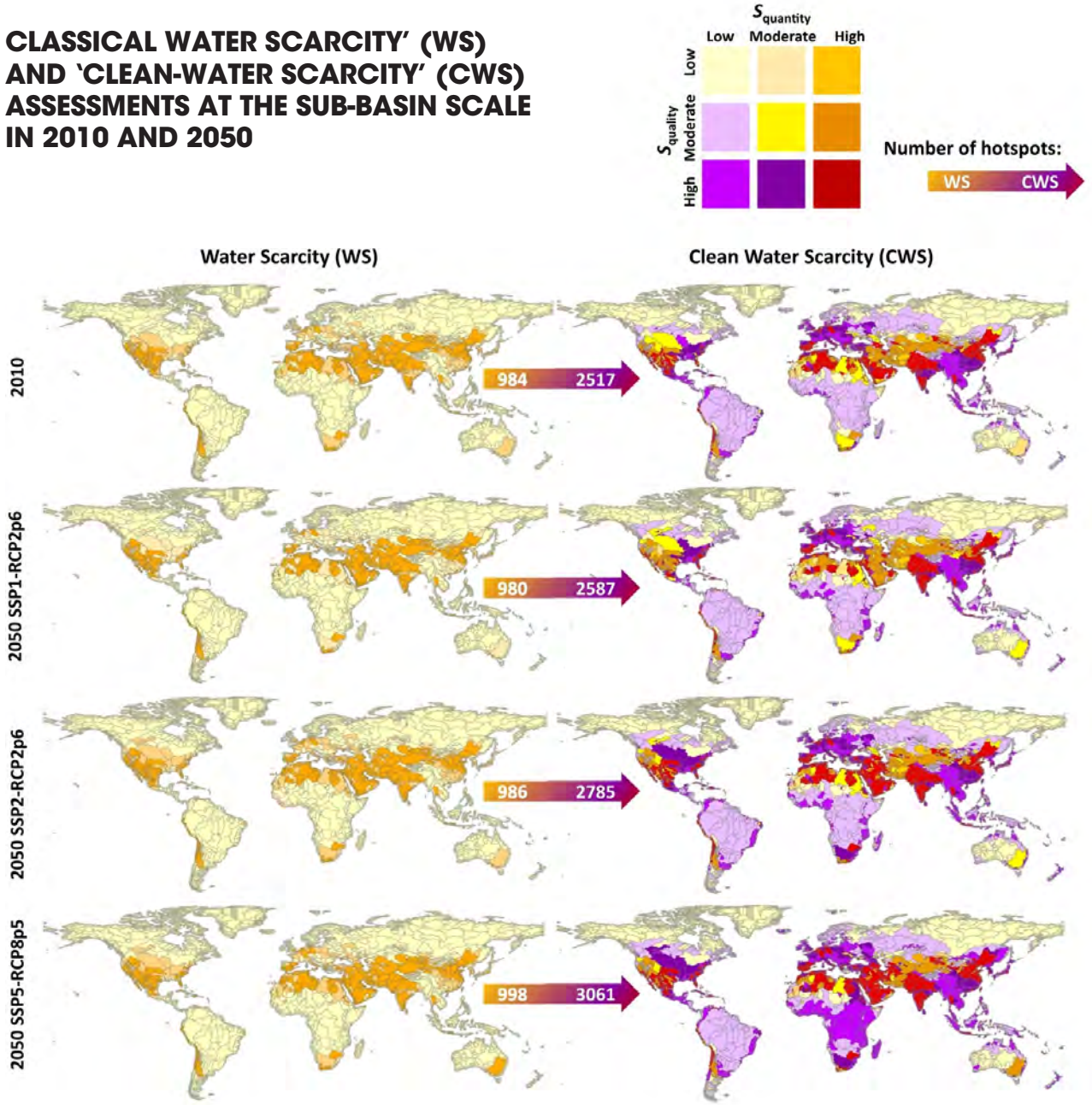
world where the number of people without access to water is increasing. In 2000, about 350 million people in Sub-Saharan Africa were without access to basic drinking water services which has gone up to 387 million in 2020. Most assessments point out that Africa is heading for a water-stressed future. In fact, it is not just the access but also availability of water is projected to be declining in the near future. More to it, the declining quality of water will effectively mean that more and more people will be left with not-usable water sources. The World Bank's "Water for Shared Prosperity" report forecasts that by the end of this century Africa's per capita freshwater resources will be 64 per cent lower than the current level.

QUALITY CONCERNS

The projected water scarcity is going to be exacerbated by declining water quality in numerous regions, according to a study published in *Nature Communications* in February, 2024. A significant factor contributing to this crisis is nitrogen pollution in rivers, a concern that emerged in 2010 and is anticipated to persist until 2050, the study found. The global impact of future nitrogen pollution is alarming, with the number of sub-basins experiencing water scarcity expected to triple. The study highlighted that an additional 40 million square kilometres of river basin area and 3 billion more people may face water scarcity in 2050 than previously estimated.

The study introduced the term "clean-water scarcity" and provided a comprehensive assessment considering both water quantity and quality. This assessment based on global nitrogen pollution and incorporating various climatic and socio-economic scenarios, revealed a direr situation than previous evaluations. Comparing the clean-water scarcity assessment to the traditional water scarcity assessment based solely on quantity, the number of sub-basins facing severe scarcity doubled in 2010 and is projected to potentially triple by 2050. Water pollution, particularly nitrogen pollution, played a significant role in aggravating water scarcity in 2,000 sub-basins worldwide. In 2010, 984 sub-basins were deemed water scarce based on quantity alone, while 2,517 sub-basins faced scarcity due to both quantity and quality. This number is anticipated to increase to 3,061 sub-basins in the worst-case scenario in 2050, as outlined in the study. This alarming projection indicates a more than doubling of the global area and population affected by severe water scarcity. When considering only water quantity, the study estimated that

CLASSICAL WATER SCARCITY' (WS) AND 'CLEAN-WATER SCARCITY' (CWS) ASSESSMENTS AT THE SUB-BASIN SCALE IN 2010 AND 2050



Source: "A triple increase in global river basins with water scarcity due to future pollution", *Nature Communications,* Feb 6, 2024

45 per cent of the global population lived in areas with severe water scarcity in 2010. However, when water quality is factored in, this estimate rose to 80 per cent.

Future clean-water scarcity hotspots were identified in China, India, Europe, North America, and potentially Central Africa in the worst-case scenario, each with unique challenges requiring targeted solutions. Nitrogen losses in rivers can stem from various sources, including human waste, agricultural practices and fertiliser applications. In the worst-case scenario, sewage is projected to become the dominant source of nitrogen pollution in rivers due to rapid urbanisation and inadequate wastewater treatment infrastructure.

India, for instance, experiences nitrogen pollution primarily from agriculture in the first two climate scenarios, but sewage is projected to surpass agriculture as the main source in the worst-case scenario. A similar trend was observed for Africa, where both agriculture and sewage contribute to nitrogen pollution, but sewage was projected to be the main source in the worst-

All African regions except Central Africa saw varying increases in the proportion of the population using basic drinking water services between 2015 and 2022. Compared to 68.7 per cent in 2015, the average percentage of all five regions with access to drinking water was 72.9 per cent in 2022

case scenario.

Universal access to safe water and sanitation seems a distant dream for Africa. In July 2024, the African Union, African Development Bank, United Nations Development Programme and United Nations Economic Commission for Africa released the "2024 Africa Sustainable Development Report" – the latest assessment on the continent's progress on the Sustainable Development Goals (SDGs). At the current pace, the continent will not be able to ensure access to safe water and sanitation services for all by 2030 (SDG 6), the assessment said.

According to the assessment, all African regions except Central Africa saw varying increases in the proportion of the population using basic drinking water services between 2015 and 2022. Compared to 68.7 per cent in 2015, the average percentage of all five regions with access to drinking water was 72.9 percent in 2022. Based on data from 2022, this was less than the global average of 91.2 percent. But, Southern and North Africa with averages of 90.2 per cent and 93 per cent in 2022, were close to the world average of 91.2 per cent in the same year, said the assessment. With respect to basic sanitation services, access in Africa increased less than 1 percentage point annually over the 2015–2022 period; rising from 46.9 per cent in 2015 to 52 per cent in 2022. Except for North Africa (93 per cent), access to basic sanitation services in Africa was lower than the world average (81 per cent) in 2022. This modest increase in access to drinking water services and basic sanitation services is not sufficient to ensure access to safe water and sanitation services for all by 2030, the target year for achieving the SDGs.

Another assessment of the progress on SDGs titled "the Sustainable Development Report (SDR)", released by UN Sustainable Development Solutions Network (UN SDSN) in June 2024, some 44 countries in the continent faced "major challenges" and nine countries faced significant challenges in achieving SDG 6. In 17 of the 44 countries facing major challenges, the rate of progress was insufficient to meet the SDG target and had been said to be "stagnating" in the UN SDSN report. The report, published since 2016, provides the most up-to-date country-wise data to track and rank the performance of all UN member states on the SDGs. Five of the 17 countries facing major challenges include Ethiopia (second most populated in Africa), Democratic Republic of the Congo (fourth most populated), Kenya (seventh most populated), Sudan (eighth most populated) and Uganda (ninth most populated). With a total population of around 380.6 million, these five countries accounted for a little over 26 per cent of Africa's population. The continent must prioritise bolstering and improving its physical infrastructure in light of potential outbreaks and the increased demand for water brought on by conflicts and natural disasters, commented Amira Mohamed Taha, Fayoum University, Egypt along with George T. Abell Professor in Infrastructure from Colorado State University and others in the journal *Nature* in June 2024. ■


PZ
Cussons
TOILET SOAP

URBAN WATER POVERTY

HIGHPOINTS

Africa is the world's youngest urban continent; **In the 1960s, Africa was 80% rural. Currently, 50% of the continent is urban.**

Increase in water demand in Africa during 2005-2030 is projected to be 283%. Around 20% of this demand will come from the municipal and domestic sector.

At least **24 large cities** in 15 countries are **likely to be water-scarce by 2050**.

The service gap between the provision of water and the growing urban population is **widening.**

PHOTOGRAPH: KIZITO MAKOYE

YOUNGEST URBAN CONTINENT'S RURAL WOES

Fast urbanising Africa grapples with unequal distribution and access to water

ON A quiet Saturday evening, Alex Mumo sits outside his modest home, reflecting on his 17-year journey in Tanzania's financial hub. Arriving in Dar es Salaam in 2007 with nothing but hope, he now lives with his wife, two daughters, and runs a street kitchen in the sprawling Tandale slum, frying potato chips and eggs. His monthly income of Tanzanian shillings 250,000 (approximately US$ 93) reflects the harsh realities of urban life. "When I first came here, I had nothing but the clothes on my back," Mumo says. "This city has given me opportunities I never imagined." Despite facing numerous challenges,

including squatting in a friend's room, Mumo did not give up. “Life was too tough then,” he recalls. “For many years, I slept on a bare floor with hardly enough space to stretch out.” In Dar es Salaam, 70 per cent of inhabitants live in informal settlements like Tandale—a vast, labyrinthine neighbourhood of flimsily built concrete houses.

Mumo’s story highlights the rising wave of rural-urban migration sweeping across Africa. Rapid urbanisation in Dar es Salaam - Tanzania’s largest city with a population of 6 million -is a beacon of hope for many and a battleground of infrastructural and environmental challenges. The city’s population, expected to double by 2035, calls for urgent sustainable urban planning. Dar es Salaam, once a modest coastal town, is now a sprawling metropolis struggling with rapid urban sprawl and a surging population driven by rural-to-urban migration. This influx, analysts say, has strained infrastructure, leading to congested roads, overcrowded public transport, and an overburdened healthcare system. Housing shortages have resulted in informal settlements lacking basic amenities like clean water and sanitation. Analysts point to cities like Dar es Salaam, which faces severe issues due to its rapid expansion. Contributing around 40 per cent of Tanzania’s GDP, Dar es Salaam is set to become a megacity by 2040. However, it is highly vulnerable to climate change risks such as flooding, sea-level rise, and coastal erosion, threatening infrastructure assets worth billions of dollars, according to the United Nations. Mumo recalls a tense moment in May 2023 when his home was engulfed by floods, forcing his family to take refuge on a rooftop. “Most of my belongings, including food, clothing and a radio set, had been destroyed by the floodwater,” he says. As the population living in slums increases, Dar es Salaam exemplifies the difficulties of managing urbanisation, natural disasters, and poverty.

Experts from ICLEI, a network of over a thousand cities focused on sustainable development

The shortage of clean water has serious implications for the health of Tandale residents. Children frequently contract diarrhoea, putting additional strain on already overburdened health services. “It’s a vicious cycle,” said Aisha Mbasha, a community health worker in Tandale

and resilience, highlight the city’s growing challenges. Local residents bear the heaviest burden due to logistical and infrastructural challenges. Until recently, much of Africa’s urbanisation has been characterised by insufficient infrastructure, a lack of formal jobs, and haphazardly built and often squalid slums. Lack of planning, weak regulations and the difficulty of obtaining title deeds for land cause cities to grow out rather than up, making them more vulnerable to natural disasters, analysts say. James Mwenda, a resident of Kigogo, faces a serious health challenge for his family due to perpetual wastewater flow from a broken sewer. “I am worried for my children. They often step on this dirty water while playing,” he says. Mwenda, a father of four, routinely dumps seeping sludge from his toilet into the Msimbazi River. “We don’t have other choices; this is the best way to dispose of it,” he says. Officials state that most residents in this squalid slum lack access to better sanitation.

For residents of Dar es Salaam, the daily quest for clean water has become a grueling ordeal. A combination of factors — aging pipes, persistent leaks, and a booming population — has pushed the city’s water infrastructure to a breaking point. The result: a crippling water shortage that forces residents into impossible choices. Fatuma Mchome starts her day long before sunrise, her bare feet shuffling through the dust as she joins a long queue to fetch water. “You have to be the first one in line,” says Mchome, balancing a bright yellow jerry can on her hip. “If you come late, you might go home with nothing.” For the 33-year-old mother of four living in the Tandale slum, the search for water is a daily struggle. Water scarcity in this impoverished neighbourhood is a shared burden for many residents. The taps are often dry, and the local water vendor’s cart, piled high with plastic containers, becomes the last resort. “It’s too costly, but what choice do we have?” Mchome asks. Nearby, John Nyondo, a father of four, shakes his head as he talks about his family’s worsening plight. “The water we get is not even clean,” he says, holding up a murky,

"36% CITIES TO FACE WATER CRISIS BY 2050"

As urban population increased by leaps and bounds, domestic water use almost quadrupled in the past 60 years

ROBERT MCDONALD

WITH GLOBAL urban growth set to add more than 2 billion additional people by 2030, our cities will expand. Today, approximately 54 per cent of the global population, or 3.9 billion people, live in cities. This is likely to grow between 60 and 92 per cent by the end of the century. Historically, as urban population increased by leaps and bounds, domestic water use almost quadrupled in the past 60 years. Factors such as wealth and access to drinking water infrastructure contributed to high water usage. The worrying point is this trend will continue with the domestic water use forecast set to increase by another 80 per cent by 2030.

In a recent research published in the online journal, *Nature Sustainability,* my colleagues and I found that 16 per cent of the cities featured in our sample experienced water shortage. These cities witnessed at least one month of surface water deficit during the 1971-2000 baseline period. This happened even after they prioritised water over agriculture. According to the study, by 2050, Los Angeles, Jaipur and Dar es Salaam are predicted to witness the greatest surface-water deficit. On an average, this will exceed 100 million cubic metre (m^3) per year. It also says that urban surface-water deficit of the top 20 cities is currently about 2,338 million m^3, which is around 35 per cent of the total deficit.

While growth in urban population is leading to increased water demand, climate change will make supply more variable. In some places, it will lead to a reduction of availability. It is likely that by 2050, 36 per cent of the world's cities will face a water crisis. The common opinion of various studies is that water shortage will increase in the years to come. In the future, one in six large cities is likely to be at the risk of water deficit.

Increased demand for urban water supply will put pressure on groundwater resources. We investigated urban groundwater stress by calculating the urban groundwater footprint of regional aquifers.

Climate change and socio-economic factors like urbanisation will lead to an increasing urban groundwater footprint. Historically, many cities in less developed countries had systems that were inadequate to provide 24X7 water access to its people, a goal that will become even harder to reach in the future.

Everyone is talking about Cape Town. Prior to this, droughts hit Sao Paulo and California. As weather varies, it is impossible to predict which cities may face drought in the future. However, what we can say with certainty is that increased water demand and less regular supply due to climate change will make events like the Cape Town drought frequent.

There are two solutions. One is expanding water supply and increasing storage. This will ensure that cities survive under drought. This can be done by long-distance water transfers, but can also come from groundwater or desalination. When cities appropriate more water, they impact the freshwater ecosystem.

Sometimes urban water usage is more than in agriculture. Also, society should make more efficient use of water. This can be done by fixing leaky pipes, which causes wastage. Steps must be taken to make farmers efficient in use of irrigation water. Water reuse is an option too.

(Robert McDonald is a scientist at the US-based environmental organisation The Nature Conservancy. *The column is based on a conversation with* Down To Earth *magazine.)*

brownish sample. "But we have to use it for everything — cooking, washing, and drinking."

The shortage of clean water has serious implications for the health of Tandale residents. Children frequently contract diarrhoea, putting additional strain on already overburdened health services. "It's a vicious cycle," said Aisha Mbasha, a community health worker in Tandale. "People get sick because they don't have clean water, and then they can't afford to get treated." The crisis in Tandale reflects broader issues plaguing Dar es Salaam's water supply, riddled with ageing infrastructure, broken pipes, and outdated systems. These problems are exacerbated by sabotage and vandalism of the water distribution network. Despite the dire need, efforts to

upgrade and repair the city's water infrastructure are often slow and insufficient due to inadequate funding.

The cost of this crisis is starkly visible in Tandale. In a dimly lit shack, Maria Kasanga tends to her elderly mother. "She is too frail to walk to the water points," Kasanga explains, gently wiping her mother's forehead with a damp cloth. "So I have to do it for her, even if it means missing work." Kasanga's struggle highlights the daily sacrifices made by many residents. Missing work means losing a day's wages — money that could have been used to buy food or medicine. "It's a constant juggling act," she says. "We have to choose between water and other necessities." For children like 12-year-old Samuel, the water crisis affects their education. "I often have to skip school to help my mother fetch water," he says. "I want to study and become a doctor one day, but it's hard when you have to worry about water."

As one of Africa's fastest-growing cities, the city's water demand far outstrips supply, leading to frequent shortages and rationing. Moreover, rapid urbanisation and population growth have strained the existing water resources, pushing the city's water management systems to the brink. For 42-year-old Hadija Mbwana, who sells charcoal to earn a living, the water shortage presents a difficult moral dilemma: Her children must choose between drinking murky water and risking illness or suffering from extreme thirst. "I cannot afford to buy piped water. Groundwater is cheaper, but it's dirty, smelly, and too salty to drink," she says. Herbert Kashililah, a water expert and chairman of the Tanzania Water & Sanitation Network, says the city's old pipelines are riddled with leaks and illegal connections. "We must modernise this infrastructure by replacing old pipes, building new reservoirs, and upgrading treatment plants to ensure water quality and

As one of Africa's fastest-growing cities, Dar es Salaam's water demand far outstrips supply, leading to frequent shortages and rationing. Moreover, rapid urbanisation and population growth have strained the existing water resources, pushing the city's water management systems to the brink

reliability," he says. Kashililah also stresses the importance of better management and regulation of water resources to reduce corruption and ensure that water reaches those who need it most. He highlights the role of community involvement in addressing the water crisis. "Communities must be part of the solution. Public awareness campaigns can educate people on the importance of storing water and how they can reduce wastage," he explains.

Campaigners urge the government to end the crisis. "This is not just a technical issue — it's a human rights issue," says Linda Mushi, a water rights activist. "The government must urgently solve this problem." While the Dar es Salaam Water and Sanitation Authority (DAWASA) has recently unveiled multiple initiatives to address the city's water crisis, there's no end in sight for Tandale residents. Local residents in this impoverished neighbourhood are increasingly angered by what they describe as empty promises. "We have been waiting in vain for years, but the water situation has not improved," says Nyondo. "We need real action, not just words."

Mkama Bwire, DAWASA's acting chief executive officer, vows to end the worsening plight of water consumers in the bustling city. "We are aware of the water crisis and are committed to devising short-term and long-term solutions to solve this issue," he says. DAWASA is implementing various initiatives to boost the capacity of existing water treatment plants by increasing their output by an additional 196 million litres per day, Bwire says. The agency is also planning to drill new boreholes in strategic locations to provide a crucial buffer during periods of high consumption and low supply. "We are targeting areas that are currently underserved to ensure equitable water distribution," he says. DAWASA is also revitalising its distribution network by replacing ageing pipes to reduce water loss. "Our goal is to reduce water loss from 47 per cent to less than 20 per cent over the next five years (by 2028)," he assures.

Tanzania's Minister for Water, Jumaa Aweso, recently inspected DAWASA's production plants, revealing deliberate damage that has worsened water scarcity in the city. The government has

GLOBAL URBAN POPULATION (IN MILLION PERSONS) FACING WATER SCARCITY FROM 2016 TO 2050 (including the 10 countries with the largest increases)

	2016			2050			Change between 2016 and 2050		
	Perennial	Seasonal	Total	Perennial	Seasonal	Total	Perennial	Seasonal	Total
Asia	268.0	340.8	608.8	621.0 (374.3–711.4)	722.2 (495.0–968.0)	1343.2 (1090.2–1511.8)	131.7% (39.7%–165.4%)	111.9% (45.3%–184.1%)	120.6% (79.1%–148.3%)
India	98.0	124.1	222.1	255.1 (133.7–312.9)	295.3 (164.9–355.0)	550.4 (375.5–644.1)	160.4% (36.4%–219.4%)	137.9% (32.8%–186.0%)	147.8% (69.0%–190.0%)
China	72.1	86.9	158.9	128.7 (58.6–140.1)	112.2 (69.9–225.9)	241.0 (187.9–315.5)	78.7% (–18.7%–94.5%)	29.2% (–19.6%–160.1%)	51.6% (18.2%–98.6%)
Pakistan	25.7	14.2	39.9	70.8 (45.6–75.8)	26.7 (11.7–45.0)	97.5 (72.4–106.0)	175.9% (77.6%–195.2%)	87.4% (–18.1%–216.1%)	144.3% (81.5%–165.6%)
Indonesia	0.0	29.0	29.0	9.3 (0.0–38.9)	61.4 (28.0–100.7)	70.7 (30.2–107.9)		111.7% (–3.5%–247.5%)	143.7% (4.1%–272.3%)
Philippines	0.0	3.1	3.1	0.0 (0.0–4.1)	39.6 (5.5–51.5)	39.6 (5.5–51.5)		1164.3% (74.2%–1543.8%)	1164.3% (74.2%–1543.8%)
Africa	13.8	67.1	80.9	73.2 (33.3–115.1)	238.0 (133.3–338.9)	311.2 (210.3–372.2)	429.5% (140.5%–732.7%)	254.8% (98.7%–405.4%)	284.7% (159.9%–360.1%)
Nigeria	0.6	17.2	17.8	16.4 (0.0–30.5)	50.6 (22.2–76.9)	67.0 (40.4–85.1)	2741.1% (–100.0%–5196.9%)	194.2% (28.8%–346.8%)	276.7% (127.3%–378.6%)
Egypt	1.7	0.0	1.7	3.8 (3.3–4.2)	51.8 (0.0–57.9)	55.6 (3.6–61.6)	123.1% (91.1%–145.4%)		3154.9% (111.5%–3506.3%)
North America	45.7	62.8	108.5	89.9 (40.9–113.0)	103.6 (70.2–147.9)	193.5 (147.3–226.4)	97.0% (–10.4%–147.6%)	64.9% (11.7%–135.4%)	78.4% (35.8%–108.7%)
United States	24.0	26.9	50.9	41.8 (25.7–60.9)	50.7 (29.5–91.2)	92.6 (62.8–131.5)	74.0% (7.1%–153.5%)	88.6% (9.8%–239.0%)	81.7% (23.3%–158.2%)
Mexico	21.6	28.7	50.3	48.1 (9.8–66.4)	26.7 (15.4–58.7)	74.8 (62.9–89.9)	122.5% (–54.7%–207.2%)	–6.9% (–46.3%–104.3%)	48.6% (25.0%–78.5%)
South America	7.7	28.8	36.5	16.7 (8.7–41.8)	65.8 (43.9–130.4)	82.5 (52.7–160.9)	116.4% (13.4%–441.9%)	128.2% (52.4%–352.2%)	125.7% (44.2%–340.4%)
Brazil	0.1	7.7	7.7	1.6 (0.0–24.3)	33.7 (11.4–89.4)	35.3 (11.6–94.2)	2416.0% (–100.0%–38585.7%)	338.3% (48.9%–1063.3%)	355.1% (49.8%–1116.0%)
Europe	21.8	69.1	90.9	35.0 (14.4–42.6)	79.3 (66.0–132.9)	114.2 (84.5–162.2)	60.7% (–34.0%–96.0%)	14.7% (–4.5%–92.3%)	25.7% (–7.0%–78.5%)
Oceania	0.4	2.5	2.8	0.7 (0.1–2.6)	8.4 (2.6–14.8)	9.0 (3.0–15.4)	78.4% (–76.9%–608.1%)	241.9% (7.7%–502.6%)	220.4% (7.9%–444.1%)
World	359.3	573.4	932.7	839.6 (475.6–905.3)	1225.0 (902.3–1647.2)	2064.6 (1692.7–2373.0)	133.7% (32.4%–152.0%)	113.6% (57.4%–187.2%)	121.3% (81.5%–154.4%)

For 2050 the average values of urban population using the ensemble mean of runoff from GCMs under four scenarios are listed outside parentheses while the range (min-max) of estimations using runoff from each GCM under four scenarios are provided within parentheses
Source: "Future global urban water scarcity and potential solutions", *Nature Communications,* August 3, 2021

invested in machinery capable of producing 590 million litres of water daily, but due to inefficiencies, they're currently producing 320 million litres daily, leaving a shortfall of 270 million litres, according to Aweso. Government data shows that DAWASA sells 210 million litres daily but loses 110 million. Aweso has also promised to tackle these inefficiencies as part of the government's broader strategy to improve water access in Dar es Salaam. However, these improvements are still in their early stages, and residents such as Mchome remain skeptical of any real results. "I don't think the situation will change anytime soon," she says.

URBAN AFRICA'S EMERGING CHALLENGE

Cities across the continent endure similar experiences: rapid urbanisation, more water demand but less availability and inadequate infrastructure to deliver services. For instance, consider Rwanda which has one of the highest population densities in Africa (483 people/sq. Km). At the same time, Rwanda is also among the countries having the lowest per capita water availability (670m^3/capita/year) and storage capacity in Africa. Besides inadequate per-capita availability, floods accompanied with soil erosion are a common issue in Rwandan cities. The urban population of Rwanda is increasing rapidly, as well; socio-economic life is improving. Water demand for satisfying the needs in the municipal sector is increasing. The high water demand together with human-made activities is causing numerous water resource challenges in terms of overall water management. Although Rwanda remains predominantly rural, the country has one of the fastest growing urbanisation rates (app. 4.5 per cent annually) in the world. Only five other countries in the world held a higher rate of urbanisation (Madagascar: 4.7 per cent, Niger: 4.9 per cent, Eritrea: 5.0 per cent, Uganda: 5.7 per cent, and Burkina Faso: 6.0 per cent). In Rwanda, the country's urban population is expected to increase from 16.5 per cent in 2012 to 30 per cent

Africa is the youngest urban continent. In a breathtaking change over, from an overwhelming rural landscape, it has become the fastest urbanising continent. The African Development Bank terms urbanisation as "the most profound transformations that the African continent will undergo in the 21st century"

in 2032; this means that 1.7 million of population in 2012 to 4.9 million of population in 2032 will be part of urban settlements

Its capital, Kigali, is a major urban centre with 76 per cent of the population categorised as "urban". Majority of the country's urban residents reside in this city where access to municipal water constitutes a critical issue with the long length of the water supply distribution network of 2,080 km. Even for the proportion of households currently connected to the piped network, water provision is uncertain due to regular interruptions. The residents who are not connected to the piped network at all face higher average water costs and are generally even poorer than connected residents. In urban Rwanda, mainly in the City of Kigali, heavy rainfall events cause rapid surges in the flow of rivers and drainage systems leading to floods downstream. The flash floods are observed mainly in areas where the rapid urbanisation of hill slopes has dramatically increased the runoff water. In addition, inadequate drainage systems and constructions in flood-prone zones have made many neighbourhoods of Kigali highly susceptible to flooding and erosion.

Water scarcity in urban Africa is an emerging challenge. Africa is the youngest urban continent. In a breathtaking change over, from an overwhelming rural landscape, it has become the fastest urbanising continent. The African Development Bank terms urbanisation as "the most profound transformations that the African continent will undergo in the 21st century." In the 1960s, Africa was 80 per cent rural. Currently, 50 per cent of the continent is urban. In 1990-2020, the number of cities in Africa leaped from 3,300 to 7,600. Expectedly, urban population

KEY WATER SECURITY CHALLENGES IN SURVEYED AFRICAN CITIES

Very important | Important | Not important | No answer

Cities	Floods	Insufficient coverage of water and sanitation services	Water pollution	Water scarcity and droughts	Ageing, obsolete infrastructure/ lack of infrastructure	Waterborne diseases	Competition/ conflicts over water allocation
Lusaka (Zambia)							
Cape Town (South Africa)							
Kampala (Uganda)							
Monrovia (Liberia)							
Golf 3 (Togo)							
Kanembakache (Niger)							
Saint Louis (Senegal)							
Nouakchott (Mauritania)							
Bangui (Central African Republic)							
Brazzaville (Republic of the Congo)							
Cotonou (Benin)							
Lome (Togo)							
Bama (Burkina Faso)							
Abidjan (Côte d'Ivoire)							
Antananarivo (Madagascar)							
Cocody (Côte d'Ivoire)							
Thies (Senegal)							
Bangangte (Cameroon)							
Vogan (Togo)							
Mbour (Senegal)							
Maputo (Mozambique)							
Abuja (Nigeria)							
Al Hoceima (Morocco)							
Rabat (Morocco)							
Chefchaouen (Morocco)							
Accra (Ghana)							
Dakar (Senegal)							
Marrakech (Morocco)							
Meknes (Morocco)							
Fes (Morocco)							
Tanger (Morocco)							
Tetouan (Morocco)							
Bobo-Dioulasso (Burkina Faso)							
Rosso (Mauritania)							
Dionaba (Mauritania)							
Banjul (Gambia)							

Note: 36 cities responded to the question "Which water risks are the most important in your city?"
Source: OECD (2021[9]), OECD Survey on Water Governance in African Cities, OECD, Paris.

also increased by 500 million during this period. The United Nations Office for Project Services (UNOPS) that implement humanitarian and development projects of the multilateral body says that by 2050 more than 1.3 billion people in Africa will be living in urban areas. About 57 per cent of the population currently lives in rural areas, but the proportion of the population living in urban areas is projected to exceed 60 per cent by 2050. According to the World Resources Institute (CWRI)'s report "Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South", "Recent United Nations (UN) forecasts indicate that between 2010 and 2050 the urban population in developing countries is likely to almost double from 3.6 billion to 6.7 billion. About one-third of this growth will occur in just three countries: Nigeria, India, and China, with Sub-Saharan Africa and the Indian subcontinent expected to absorb the majority of overall growth."

This unprecedented migration of people to urban areas also means the water woes that haunt the rural population will grip the urban settlements. All indicators point towards this. First, the demand for water is going to increase like never before. According to the World Bank estimates, "The increase in water demand in Africa between 2005 and 2030 is projected to be 283 per cent—three times higher than almost any other region. A significant portion of this new demand (an estimated 92 billion cubic meters or 20 per cent) will come from the municipal and domestic sectors, and competition with other water-using sectors, most notably agriculture (which accounts for 72 per cent of this increase), will increase dramatically." Secondly, as in the rural areas, the number of urban people facing water scarcity in urban Africa will increase by around 285 per cent. At least 24 large cities in 15 African nations are likely to be water-scarce in 2050, finds a world-wide estimation of the urban population facing water scarcity led by scientists from the Beijing Normal University, Shanghai Normal University and Deakin University, Australia,

The increase in water demand in Africa between 2005 and 2030 is projected to be 283 per cent—three times higher than almost any other region. A significant portion of this new demand (an estimated 92 billion cubic meters or 20 per cent) will come from the municipal and domestic sectors

which was published in the journal *Nature* in August 2021. Urbanisation and climate change together are projected to be key drivers of the water scarcity in the African cities, said the study. At the global scale, the urban population facing water scarcity was projected to increase rapidly, reaching 2.065 billion people by 2050, a 121.3 per cent increase from 2016. But, in Africa, the number of urban people facing water scarcity will increase by 284.7 per cent. This is the highest increase amongst all regions – Asia, North America, South America, Europe and Oceania. Of the 10 countries projected to have the highest number of urban residents facing water scarcity, Nigeria and Egypt are two prominent ones. Nigeria will witness a 277 per cent increase in water scarce urban residents and Egypt will report an unprecedented 3,155 per cent increase. In Nigeria, the population of cities experiencing water scarcity throughout the year will rise by around 2,741 per cent. During the same period, urban population facing seasonal water scarcity will increase by 194.2 per cent. The World Bank estimates that "over the next 25 years the demand for water in Africa will almost quadruple—a much faster rate than any other region in the world." Its 2030 Water Resources Group said earlier, "Water supply is shrinking, and water quality is deteriorating. As water demand grows, cities are forced to rely on water sources that are further from the city—and more expensive to tap."

An analysis of the water crisis reported across major African cities in January-July 2024 by *Down to Earth* magazine resonates with findings of the above study. Major capital cities in Africa faced water crises during this period. For instance, urban population growth and resultant domestic water demands are leading to a continuous increase in water scarcity shows the water crisis faced by Johannesburg in Gauteng province of South Africa since late 2023. Johannesburg is likely to be a "Day-zero" city - when the taps will run dry - according to global city-wise and

24 CITIES IN 15 AFRICAN NATIONS AT RISK OF WATER SCARCITY IN 2050 AND THE POTENTIAL SOLUTIONS FOR ADDRESSING THE CRISIS

Note: The Blue ■ denote that the solution is applicable and probably can solve the issue ; ■ denote that the solution is inapplicable or cannot solve the issue,The cities with population above 1 million in 2016, which would face water scarcity in 2050

Country	*City	Population in 2016 (000's)	SSP1& RCP 2.6***	Potential solutions for addressing water scarcity					International water transfer/ water trade
				Desalination of sea water	Groundwater exploitation	Reservoir construction	Interbasin water transfer	Domestic virtual water trade	
Algeria	El Djazair (Algiers)	**2,626**							
Angola	Luanda	**7,265**							
Burkina Faso	Ouagadougou	**2,306**							
Egypt	Al-Qahirah (Cairo)	**19,230**							
Egypt	Al-Iskandariyah (Alexandria)	**4,886**							
Ethiopia	Addis Ababa	**4,040**							
Kenya	Nairobi	**4,065**							
Kenya	Mombasa	**1,139**							
Libya	Tarabulus (Tripoli)	**1,142**							
Mauritania	Nouakchott	**1,105**							
Mongolia	Ulaanbaatar	**1,415**							
Morocco	Dar-el-Beida (Casablanca)	**3,623**							
Morocco	Rabat	**1,812**							
Morocco	Fès	**1,146**							
Morocco	Tanger	**1,036**							
Nigeria	Kano	**3,661**							
Senegal	Dakar	**2,830**							
South Africa	Johannesburg	**5,147**							
South Africa	Cape Town	**4,208**							
South Africa	Ekurhuleni	**3,559**							
South Africa	Pretoria	**2,176**							
South Africa	Port Elizabeth (Nelson Mandela Bay)	**1,198**							
Sudan	Al-Khartum (Khartoum)	**5,260**							
Tunisia	Tunis	**2,218**							

Source: "Future global urban water scarcity and potential solutions", *Nature Communications,* August 3, 2021

MAKING CITIES WATER SENSITIVE: A GLOBAL SOUTH PERSPECTIVE

There is a risk of Malthusian determinism in assuming that population growth per se is the determining factor for all urbanisation problems

DEPINDER KAPUR

A NORMATIVE thinking—that sees population growth, economy and climate change as driving forces—dominates the origin of the water-sensitive cities discourse/framework. The focus of this discourse originating from the Global North is that we move beyond an infrastructure focussed "conventional" approach of the last century. This approach is described as: "the rapid pace and scale of urban growth, combined with the impacts of climate change and economic development, is challenging the capacity of existing water systems to provide the world's cities with clean water and sanitation, and healthy and safe urban environments. There is now widespread agreement that conventional water management approaches are ill-equipped to meet the diverse and complex needs of cities. These infrastructure and governance systems remain largely influenced by twentieth century solutions and experience, which are typically characterized by fragmentation and technologically dominant solutions."

A rapid urban population growth, economy and climate change variables may certainly be impacting cities everywhere, but perhaps its intensity and its formal or informal typology is very different in context of the Global South. There is also a risk of Malthusian determinism in assuming that population growth per se is the determining factor for all urbanisation problems. While there is no denying that any form of urbanisation will yield externalities of waste, inequity in urbanization can be a significant contribution to water and used water management challenges of our cities. A political economic framework of analysis when applied to understanding water and waste in cities helps us better frame any perspective of water-sensitive cities, climate-resilient cities, and several other such discourses that are being developed today.

From discourse to framework: Water-sensitive cities Monash University in Australia coined the term "water-sensitive cities" and described it as follows: A water-sensitive city of the future is a place where people want to live and work. It is a place that:

- serves as a potential water supply catchment, providing a range of different water sources at a range of different scales, and for a range of different uses;
- provides ecosystem services and a healthy natural environment, thereby offering a range of social, ecological, and economic benefits; and
- consists of water-sensitive communities where citizens have the knowledge and desire to make wise choices about water, are actively engaged in decision-making, and demonstrate positive behaviours such as conserving water at home and not tipping chemicals down the drain.

The discourse further constructs a linear presentation of movement describing a desirable direction: from water, sewerage and storm-water infrastructure provisioning to governance for efficient water use, equity in access to water and wastewater, citizen participation and water literacy, improving equity and liveability of the already planned cities. This discourse is developed into a framework to reach the desired "water-sensitive city". Qualitative indicators are then defined for achieving seven goals/outcomes of a water-sensitive city.

The water-sensitive cities framework emerging from the Global North countries (Europe and Australia) has as its foundation cities that have planned urban development with a statutory legal entitlement to housing and basic infrastructure (including water, wastewater and drainage) for all residents of their cities. The core aims of urban planning have been substantially achieved and access to water and sanitation is realised as a *de facto* human right of all residents. A water-sensitive city in the developed country context aims at achieving second-generation outcomes—higher standards and more effective standards of water conservation and wastewater management (nutrient removal, carbon sequestration, energy extraction and methane reduction), and adaptation to water stress and/or urban flooding accruing from climate change impact—creating a safer, sustainable and attractive urban liveable environment, a city that becomes an attractive destination for housing, tourism and businesses. Existence of good quality grey infrastructure is at the core of water-sensitive cities. The existence of basic infrastructure of 100 per cent water supply, sewerage and more than 80 per cent drainage forms the basis for the water-sensitive cities discourse in developed countries. Does this condition exist for developing countries of the global south?

The urbanisation trend in the Global North is very

different from that in the Global South. Rapid population growth is witnessed in cities of the Global South cities, which are grappling with an urban expansion that is unplanned and highly iniquitous. Priorities of our cities are improving access to basic services of water supply and wastewater and drainage management for the less privileged informal settlements that house as much as 50 per cent of our urban population in large cities, if not more. Hence even though the rationale for water-sensitive cities may be the same for the Global North and the Global South cities, the goal, principles and desirable outcome priorities, will be completely different.

(Depinder Kapur is with the Centre for Science and Environment, New Delhi)

ensuring sustainable water supply amidst growing demand and infrastructural decay. The city must learn from experiences of Cape Town and take appropriate measures, suggested Kevin Winter, theme leader at the University of Cape Town Future Water Institute. "Cities need to adapt much faster to climate change. One of the biggest lessons for Cape Town is that storage dams are not reliable when there is inadequate rainfall to recharge them. Almost 98% of Cape Town's water supply comes from surface water dams" stated Winter.

Similarly, Kenya is also facing an unprecedented water crisis in its expanding urban areas, like in rural areas. Kenya is lagging behind in delivering water to its 50 million people, with at least a third of the population lacking access to clean drinking water. This is despite the country making strides in infrastructure-related areas such as transport. More than 16 million of the population relies on untreated and unsafe water sources, such as ponds, shallow wells, rivers and even lakes for drinking water. Data collected by different organisations shows that the situation is particularly dire in rural areas and among the urban poor.

Kenya's rural areas have traditionally been plagued with an inability to access safe water. "In rural Kenya, the average cost of coping with an unreliable or distant water supply is approximately $38 per month. In comparison, the average water bill of a typical household in Nairobi that is connected to a piped system, is only $4.46 per month," global water body Water.org said in one of its 2020 statements. "This comparison highlights the economic burdens that often fall more heavily on unconnected rural customers than on households with piped connections," it added. However, the problem is now widespread in urban slums despite good coverage, according to data. Water.org noted that in many areas, piped water connections did not produce a "reliable, constant" flow of water.

Water affordability in rural and urban areas is a major issue, with both suffering the problem of lack of access, according to Wangai Ndirangu, head of capacity-building in sustainable water management network WaterCap Kenya. Ndirangu noted that the lack of access to water in urban areas was caused because of low supply and high demand — especially in slums — controlled by cartels, migration from rural areas and population growth in cities and towns, coupled by poor planning and management. "With nearly 600,000 people in Kenya moving to towns each year, infrastructure quickly gets overwhelmed and this has resulted in excessive extraction of water in low- and middle-income areas of Nairobi to meet demand," he said. "In urban Kenya, water is a factor in poverty. It is less accessible to the poor and the more the poor one is, the more they are unlikely to be able to afford clean drinking water," he added.

On the other hand, lack of access in rural Kenya is influenced by poor coverage of the water network. This means that while water sources including rivers and streams, ponds, wells and springs are present, people have to walk for long distances to get the commodity. The observation is shared by the UN Human Rights Office which in 2019, undertook a pilot assessment of the enjoyment of the right to water in Kenya in informal settlements in the country.

It found that while urban areas had better access than rural areas, inequalities were particularly acute in informal urban settlements where residents relied on unreliable water services from formal and informal providers. "Only a minority of households in informal settlements have access to the public water supply, which is less costly. In informal settlements, water supply has been privatised by 'cartels' and many residents rely on private water vendors, particularly during the dry season," it added. It found that the commodity sells a litre less in urban middle class neighbourhoods — where piped water is available — than in the slums where the majority relies on water vendors. It further revealed that the majority of respondents spent more than 3 per cent of their monthly household income on water, which is above the

WATER STRESSED CITIES IN SUB-SAHARAN AFRICA (1979-2019)

City	Country	Province	Overall Water Risk
Asmara	Eritrea	Anseba	Extremely High
Djiboutii	Djibouti	Djibouti	Extremely High
Arusha	Tanzania	Arusha	Extremely High
Madibir,	Tanzania	Mbeya	Extremely High
Harare	Zimbabwe	Harare	Extremely High
Mavinga	Angola	CuandoCubango	Extremely High
Luchazes	Angola	Moxico	Extremely High
Middelburg	South Africa	Mpumalanga	Extremely High
Cape Town	South Africa	Western Cape	Extremely High
Windhoek	Namibia	Khomas	Extremely High
Maradi	Niger	Maradi	Extremely High
Agadez	Niger	Agadez	Extremely High
Lagos	Nigeria	Lagos	Extremely High
Ouagadougou	Burkina Faso	Centre	Extremely High
Dakar	Senegal	Dakar	Extremely High
Nouakchott	Mauritania	Nouakchott	Extremely High
Zinder	Niger	Zinder	Extremely High

Note: This is based on the analytical tool "Aqueduct Water Risk Atlas" of the World Resources Institute. Aqueduct's tools use open-source, peer reviewed data to map water risks such as floods, droughts and stress.
The above risk ranking is based on a scale of 1-5. "Extremely High" ranking is for those cities that scored 5 in the scale.

international standard for affordability. This implies that Sustainable Development Goal 6 on universal and equitable access to safe and affordable drinking water by 2030 remains a mirage.

ISSUE OF EQUITY

The fast urbanising Africa grapples with unequal distribution and access to water. The COVID-19 pandemic brought out the scale and severity of this aspect of urban water governance in the continent. "COVID-19 has acted as a magnifying glass on pressing water challenges, stressing and widening amongst others existing inequalities in access to water and sanitation services," noted the Organisation for Economic Co-operation and Development (OECD). According to UNOPS, "Many cities and urban areas in Africa struggle to ensure an adequate water supply for current residents. And large differences exist between countries. In Liberia, for example, urban access to safely managed piped water is around 9 per cent – in South Africa, it's 99 per cent." The WRI, in one of its analysis of the continent's water crisis, said, "Inequitable access to basic water services, loss of natural water systems, unplanned urban expansion, and more frequent and intense droughts and floods will undermine the security, well-being and development prospects of Africa's urban dwellers — 60 per cent of whom live in slums." The WRI terms access to water a matter of urgency across Africa, particularly "where the number of water-insecure urban residents is rising — even when dams are full and aquifers are replenished by the wet season. Nearly 63 per cent of urban areas in Sub-Saharan Africa lack access to basic water and sanitation." A 2019 WRI analysis of five cities in Sub-Saharan Africa illustrated that less than 25 per cent of the urban population had access to safely managed water, while only 42 per cent had access to safely managed sanitation services. "The service gap between the provision of water and the growing urban population is widening," the WRI analysis warns.

The OECD in its "Water Governance in African Cities" report published in 2021, said, "Disparities related to urban water access across African countries are linked with the characteristics of urban habitat; but national averages also mask huge intra-country disparities, within and across cities, and between urban and rural areas, depending on where infrastructure and public services are concentrated. They tend to be mostly located in central and planned areas of African cities, while access to services declines when moving away from city centres."

KEY MEGATRENDS AFFECTING WATER SECURITY IN AFRICAN CITIES

Cities	Climate change	Urbanisation	Demographic changes	Fighting poverty and inequalities	Economic development and growth	Food insecurity	Fighting waterborne diseases	Institutional and territorial reforms	Global crises
Brazzaville (Republic of the Congo)									
Lusaka (Zambia)									
Cocody (Cote d'Ivoire)									
Cotonou (Benin)									
Bangui (Central African Republic)									
Nouakchott (Mauritania)									
Saint-Louis (Senegal)									
Cape Town (South Africa)									
Monrovia (Liberia)									
Bangangte (Cameroon)									
Kampala (Uganda)									
Bama (Burkina Faso)									
Rosso (Mauritania)									
Accra (Ghana)									
Al Hoceima (Morocco)									
Fes (Morocco)									
Golf 3 (Togo)									
Tetouan (Morocco)									
Maputo (Mozambique)									
Kanembakache (Niger)									
Marrakech (Morocco)									
Meknes (Morocco)									
Rabat (Morocco)									
Dakar (Senegal)									
Abuja (Nigeria)									
Tanger (Morocco)									
Vogan (Togo)									
Lome (Togo)									
Mbour (Senegal)									
Abidjan (Cote d'Ivoire)									
Antananarivo (Madagascar)									
Chefchaouen (Morocco)									
Bobo-Dioulasso (Burkina Faso)									
Dionaba (Mauritania)									
Banjul (Gambia)									
Thies (Senegal)									

Note: 36 cities responded to the question "Which megatrends are putting water at risk in your city?"
Source: OECD (2021[9]), OECD Survey on Water Governance in African Cities, OECD, Paris.

CLEAN WATER POVERTY

Declining water quality is adding to the urban water crisis in Africa. A recent study by Edward R. Jones, Marc F. P. Bierkens and Michelle T. H. van Vliet of the Department of Physical Geography, Faculty of Geosciences, Utrecht University, Utrecht, the Netherlands on the impact of water quality on overall water scarcity says, "Water quantity and quality are interrelated. Since, water scarcity increases the concentration of pollutants, while water pollution reduces the availability of clean water. The study titled "Current and future global water scarcity intensifies when accounting for surface water quality" was published in *Nature* in May, 2024. It evaluates "clean water scarcity", or level of access to clean water. Some 3.8 billion people or 55 per cent of the global population is currently exposed to clean water scarcity at least one month per year, the study found. Of this, 1.1 billion people or 16 per cent of the world's population is exposed to clean water scarcity for more than nine months per year. In comparison, 3.3 billion or 47 per cent of the world's population suffers from water scarcity, where water demand is more than water availability (excludes water quality). Further, the exposure to clean water scarcity for at least one month per year will increase to 56–66 per cent by the end of the century, according to the study.

Clean water scarcity will hit the developing countries the most in future, particularly Sub-Saharan Africa, driven by a combination of water quantity and quality aspects. "Strong reductions in both anthropogenic water use and pollution are therefore necessary to minimize the impact of future clean water scarcity on humans and the environment, says one of the most comprehensive scientific global assessments on water scarcity," claim the lead researchers from Utrecht University. Poor urban water security is also threatening the achievement of SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities). Going forward, the cities need to focus on strategies for promoting water-sensitive urban planning and governance.

"We are living in what could be called the urban century," said Robert Mc Donald, scientist

The UN expects rapid urbanisation will go on at least till the mid of 21st century. By then, urban populations would make up about 66 per cent of the world's total population

at the US-based non-profit Nature Conservancy. Rightly so. More than 2 billion additional people, or one-quarter of the current global population, are expected to be in cities just three decades from now. They will all need water to drink, to bathe, to use the toilet, to wash their clothes and dishes, and for electricity, even as weather patterns become increasingly uncertain. Forecasts say urban water consumption might increase by 80 per cent by 2050. Growing abuse will further leave this seemingly infinite resource polluted and contaminated. As governments and water agencies scramble to avert their own Day Zero, they can turn to the ones who have quietly fought water stress through innovations and by integrating various urban water management strategies.

While the world's most dramatic urban crisis unfolds in Africa, recent studies say at least 200 cities across the world are fast running out of water. This comes as a surprise because cities across the world have grown, thrived and expanded along rich, perennial sources of water, be it lakes, rivers, springs or even seas. So, where did all the water go? McDonald offered an explanation. "The main long-term driver of these shortages is the unprecedented urban growth occurring around the world," he said. Rightly so. There has been a massive redistribution of populations in recent decades. Urban areas, which account for just 3 per cent of the total landmass, are now home to 54 per cent of the global population today, says a study published in *Nature* in 2018. The UN expects this rapid urbanisation will go on at least till the mid of 21st century. By then, urban populations would make up about 66 per cent of the world's total population. Around 90 per cent of this growth is expected to be in developing countries.

With growth in population come changes in land-use patterns, which can affect water availability in a city. For instance, Sanaa of Yemen, which after exploiting the last drops of groundwater is looking for alternative sources. The city is growing at 7 per cent a year. World Bank officials working on water projects in the Sanaa basin said groundwater level in the basin

PROJECTED WATER-STRESSED CITIES IN SUB- SAHARAN AFRICA (2015-2045/2035-2065/2065-2095)

Cities	Projected Water Stress (Value In Year 2015-2045)	Projected Water Stress (Value In Year 2035-2065)	Projected Water Stress (Value In Year 2065-2095)
Arusha, Tanzania	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Madibira, Tanzania	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Mavinga, Angola	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Luchazes, Angola	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Middelburg, South Africa	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Cape Town, South Africa	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Maradi, Niger	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Lagos, Nigeria	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Ouagadougou, Burkina Faso	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Dakar, Senegal	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)
Nouakchott, Mauritania	Extremely high (>80%)	Extremely high (>80%)	Extremely high (>80%)

Note: This is based on the analytical tool "Aqueduct Water Risk Atlas" of the World Resources Institute. Aqueduct's tools use open-source, peer reviewed data to map water risks such as floods, droughts and stress.
The above risk is based on percentage values of water stress on a scale of 1-100 per cent. On this scale, >80% score indicates "Extremely High" risk.
The above risk is based on the "business as usual" scenario of temperature increase by 2.8°C to 4.6°C by 2100. Also the socioeconomic scenario is characterised by regional competition and inequality, including slow economic growth, weak governance and institutions, low investment in the environment and technology, and high population growth, especially in developing countries.

had fallen from 30 metres in the 1970s to around 150 metres in the 1990s. Media reports speculated that the city might have experienced Day Zero in 2019. To avert the crisis city authorities tapped fossil aquifers—deep pockets under rock layers where water has remained stored for millennia. Once tapped there is no way to replenish these aquifers. Eric Odada, professor of geology at the University of Nairobi and director of the African Collaborative Centre for Earth System, said lack of water governance is also at the helm of Nairobi's long-standing crisis. The city is so heavily dependent on surface water that it plunges into a crisis whenever the monsoon plays truant. The water shortage became acute in 2016 because the city had not received adequate rainfall for four consecutive years. But heavy rains in April 2017 had caused severe floods. Ideally, this should have ended the city's water woes. Instead, people continued to queue up for water in several localities. "This situation would not have arrived had the government harvested the excess floodwater," said Odada. The other major problem is inadequate water supply networks. About 75 per cent of the Nairobians buy water from the kiosks and pushcart vendors at a higher price—up to 300 times the supply rate—because they are either not covered under the city's water supply system or do not receive adequate supply

Water risk or water stress occurs due to drought and flood. The health cost borne by countries is mainly related to these events. The change in precipitation pattern and reduction of the number of rainy days are intensifying the water stress across the world. Access to clean water supply is a threat to many of the countries in the world. As per the data of Joint Monitoring Progress report of WHO-UNICEF, 2023, access to clean water to the world is 73 per cent.

But this in no way reflects the accessibility to clean water in Sub Saharan Africa. Climate change is worsening the problem, by intensifying the floods and droughts in the region through increased temperature, rise of sea levels, glacial melts and drastic change in rainfall pattern. Out of the total population of Sub Saharan Africa – only 33 per cent of the population have access to safe drinking water as per the data of 2022 Joint Monitoring Progress report of WHO-UNICEF.

It is very important to understand the risk of upcoming water stress in the region. For this analysis of the data on water stress in the coming years is very important. To manage the available water source is right now the need of the hour. To meet the Sustainable Development Goal (SDGs) in 2030, understanding the future trend of water stress is very important. ■

DISEASE BURDEN

HIGHPOINTS

Water and sanitation are intertwined: **lack of safe sanitation practices** and behaviours **lead to water pollution and diseases**.

Death rates due to unsafe water sources are high in Africa: 50 deaths per 100,000 people, which is **1000-fold of that in developed countries**.

Poor faecal sludge management and sanitation **caused 115 deaths per hour** from excreta-related diseases **in Africa.**

A few countries in Africa have **reported impressive progress in sanitation sector,** even though the pace at which it is needed has not been achieved.

PHOTOGRAPH COURTESY: UNICEF

NOT A HEALTHY SIGN

Safe water and sanitation is an economic imperative for Africa

CHOLERA IS a marker of inequality." This is how the Global Taskforce on Cholera Control, a global network to fight cholera, describes the acute diarrheal disease caused by the bacterium *vibrio cholerae*. It is also called "a disease of poverty" as its outbreaks are mostly reported in densely populated areas without access to safe water and sanitation. For Africa, it has been a scourge for the last 53 years. For the second driest continent of the world with high level of inequality in access to safe water and sanitation, the disease burden is too high. Various studies estimate that at least 40 million people live in cholera-endemic areas in Africa with a risk of frequent outbreaks. An assessment published in the *International Journal of Surgery Global Health* in March 2024 said, "If the present trend continues, the number of cases reported in 2021, Africa's deadliest year for cholera in over a decade might be surpassed. The

current average case fatality ratio is more than the tolerable threshold of less than 1 per cent." "Reports are estimating that there are approximately 1.3 million to 4.0 million cases of cholera each year. These cases of cholera are resulting in 21, 000 to 143, 000 deaths annually, and 54 per cent of these deaths are reported in Africa," said a report of the New Partnership for Africa's Development (NEPAD), an economic development programme of the African Union. The illness is easily preventable by ensuring access to safe drinking water and sanitation and is curable through simple treatments like oral medicine, or in severe cases, intravenous rehydration. But as per the World Health Organization (WHO), 83 per cent of deaths in sub-Saharan Africa between 2000 and 2015 were due to cholera.

Currently, the world is witnessing massive outbreaks of cholera, particularly in Africa. In mid-2021, WHO warned the world of an upsurge in cholera outbreaks with high mortality rates. Its forecast said that it would spread to areas that were free of cholera for decades. In 2021, 23 countries reported cholera outbreaks, mainly in Africa and the Eastern Mediterranean. In 2022, it was reported in 30 countries, of which 14 had not reported cholera in 2021. In January 2023, WHO classified the global resurgence of cholera as a Grade 3 Emergency, the highest internal level for a health emergency requiring a comprehensive response. By January 2024, at least 30 countries reported cholera cases. From January 1 to May 16, 2024, some 194,897 cholera cases and 1,932 deaths were reported world-wide. The region with the highest reported case count was the Eastern Mediterranean Region, followed by the African Region, the Region of the Americas, the South-East Asia Region, and the European Region. As per the WHO Africa Region's Monthly Regional Cholera Bulletin (as of June 30, 2024), cholera outbreaks were reported in 14 countries of the continent. It was declared a "crisis" in Comoros, the Democratic Republic of

The repeated outbreaks of cholera, and often in wider geography, are an indicator of what lack of access to safe water and sanitation can result in

the Congo (DRC, or Congo) and Ethiopia. "Since the beginning of the year 2024, the number of cholera cases and deaths reported to the WHO Regional Office for Africa (AFRO) as of 30 June was 104, 038 and 1, 732 respectively, with a case fatality ratio of 1.7 per cent. Comoros, Ethiopia, Congo, Zambia, and Zimbabwe account for 85.7 per cent (89,208) of the total cases and 91.2 per cent (1,580) of total deaths reported till June 30, 2024," said the AFRO's monthly bulletin released in July 2024.

The COVID-19 pandemic disrupted the hard-won years of progress against the cholera pandemic. Since the first cholera pandemic of 1817, the world has been hit by six more. It has earned a spot in the Guinness Book of Records for being the longer-enduring pandemic. The seventh and current cholera pandemic, which began in 1961, has lasted longer, spread further, and infected more people than any of its predecessors, and remains entrenched in sub-Saharan Africa where it causes intermittent outbreaks in communities already burdened with conflict, lack of infrastructure, poor health systems and malnutrition. Though cases were on the wane since 2017, several countries including Nigeria, Ethiopia, Sudan, Niger, Somalia, Cameroon, and Mozambique reported outbreaks of cholera since the onset of COVID-19 in 2020. In Nigeria, which faced one of the largest outbreaks, cholera had spread to 32 of its 36 states, sickened 90,000 people and caused more than 3,000 deaths by the end of 2021. In Zambia, the Disease Intelligence Agency, the water utility companies and the local authorities heightened active surveillance-reporting of diarrhea cases every morning just like for COVID-19, after they found faecal contamination of water in seven townships of capital city Lusaka in October 2021. To contain the spread, authorities in Nigeria supplied tanker water in high-risk areas, while those in Lusaka secured bottles of liquid chlorine to disinfect water. Some analysts blamed COVID-19 for the cholera outbreaks. As priority shifted towards COVID-19 containment, it resulted in a lapse in contact-tracing and the diagnosis and treatment of cholera patients in high-risk areas. Bioye Ogunjobi, a UNICEF official in Nigeria, however, blamed it on the governments' lackadaisical attitude towards ensuring access to safe water and sanitation. The repeated outbreaks of cholera,

FACING THE TOILET CHALLENGE

Our research suggests a probable link between open defecation and antimicrobial resistance

OMOLOLU FAGUNWA AND HELEN ONYEAKA

IMAGINE YOU are miles from the nearest restroom, and nature's call is urgent – a situation that might raise a mild panic during a hike or at a music festival. Now, picture that same scenario, not as a one-off inconvenience, but as a daily reality. This is the case for about half a billion people globally.

In African countries, the issue of open defecation often goes unaddressed by society and policymakers despite its negative impact on health, economic development, dignity and the environment. Led from Queen's University Belfast, a team of multidisciplinary researchers aimed to evaluate how prevalent the practice is in African countries and which social factors are driving it. We also aimed to establish which communities were in most urgent need of interventions. We used demographic and health surveys, alongside World Bank data. In a recent paper we set out our findings.

Our main ones were that in Nigeria, Ethiopia, Niger, the Democratic Republic of Congo, Burkina Faso and Chad, a large number of people engaged in open defecation. We found that as few as 10 countries could account for 247 million Africans defecating in the open by 2030 if critical and emergency actions are not taken. The biggest driver is lack of access to proper sanitation facilities. The poorest individuals, particularly in rural areas, are more likely to resort to open defecation than people in urban areas. In regions with the most critical need, the poorest are 43 times more likely than the wealthy to resort to open toileting.

We recommend tackling poverty, and intervening in regions and communities that urgently need improved sanitation infrastructure and programmes. West Africa needs special attention since many of its communities are in the critical category.

A SYSTEMATIC APPROACH

Sanitation has far-reaching implications for food safety. Contaminated water sources and unsanitary conditions can spread waterborne diseases, which can contaminate food and put millions at risk. Addressing open defecation is a step in ensuring the safety and hygiene of the food chain. The link between poor sanitation and health is well documented. But our study casts this relationship in a new, alarming light: the likely role of open defecation in antimicrobial resistance. Antimicrobial resistance is the ability of microbes, such as bacteria, viruses and fungi, to resist the effects of medications that were once used effectively against them. It is a looming crisis, threatening to make antibiotics ineffective. Common infections could once again become deadly.

Our research suggests a probable link between open defecation and antimicrobial resistance. When people defecate outdoors, resistant bacteria from human waste can contaminate water and food. This often leads to faecal-oral diseases and urinary tract infections. However, there is a need for more research to clarify the relationship, its implications and prevention. A clear recommendation from our research is that data about antimicrobial resistance should be integrated into health surveys. While the full breadth of the study's findings is huge, its conclusions are clear: open defecation is a challenge in Africa that requires actions. Our research doesn't just ring the alarm bell; it provides a blueprint for change, identifying specific regions where the practice is most prevalent and where interventions could have the greatest impact.

WHAT NEEDS TO BE DONE

Addressing open defecation across a continent as vast and diverse as Africa is no small feat. We made a number of recommendations in the study.

A pragmatic three-tier priority system: This will categorise regions based on the urgency of need for intervention: critical, high, and medium. Regions marked as critical are those with the highest prevalence of open defecation (more than 80% of the population) and the least access to sanitation facilities. These areas need immediate attention with the deployment of resources and sanitation infrastructure. The high priority regions have some access to sanitation. Here, the strategy is a combination of infrastructure development and community education. For medium priority areas (40 per cent - 59 per cent), where some sanitation infrastructure may exist,

the focus should be on sustainable practices, behavioural change and maintenance of existing facilities.

The system above is just to cut the high rates and inequalities among communities in a country. There is also a lot to do in communities with an open defecation rate of less than 40 per cent. The goal is to reinforce positive behaviour and ensure facilities are maintained and improved.

Policy support, such as incentives for building private toilets or community sanitation blocks, may also help. This tiered strategy hinges on continuous assessment and reallocation of resources. Interventions should respond to the changing landscape as regions improve or decline.

Support sanitation projects and policies: Advocacy is important to increase awareness and donations to organisations that build toilets and provide sanitation programmes in affected areas.

Educate and spread awareness: Learning about the cultural and socio-economic factors that contribute to this practice must be encouraged and the knowledge shared with others. Campaigns that focus on the importance of sanitation for health and the environment are key.

Encourage sustainable sanitation practices: This includes using toilets properly, not littering, and understanding local challenges. The use of compostable toilets and other sustainable waste management practices where traditional toilets are not feasible must be encouraged.

Foster global partnerships for sanitation: Global partnerships can amplify efforts to end open defecation. Collaborations between governments, NGOs, private sector stakeholders and international organisations must be encouraged. Pooling resources and sharing knowledge can lead to more effective and sustainable solutions.

(Omololu Fagunwa is Research Fellow in Queen's University Belfast and Helen Onyeaka is Associate Professor in University of Birmingham)

and often in wider geography, are an indicator of what lack of access to safe water and sanitation can result in.

Consider Zimbabwe, for instance. In 2023 the country had one of its worst cholera outbreaks of recent past. The year-long outbreak started in Chegutu, a farming and mining town some 100 miles west of the capital city of Harare, where the first case was detected in February 2023. The number of cases gradually increased throughout 2023, eventually spreading to all the 10 provinces of the country. The WHO intervened with a vaccination drive in January 2024 after which infection rate significantly declined. The other intervention involved the distribution of water treatment pills to residents in most cholera hotspots. Some non-government organisations (NGOs) deployed thousands of Community Health Promoters to educate citizens on the importance of behaviour change. The government and non-government organisations also drilled 3,000 boreholes at the peak of the pandemic. The outbreak showed signs of waning due to above interventions. But by May 2024 there were fresh outbreaks. The country had recorded over 30,000 cholera cases and 600 deaths in the first four months of 2024.

Experts remained concerned that although the epidemic appeared to be under control by August 2024, the conditions that caused the outbreak and spread of the disease remained unaddressed. Zondayi Matava, a 37-year old push-cart operator at Harare's Mbare long distance bus terminus and a survivor of cholera infection in 2023, explained why cholera could never be eradicated. "Non-availability of clean water and the ever declining sanitation situation," he said. In Mbare, the capital city's oldest suburb, faecal waste could be seen spilling from the broken sewage pipes of the dilapidated multi-storey residential flats. Even in the central business district and in residential suburbs mountains of waste remained uncollected. The local authority could provide only 25 per cent of the city's water requirement leaving the rest of the residents to rely on unsafe sources. In a country where poverty is endemic, unregulated vending is out of control. Harare's City Health Department revealed in January 2024 that half of the boreholes in the city were contaminated with sewer and human waste, making them potential sources of cholera and typhoid.

Itai Rusike, the executive director of the Community Working Group on Health (CWGH), said, "Although the epidemic was under control, the conditions remain conducive for the disease to flourish." "Cholera remains a public health problem in predominantly overcrowded areas and public gatherings where access to clean and safe water and sanitation remain a challenge," Rusike said. "Cholera is eliminated by severing the faecal-oral transmission route. That means to ensure that drinking water and food is free from human faecal matter." He cited weaknesses in water and sanitation infrastructure and services, high risk hygiene and social practices, gaps

in surveillance and failing healthcare systems as some of the factors that have been driving the epidemic. Community Water Alliance (CWA) coordinator Hardlife Mudzingwa said that the main driver of cholera was the lack of sufficient potable water for communities. Harare was able to supply water to a small portion of the city's residents leaving the rest to make do with supplies from unsafe sources, while in Bulawayo, the country's largest city, residents got water only once a week. "In Harare, the local authority is able to supply around 320 megalitres of water per day (a megalitre is equal to a million litres) while the demand is for 1,200 megalitres. This huge gap means the residents are using water from unsafe sources. This explains the unending cholera outbreaks," Mudzingwa said. Precious Shumba, the executive director of the Harare Residents Trust (HRT), attributed the crumbling sewerage system in the capital city of Harare to the latest outbreaks of cholera. "In Harare, especially the old suburbs built before the Independence, the underground water and sewer pipes are sand blocked, rusty and now too small for the increased population," Shumba said. "With the accelerated urbanisation, unplanned settlements have emerged. People living in these settlements have no piped water; neither do they have sewer systems. The result is that residents have dug shallow wells or boreholes, and septic tanks on their 200-300 square metre residential stands." "Due to high rate of leakages of both sewer and water pipes, cholera outbreaks have also been frequent and rising as well," Shumba said.

In Ethiopia, where WHO termed the cholera outbreak as a crisis in 2024, the lack of access to safe water and sanitation has made cholera endemic. Since August 2022, when the current outbreak started, the country had reported 44,044 cases and 571 deaths (as of May 2024). Between 2019 and 2021, Ethiopia reported a total of 15,515 suspected cholera cases. Three-fourths of the cases were reported from the drought affected regions of Oromia, Somali and

Cholera remained a significant public health problem among the vulnerable populations living in many resource-limited settings with poor access to safe and clean water and hygiene practices

Southern Nations, Nationalities and Peoples Region. According to Ethiopia Public Health Institute, "More than 15.9 million Ethiopians, constituting 15 per cent of the total population, live in areas with a history of recurrent cholera outbreaks. The last 9 years (2015-2023) of national cholera surveillance data show the country has been experiencing cholera outbreaks every year."

Fikadu Yohannes, a medical doctor at the School of Public Health, College of Health Sciences, Addis Ababa University, said, "Despite major improvements seen in health service delivery system Ethiopia continues to be significantly affected by cholera outbreaks." Fikadu said cholera remained a significant public health problem among the vulnerable populations living in many resource-limited settings with poor access to safe and clean water and hygiene practices. "Recurring cholera outbreaks are an indication of deprived water and sanitation conditions as well as weak health systems, contributing to the transmission and spread of the cholera infection." The country ranks among the lowest in the Sub-Saharan Africa in terms of access to clean drinking: around 31 per cent of the population depends on unsafe sources of drinking water. The "National Cholera Elimination Plan: 2022-2028" of Ethiopia has the national goals of stopping local transmission in cholera hotspot areas by 2028 and reducing fatality by 90 per cent (from the 2020-2022 average of 1.8 per cent case fatality rate). Of the estimated US$404 million budget for the plan, over 90 per cent of allocations have been made for improving water, sanitation and hygiene infrastructures, signifying the criticality of safe water and sanitation to combat cholera.

In Malawi, another country under grip of cholera in recent years, it has been a recurring public health challenge since1973. The disease re-emerges often, with significant outbreaks recorded in subsequent years, often aggravated by poor sanitation, inadequate access to clean water, and high population density in affected areas. Data from the country's Ministry of Health

PHOTOGRAPH COURTESY: UNICEF

showed that after recording the first case of cholera in 1973, Malawi experienced multiple cholera outbreaks in 1980s and 1990s with significant outbreaks occurring in 1982, 1988, and the mid-1990s. Khumbize Kandodo-Chiponda, the health minister of Malawi, said, "In 2001-2002, Malawi was hit by the worst Cholera outbreaks with thousands of cases reported and 900 people died." The Minister added that the country was again hit by a severe outbreak from 2008-2009 and later in 2015-2016 where 24 out of 29 districts reported over 6,500 cholera cases and 160 deaths. In 2017-2018, the country reported 900 cases and 30 deaths in fresh outbreaks. In 2022-2023 the country faced one of its most severe cholera outbreaks in decades. The outbreak started in early 2022 and continued into 2023-2024, with over 36,000 cases and 600 deaths recorded up to early May 2024. It shows that Malawi has never been cholera-free since 1973.

Like in other countries with chronic cholera outbreaks, Malawi also attributes it to lack of safe water and sanitation. Climate change induced disasters are increasingly being cited as a trigger for fresh outbreaks. Disasters like floods contaminate water sources and people in relief camps often don't have access to clean water leaving them no alternative to contaminated water sources. Adrian Chikumbe, the public relation officer of the country's Ministry of Health, said "Climate change has resulted in irregular weather patterns including extreme rainfall resulting in floods. As a result, some sanitation facilities have been damaged leaving people to revert to improper human waste disposal." "Malawi has been experiencing tropical storms and each time these natural disasters happen we have cholera outbreaks," Chikumbe said. Chikumbe said that the cholera outbreak of 2023-2024 was linked to cyclone Freddy which destroyed sanitation facilities and contaminated water sources. According to the African Union Development Agency and NEPAD, "Malawi had almost entirely eradicated cholera and there were only two cases that were reported in 2021. However, in the last 11 months (of 2022), over 950 Malawians have died and approximately 29,000 cases of cholera were reported during the same period." These agencies also attributed the outbreaks to the tropical storm Ana and cyclone Gombe. "This is because these storms destroyed existing latrines and hand-washing facilities in 2021. There was also the emergence of informal mining settlements that emerged along Lake Malawi. Unfortunately, the informal settlers are utilising the lake for washing and sanitation."

However, public health experts linked the country's cholera outbreaks to environmental and socio-economic factors. Ted Bandawe, Hospital Director for Mzuzu referral hospital, noted that many cholera outbreaks in Malawi were linked to environmental issues, inadequate water supply and sanitation facilities where contaminated water sources and poor sanitation infrastructure provided ideal conditions for the spread of cholera. Bandawe emphasised that climate change impacts, such as floods and droughts, disproportionately affected the poor communities. "When you follow the pattern of cholera outbreaks in Malawi you would notice that they are mainly influenced by weather events. We have been recording worst cholera outbreaks due to heavy rains and flooding, often linked to cyclones and other severe weather events," said Bandawe. On the other hand, Bandawe said, "Due to economic challenges, people migrate to areas where they can find economic means to fend for their families. In recent past, we have seen high population density in urban and peri-urban areas which facilitate the rapid spread of cholera, especially in settlements with inadequate sanitation." A 2024 estimate of the World Bank showed that the country's urban population was rising at 4.24 per cent annually. Reports from the United Nations and Water Aid indicated that every third person in the country didn't have access to clean water. Some 70 per cent of the country's population lived below the $2.15 international poverty line. "High levels of poverty mean that many Malawians live in overcrowded and unsanitary conditions where cholera can spread rapidly. Informal settlements with inadequate waste disposal systems are particularly vulnerable," Malata said.

The disease and mortality burden due to absence of access to safe water and sanitation is felt elsewhere as well. Infections contracted from healthcare settings (healthcare-acquired infections or HAI) such as sepsis and pneumonia lead to thousands of preventable deaths in Sub-Saharan

People migrate to areas where they can find economic means to fend for their families. In recent past, we have seen high population density in urban and peri-urban areas which facilitate the rapid spread of cholera, especially in settlements with inadequate sanitation

Africa every year, according to a new study released in April 2024 by the WaterAid, an international non-governmental organization. Treatment of HAIs is costing the region $8.4 billion annually, showed WaterAid study. Healthcare facilities without adequate WASH leave patients and staff vulnerable to HAIs, the authors of the report alerted. The study explored the rates of these infections in Ethiopia, Ghana, Malawi, Mali, Nigeria, Uganda and Zambia. In 2022, more than 2.6 billion cases of HAIs were reported in the seven sub-Saharan African countries, which led to 277,160 excess deaths. Nigeria recorded the highest incidence of HAIs in 2022, followed by Ethiopia, Uganda, Ghana, Malawi, Zambia and Mali. The average number of HAI cases in Nigeria was estimated to be 848,000 in 2022, of which half were predicted to be antimicrobial resistant, the report showed. These HAIs caused 93,600 deaths, the researchers estimated. That year, the total economic cost of HAI in Nigeria was $4.5 billion, they added. The economic cost of HAIs in the seven countries put together amounted to at least $8.4 billion, costing on average 1.1 per cent of their total gross domestic product and 4.6 per cent of health expenditure, the analysis showed. Among the seven countries, the proportion of GDP spent on treating HAIs in 2022 was the highest in Malawi (2.9 per cent) followed by Zambia, Ghana, Uganda, Nigeria, Ethiopia and Mali. Though Nigeria had the highest number of healthcare associated infections, the country spent only 0.9 per cent of its GDP on treatment. This is equivalent to the total amount needed to provide universal, basic clean water and waste services in healthcare facilities in the 46 least developed countries (LDC), the report underscored.

HAIs are transmitted during treatment and recovery phases in healthcare institutions due unhygienic practices. The most common HAIs are surgical site infections, bloodstream infections and respiratory tract infections, including pneumonia, the authors noted. The highest rates are found in intensive care units and neonatal or pediatric departments, they added. A growing

IN 2021, UNSAFE WATER AND INADEQUATE SANITATION IN AFRICA WERE RESPONSIBLE FOR 58% OF THE GLOBAL BURDEN OF (DALYs)

Region	Disability-adjusted life years (DALYs)	DALYS (% of global)	Percentage share of all DALYS	DALYS (per 1 lakh people)
Africa	36,602,765.07	58.25	0.06	2646.06
America	1293218.59	2.06	0.00	125.94
Europe	201150.11	0.32	0.00	23.71
Asia	24695130.10	39.30	0.02	534.21
Global	62840745.27		0.02	1077.65

DALYs are the sum of the years of life lost to due to premature mortality (YLLs) and the years lived with a disability (YLDs)
Source: "Global burden of disease 2021", *Institute for Health Metrics and Evaluation,* May 2024

IN 2021, UNSAFE WATER AND POOR SANITATION IN AFRICA WERE RESPONSIBLE FOR 44% OF GLOBAL DEATHS

Region	No of deaths due to Unsafe water, sanitation, and handwashing	Death burden (% of total global deaths)	Percentage share of all deaths	Deaths per 100000 population
Africa	533,276.79	44.00	4.79 (highest amongst all regions)	38.55 (highest amongst all regions)
America	29275.11	2.41	0.32	2.85
Europe	6416.29	0.53	0.06	0.76
Asia	645552.99	53.00	1.75	13.96
Global	1215365.13		1.79	15.4

Source: "Global burden of disease 2021", *Institute for Health Metrics and Evaluation,* May 2024

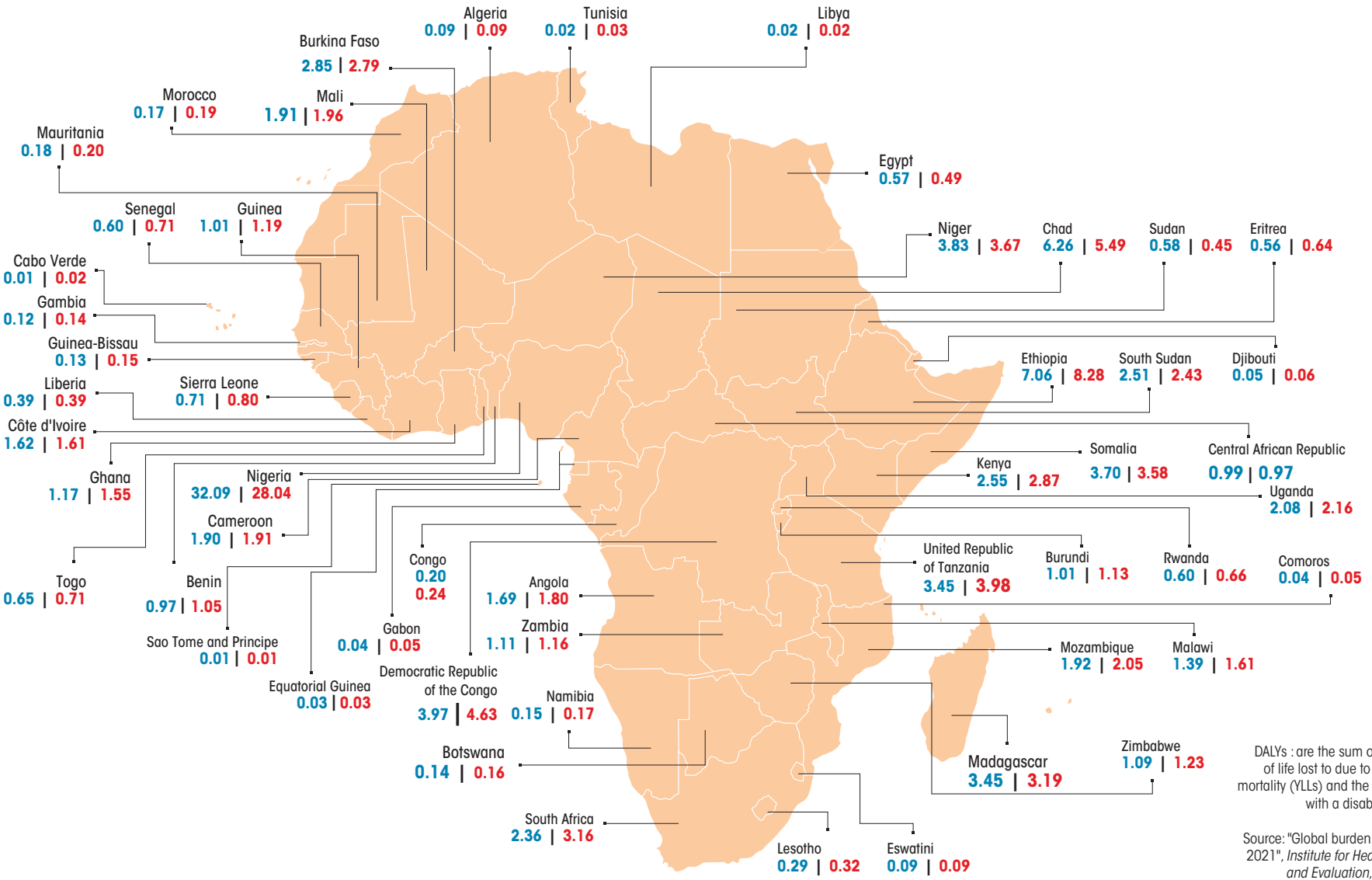
proportion of these infections are resistant to anti-microbial drugs, which means they are costlier to treat and take longer to recover from, leading to worse health outcomes for patients. According to WaterAid, at least 50 per cent of these medical costs could be averted by improved hand-washing facilities, clean water and decent toilets. Guy Hutton, Senior Economist and Financing Specialist Working in Water, Sanitation and Hygiene who conducted the research, said: "It should be the number one priority of health systems around the world to combat healthcare associated infections. In the African countries covered in this study, at least one in every 10 patients admitted to hospital is unnecessarily burdened by an additional infection circulating within the hospital." He added, "These preventable infections impact patients, their families and healthcare providers by causing additional illness, prolonged hospital stay, potential disability, and sometimes death, and they lead to significant excess expenditures and absorb valuable time of healthcare professionals that could have been used to treat other patients."

Decline in groundwater quality is another emerging challenge that adds on to the disease burden. While a majority of the economy is dependent on groundwater in Sub-Saharan Africa, little attention is paid to its quality. Due to geological formations several African countries have higher concentrations of fluorides, arsenic and chlorides. These also make groundwater unfit for drinking without treatment. A 2020 study by the Delhi-based research and advocacy non-profit Centre for Science and Environment (CSE) found high concentration of iron, magnesium and chlorides due to natural mineralisation in groundwater of Uganda. Fluoride levels were also higher than the drinking water guidelines by WHO due to volcanic deposits. These results in various diseases such as fluorosis, while iron results in unpleasant odour and taste and manganese damages the plumbing fixtures and laundries. In Tanzania, the CSE study had identified that the groundwater was polluted with nitrates and sulphates. Mining of these resources and hazardous dumping of waste in the open, results in the waste ending up in waterbodies and this increases their salts and mineral contents, affecting their pH value (acidity or basicity). The community should either have community-level water supply systems which treat the groundwater before supply to households or there should be mechanisms where the groundwater supplies are treated

IN AFRICA, UNSAFE WATER, SANITATION, AND HANDWASHING ACCOUNTED OVER 62 MILLION DALYS AND HALF A MILLION DEATHS IN 2021

Three Sub-Saharan African nations – Nigeria, Ethiopia and Chad— account for around 45 and 42 per cent of the DALYS and deaths in Africa attributable to unsafe water, sanitation, and handwashing

XX DALYS (% of Africa total) XX Deaths (% of Africa total)



DALYs : are the sum of the years of life lost to due to premature mortality (YLLs) and the years lived with a disability (YLDs)

Source: "Global burden of disease 2021", *Institute for Health Metrics and Evaluation*, May 2024

before supply to households, which again can be a costly affair for the rural households. Water resources are unevenly distributed in Africa, pointed out Puneet Srivastava, senior international expert on water working with WaterAid UK.

WATER-SANITATION NEXUS

Water and sanitation are intertwined: lack of safe sanitation practices and behaviours lead to water pollution and diseases, besides other reasons. But safe sanitation is critical to ensuring safe water and also to bring down the disease burden arising out of this. Unsafe water and sanitation has been a major killer in Africa. Going by an analysis by data-centric portal Our World in Data, deaths attributable to unsafe water sources is much higher in the Africa continent. "Death rates (due to unsafe water sources) are high in lower-income countries, particularly across Sub-Saharan Africa and Asia. Rates here are often greater than 50 deaths per 100,000 people," said an analysis of this portal. In comparison to death rates in developed block of countries, like in Europe, this rate in Africa is over 1000-fold. In a report "Triple Threat", released in March 2023, UNICEF said that nearly two of five deaths due to lack of sufficient access to water, sanitation and hygiene (WASH) were from 10 countries in Sub-Saharan Africa. Some 190 million children residing in the 10 African countries faced the triple threat of a combination of water-related risks, water-borne illnesses among children under five and climate-related hazards. The threats were most acute in Benin, Burkina Faso, Cameroon, Chad, Ivory Coast, Guinea, Mali, Niger, Nigeria and Somalia, making West and Central Africa one of the world's most water-insecure and climate-impacted regions. The 10 African countries were classified as either "fragile" or "extremely fragile" by the Organisation for Economic Co-operation and Development (OECD)

Some 190 million children residing in the 10 African countries faced the triple threat of a combination of water-related risks, water-borne illnesses among children under five and climate-related hazards

and according to the UNICEF report they had less than 50 per cent access to basic drinking water or sanitation services. The lack of safe drinking water, sanitation and hygiene is destructive to all aspects of a child's life. It puts fundamental needs—good nutrition, health, education and safety—at stake. African countries carry the heaviest burden of child deaths from diseases caused by inadequate wash services, the report said. Globally, a total of 394,802 children under five years died of inadequate wash services and 254,976 of those were in sub-Saharan Africa alone. The World Bank's water security diagnostics shows that "the economic and human developments costs associated to these gaps (inequality in access to water and sanitation) are too high." By 2050, "water scarcity could reduce GDP by 6 per cent (in Sub-Saharan Africa). Half of global maternal deaths occur in Sub-Saharan Africa. Poor water, sanitation, and hygiene (WASH) also lead to increased diarrheal diseases, which are still the leading cause of death in the region, causing more than 8 per cent of child deaths. Nearly 35 per cent of all children are stunted, which is in part attributable to unsafe water, inadequate sanitation, and insufficient hygiene," according to the World Bank analysis.

The Global Burden of Disease 2021 report, led by the Institute for Health Metrics and Evaluation (IHME), gives the latest estimate on the water-sanitation related mortality and morbidity in Africa. According to this report, globally, unsafe water, sanitation, and hand-washing contributed to 62.84 million Disability-Adjusted Life Years (DALYs) in 2021. DALYs are the sum of the years of life lost to due to premature mortality (YLLs) and the years lived with a disability (YLDs). Africa with 36.6 million DALYs accounted for about around 58 per cent of the global total, followed by Asia (39 per cent). At least 1.21 million people died worldwide as a result of unsafe water, sanitation, and lack of hand-washing. Africa accounted for about 44 per cent of these deaths, followed by Asia (53 per cent) according to the Global Burden of Disease 2021 report.

A NEW CALL FOR ACTION

An average of 630 million years of life are lost in Africa due to disease burden

THE HEALTH ministers of African countries met in the last week of April 2024 in Kenya and launched two key initiatives: the Eastern Africa Regional Integrated Surveillance and Laboratory Network (RISLNET) and the Eastern Africa Regional Cholera Taskforce. The ministers, from 14 countries in the wider Eastern Africa region and under the auspices of the Africa Centres for Disease Control and Prevention (Africa CDC), expressed concerns over the growing burden of infectious diseases, especially cholera, and called upon governments to work together.

The goal of the Eastern Africa Regional Cholera Taskforce is to streamline regional strategies for cholera management and prevention, foster experience sharing and strengthen collective efforts to contain an outbreak, according to Africa CDC. "An average of 630 million years of life are lost in Africa due to the heavy disease burden," the principal coordinator of the regional collaborating centres of Africa CDC, Justin Maeda, said.

"If someone is expected to live up to 70 years and lives for 50 years, 20 years short of the expected full expectancy, that's a loss in years of life. If one was supposed to live for 70 years of full production and 20 years is lost, then they are deemed to have lived for half their productivity," said Maeda.

He emphasised the urgent need for African countries to address this economic failure, which amounts to an average of Ksh324 trillion ($2.4 trillion). "Due to this, we must take health as an investment, not a liability. We need to invest in that and use it as advocacy to ensure that more funds go to health and support the sector," he noted, arguing that if the continent doesn't have a healthy population and workforce, then it cannot drive the development agenda.

However, Maeda added that Africa has made some considerable progress, and it is important to build on this gain by enhancing community health responses. Ali Haji Adam Abubakar, who is the Somalia Minister of Health and the current chairperson of the Regional Ministerial Steering Committee (ReSCo) for the Africa CDC Eastern Africa Regional Coordinating Centre, oversaw the two launches. Abubakar said since the beginning of 2024, there were 62,175 cholera cases and 1,232 deaths till March 31, with a case-fatality ratio of 2 per cent, according to the World Health Organization (WHO) Regional Office for Africa. The Democratic Republic of the Congo, Ethiopia, Mozambique, Zambia and Zimbabwe accounted for 94.6 per cent (58,802) of the total cases and 95.7 per cent (1,179) of the total deaths this year. He warned that if quick interventions are not rolled out, the ever-increasing threat of cholera will only spiral out of control and increase the disease burden associated with it.

Kenya Health Cabinet Secretary Susan Nakhumicha hailed the Africa CDC for setting strategic priorities for 2023-27, including the two key initiatives in question. She said the strategic priorities will guide their activities and help achieve the common goal of keeping citizens across the region healthy and safe.

"We need to make true our commitment to this goal to safeguard our region and the continent," Nakhumicha said, adding that disease and pandemic outbreaks know no borders, which makes collective interventions crucial to regional outbreaks.

The Kenyan health minister said enhancing surveillance and rapidly containing any disease threats are best practices that must continue, noting that the national public health institutes are the bedrock of the health system. "Let us discuss strategies to foster their capacity, foster innovation and promote excellence in research and surveillance," she added.

Meanwhile, the Eastern Africa RISLNET will leverage existing regional public health assets — including the surveillance and laboratory networks operated by public agencies, private organisations, foundations and universities — to create an integrated electronic network of regional surveillance platforms.

"RISLNET was established to coordinate and integrate all public health laboratory, surveillance and emergency response assets, including public health data, to effectively support prevention, rapid detection and response to current and emerging public health threats within the Eastern Africa region," read the Africa CDC statement.

The Eastern Africa RISLNET will be integrated into the operations of the Africa CDC Regional Collaborating Centres to help facilitate close networking among national public health institutes, academic institutions, private and public laboratories, centres of excellence as well as non-governmental and civil society organisations. Other entities it aims to support include veterinary networks for developing and implementing regionally appropriate plans for antimicrobial resistance, pandemic preparedness and rapid response.

"The Eastern Africa RISLNET also seeks to promote partnerships and collaboration on public health research, training, knowledge exchange and experience sharing at the regional level in Africa," the statement read.

To support Africa CDC efforts, CS Nakhumicha announced that the Government of Kenya has approved access to 10 pieces of prime land and $2 million towards the construction of the Eastern Africa Regional Coordinating Centre in Nairobi.

However, when the death rate is considered, the burden in Africa is far greater, with at least 38 people (per 100,000 population) dying from inadequate access to clean water and sanitary facilities, as compared to 12 people in Asia. Around 5 per cent of all deaths in Africa were attributed to poor hand-washing, poor sanitation, and hazardous water, compared to 1.79 per cent worldwide. Africa has the largest percentage of deaths attributable to this "risk." Unsafe water and sanitation contributed 1.75 per cent of all deaths in Asia lower than the global average. America and Europe followed with 0.32 per cent and 0.06 per cent, respectively.

The economic loss due to the lack of access to safe drinking water and sanitation is estimated to be 5 per cent of the region's gross domestic product. According to WHO, every dollar invested in sanitation could yield over six-fold return. This was recognised in 2008 when 52 countries in the continent signed the Libreville Declaration on Health and the Environment for Africa. But the "Strategic Action Plan to Scale Up Health and Environment Interventions in Africa 2019-2029", adopted at the closing of the Third Inter-ministerial Conference on Health and Environment held in the Gabon in November 2018, showed that financial resources for these are limited.

In sanitation sector, the real challenge is eradicating open defecation practices in Africa. Around 196 million of the 494 million people practicing open defecation in the world are from Sub-Saharan Africa, according to the Joint Monitoring Programme (JMP) report released on WASH by WHO and UNICEF on July 1, 2021. The JMP report stated that sub-Saharan Africa lacked access to safe sanitation. About a billion people in the region lacked safely-managed sanitation. Majority of the population in Sub-Saharan Africa lacks access to basic sanitation. According to UNICEF, the use of improved facilities that are not shared with other households is 'Basic

The economic loss due to the lack of access to safe drinking water and sanitation is estimated to be 5 per cent of the region's gross domestic product. According to WHO, every dollar invested in sanitation could yield over six-fold return

Sanitation'. There has been a reduction in open defecation to 18 per cent from 32 per cent in the countries of sub-Saharan Africa. But this has been replaced majorly by unimproved and limited sanitation which increased to 50 per cent from 45 per cent. According to the definition of the JMP report, the use of improved facilities that are shared with other households is 'limited sanitation'. According to UNICEF, these are again not safe sanitation practices. Communities usually tend to go back to open defecation if they adopt such unsafe sanitation practices. The rural areas of these countries, where the most number of people reside, show the same pattern. Usage of improved sanitation facilities that are not shared with other households and where excreta are safely managed and treated offsite is "Safely Managed Sanitation". Open defecation in rural areas of Sub-Saharan Africa decreased from 47 to 27 per cent. But unimproved and limited sanitation increased to replace it. Disposal of human faeces in fields, forests, etc or with solid waste is "Open Defecation", according to the JMP 2021.

Poor faecal sludge management and sanitation caused 115 deaths per hour from excreta-related diseases in Africa, according to a joint study by the UN Environment Programme and the International Water Management Institute, an international research organisation. The report, titled "Fecal sludge management in Africa: socio-economic aspects, human and environmental health implications", was released on World Toilet Day in 2020 (November 19). The day is observed every year to raise awareness about the 4.2 billion people living without access to safely managed sanitation. Faecal sludge is a mixture of human excreta, water and solid substances such as toilet paper or other cleansing materials as well as menstrual hygiene materials that are disposed of in pits, tanks or vaults of on-site sanitation systems. Faecal sludge contains a high number of microorganisms originating from faeces, many of which are pathogenic. Direct and indirect contact with untreated faecal sludge poses a significant health risk. Some 300 million of the two billion people lacking basic sanitation facilities globally live in Africa. Access to sanitation

PHOTOGRAPH: ISTOCK

facilities remains a challenge for urban populations in many Sub-Saharan African cities, particularly for people living in poor peri-urban areas. The report noted that poor faecal sludge management also contributed to huge economic losses in Africa. The analysis found that sustainably managing faecal sludge in Africa was hindered by a number of factors. These included population growth and urbanisation, over-reliance on financial aid for construction of treatment plants, low revenue generation from users of treatment facilities, poor operation and maintenance and inefficient institutional arrangements for faecal sludge management. It also said African countries should make direct investments to very poor households, in order to achieve the UN-mandated Sustainable Development Goal (SDG) 6: Water and sanitation for all by 2030.

African women and children are bearing the brunt of the continent's sluggish pace in sanitation, with health, nutrition, education, gender equality and poverty reduction being at stake. The situation is dismal in Sub-Saharan Africa where countries have not attained safely managed sanitation services and are still at the basic services level, according to the UNICEF. The scenario is no better in East Africa where over half the people in informal settlements live in unsanitary conditions. At present, in this region there is no country with more than 68 per cent access to adequate sanitation. Rwanda appears to be the only one to achieve this percentage and above. Despite commitments by several governments and the United Nations' recognition of sanitation as a basic human right, it still remains neglected. At the current rate of progress, universal access to safely-managed sanitation, the aim of SDGs, won't be achieved until 2107—77 years behind schedule. The knock-on effects of poor sanitation are considerable. According to a study done by Lixil Corporation, which specialises in water and housing products, global research firm Oxford Economics and the UK-based WaterAid, lack of proper sanitation costs the global economy a staggering US $222.9 billion annually. Of this, mortality rate accounts for $122.8 billion, medical treatment $56.6 billion, lost productivity $16.5 billion and the time spent on finding a toilet $27 billion. Africa accounted for about $19.3 billion of this total cost after the launch of the SDGs, of which about 75 per cent came from sanitation-related deaths. In many countries, the economic cost of poor sanitation and hygiene amounts for more than 5 per cent of their gross domestic product.

A few countries in Africa have reported impressive progress in sanitation sector, even though the pace at which it is needed has not been achieved. For instance, Ethiopia. The sanitation status in Ethiopia is a significant challenge. As Africa's second most populous country, Ethiopia

exhibited an estimated growth of 6.4 per cent in the fiscal year 2021–22.2 In terms of water and sanitation, 64 million citizens have easier access to basic drinking water, and the practice of open defecation has significantly declined. Despite these strides, approximately 60 million Ethiopians still lack access to safe drinking water, contributing to 7 per cent of the global water crisis, and over 112 million (93 per cent) are without basic sanitation facilities, with 22 million (18 per cent) continuing open defecation. Poor sanitation is a major cause of waterborne diseases, such as diarrhoea, which is a leading cause of death among children under the age of five in Ethiopia, according to JMP report.

Nationally, 97 per cent of urban residents rely on on-site sanitation (toilets and latrines not connected to a sewer system) and over 80 per cent of the urban population relies on dry pit latrines. There is extensive sharing of toilets, and very inadequate downstream services to support the safe management of faecal sludge that is removed from pits and cesspools when they fill up. Data from a representative sample of households across 10 sample towns surveyed by the World Bank4 illustrates that three quarters of all households were using a dry toilet, and more than half of these households used a dry toilet that was shared by several families. Most people use a toilet that was located outdoors, and the top-structures are built predominantly from chika (wood and mud) or concrete blocks, with a corrugated iron roof. 18.4 per cent of the population shared a toilet between five households; 32.0 per cent of the population shared a toilet between two to four households; and 49.6 per cent of the households had one toilet to their household.

The present urban and small-town sanitation conditions in Ethiopia are alarming; from the viewpoints of both poor management and poor urban planning. About 70 per cent of urban

Approximately 60 million Ethiopians still lack access to safe drinking water, contributing to 7 per cent of the global water crisis, and over 112 million (93%) are without basic sanitation facilities, with 22 million (18%) continuing open defecation

residents in Ethiopia live in slums, 60 per cent do not own the home they live in and over 50 per cent use a toilet they share with other households. According to the JMP report of 2022, the estimated coverage for urban sanitation in 2022 were as follows—improved or safely-managed (17 per cent), limited (29 per cent), basic (5 per cent) and unimproved facilities (46 per cent). Open Defecation (OD) in urban areas is reported at three per cent. Sanitation coverage in urban slums, which covers most of the urban areas, is not as good as the coverage in the total urban area. Urban slums contain 80 per cent of the population of the urban areas, yet have poorer provisions of sanitation facilities.

Ethiopia's rapid urbanisation is putting stress on the already inadequate water supply and sanitation (WSS) system in urban areas. The capacity of urban centres to adequately dispose of wastewater is low, exposing natural resources to pollution, and posing a risk to human health. Out of the estimated 3,98,985 m3/ day of wastewater produced in Addis Ababa, Addis Ababa Water and Sewerage Authority (AAWSA) only has the capacity to properly dispose 1,727m3/day or 0.43 per cent of wastewater. The situation is even worse in other secondary cities including, Mekelle (0.35 per cent), Bahirdar and Hawassa (0.22 per cent), Gondar (0.07 per cent), Dire Dawa (0.05 per cent), and Adama 0.41 (per cent), according to an estimate by the World Bank. The lack of access to sanitation facilities in Ethiopia is due to several factors, including limited infrastructure, inadequate funding, and a lack of awareness about proper sanitation practices. The rural areas in Ethiopia are particularly affected, with many households lacking access to basic sanitation facilities, such as toilets and hand-washing stations. To address this issue, the Ethiopian government has launched various initiatives and programs aimed at promoting sanitation and hygiene in the country. For instance, the government's "One WASH National Program" aims to provide access to safe water supply and sanitation facilities in 307 Woredas (districts) in Ethiopia by 2030. The program focuses on increasing access to sanitation facilities, promoting proper hygiene practices, and improving the management of sanitation infrastructure.

VACCINE DROUGHT

THE DEMAND for cholera vaccine continued to outpace supply, even as 24 countries have reported close to 200,000 cases in 2024 (as of July), according to the World Health Organization (WHO). Since January 2023, 16 countries had requested 92 million oral cholera vaccine (OCV) doses, nearly double the 49 million doses produced during this period. In March 2024, the WHO reported a shortfall in the global stockpile of OCV. Consequently, a single vaccine dose was recommended instead of the previous two-dose regimen. The situation, however, since improved. The stockpile exceeded the emergency target of five million doses in early June for the first time in 2024. As of 10 June 2024, the stockpile contained 6.2 million doses.

Currently, the world is facing the seventh cholera pandemic, which took off in the 1960s. Since 2021, there has been a spike in cases of cholera. In January 2023, WHO classified the global spike in cholera as a grade 3 emergency, an event requiring a major to maximal WHO response. This created more demand for vaccines. More doses were requested for outbreak response between 2021 and 2023 than in the entire previous decade, according to the WHO. According to forecasts, global production capacity in 2024 could be 37-50 million doses. This will likely continue to be inadequate to meet the needs of millions of people directly affected by the disease, WHO noted.

WHO has prequalified three vaccines: Euvichol, Euvichol-Plus and Euvichol-S produced by EuBiologicals Co Limited, Republic of Korea. In 2011, WHO prequalified Shanchol from India's Shantha Biotechnics [acquired by Sanofi Pasteur] after it was licensed in India in 2009. In 2013, WHO created a global stockpile of cheap, safe and effective inactivated whole-cell OCVs. Shanchol was discontinued by Sanofi Pasteur in 2023, leaving EuBiologics as the only supplier.

Open defecation near water source deteriorates quality causing a vicious circle of poor sanitation & water crisis. Nigeria is an example of this intertwined challenge. Residents of Nigeria's Gwagwalada area council, located around 65 kilometres from the Abuja city centre, are struggling to get drinking water. A closer look shows that the problem is due to the quality of drinking water at the local sources. The area council, like many of others, witnesses rampant open defecation near water sources. Providing safe and sustainable water to rural areas is very important to Nigeria, as around 70 per cent of the West African country's population lives in villages.

Mohammad Ushman, 35, has been the head of the Mabo / Bashi community in Paikonkore village in the area council for the last 14 years. The people in his village are forced to drink contaminated water, he said. This is despite the fact that around 60-70 per cent of the households in the village has toilets, he added. These toilets are mainly 'pit toilets' — a pit dug in the ground covered by a pan. After heavy rains, the pits overflow and increase the risk of water contamination, shared villagers. Paikonkore village has only one borewell to cater to a population of 4,000. Long queues are observed in front of the borewell, especially during summers, said Ushman. The villages in this area council also buy a jerry can of 20-30 litres, which cost 300-500 Naira, the residents said. A family of 10 people needs at 10 jerry cans per day and thus, roughly 30-50 per cent of their income goes towards getting safe and clean water, explained Ushman. Needless to say, as the households barely manage to get enough drinking water every day, sanitation takes a back seat. Small farmers make 30,000-40,000 Naira per annum. They are forced to drink contaminated water from the wells or buy poor quality water at cheaper rates of 50 Naira per jerry can. Usually, the villages get water at a frequency of once in three days for three hours in the morning at the common water points. When these common points of water collection are out of order, it takes four-five months by the government agency to repair them. In such a case, the community has to take charge in the village.

The scarcity of water has led to blocked and smelly toilets. Lukaiya Suleman, 41, resident of the Dagiri village has six children and cannot adequately meet the hygiene needs as they do not have access to enough clean water. A majority of the households in the village do not have toilets and those who have constructed toilets cannot maintain them as there isn't enough water to clean, he added. After defecating in the open, they can only afford to clean themselves when they take a bath, Suleiman shared. The supply of water at common collection points is also not

regular. Open defecation is common in the village and this is one the main reasons for contamination of drinking water, said Mohammed Sahibu, a 42-year-old government school teacher in Paikonkore. Although a few households share toilets, the condition of the toilets are poor, Sahibu said. In most cases, the toilets are choked and the people again go back to the field for defecation, he noted. A 2019 report by the CSE on open defecation practice in the country said that the reasons are more related to the topography of the areas. During peak summer, when the yield of the borewells decline, the villagers go to nearby rivulets 1-2 kilometres away to fetch water. Not only is the travel time long, the water quality is also poor because the villagers relieve themselves in bushes around the rivulets. The CSE report also highlighted that the open defecation is the highest for rural areas. Moreover, the traditional methods of hanging toilets and bucket toilets were observed in rural areas, the study noted.

Outbreak of diseases such as cholera, dysentery and other intestinal diseases are common to all the villages in this area council. Jibril Salihu Heske, 45, deputy in-charge of the primary healthcare centre in Dagiri village, explained that the cases of waterborne diseases increase every year during the rainy season. The healthcare centre reported 60-75 cases of malaria in December and 3-4 deaths reported in the months of April, May and June of 2023, shared Heske. A household spends around 5,000-6,000 Naira per month on lab tests and medical treatment, which is around another 40-50 roughly per cent of their income. The reason behind this is contamination of drinking water sources (where open defecation is the main reason) and low awareness on hand-washing and self-cleaning post defecation, according to local government officials.

Since the villages depended on pit toilets, the desludging of the pits and dumping of the sludge are the next important points which need to be taken care of, said Hamidu Garba, a local chemist in Paikonkore village and who earns 10,000 Naira per day. Desludging charges vary from 300,000 to 60,000 Naira for a 2m x 2m pit, he noted. "It is very difficult for us to bear this cost." In the village Anguwan Dabodna of the central ward of Gwagwalada area council, tile artisan Habibatu Abuwaqar's family of 30 members depend on a single toilet. They desludge the pit toilet themselves once it gets filled, and dispose the sludge in open areas of the village, which contaminate the nearby water source, according to Mujammed Musa Danladi, water, sanitation and hygiene in-charge of the local government of Gwagwalada environmental services. Mismanagement and unsafe disposal of faecal sludge, especially in Nigeria's rural areas was also highlighted in the CSE report. Schools in the villages are also facing the brunt of unsafe water and sanitation. Many villages have no water supply in the school and, as a result, the students need to carry their own water or even go to nearby houses to get water. In most of the cases, separate toilets for girls and boys are absent or are locked. The toilets are few and poorly maintained. The students use the school grounds to relieve themselves. Girl students opt out of schools mostly because of this, said 46-year-old Abubakar Sadiq Ahmad from the Lea Primary School, Dagiri.

Unimproved sanitation will increase the chance of contamination of groundwater. Nigeria thus needs to fix its sanitation problems to get safe and sustainable water supply, especially in a climate-risked world

As per the Joint Monitoring Progress Report of 2022, around 31 per cent of the population is practicing open defecation — the scenario has not changed since 2004. The population using unimproved sanitation increased from 27 per cent to 28 per cent from 2004 to 2022. Since the 1970s, the country has been facing cholera outbreaks annually. Unimproved sanitation will increase the chance of contamination of groundwater. Nigeria thus needs to fix its sanitation problems to get safe and sustainable water supply, especially in a climate-risked world. The country should be now ready to take up the issues of unsafe sanitation by working on the toilet technologies and strengthening policies on sewage and implement it. The country needs to provide solutions to the community that is sustainable, suiting to the needs of geography and groundwater. ■


FRANCE
TEXAS

MIGRATION & CONFLICTS

HIGHPOINTS

Water scarcity is a major reason for internal migration in the contemporary world. **Low rainfall events account for 10-11% of the increase in migration during 1970-2000**.

Across Africa, the incidences of **violence over water resources increased** by around **34 per cent during 2022-2023**.

Sub-Saharan Africa is very prone to conflict over water. Its capacity to create conflicts was underestimated.

By 2050, **some 200 million additional people would be termed as "environmental migrants"**. These are the people who are displaced due to environmental factors, including extreme water events.

PHOTOGRAPH: ISTOCK

THE DRIVER

Water stress triggers conflicts, displacement and migration

WATER SCARCITY triggers distress migration. This reactivates our ancestral memory — some 400,000 years ago, a dry spell in East Africa forced our ancestors to migrate out in search of water-rich geography. As they say, as humans we have been chasing water since then, more than food and shelter as it is that central to us. While we sought water for settlement in ancient times, the lack of access to it has led to the contemporary out-migration to places that offer both easy access to water and also livelihood options. In ancient times, agriculture and hunting were primary survival occupations while we have added many more over the time.

Will the world witness another such transformational migration due to lack of water? There is impeccable evidence of a severe water crisis. Climate change has aggravated this. Various estimates suggest that 66 per cent of the planet's land areas are losing water. Populations facing extreme drought might double by the late 21st century. A recent World Bank report titled "Web and Flow: Water, Migration and Development", analysed the "largest dataset on internal migrants" assembled from 64 countries and 189 censuses during 1960-

2015. It argues that water scarcity is a major reason for internal migration in the contemporary world. While the inherent human affiliation to a water body as the capital for settlement and societal evolution remains unchanged, the recent anthropogenic changes have made us more prone to water scarcity than five million years ago.

This massive analysis of data establishes that low rainfall events account for 10-11 per cent of the increase in migration between 1970 and 2000. "Strikingly, dry shocks have 5 times the effect on out-migration than wet shocks have — the impact of wet shocks is more muted. This suggests that local adaptive capacity may be significantly constrained in the event of repeated dry shocks," the report said. The water scarcity-driven waves of migration have been more eminent in developing and poor countries. There are various reasons for migration, like looking for better economic opportunities, seeking higher education, conflicts and also major disasters. While dry spells or lack of water ranked just below education as a reason for migration, in many countries, this has become a more decisive driver of migration. Climate change has added to these woes. In the last three decades, an average 25 per cent of the world's population suffered abnormal rainfalls annually. Such shocks have immense economic impacts on people, which are reasons for migration anyway. But increasing dry spells, as predicted in a changed climate scenario, would add on to this, thus fastening out migration. But the World Bank report finds that the poorest in a region would be left behind to fend for themselves in areas ravaged by deficit rainfalls. Water shocks affect not only the number of people who move but also the skills they bring with them, said the report. Migrants who leave regions with lower rainfall and frequent drought usually possess lower educational levels and skills than other migrant workers, implying significantly lower wages and less access to basic services at their destination. It said that 80 per cent of the poorest population would not be able to migrate out even though they were left with no adequate water as migration involves costs and also certain skills.

RISING CONFLICTS

In Africa, number of water conflicts increased by around 34% during 2022-23

Year	No of conflicts and disputes over water in Northern and Sub-Saharan Africa
2019	28
2020	24
2021	29
2022	53
2023	71

Source: Pacific Institute, August 2024

Water-intensive sectors account for 56 per cent of jobs in low-income countries but only 20 per cent in high-income countries. In Sub-Saharan Africa, where water-dependent jobs account for 62 per cent of total employment

WATER-MIGRATION LINK

The link of scarcity or lack of access to water and human migration is a subject of many deliberations. Evidence from the recent past establishes that in many countries internal migration has been caused by water scarcity and events that cause temporary disruption of water supply, besides climatic events like drought and floods. In developing countries, where farming and fishing are frequently the primary sources of income, employment is dependent on water-intensive industries and is sensitive to water availability. Water-intensive sectors account for 56 per cent of jobs in low-income countries but only 20 per cent in high-income countries. In Sub-Saharan Africa, where water-dependent jobs account for 62 per cent of total employment, low rainfall availability frequently results in significant negative gross domestic product or GDP growth. The management and distribution of shared water resources can have an impact on social cohesion and the likelihood of conflict at the local, national, and transnational levels. Water resources that are managed effectively and equitably can foster community trust, inclusivity, and cooperation, ultimately leading to peace. However, if mismanaged, water can act as a threat multiplier, exacerbating existing conflicts or leading to

EVOLUTION OF WATER AND CLIMATE-RELATED MIGRATION POLICY INSTRUMENTS AT THE GLOBAL SCALE

MIGRATION-RELATED policies and agreements at the global level started to emerge explicitly, and relatively, they trace back to the United Nations High Commissioner for Refugees (UNHCR) to the year 1950. Accompanying timeline demonstrates an overview of migration and water-related policies that indirectly or directly address the migration context. A specialised United Nations agency, UNHCR, was founded in 1950 after World War II resulted in millions of people leaving their homes. The UNHCR was created with the mandate to protect refugees, forcibly displaced communities and stateless people, and assist in their voluntary repatriation as well as local integration or resettlement. In January 1992, the Dublin principles were formed at the International Conference on Water and the Environment, whereby the value of water is highlighted. Ten years later, the UNHCR released General Comment Number 15, "The right to water," which described how the right to water should apply to everyone, including refugees, internally displaced populations, and so forth. In 2005, the guidelines for the realisation of the right to drinking water and sanitation delineated how water and sanitation needs of those vulnerable and marginalised, including refugees, should be addressed. Post the SDGs launch in 2015, international governance mechanisms for managing migration include the resolution on international migration and development and the New York Declaration for Refugees. These documents both included the necessity of water and sanitation for refugees and migrants. Most recently, in 2018, the member states of the UN formed the Global Compact for safe, orderly, and regular migration, which strengthens the global community's response towards sustainable solutions in addressing the situation surrounding migrants.

(Excerpted from "Water and Migration: A Global Overview", 2020, United Nations University Institute for Water, Environment and Health)

On migrants and migration

Source: "Water and Migration: A Global Overview", *UNU Institute for Water, Environment and Health*, 2020

new conflicts. On the other hand, those displaced due to water scarcity add pressure on the resources and infrastructures of the settlement locations. This causes social tensions and armed violence as well. There are studies that claim that in Somalia gender-based violence increased by 200 per cent against a group of displaced people.

"As water stress increases, so do the risks of local or regional conflict," said Audrey Azoulay, Director-General of UNESCO. "The United Nations World Water Development Report 2024", published by UNICEF on behalf of UN Water, said, "Conflicts over water can occur when demand exceeds supply, when availability is compromised due to pollution, when access to

(and allocation of) water is disputed, when water supply and sanitation services are disrupted, or when water management institutions are inadequate. They can range from legal disputes to violent altercations, often reflecting event-specific socio-political, demographic and environmental conditions. The linkages between water and armed conflict are complex. Water has most often been a tool, a target or a victim of warfare, but typically not the cause of war." Conflicts arising out of water-scarce situations also cause forced displacement. Climate change is also responsible for displacement and migration. Rising numbers of extreme weather events and dry spells like drought becoming longer have further deepened the water-migration nexus. In an overview research paper published by the Wiley Interdisciplinary Reviews in May 2023, the lead author Li Xu of the Global Institute for Water Security, University of Saskatchewan, Saskatoon, Canada, wrote, "Water-migration nexus represents one of the complex interactions between water and humans. Human settlements are highly dependent on water availability as water plays a crucial role in social welfare that directly relates to food and life quality. When water conditions are significantly altered that threaten people's livelihoods, effective adaptation is required to maintain harmonious human and water relations. Migration may be viewed as an effective way or an opportunity for people to adapt to the threatened water systems as it allows people to diversify their income and build resilience." Kitty van der Heijden, head of international cooperation at the Netherlands' foreign ministry, once said, "If there is no water, people will start to move. If there is no water, politicians are going to try and get their hands on it and they might start to fight over it." So, water is a source of conflicts that displace people

The linkages between water and armed conflict are complex. Water has most often been a tool, a target or a victim of warfare, but typically not the cause of war

and also a trigger for migration.

The building of two dams by the Nigerian government in the 1990s that stopped nearly 80 per cent of water flow to the Hadejia-Nguru wetland is often cited as a case of how water scarcity could trigger migration. Some 1.5 million people depended on this wetland for livelihood using it for fishing, cattle grazing and also irrigating their lands. But as it dried out, people had to migrate out, many of them reportedly joined extremist groups like Boko Haram and many also tried to flee the country using human traffickers. "For the past three years, Europe has been convulsed by a crisis of migrants, some from Syria and the war-torn Middle East, but also hundreds of thousands coming from the arid Sahel region of Africa, including Nigeria, Mali, and Senegal. They are fleeing poverty and social breakdown caused by insurgent groups such as Boko Haram. But environmentalists and others in the region say that behind this social chaos lies serious water mismanagement in the drought-prone region," wrote Fred Pearce, an author and journalist based in the U.K, on the website YaleEnvironment 360 published by the Yale School of the Environment.

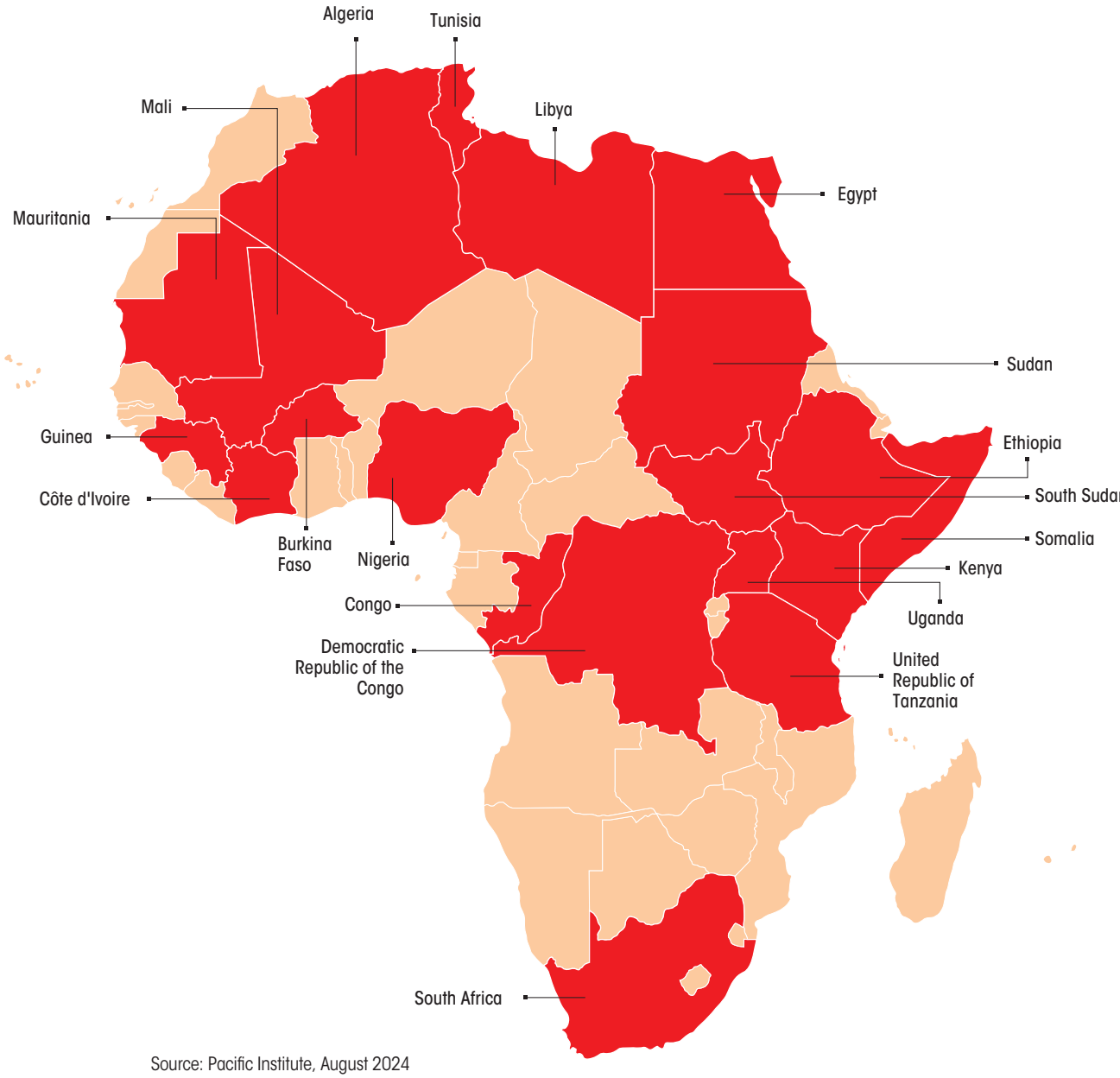
WATER AS A CONFLICT TRIGGER

Water is a strategic natural resource for any nation. But in Africa, where most of the river basins are shared by a number of countries, water is also a resource that has caused numerous inter-country conflicts. Asia and Africa are the two main global hotspots of water-related conflicts, according to the Pacific Institute data. Almost 80 per cent of all conflicts worldwide are concentrated in these two regions. Among these are the conflicts in which water or water systems have been used as a weapon, a trigger, a target, or a victim of violence. Asia is the leading region for water conflicts, where around 54 per cent—or more than half of the conflicts and disputes—have been recorded. Africa is second, with close to 24 per cent—or one-fourth—of the conflicts, followed by Latin America and the Caribbean region (taken as a group, accounting for 12 per cent) and Europe.

With increase in geopolitical tensions, water has been considered as a weapon of war. The

20 COUNTRIES REPORTED 68 INCIDENCES OF CONFLICTS OVER WATER RESOURCES (2004-2013)

Five countries accounted for over 54 per cent of these and include: Somalia (12), Ethiopia (7), Egypt (6), Kenya (6) and Sudan (6)



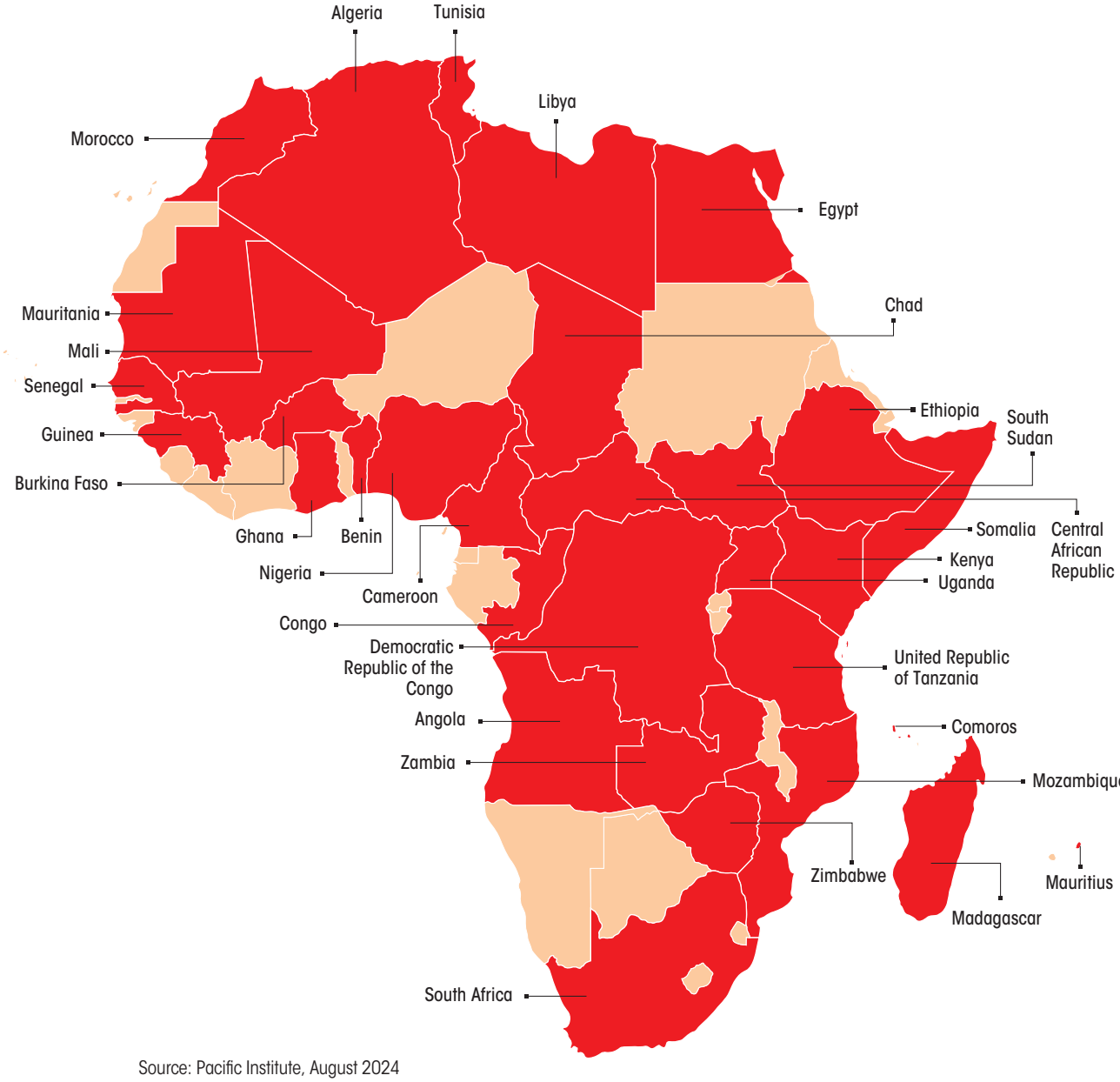
Source: Pacific Institute, August 2024

intentional attacks on civilian water infrastructure in West Asia during the past two years, including those in Gaza and the West Bank, Yemen, Syria, Iraq and Israel, as well as the ongoing fighting in the Russia-Ukraine war, demonstrate that water has been a target or casualty of violence. In 2022, there have been at least 36 incidents in Russia-Ukraine, where water systems have suffered damage. In June 2023, Nova Kakhovka dam, the Russia-occupied southern Ukraine suffered a collapse.

Drought and water stress linked to climate change has been a trigger behind rising conflicts in Africa. For instance, in the disputes across Sub-Saharan Africa—which includes countries such as Burkina Faso, Mali, Ethiopia, Nigeria, Somalia, and Kenya—traditional herders and

32 COUNTRIES REPORTED 295 INCIDENCES OF CONFLICTS OVER WATER RESOURCES (2014 TO 2023)

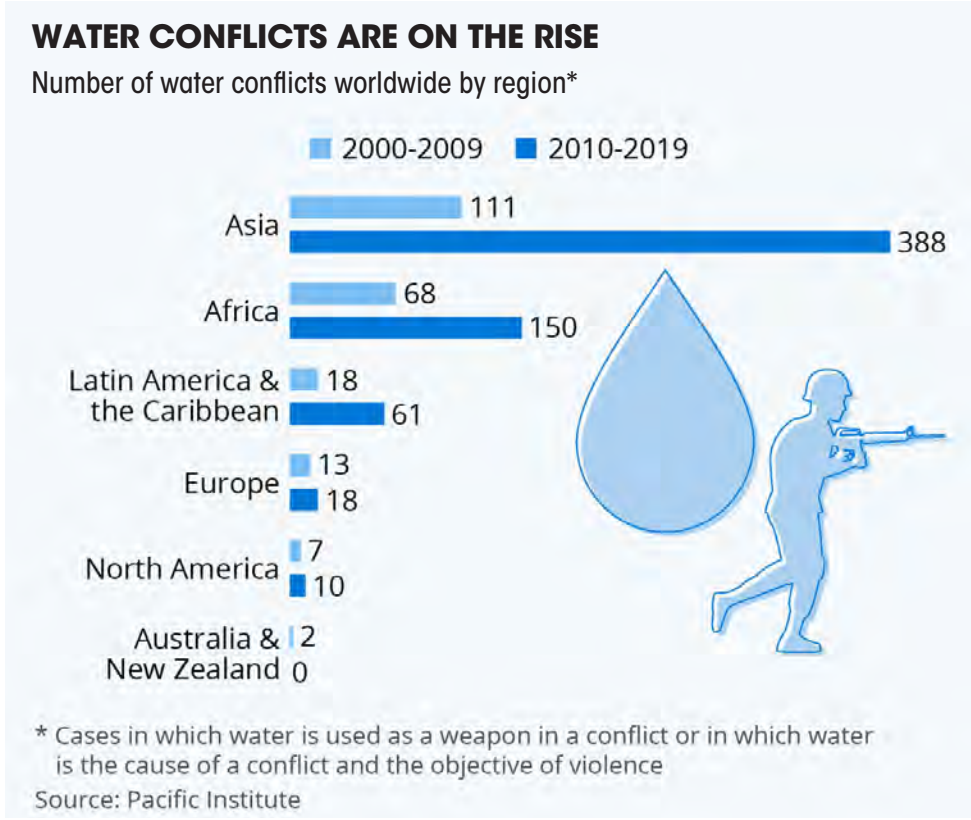
Five countries accounted for over 54 per cent of these and include: Somalia (41), South Africa (36), Sudan (32), Kenya (31) and Burkina Faso (22)



Source: Pacific Institute, August 2024

farmers continue to compete for scarce water resources. In Burkina Faso, at least 32 water facilities were destroyed during January to May in 2022, impacting nearly 300,000 people. Targeted attacks ranged from direct hits on water points and water trucks, purposeful contamination of water resources to sabotaging public water network's generators. "Disrupting civilians' access to water is no longer a mere by-product of the conflict; it has become a weapon of war and marks a new, despicable turn in violence. For the sake, dignity and survival of an already exhausted population, this war on water must stop," said Hassane Hamadou, country director for the Norwegian Refugee Council in Burkina Faso in a statement in May 2022.

In South Africa too, the unrest over the failure to provide safe water and sanitation is



growing. Vandalism of water infrastructure continues to cripple the Eastern Cape municipality, acknowledged the country's water and sanitation department in a media report dated January 2023. Incidences of vandalism of the local pump station at Fort Beaufort and surrounding areas were reported that left the residents without the supply of water. These incidents over the years indicate a link with climate change and water-related violences. With temperatures on the rise and rainfall becoming more erratic, climate change may contribute as a trigger for water conflicts across Asia and Africa.

A research paper by José Antonio Peña-Ramos of Faculty of Social Sciences and Humanities, Universidad Autónoma de Chile, Providencia, Chile and others published in the *Frontiers in Environmental Sciences* in 2022 examined the role of inequality in fresh water distribution in fomenting conflicts in the Sub-Saharan Africa. Its conclusion based on assessment of water conflicts in the continent said, "After analyzing all the conflicts, paying particular attention to their origin, evolution, and eventual resolution, or their possible future escalation, we can conclude that Sub-Saharan Africa is a region very prone to conflict over water. Moreover, its capacity to create conflicts was underestimated as we can see that in most cases, given the regional context where the relations between the states are not oriented towards cooperation but conflict, the regulation of the conflicts did not follow any clean-cut course of action, lacked cooperation and flexibility and, thus, resulted inefficiently and

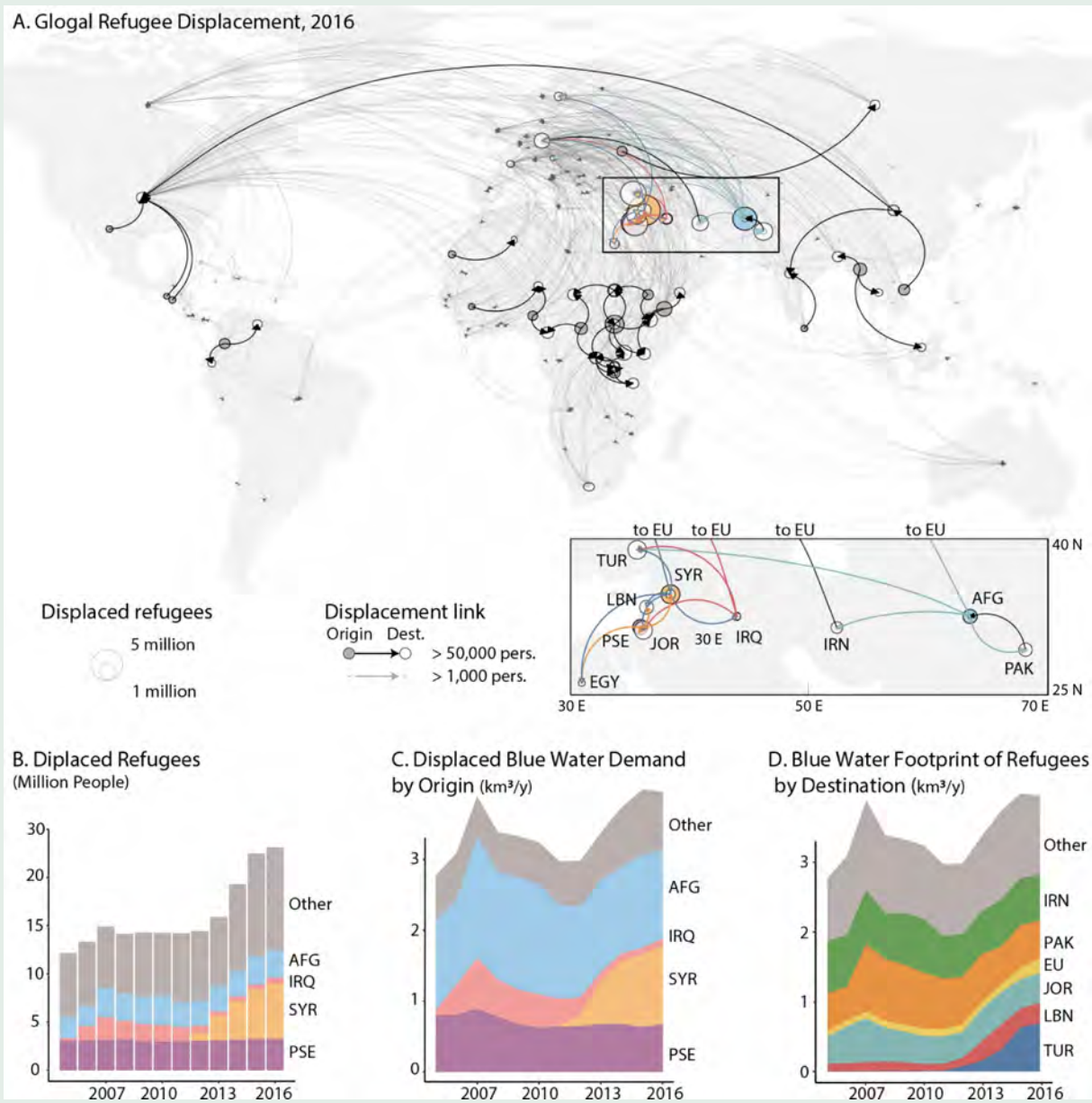
Despite comprising only five states, Sub-Saharan Africa saw many conflicts in 60 years (1958–2019) in which water played the role, in whole or in part, of a trigger. The basis of the conflicts varied, although in all of them, an inevitable clash of interest propelled different groups toward conflict

REFUGEES AND WATER FOOTPRINT

The water stress of refugee displacements is disproportionately borne by a few countries

DO HUGE displacement of people and immigration impact water availability of the recipient destinations? Millions of people displaced by conflicts have found refuge in water-scarce countries, where their perceived effect on water availability has shaped local water security discourses, said a study titled "Food demand displaced by global refugee migration influences water use in already water-stressed countries" published in *Nature Communications* in May 2023. The study examined the water footprints of refugees of conflicts and how it impacted the water uses in the destination countries. Water footprint quantifies "the volume of water necessary to produce, process, and distribute a person's annual food consumption." In 2021, armed conflicts displaced about 80 million people world-wide, out of which 30 million had to move to different countries thus referred to as refugees. Arrival of refugees in such a large number in the country of destination will surely impact its local water use or demand. The study said, "These flows of

Global refugee flows and displaced food and water demand



Source: "Food demand displaced by global refugee migration influences water use in already water stressed countries", *Nature Communications*, May 2023

'virtual' water between the origin and destination countries of traded food affect the global distribution of water resources and the water stress of nations."

"Our analysis has shown that the water stress of refugee displacements is disproportionately borne by a few countries that host an incommensurate number of refugees amidst severe pre-existing water security challenges. This burden exacerbates a broader landscape of water inequality and injustice in the Global South, where resource mismanagement, poor governance, the commoditisation of water and land, extractive industries, environmental cost shifting, and the legacies of colonialism often amplify water scarcity in arid and semi-arid regions that will be strongly impacted by climate change," noted the authors of the study.

required more time and human resources to, at least, diminish conflict intensity."

This analysis, which claimed to be the first of its kind for the region, said, "Despite comprising only five states, Sub-Saharan Africa saw many conflicts in 60 years (1958–2019) in which water played the role, in whole or in part, of a trigger. The basis of the conflicts varied, although in all of them, an inevitable clash of interest propelled different groups toward conflict. Furthermore, all conflicts involved two or more states or actors (communities, groups) from different states. All these conflicts also revealed the strategic value of water in the region." According to data-centric portal Statista, Africa is the second hotspot of water conflicts after Asia. During 2000-2019, the number of water conflicts went up from 68 to 150. Statista defines water conflict as "cases in which water is used as a weapon in a conflict or in which water is a cause of a conflict and the objective of violence."

The World Economic Forum's annual "Global Risks by Impact" report has been ranking water crises as one of the top five threats. Peter Gleick, head of the Oakland-based Pacific Institute, has spent the last three decades studying the link between water scarcity, conflict and migration and believes that water conflict is on the rise. "With very rare exceptions, no one dies of literal thirst," he told the news agency Reuters. "But more and more people are dying from contaminated water or conflicts over access to water." Sabeeha Quereshi, the World Health Organization regional emergency preparedness and response (EPR) coordinator/head for Eastern and Southern Africa, said, "The current global water crisis will worsen as human populations multiply, climate change deepens, and the drivers of human displacement become more complex, from conflict and persecution to the increasingly pertinent variables of heightened mobility. A clear example of the deteriorating situation in many regions occurred in 2017 when severe drought displaced almost 20 million people across the Middle East and Africa, which I witnessed firsthand in Syria and Iraq and is one of the worst humanitarian crises in the past century." The International Organization for Migration, a UN agency, has projected that by 2050, some 200 million additional people would be termed as "environmental migrants". These are the people who are displaced due to environmental factors, including extreme water events. After 2050, this can reach as high as one billion environmental migrants, said the UN agency.

Short-distance migration — accounting for the most considerable portion of global migratory movements — is very critical for climate change adaptation, according to new research from the University of East Anglia (UEA). Most migratory movements, contrary to popular belief, involve short-distance relocation caused primarily by economic, social and environmental variables such as climate change, said "the Everyday mobility and changing livelihood trajectories: Implications for vulnerability and adaptation in dryland regions report". The study, published on March 9, 2023, concentrated on those living in the drylands of India and parts of Africa. The focus had always been on international migration and how

The International Organization for Migration, a UN agency, has projected that by 2050, some 200 million additional people would be termed as "environmental migrants". These are the people who are displaced due to environmental factors, including extreme water events

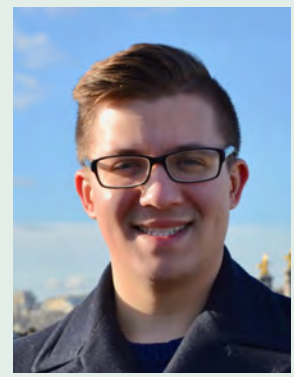
"HOW DROUGHTS AND FLOODS LEAD TO MIGRATION — AND WHAT GOVERNMENTS CAN DO TO HELP"

Political instability, chronic poverty and inequality and climate change worsen water-driven migration

CAMERON FIORET & NIDHI NAGABHATLA

EXTREME WATER events affecting water for drinking, cooking, washing and agriculture drive migration all over the world. Cyclone Eloise battered Mozambique, displacing 100,000 to 400,000 people and weakening the country's infrastructure. People displaced by the storm were in need of food, hygiene kits and personal protective equipment (PPE). Cyclones are just one form of extreme water events that will play out more frequently and adversely as water crises worsen with climate change. Water extremes and climate change will cause more than one billion people to migrate by 2050. Migration will be spurred by drought, as in the Sahel in Africa, shortsighted water management, as in the Aral Sea region of Kazakhstan and Uzbekistan, flooding, as in Bangladesh and small island developing states, and other extremes like cyclones.

Addressing water-driven migration will require research that crosses borders and research boundaries. As climate change continues to cause serious displacement and socio-political upheaval, governments must take action to minimize the effects on people vulnerable to migration.



THE STAKES OF WATER-DRIVEN MIGRATION

Water-driven migration is a crucial challenge for people living in vulnerable and unstable regions. Water stress acts as a direct or indirect driver of conflict and migration. As water and climate extremes become worse, more people will face water crises and be forced to migrate. For instance, take the famous case of the Aral Sea that shrank to 9,830 square kilometres in 2017 from 55,700 square kilometres in the 1970s. More than 100,000 people migrated due to collapse of agriculture, fisheries, tourism and increased illnesses such as tuberculosis and diarrhea.

Vulnerable populations bear the brunt of impacts on water availability, food production, livelihoods and income. As water and care providers, women and girls carry the burden of fulfilling water needs for their households and families. Women and girls also bear disproportionate health impacts of water crises as more hours are spent organizing household water needs. A recent report explains that political instability, chronic poverty and inequality and climate change worsen water-driven migration. With at least 33 nations set to face "extremely high (water) stress" by 2040, it is more pressing than ever to face this problem with a strategic approach.

A SEVEN-POINT STRATEGY

Countries that have committed to the United Nations Sustainable Development Goals could address water-driven migration through SDG 16 (peace, justice and strong institutions). Policy can be aligned with SDG 16 along a seven-point strategy:

Address the connection between water ownership, distribution and migration: Water ownership and distribution likely influence migration at local, regional and global levels. To capture the scope of water issues, future research must strike a balance between scientific and social aspects of water.

Understand how water crises influence migration: Causality is important in addressing migration. Land, water and human security issues could serve as a base for outlining a preventative outlook for new and emerging migration pathways.

Integrate diverse perspectives in water migration assessments: Water cooperation treaties must integrate under-represented, marginalized and racialized migrant voices. The United Nations University's Institute for Water, Environment and Health has developed an approach to aggregate the causes and consequences of water-driven migration. This framework can help policy-makers interpret migration in diverse socio-ecological, socio-economic, and socio-political settings.

Assess water, migration and development practices through participatory, bottom-up and interdisciplinary

approaches: Research should be participatory, applicable between disciplines and socially inclusive to complement scientific, descriptive methods. Nuanced facts of the diverse influences that shape migration can provide understanding to build resilience among vulnerable populations.

Manage data, information and knowledge: Researchers need updated data to examine how water crises are linked with human migration. To close the gaps, the UN has pointed to the need to improve capacity for data analysis within and between countries. Also, there must be stronger co-ordination at the state, regional and international levels to share best practices.

Apply a gender-sensitive lens: The economic, health and societal effects of water-driven migration affect men, women and children differently. Filling these knowledge gaps will require a gender-sensitive approach to assess causes and effects. Namrata Chindarkar, a water and public policy researcher, has argued that comprehensive and holistic investigations of the states people come from, end up in and transit through must be gender-sensitive if they are to be inclusive.

Understand water, migration and peace: There is potential for using water security to promote peace. Broader approaches could help examine key links between water, migration and peace.

Policy-makers must prepare for the consequences of water crises by adopting improvements that address the concerns of those vulnerable to migration. The seven-point strategy calls for policy-makers to use strategic and integrated approaches between disciplines. Research that maps causes, risks and impacts at the local, regional and global levels can strengthen water migration policies.

(Cameron is Visiting Scholar, University of Michigan, University of Guelph. Nidhi is Research Fellow, Institute on Comparative Regional Integration Studies, United Nations University)

climate change will force many to flee across borders. A large number of people migrate short distances inside their own countries to harness opportunities out there or adapt to shocks and stressors in their life, said Mark Tebboth, who led the research. "Supporting and enabling this migration will help people to continue to adapt to the pressures in their lives," Tebboth said in a press release.

The drylands of Ghana, Kenya and Namibia are the areas analysed when it comes to Africa. Arid, semi-arid, and dry sub-humid areas are collectively known as drylands — the largest global biome — covering 45 per cent of the Earth's surface and home to more than a third of the population. Drylands are distinguished by poor and extremely unpredictable water supply and high temperatures. Multiple pressures — increasing rates of aridity and soil degradation; poorly planned and implemented development interventions; rapid population growth; historically high rates of poverty; poor communication infrastructure; and isolation from national centres of power — exert stress on these regions. These variables strain natural resource-based livelihoods, forcing communities to migrate. Such migration "is normalised within lives and livelihoods and these movements are crucial in helping people to manage different shocks and stresses within their lives, including increasing climate variability," Tebboth noted.

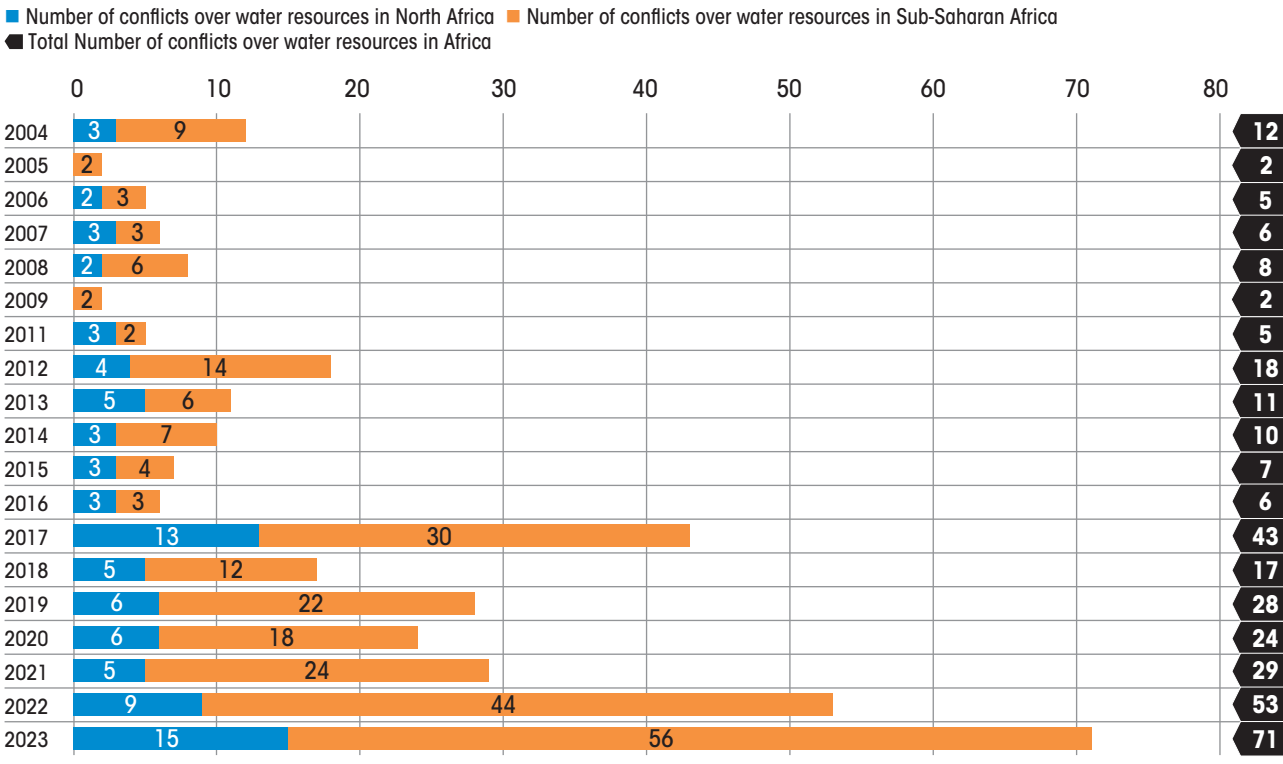
Most mobility, especially that in which environmental change is of some influence, is and will remain local, added Tebboth. "Land degradation lowered agricultural incomes in Ghana by $4.2 billion between 2006 and 2015, increasing the national poverty rate by 5.4 per cent in 2015," the Intergovernmental Panel on Climate Change (IPCC) had pointed out. Environmental and land degradation increased mobility in Kenya, it added. "Fragmentation of habitats, reduction in the range of livestock grazing and higher stocking rates are considered to be the main drivers for vegetation structure loss in the rangelands of Kenya," the report said.

WATER, CLIMATE AND DISPLACEMENT

More human beings are being displaced by force today than at any other time in humankind's history. Such forced displacement is being further exacerbated by environmental impacts and climate change. More than 216 million people across six continents will be on the move within their countries by 2050 in large part due to climate change, according to the "World Migration Report 2024" released by the United Nations in May 2024. Climate change cannot be considered the sole driver of food insecurity or migration, according to the document since political power, incompetent governance, globalised food production and other social factors

OVER THE PAST 20 YEARS (2004 TO 2023), SUB-SAHARAN AFRICA HAS ACCOUNTED FOR 75% OF ALL CONFLICTS (357) ON WATER RESOURCES

Water disputes across Africa have surged five-fold in the last decade, escalating from 12 incidents in 2014 to 71 in 2023. In Sub-Saharan Africa, these conflicts have increased 6.2-fold.



Source: Pacific Institute, August 2024

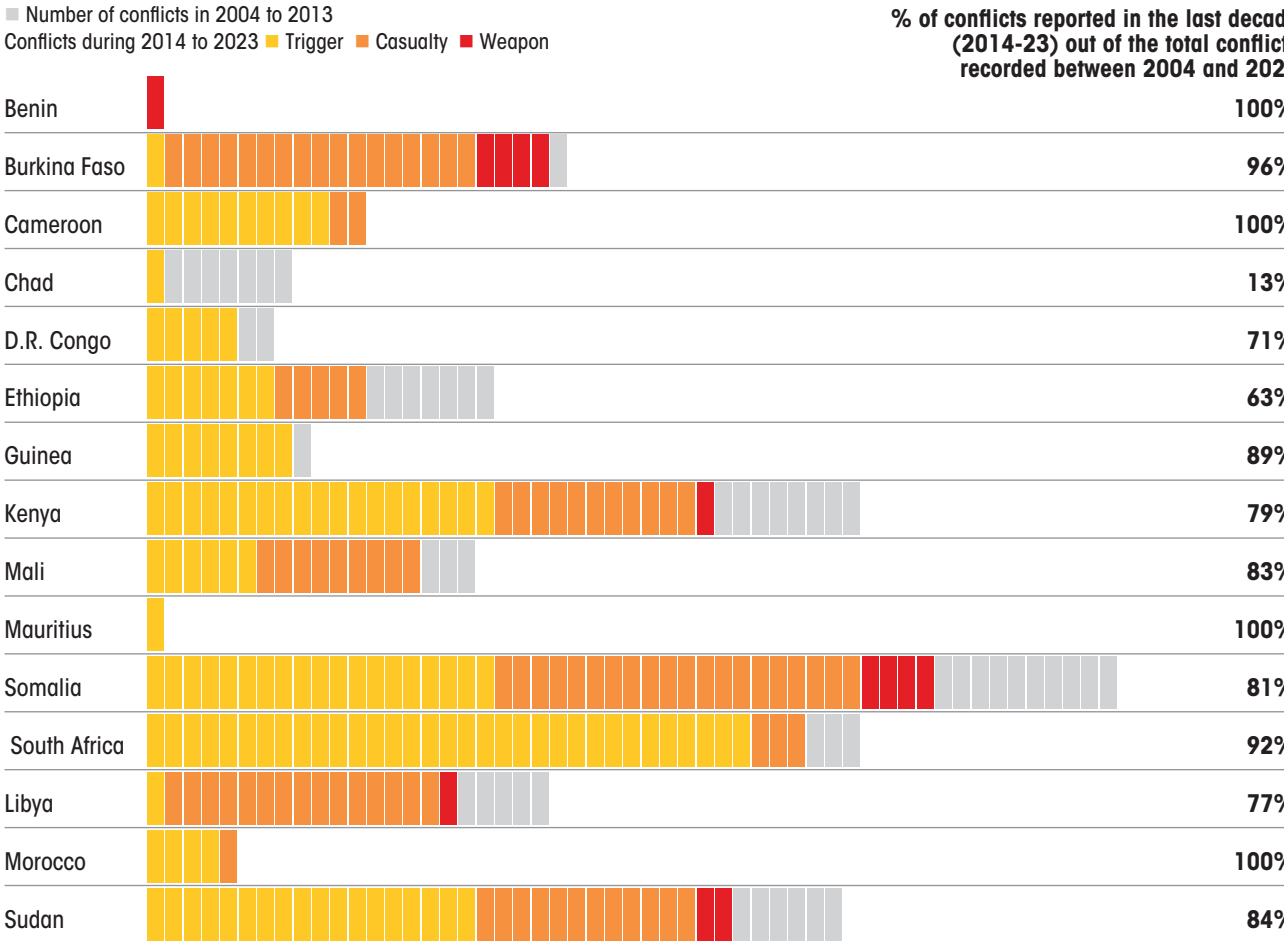
also play a role. What climate change does is increase pressure on existing systems and communities. According to the report, migration is a coping or adaptation strategy to reduce the adverse effects of climate change. "The outcomes of migration as an adaptation tool depend on the circumstances of the individuals or households engaging in human mobility, as well as on the involvement and agency of migrants," it said.

No region of the planet inhabited by humans is unaffected due to climate change and the consequent migration of people. The report profiled the Global South — Africa, Asia, Latin America and the Caribbean and Oceania — in addition to the Global North (Europe and North America) to come up with a grim picture of how climate change is forcing people to move from their homes, within their home countries or continents. On the continent of Africa, the analysis looked at sub-regions such as North Africa, West and Central Africa as well as East and Southern Africa. North Africa, which is often clubbed with West Asia as the Middle East and North Africa (MENA) region due to similarities in culture and landscape, has experienced significant warming over the last several decades, while at the same time seeing its rainfall decrease during the wet season, particularly in countries such as Libya, Algeria and Morocco.

A 2021 report by the World Bank has projected that without tangible action on climate and development, millions of people across North Africa could be forced to move within their countries as a result of climate change. The report cited instances including Libya, which has still not recovered from the Arab Spring over a decade ago. Local militias have weaponised water scarcity, including using water infrastructure for leverage against the central government and other rivals. Libya also witnessed the "Medicane" Daniel which devastated the port city of Derna. In Algeria and Morocco, there have been significant displacements triggered by droughts and wildfires. "By end of 2022, wildfires induced 9,500 displacements in parts of

AFRICA RECORDED 71 WATER-RELATED CONFLICTS AND DISPUTES IN 2023, WHICH WAS THE HIGHEST NUMBER IN A SINGLE YEAR IN 20 YEARS

80% of these occurred in the Sub-Saharan Africa region, with South Africa reporting the highest number of such incidents; this year accounted for nearly ninety-two percent of all conflicts in the country between 2004 and 2023.



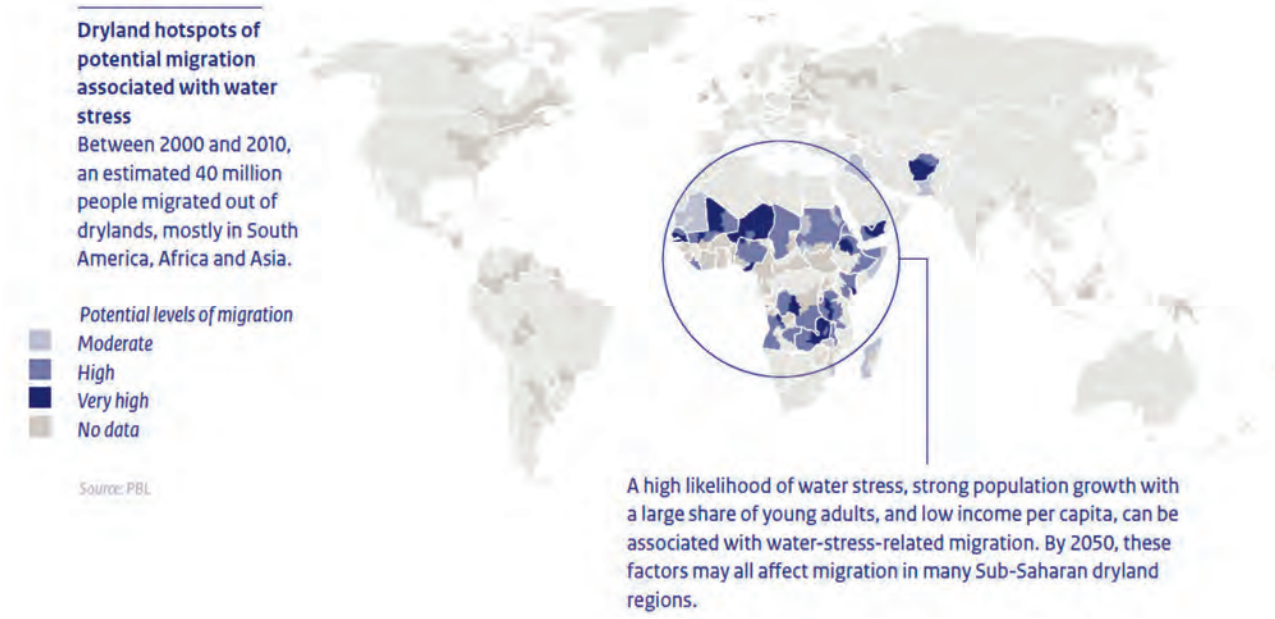
Source: Pacific Institute, August 2024

northern Morocco, and in the same year, 2,000 displacements — also due to wildfires — were recorded in north-eastern Algeria. Wildfires also destroyed significant swaths of land, especially in Morocco, where they ruined more land in 2022 than in the previous nine years combined," the report said.

North Africa is separated from the rest of the continent by the Sahel, a band of dry scrublands that stretch from the Atlantic in the west to the Red Sea in the east. Rainfall in the Sahel has decreased by over 20 per cent since the 1970s, making this part of Africa one of the most prone to droughts. At the same time, parts of the sub-region have experienced significant sudden-onset disasters, which have displaced millions of people. "Nigeria, for example, had the largest number of internal displacements due to disasters in Sub-Saharan Africa in 2022 (more than 2.4 million). This was also the highest figure recorded in Nigeria in 10 years. The displacements were largely the result of floods between June and November 2022," noted the report.

Climate change is playing havoc in the south and east of the continent. By May 2023, more than 2 million people had been internally displaced due to drought in Ethiopia and Somalia (combined), while over 866,000 refugees and asylum-seekers in Kenya, Ethiopia and Somalia were living in drought-affected areas at the start of the year. Southern Africa has seen climate

DRYLAND HOTSPOTS OF POTENTIAL MIGRATION ASSOCIATED WITH WATER STRESS



Note: The impacts of water stress are seen to be a driver of migration. Especially in areas where many people are employed in agriculture this is the case, since water availability has a strong impact on agricultural productivity. The propensity to migrate is also generally higher amongst younger people. Therefor, the demographic characteristics of a region influence who moves in response to economic changes that are influenced by water stress. Under a business-as-usual scenario, especially regions in Sub-Saharan Africa can face migration related to water stress.
Source:"The Geography of future Water Challenges", *PBL Netherlands Environmental Assessment Agency,* 2018

change-linked disasters, including cyclones, become more frequent and intense. Cyclone Freddy, one the longest-lasting cyclones ever, wrought havoc in Malawi, Mozambique and Madagascar in early 2023. It killed more than 500 people, and displaced over 500,000 in Malawi alone.

In 2023, the number of internally displaced people increased to 75.9 million, from 71.1 million in the preceding year, according to the Global Report on Internal Displacement 2024 (GRID-2024) released by the Geneva-based Internal Displacement Monitoring Centre (IDMC), a leading institution on monitoring of internal displacement in the world. IDMC defines internal displacement as "the number of forced movements of people within the borders of their country recorded during (a) year." The GRID records internal displacements due to conflict and violence and disasters.

Tracked since 2018, the report has been recording a trend of disasters — particularly weather-related ones — displacing more people than conflict and violence, traditionally the dominant reasons for displacement. But during 2022-2023, this trend seems to have reversed: conflicts and violence again causing more displacements, particularly in the last two years. According to GRID-2024, "68.3 million people were living in internal displacement as a result of conflict and violence at the end of 2023, the highest figure since data became available. Sudan, Syria, the Democratic Republic of the Congo (DRC), Colombia and Yemen host nearly half of the world's internally displaced people." This is a 49 per cent increase over the 2022 figure.

On the other hand, the disaster-induced internal displacement population was 7.7 million by the end of 2023; one-fourth of it was caused by earthquakes. "We detected disaster displacement in 148 countries and territories in 2023, with significant events across six continents. Some high-income countries, such as Canada and New Zealand, reported their highest figures ever," says the GRID-2024. However, internal displacement due to weather-related disasters came down by a third in 2023, in comparison to 2022. On the face of it, it indicates fewer burdens of weather-related disasters, considered the most enduring impacts of climate change. But an analysis of the GRID-2024 data shows that disasters continue to

PHOTOGRAPH: ISTOCK

trigger more internal displacement than conflict and violence. Overall, 56 per cent of all internal displacement in 2023 was caused by disasters, while the rest by conflict and violence, according to GRID-2024. Weather-related displacement reported in 2023 is the third highest in the last one decade, notwithstanding the dip in number in comparison to 2022.

The relatively less displacement due to weather-related disasters, the GRID-2024 attributes, is due to the change in a global weather phenomenon. In 2023, La Nina ended and El Nino set in. La Nina is cooler than the normal phase of the El Nino Southern Oscillation (ENSO) phenomenon in the central and eastern equatorial Pacific Ocean. La Nina is associated with a higher number of storms and floods while El Nino is associated with dry weather resulting in droughts. "Storms and floods led to fewer displacements across most of Asia, but floods in other areas triggered record numbers, particularly in the Horn of Africa," says the report on the linkage of displacement with withdrawal of La Nina.

"The decrease (in displacement due to disasters) is partly explained by the onset of the El Nino phenomenon, which led to below average rainfall during the monsoons and a weaker cyclone season," reasons the GRID-2024. However, the report adds, "That said, floods and storms continued to uproot people from their homes, often in the same places where displacement tends to be recorded year after year." Earlier Down To Earth reported that incidents of flood and storm increased due to La Nina, consequently leading to more displacement. GRID-2023 said the number of people displaced by disasters rose by 40 per cent in 2022 rather than 2021. Of the total disaster displacement in 2022, 98 per cent were triggered by weather-related events like floods and storms. According to GRID-2023, "6 out of 10 disaster displacements were triggered by floods, suppressing storms for the first time since 2016." The GRID-2023 attributed the increase in disasters, particularly weather-related, to the three-year-long La Nina. "(This is) largely the result of the effects of La Nina which continued

for a third consecutive year," said the GRID-2023.

Across Africa, the incidences of violence over water resources increased by around 34 per cent during 2022-23, according to the latest data from the Pacific Institute. There were at least 71 such incidents recorded in 2023 compared to 53 in 2022. From 2019-23, such conflicts increased by around 154 per cent. In 2023, Africa reported the highest number of water-related conflicts and disputes since 2019, revealed an analysis of the world's most comprehensive open-source database on water-related violence released August 26, 2024.

Disputes over water resources in sub-Saharan Africa rose by 27 per cent in a year. The number of events reported in the region increased to at least 56 in 2023 from 44 in 2022. It accounted for 79 per cent of all incidents reported in Africa in 2023. Northern Africa reported an increase by around 67 per cent during this period. In 2023, at least 15 events were reported from North Africa, compared to nine in 2022.

Latin America and the Caribbean, Southern Asia, Western Asia and sub-Saharan Africa were identified as regions of special concern in the Pacific Institute's conflicts database for 2023. These regions have been hit by drought and unequal access to water resources. For example, numerous water wells and infrastructure were destroyed, hundreds of people were killed and fights broke out over access to drinking water and grazing areas throughout the region between ethnic militias and clans in Somalia, Ethiopia, Burkina Faso, Mali and other countries. At least two people were killed and twenty more injured as Kotoko farmers and Arab Choa herders fought over land and water in Makary, Goulfey, Amdagalgui and Ngouma (Logone-et-Chari, Far North, Cameroon) on October 6 and 7, 2023.

Recent data revealed a significant increase in drought-related incidents and conflicts

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over water availability and management in Latin America and India. So, globally, there has been an overall increase in all three categories of conflicts (trigger, casualty, weapon) globally. These events include attacks on water systems, unrest and disputes over the control of and access to water, and the use of water as a weapon of war. At least 347 such events were reported worldwide in 2023, in comparison to 231 in 2022. In 2000, only 22 such incidents were observed.

Of these, the attacks on water and water infrastructure accounted for half of the incidents in 2023. Violence triggered by disputes over access and control of water accounted for 39 per cent and water was used as a weapon of war accounted for 11 per cent of the total events reported and included in the database.

Globally, both the interstate and intrastate conflicts over water have increased between 2022 and 2023. But in Africa, sub-national conflicts between farmers and pastoralists, urban and rural water users, religious groups and family clans in 2023 (62 per cent of the events) continue to far outnumber transboundary events, where two or more nations were involved (38 per cent of the events). The trend is accelerating despite a 2000 UN resolution that explicitly recognised the essential human right to water and sanitation. Extreme weather — including drought and flooding — due to a changing climate is further straining the water systems around the world. "The large increase in these events signals that too little is being done to ensure equitable access to safe and sufficient water and highlights the devastation that war and violence wreak on civilian populations and essential water infrastructure," said Morgan Shimabuku, senior researcher with the Pacific Institute. ■

RIVERS

HIGHPOINTS

In Africa 63 international **transboundary river basins** cover about **62% of the region's land area**.

A key water-resources issue in Africa is the multiplicity of international water basins in a climate of **weak international laws**.

Only **one-third** of the Sub-Saharan Africa **countries sharing rivers** have 90% of their basins **covered with operational arrangements**.

Water scarcity is exacerbated by declining water quality in numerous regions and the situation is expected to **worsen in the years to come**.

PHOTOGRAPH: ISTOCK

TRANSBOUNDARY TENSION

Africa needs to augment transboundary rivers cooperation to ensure water security

IN JULY 2024, Ivory Coast (also known as Cote d'Ivoire) joined the United Nations Water Convention, becoming the 10th African nation to do so. In 2024, at least three more African nations, which include Sierra Leone, Zambia and Zimbabwe, were in the final stages of accession and joining the convention. Ivory Coast joined the convention to enhance cooperative water management across borders in response to growing water stress and the effects of climate change on the water resources it shares with its neighbours. It is now the 53rd Party (country) to the 1992 UN Water Convention, which is also known as the Convention on the Protection and Use of Transboundary Watercourses and International Lakes. The Convention was initially established as a regional framework for the pan-European region. Since its global expansion to all UN Member States in 2016,

Chad, Senegal, Ghana, Guinea Bissau, Togo and Cameroon were the first African nations to accede. They were later joined by Nigeria, Namibia and The Gambia in 2023. The Water Convention facilitates cooperation on surface water and groundwater too. The Convention requires Parties to prevent, control, and reduce negative impacts on water quality and quantity across borders, to use shared waters in a reasonable and equitable way, and to ensure their sustainable management through cooperation. Parties bordering the same transboundary waters are obliged to cooperate by concluding specific agreements and establishing joint bodies.

Africa is unique in terms of its transboundary water resources. Transboundary water (TBW) resources are especially important in Africa, where 63 international transboundary river basins cover about 62 per cent of the region's land area and account for 90 per cent of the total surface water. The Africa Development Bank's "The Africa Water Vision for 2025" identifies multiplicity of transboundary water basins as a critical issue gripping the continent's water resources. "A key water-resources issue in Africa is the multiplicity of international water basins in a climate of weak international water laws and weak regional cooperation on water-quality and water-quantity issues," it says.

So, this development in Ivory Coast strengthens the continent's strong momentum for water cooperation. "Cote d'Ivoire's accession is a milestone for multilateralism and reaffirms the role of the UN Water Convention as a tool to support water cooperation for peace, sustainable development, and climate change adaptation across borders," said Tatiana Molcean, executive secretary of the United Nations Economic Commission for Europe (UNECE). Forty per cent of the continent is situated on transboundary aquifers, where 33 per cent (381 million people) of Africa's population resides. In addition to facilitating cooperation on surface water, the Water Convention helps countries work together on groundwater

Africa is unique in terms of its transboundary water resources. Transboundary water resources are especially important in Africa, where 63 international transboundary river basins cover about 62 per cent of the region's land area and account for 90 per cent of the total surface water

reserves, which are less susceptible to climate change impacts and hence crucial for climate change adaptation. For instance, in September 2021, the UN Water Convention supported the agreement to establish a legal and institutional framework for cooperation between Gambia, Guinea-Bissau, Mauritania, and Senegal on the management of the Senegal-Mauritania Aquifer Basin.

In fact, 20 more countries across the world are in the process of joining, the majority of which are in Africa. These include Botswana, which is in the process of joining the water convention, confirmed UNECE in October 2023. Ivory Coast shares eight transboundary river basins (Black Volta, Bia, Tanoe, Comoe, Niger, Sassandra, Cavally and Nuon) with six of its neighbours, which include Ghana, Burkina Faso, Mali, Guinea, Liberia, and Sierra Leone. Among these, the Niger basin, which is the continent's third-longest river at 4,200 kilometres and traverses nine countries (Benin, Burkina Faso, Cameroon, Chad, Ivory Coast, Guinea, Mali, Niger, and Nigeria), is one of Africa's most vulnerable regions to climate change. The Niger River basin is likely to experience the largest decrease in river flows in all of Africa due to climate change, according to a recent study titled "Combined impacts of climate and land-use change on future water resources in Africa" published in the journal *Hydrology and Earth System Sciences* in January 2024. Under the convention, the parties (or nations) are required to cooperate for the sustainable management of transboundary waters. Given Ivory Coast's high vulnerability to climate change, this convention can facilitate the necessary cooperation for managing the eight river basins it shares with six neighbouring countries.

While all 54 countries are facing water insecurity, Ivory Coast is categorised as the 40th

REASONS TO SCALE UP TRANSBOUNDARY COOPERATION—NOW!

River Basin Organisations are the best example of joint institutions to manage shared water resources

SAROJ KUMAR JHA AND DMITRY MARIYASIN

CONCERN AND hope were the two sentiments of World Water Day 2024, with its theme, "Water for Peace". Concern because of the pressure today on the world's freshwater resources from climate change, fragility, and ecosystem degradation. Hope because, despite this, the international community came together to support countries and basin organisations working on cooperative water management through partnerships like the Global Facility for Transboundary Water Cooperation and the Transboundary Water Cooperation Coalition. Through these, and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), and at gatherings, such as the Global Forum on Transboundary Water Cooperation for Climate and Development in July 2023, we see the power of partnerships when it comes to promoting cooperation over water resources.

It goes without saying that water is a fundamental resource for life on Earth, its management critical for the well-being of human societies. But it can also be a source of tension and conflict, particularly in regions where it is scarce or where its allocation is contested. As populations grow and climate change impacts its availability, the potential for disputes over water is likely to increase. Institutions and mechanisms that can, through dialogue and cooperation, address conflict, limit trade-offs, and maximise shared benefits are crucial for peace and development. So far, however, only 24 nations have operational arrangements for water cooperation for all their basins shared with neighbouring countries, as the second round of reporting on SDG indicator 6.5.2 on transboundary water cooperation, carried out by UNECE and UNESCO, shows. Cooperation on transboundary aquifers is even less advanced: The work on SDG 6.5.2 identified just eight aquifer and groundwater-specific arrangements worldwide.

Given this lack of agreement on mechanisms governing transboundary waters and the magnitude of challenges being faced by communities in river basins and elsewhere, much more support is needed from the international community for transboundary water management. Even more so now as water has the unique potential to serve as a catalyst for cooperation and dialogue.

TOWARD MORE COOPERATION

Whenever stakeholders come together to manage shared lakes, aquifers, and rivers, they forge trust, collaborative frameworks, and mutual benefits beyond these that contribute to peace and stability. In part this is because the shared management of resources involves the collection and exchange of data, joint decision-making, and the equitable allocation of water. These cooperative processes can help parties address the root causes of water-related conflicts—and develop solutions acceptable to all. They also create more social and economic benefits from water than would be available if countries managed this precious resource unilaterally. Global experience shows that transboundary waters cooperation increases the type and size of benefits — the size of the "pie" — that countries can obtain from sustainable water management.

UNECE and the World Bank's Cooperation in International Waters in Africa (CIWA) program are supporting the development of agreements for the Senegalo-Mauritanian Aquifer Basin in the Western Sahel. Our lessons from it are relevant for other transboundary aquifers around the world. Cooperation over water extends to broader development, with frameworks and joint institutions providing a powerful enabling environment. River Basin Organisations are the best example of joint institutions to manage shared water resources, helping countries to identify shared visions and implement joint investments. Based on the Water Convention, 100 or more agreements have made the availability of water more predictable, led to fewer losses from floods and droughts, or supported the agriculture and energy sectors.

These enhance livelihoods and reduce poverty in communities in a river basin and beyond it. Such positive outcomes can alleviate some of the socio-economic pressures that contribute to fragility and conflict.

AFRICAN BASINS

The recently completed Regional Rusumo Falls Hydroelectric Project will benefit people in Burundi, Rwanda, and Tanzania. This project materialized after more than a decade of dialogue spearheaded by the Nile Basin Initiative and its technical office, the Nile Equatorial Lakes Subsidiary Action Program. In the Senegal Basin, 20 years of World Bank engagement with Senegal River Basin Organization (Organisation Pour la Mise en Valeur du Fleuve Sénégal) facilitated the integration of Guinea—home to the river's headwaters—information-sharing, a master plan, and cost-sharing formula.

Still more needs to be done. In this respect, globalising the Water Convention is a promising signal. Since the Convention's global opening in 2016, 11 countries from Africa, Latin America, and the Middle East have joined it—five in 2023—and more than 20 are in the process of doing so. The Water Convention, serviced by UNECE, has built cooperation among riparian states at both political and technical levels: In 2017, it supported a framework to prevent conflict related to the sharing of water resources in the Economic Community of Central African States.

By joining the Water Convention, countries signal their commitment to cooperation and get help defining their priorities and drawing up a roadmap to do so. The Transboundary Water Cooperation Coalition—a diverse, multi-stakeholder partnership of governments, intergovernmental organizations, regional integration organizations, international financial institutions, academia, and NGOs—aims to raise the profile of transboundary water cooperation at all levels by 2030. Leveraging the comparative advantages of each, it paves the way for coordinated action to tackle the polycrisis related to water. By acknowledging that water is an instrument for peace as well as an engine for growth and prosperity, we will be able to offer much-needed stability in a world in turmoil.

(Saroj Kumar Jha is Global Director, Water Global Practice, World Bank. Dmitry Mariyasin is Deputy Executive Secretary of the UN Economic Commission for Europe.)

"water insecure country in the continent", according to the Global Water Security 2023 Assessment. Meeting the water needs of the country's 30 million residents, whose population is growing by 2.5 per cent annually, presents numerous challenges. The region's water supplies are threatened by urbanisation, climate change effects such as drought and flooding, and pollution from industrial and agricultural waste, illicit gold panning, and untreated wastewater, stated UNECE, which serves the UN Water Convention. The nation's water resources are also dispersed unevenly, with the north and northeast experiencing water stress. "In the context of increasing water scarcity and high demand for water in Africa, Cote d'Ivoire's accession as the 10th African Party to the 1992 Water Convention is a significant step for the continent," said Claver Gatete, Executive Secretary of UNECA.

According to the latest Sustainable Development Goals (SDG) indicator 6.5.2 report, in Ivory Coast only 25 per cent of the transboundary basin area is covered by operational arrangements. No transboundary aquifers shared by the country are covered by operational arrangements, shows the UN portal on SDG 6. "The accession of Côte d'Ivoire to the UN Water Convention will support relations with countries with which we share water resources. In our capacity as defenders of water in the context of the United Nations, we must use transboundary cooperation to reinforce peace and for harmonious and sustainable development in our countries," said Minister of Water and Forest of Ivory Coast, Laurent Tchagba.

At least three nations, which include Sierra Leone, Zambia, and Zimbabwe, are in the final stages of accession. With a mere 7 per cent of the transboundary basin area in Sierra Leone covered by operational arrangements and the lowest amongst the African nations, the country in January 2024 confirmed its intention to accelerate the accession process to the Water Convention. This will also support the country's objective in climate change resilience and ecosystem restoration. In February 2024, Zambia's Cabinet had approved the accession to the global water convention and the country is likely to join the United Nations Water Convention before October 2024, according to Stanley Hantambo, Principal Water Officer, Ministry Of Water Development And Sanitation. In June 2024, Zimbabwe had confirmed its intention to accelerate the accession process to the UN Water Convention.

PHOTOGRAPH: ISTOCK

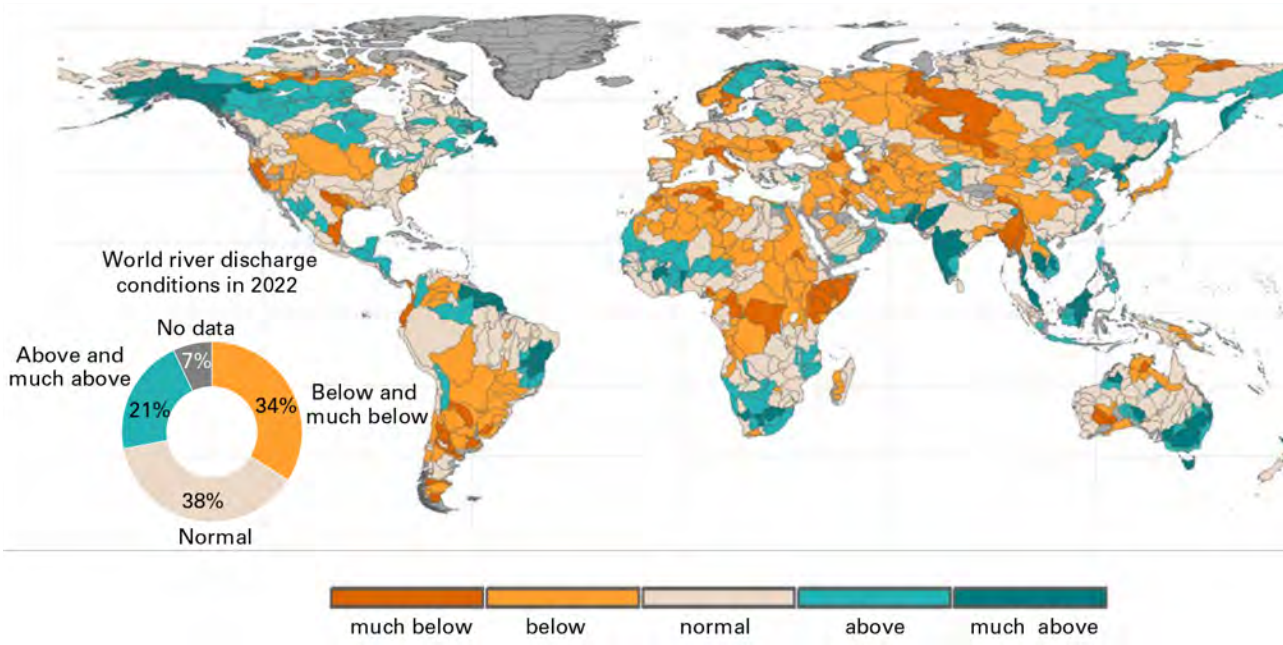
MANAGING TRANSBOUNDARY WATER SECURITY

In a recent study, Sophie de Bruin, Researcher in Environmental Change, Vrije Universiteit Amsterdam along with three water system researchers from IHE Delft, Utrecht University and Wageningen University & Research, came up with three possible futures regarding conflict risk in global transboundary river basins. "Our study projects that if nothing substantially changes in how transboundary river basins are managed and with climate change worsening, 920 million people will live in very high to high conflict-risk basins by 2050," Sophie wrote on the findings. "If nations improve water use, strengthen cooperation and do more to prevent or mitigate conflict, this number drops to 536 million," the study said. "In Africa, this number includes people living in Eritrea, Ethiopia, Rwanda, Uganda, Kenya, Somalia, Burkina Faso, Mauritania and Niger. It also includes those in Mozambique, Malawi, Benin and Togo," found the study. Africa especially faces more risks of conflicts as "several basins face extra risks like high variability of water flows and limited water availability. There is also a dependence of downstream countries on upstream ones." Sophie and her co-researchers specifically mentioned the tensions in the Nile over Ethiopia's Grand Renaissance Dam.

In this situation, the dire state of Africa's rivers is a warning sign for the future. The volume of water in Africa's major rivers decreased in 2021 compared to the average in the preceding two decades, according to the first "State of Global Water Resources" from the World Meteorological Organization (WMO) and published in November 2022. The water storage levels in the river basins, however, have gone up since 2002, an anomaly compared to the rest of the world, said the WMO report. The water discharge of Niger, Volta, Nile and Congo rivers in 2021 was less than the average calculated from 2002-2020. The water

MEAN RIVER DISCHARGE FOR THE YEAR 2022

Compared to the period 1991–2020 (for basins larger than 10 000 km²)



Note: The results presented here were derived from the modelled river discharge data, which were obtained from an ensemble of eight GHMS simulations. Inset (bottom left) shows the percentage distribution of the modelled catchment area under the given conditions. Dark gray areas indicate missing river discharge data. The results were validated against hydrological observations wherever available.
Source: State of Global Water Resources 2022 Report, World Meteorological Organization

storage levels, also known as terrestrial water storage (TWS), in these river basins have gradually increased since 2002. The greatest improvement was observed in the Congo and Nile river basins. The water storage in southern African river basins of Zambezi and Orange had been above the normal, the report said. These observations seem optimistic, but these river basins may witness a rise in temperature as a result of climate change, an earlier study warned. Most of this positive trend or increase has also resulted from an increase in TWS in a few hotspots, for example, in the Lake Victoria region.

TWS was "above normal" and "much above normal" in central Africa and "below normal" and "much below normal" in North Africa and Madagascar. The pilot report was limited to stream flow conditions, terrestrial water storage as well as the crucial role and vulnerability of the cryosphere (snow and ice cover). TWS has gone down in all other continents other than Africa from 2002-2021, the report found. But the trend in other parts of the continent might show a different direction, it flagged. But, this does not sound good for the continent. Water levels in Lake Victoria have been on the rise since October 2019 and have been at unprecedented heights. In Kenya, the floods in 2020 displaced at least 800,000 people. The flooded rivers had diverted huge volumes of water into Lake Victoria, Africa's largest lake. In June 2021, the lake was at the highest levels observed in decades due to long-lasting, intense rainfall, showed the trends revealed by United States' National Aeronautics and Space Administration. The rise in water storage in Lake Victoria due to intense rains was attributed to climate change.

The report was published at a time when climate change is affecting the river flow regime and water storage of important rivers in Africa. It was launched in response to the call for accurate water data and information to guide discussions. But, WMO acknowledged the lack of timely accessibility and availability of verified hydrological data as a key challenge. For example, just 57 per cent (eight out of 14) of African WMO member nations monitor river discharge. In the Horn of Africa, drought has been listed among the high-impact extreme events. This contradicts the continental TWS increase at the pan-African scale, pointed out

the report. This underscores the need for local assessments, as existing large local and sub-regional variability in changes cannot be related to continental trends, it said.

All Sub-Saharan countries share at least one international water basin. Thus water inter-dependency is high. For instance, the Nile basin has 10 riparian countries. In a few countries nearly all river water flows from another country, like in Egypt where most of its total flow originates from outside its borders. Similarly in Mauritania and Botswana, 95 and 94 per cent of total flow respectively come from outside the country borders. This also highlights the challenge of jointly managing the transboundary rivers.

After Europe, the Africa region has a significant number of water cooperation arrangements to manage transboundary rivers and lakes like the Lake Chad Basin Commission, the Niger Basin Authority, Senegal River Basin Development Organisation, Volta Basin Authority, and the Cubango Ovakango River Basin Commission. Still, only one-third of the Sub-Saharan Africa countries sharing transboundary rivers have 90 per cent of their basins covered with operational arrangements. "Over half of the global population lives in transboundary river and lake basins, which, alongside aquifers, account for about 60 per cent of freshwater flows. However, more than half of the world's 310 international river basins, and all but five transboundary aquifers, lack intergovernmental cooperative agreements. And it's not just about international borders: freshwater resources are not only shared just between countries but also within countries, creating an additional layer of complexity for water governance," said Saroj Kumar Jha, Global Director, Water Global Practice, World Bank.

Over half of the global population lives in transboundary river and lake basins, which, alongside aquifers, account for about 60 per cent of freshwater flows. However, more than half of the world's 310 international river basins, and all but five transboundary aquifers, lack intergovernmental cooperative agreements

The other big threat to rivers in Africa is the mounting load of pollution. In African countries, a large amount of contaminants in the environment are generated by industrial operations. Contaminants can reach water resources, both surface and underground waters, by the emission of gaseous, liquid and solid materials from different industries. For instance, take the case of rivers in Addis Ababa, the capital city of Ethiopia. Water pollution from the disposal of industrial wastewater is becoming an environmental concern in Addis Ababa. The capital city has 65 per cent (2,000) of industries of the country. Since the city has inadequate and inefficient solid and liquid waste management facilities, all point and nonpoint sources in it discharge their effluents directly into the closest surface water drain or river without any treatment. And solid waste generated by industries is often disposed of in open spaces, from where it is washed by runoff during rains and flows into rivers and seeps into shallow groundwater. About 90 per cent of industries do not have any kind of treatment plant and discharge their solid and liquid wastes untreated into the environment. Rivers in Addis Ababa are contaminated with heavy metals due to different industrial waste.

Food and textile industries take the lion's share in releasing water pollutants in Ethiopia. Chromium, sulphides, ammonium salts, chlorides and sodium hydroxide are the major pollutants that are discharged into rivers from these industries. Addis Ababa generates an estimated annual volume of 49 million cubic metres of wastewater from which, about four million cubic metres is industrial wastewater. In Ethiopia, many large and medium-scale manufacturing industries have a primary level of treatment plant. These primary-level treatment plants do not function regularly and are built to avoid penalties in the course of an inspection by Environment Protection Authority (EPA) organs. Only a few industries recycle

HUMAN ACTIONS ARE CHANGING RIVERS BY ALTERING DECOMPOSITION RATES, INCREASING GREENHOUSE GAS EMISSIONS

Though rivers occupy 0.58 per cent of the non-glaciated global land area, they receive 0.72 billion tons of terrestrial carbon per year

AGRICULTURE AND urbanisation are likely speeding up the process of breakdown of plant litter in rivers and streams globally, according to a new study. This could contribute to increased greenhouse gas emissions and disrupt the food chain, the study published in *Science* warned. Leaves that reach the rivers are decomposed by bacteria and fungi. They are, in turn, consumed by insects, which are then preyed upon by fish. Faster decomposition rates mean the carbon is released into the atmosphere even before the insects get a chance to absorb the carbon from the leaf.

"When human activities change the fundamental ways rivers work, it is concerning. Increases in decomposition rates may be problematic for the global carbon cycle and animals, like insects and fish, that live in streams," Krista Capps, co-author of the study and associate professor at the University of Georgia, said in a statement. The plant litter forms the food resources for aquatic lifeforms. The plant matter is likely being lost to the atmosphere as carbon dioxide.

Earth's terrestrial ecosystems produce over 100 billion tons of plant detritus annually. When the plant matter reaches waterbodies, its fate — whether it is locked into long-term storage, converted to greenhouse gases, or incorporated into the food web — is determined by the rate at which it is decomposed. Though rivers occupy 0.58 per cent of the non-glaciated land area, they receive 0.72 billion tons of terrestrial carbon per year.

Capps and team found a gap in our understanding of decompression rates of plant organic matter in the river and their drivers such as climate, geology, vegetation, water quality, and soils. This, according to the team, is particularly relevant for the tropics and lower-income economies as their rivers are understudied compared to the northern temperate zones.

So the team collected field data from 550 rivers around the globe and then turned to predictive modelling and machine-learning algorithms to fill in those gaps. More than 150 researchers in 40 countries contributed samples using a standardised field assay based on the decomposition of small pieces of cotton fabric. This assay estimated cellulose decomposition — the most abundant organic polymer on the planet and a main constituent of plant litter.

Their study found that decomposition rates generally increase with decreasing latitude, with accelerated rates observed in tropical regions such as Central America, the Amazon basin, Western Africa, and the Indo-Pacific. Further, many areas in middle latitudes with known human impacts — central Europe, eastern China, central North America, southeastern South America, and Japan — also saw elevated decomposition rates while boreal forests exhibit slower rates, especially in northern Asia, eastern Scandinavia, and northeastern Canada. The drivers of increased decomposition rates, according to the team, are higher temperatures and increased nutrient concentrations. "Both of these factors are impacted by human activities," David Costello, co-author of the study and an associate professor at Kent State, said in a statement. "Reducing human impacts on decomposition will keep more carbon in rivers, preventing it from entering the atmosphere as carbon dioxide and contributing to climate change," the expert added.

their process water, which is badly polluted with toxic chemicals. The major reasons for the absence of recycling process water are deficient capacity, inadequate infrastructure and lack of facility, expertise and financial resources, in addition to the lack of enforceable effluent quality standards which is only in the draft stage in Ethiopia, with recommended guidelines.

In Ghana, about 60 per cent of water bodies are polluted, with many in a critical condition, according to the executive secretary of the country's Water Resources Commission, Ben Yaw Ampomah. Apart from illegal mining activities, industrial waste, household disposals and farming were the major causes of water pollution in the country, Ampomah said. In Ghana, the manufacturing industries are mostly located in Tema, which is also called the industrial city of the country and in Tanzania, 80 per cent of industries are located in urban areas and 50 per cent of these are located in major urban areas like Dar es Salaam city and a few other towns. And in both countries, most industries are discharging their effluents directly into the

surface water bodies without any treatment. In Tanzania, the Msimbazi and Creek rivers are the most polluted water bodies in Dar es Salaam. These rivers receive large quantities of partially treated or untreated industrial wastes from various industries. Hence, they are heavily polluted. The major pollutants that are discharged into rivers are dyes, strong alkalis from textile factories and organic wastes from breweries. The volume of wastewater generated by industries is 683,717 cubic metres per day. Industrial wastewater discharge contributes an estimated 2,715 tonnes per year of Biochemical Oxygen Demand and 15,454 tonnes per year of suspended solids to the marine environment. Food processing and textile industries are the major water polluting industries in Tanzania and Ghana.

In Ghana and Tanzania, facilities for effluent treatment are rudimentary. Very few industries have a primary and secondary level of the treatment facility and discharging treated effluents. Treatment of effluents is very expensive and impacts negatively on the profits of industries. This is one of the main reasons why most industries are reluctant to treat their wastewater and simply release them into the environment. This damages numerous coastal, river and marine ecosystems and triggers the transmission of contagious diseases among people.

A study titled "Assessment of urban river water pollution with urbanization in East Africa" published on *Springer* that examined four typical urban rivers of Tanzania found, "The water quality of 30% of the investigated river sections is in the medium to good status based on the subjective WQI with sensory factors included. Moreover, the sections with

Comparing the clean-water scarcity assessment to the traditional water scarcity assessment based solely on quantity, the number of sub-basins facing severe scarcity doubled in 2010 and is projected to potentially triple by 2050. Water pollution, particularly nitrogen pollution, played a significant role in aggravating water scarcity in 2,000 sub-basins worldwide

obvious water quality decline are mainly limited to the river segments within the urban central area, and severe pollution of water bodies is closely related to large cities, indicating an increasing pollution tendency with the quickly growing population. Therefore, to help formulate water pollution control policies in response to the rapid urban expansion in African countries, it is necessary to adopt an economical and feasible method to carry out early monitoring of surface water quality timely."

Industrial effluents must be treated efficiently before they are released into the environment in order to prevent any harm or the risks they may have on the environment and human health. Enforcement of water and environmental laws must be in place to protect the environment. There should be strict policy implementation regarding different industrial effluents. Sector-specific guidelines are a must for industries to avoid the contamination of river waters. There should be a strong structure for monitoring effluent disposal. In Ethiopia, the development of comprehensive effluent quality standards is very important as it is in the draft stage.

Water scarcity is exacerbated by declining water quality in numerous regions, and the situation is expected to worsen in the years to come, a new report underlined. A significant factor contributing to this crisis is nitrogen pollution in rivers, a concern that emerged in 2010 and is anticipated to persist until 2050, the findings showed. The global impact of future nitrogen pollution is alarming, with the number of sub-basins experiencing water scarcity expected to triple. A recent study, published in February 2024 in *Nature Communications* highlighted that an additional 40 million square kilometres of river basin

"GHANA: KUMASI CITY'S UNPLANNED BOOM IS DESTROYING TWO RIVERS – SEWAGE, HEAVY METALS AND CHEMICAL POLLUTION DETECTED"

As a result of limited investment in sewage plants, most of the city's untreated wastewater is discharged into the surface water bodies

STEPHEN APPIAH TAKYI AND OWUSU AMPONSAH

GHANA'S URBAN population has more than tripled in the past three decades, from 4 million to nearly 14 million people. Competition for land in cities has increased among various land uses. These trends have led to encroachment in ecologically sensitive areas such as wetlands.

Kumasi, Ghana's second largest city, has a high level of encroachment and this has led to the pollution of water bodies. Kumasi's population growth has been rapid because of its central and strategic location and its functions as a major commercial, traditional and administrative centre. In 2022, the population of Kumasi was 3,630,326 with a growth rate of 4.02 per cent. The city's growth puts pressure on its natural assets.

As scholars of urban planning and chemistry, we conducted a study in the greater Kumasi metropolis to understand the extent of encroachment and pollution of two rivers, Subin and Wiwi. We wanted to understand how cities can be developed and functional without destroying natural resources. We also wanted to know more about the extent of water pollution, land-use dynamics and water resources regulations, and how they influence the quality of water resources.

We found that people were building homes in informal settlements along the rivers. Liquid and solid waste was being dumped into the rivers. People were using land on the river banks for agriculture and industrial activities, which had a negative effect on water quality.

We recommend that the city authorities monitor what is happening better and do more to prevent degradation of Kumasi's water bodies.

EFFECTS OF LAND USE ON THE QUALITY OF WATER BODIES

We discovered that, in the greater Kumasi metropolis, more land alongside the rivers was being used for industrial, residential and commercial purposes than for green spaces. City authorities were ineffective in controlling development in these areas despite the fact that Ghana's zoning guidelines say there should be a buffer of 100 feet (30 metres) along water bodies.

Land values in Kumasi are increasing due to rapid urban growth, but values are lower for wetlands. This difference has contributed to city residents building in wetlands. Also, the intense pressure of urbanisation on the available land has resulted in a high level of encroachment in wetlands. The study revealed that 35.4 per cent of the land uses within the River Wiwi buffers were residential development.

This research further confirmed that the Wiwi and Subin rivers had been heavily polluted with faecal coliforms over the years. Coliform counts are an indicator of possible faecal contamination, and reflect hygiene standards.

The mean of the coliform counts surpassed the limits of 400 total coliforms/100ml and 10 faecal coliforms/100ml allowed by the World Health Organization standard. The two rivers are extremely polluted with faecal matter.

The research also confirmed that heavy metals in the water bodies were above the WHO's recommended standard of 0.01mg/litre. For example, the average concentration of lead (Pb) recorded in the Wiwi and Subin Rivers was 0.018-0.031 mg/l and 0.035-0.055, respectively. Exposure to lead is dangerous to health.

As a result of limited investment in sewage plants, most of the city's untreated wastewater is discharged into the surface water bodies. This has implications for the quality and sustainability of these water bodies.

The study also showed that some city residents dump their waste near the city's wetlands. During heavy rains, the refuse runs off into the water, affecting water quality and flow.

The inability of city authorities to enforce land-use regulations and legislation has allowed people to carry out agricultural activities close to the rivers. The use of agrochemicals threatens aquatic habitats. Chemicals such as pesticides, herbicides and fertilisers are likely to seep or be washed into the rivers. The use of polluted water from the rivers for irrigation also poses a threat to human health.

The industrial activities along the water bodies include washing bays, auto-mechanical activities, welding and wood processing. These pose a threat of chemical pollution due to likely seepage of petroleum products into the water.

TIME FOR KUMASI TO WAKE UP

The development of sustainable cities relies on the ability of city authorities to plan for social, environmental and economic growth. Urban growth can coexist with natural resources if human activities located near water bodies don't threaten their quality and continued existence.

Our study shows that Kumasi has developed with little regard for its natural assets. This is a threat to the city's sustainability. City authorities ought to put in place measures to clean the water bodies and convert buffer areas into parks and green spaces. Environmentally friendly urban agriculture can also be promoted along the water bodies.

Activities such as disposal of liquid and solid waste must be stopped. The "polluter must pay" principle must be applied to people who contravene environmental regulations.

Urban centres in Ghana need a water resource management policy. Regulatory institutions such as the Physical Planning Department and the Environmental Protection Agency should be restructured and equipped to respond to emerging complex environmental problems in cities. There should be continuous environmental monitoring and regulations must be strictly enforced. The River Thames Policing model in the UK can be adopted to ensure the continuous monitoring of the water bodies. To monitor and enforce the zoning regulations, city authorities and policy-makers must invest in technologies such as drones.

The Zoning Guideline and Planning Standards provide standard setback average distances for a buffer zone of 50-100 feet from the water bodies. We recommend that the buffer should rather be 100 feet (30 metres) away from the wetland. The wetlands are an important ecosystem service that needs to be protected. Ecologically sensitive areas that are 100 feet away from wetlands should be compulsorily acquired as natural assets for the public interest.

(Stephen Appiah Takyi and Owusu Amponsah are Senior Lecturers, Department of Planning, Kwame Nkrumah University of Science and Technology.).

area and three billion more people may face water scarcity in 2050 than previously estimated. The study introduces the term "clean-water scarcity" and provides a comprehensive assessment considering both water quantity and quality. This assessment, based on global nitrogen pollution and incorporating various climatic and socio-economic scenarios, reveals a dire situation than previous evaluations.

Comparing the clean-water scarcity assessment to the traditional water scarcity assessment based solely on quantity, the number of sub-basins facing severe scarcity doubled in 2010 and is projected to potentially triple by 2050. Water pollution, particularly nitrogen pollution, played a significant role in aggravating water scarcity in 2,000 sub-basins worldwide. In 2010, 984 sub-basins were deemed water scarce based on quantity alone, while 2,517 sub-basins faced scarcity due to both quantity and quality. This number is anticipated to increase to 3,061 sub-basins in the worst-case scenario in 2050, as outlined in the study. This alarming projection indicates a more than doubling of the global area and population affected by severe water scarcity. When considering only water quantity, the study estimated that 45 per cent of the global population lived in areas with severe water scarcity in 2010. However, when water quality is factored in, this estimate rose to 80 per cent. Future clean-water scarcity hotspots were identified in China, India, Europe, North America, and potentially Central Africa in the worst-case scenario, each with unique challenges requiring targeted solutions.

Nitrogen losses in rivers can stem from various sources, including human waste, agricultural practices and fertiliser applications. In the worst-case scenario, sewage is projected to become the dominant source of nitrogen pollution in rivers due to rapid urbanisation and inadequate wastewater treatment infrastructure. In Africa, where both agriculture and sewage contribute to nitrogen pollution, but sewage was projected to be the main source in the worst-case scenario.

Large-scale pollution from untreated agricultural drainage and wastewater is putting

MICROPLASTICS FOUND IN NILE RIVER'S TILAPIA FISH: NEW STUDY

This all has serious implications for human health, as people catch and eat the fish, which introduces those microplastics and associated chemicals into their bloodstreams

DALIA SAAD

THE NILE is one of the world's most famous rivers. It's also Africa's most important freshwater system. About 300 million people live in the 11 countries it flows through. Many rely on its waters for agriculture and fishing to make a living. The Nile's two main tributaries, the Blue Nile and the White Nile, come together in Sudan's capital city, Khartoum. This industrial hub has grown rapidly over the past few decades.

The Nile is not immune to the same pollutants that affect rivers all over the world. Plastic debris is of particular concern. Over time plastics break down into smaller pieces known as microplastics. These are tiny plastic particles with a maximum size of five millimetres, all the way down to the nanoscale. Recent research found that rivers are modelled to export up to 25,000 tons of plastics from their sub-basins to seas annually. Over 80 per cent of this amount is microplastic.

This has huge negative consequences for biodiversity and the climate. As microplastics degrade, scientists have found, they produce greenhouse gases. Airborne microplastics may influence the climate by scattering and absorbing solar and terrestrial radiation, leading to atmospheric warming or cooling depending on particle size, shape and composition. It also negatively affects animal and human health. Microplastics have been shown in laboratory studies to be toxic to animals and cells.

Much of the research about microplastics in African waters has focused on marine and coastal areas. To address this gap, I conducted a study to assess the presence of microplastics in the River Nile in Khartoum. My students and I tested for the presence of microplastics in Nile tilapia. This popular African freshwater fish species forms the basis of commercial fisheries in many African countries, including Sudan. The results do not make for happy reading. In the 30 freshly caught fish we surveyed, we found a total of 567 microplastic particles. This shows that the River Nile is contaminated with microplastics that can be consumed or absorbed in various ways by the tilapia and other aquatic organisms.

OUR SAMPLE

The fish used in our study were caught just after the meeting point of the two Niles, known in Arabic as Al-Mogran. We visited the Al-Mawrada fish market in the Omdurman area, which is also alongside the Nile. All 30 specimens we bought were freshly caught.

We dissected the fish to remove their digestive tracts. The individual tracts were treated so they would digest any organic matter they contained without interfering with the analysis of microplastics. The resulting solution was subject to another extraction procedure and we then conducted physical and chemical analyses.

Every specimen had microplastics in its digestive tract: The number ranged from as few as five to as many as 47 particles per single fish. In total we identified 567 particles. This is high compared to studies that have reported microplastics in tilapia species in other rivers and lakes. There is, as yet, no global guideline or standard for what might be an "acceptable" number.

Shape, size and colour: We detected different sizes of microplastics (0.04mm to 4.94 mm), shapes (fibres, fragments, films, foams and pellets) and colours. The most common were very small (less than 1mm), fibrous — they appear slender and elongated — and coloured (dyed).

These characteristics make sense because of how fish and other aquatic organisms feed. Nile tilapia are versatile feeders: they consume a variety of organisms including phytoplankton, aquatic plants, invertebrates, detritus, bacterial films, as well as other fish and fish eggs. That puts them at a high risk of ingesting microplastics.

Nile tilapias are also more likely to consume particles that are within a similar size range as their natural prey, as well as the same shape and colour.

Smaller microplastics are especially good carriers for other pollutants such as heavy metals, resulting in additional health risks. Their small size also makes it easier for them to move into organs like the liver. Studies have found

microplastics in the tissues, muscles, livers, blubber and lungs of other aquatic as well as marine mammal species.

Fibres, the most dominant shape found in our specimens, stay in the intestine for longer than other microplastic shapes. This, too, can lead to health problems for the fish. Coloured microplastics contain dyes, many of which contain toxic chemicals.

This all has serious implications for human health, as people catch and eat the fish, which introduces those microplastics and associated chemicals into their bloodstreams.

POLLUTION SOURCES

Where does all this plastic originate? For starters, 65 per cent of plastic waste in Khartoum is disposed of in open dumps. From there, it contaminates water bodies and other parts of the environment. The city's wastewater treatment system is ineffective. The three wastewater treatment plants in Khartoum state, Karary, Wd-Daffiaa and Soba, are outdated and do not meet local and international standards. That means untreated effluent from domestic, industrial and agricultural activities is another probable source of microplastic pollution.

There are also countless recreational sites along the River Nile in Khartoum. The Nile Street is the most popular in the capital city, hosting water sports, restaurants, cafes, clubs, event venues and hotels, as well as the tea ladies (women who serve hot beverages from makeshift mobile cafes along the banks of the river). However, waste disposal and collection practices are sorely lacking, so plastic litter from these leisure activities leaks into the river.

NO EASY FIX

Tackling microplastic pollution is not easy. It will require technological advances, as well as the collective efforts of consumers, producers, governments and the scientific community. As consumers, we need to change our behaviour around plastic products, especially single-use plastics. For example, opt for fabric shopping bags instead of plastic bags; use glass and metal containers. Recycling is also important.

Governments must enforce waste management regulations and improve waste management practices, as well as helping to improve public awareness. Strategies and policies must explicitly feature microplastics.

Scientists can not only fill the knowledge gaps around microplastics. Communicating scientific findings is crucial; so too is developing innovations to protect against microplastics and their harmful effects.

(Dalia Saad, Researcher, School of Chemistry, University of the Witwatersrand, University of the Witwatersrand)

existential pressure on the delta system of the world's longest river, according to a new study. Pollution, coastal erosion and seawater intrusion challenge the sustainability of the delta, on which the population of Egypt rely for food security, noted the document published in the journal *Earth's Future* in March 2023. In this study, the researchers evaluated the levels of heavy metal pollution along the two delta branches of the iconic river to identify their sources and explore the implications of damming on heavy metal concentration.

The current levels of pollution also endanger millions of migratory birds that use the area as a stopover during their journey along the east African flyway, the researchers wrote. They arrived at this conclusion after analysing eight heavy metals — lead, chromium, cadmium, copper, zinc, iron, manganese and nickel — present in samples of sediment collected from the bottom of two branches of the river's delta. These samples were highly polluted, especially by toxic heavy metals such as cadmium, nickel, chromium, copper, lead and zinc. The high concentrations of cadmium, chromium, copper, lead, nickel and zinc are carcinogenic and can adversely affect plant and human health. They can drastically harm plant growth, causing necrosis and chlorosis in leaves and death of the plant as well. Lead can adversely impact human circulatory and cardiovascular systems, while chromium, copper, nickel and cadmium can affect renal and kidney functions.

The Nile brings together 11 riparian countries — the Democratic Republic of the Congo, Burundi, Uganda, Kenya, South Sudan, Ethiopia, Eritrea, Rwanda, Tanzania, Sudan and Egypt. Egypt, the aridest country downstream of the Nile, is undergoing one of its highest water budget deficits. This deficit is compensated by the intensive reuse of wastewater in the Nile delta, the consequences of which have been understudied until now, the researchers revealed. In the absence of proper treatment of recycled water, concentrations of heavy metals may increase and get permanently embedded in the riverbed.

Mega-dams built upstream disrupt the river's natural flow; sediments thus accumulated adversely affect its ability to flush contaminants out into the Mediterranean Sea, leaving

PHOTOGRAPH: ISTOCK

toxins to build up in bottom sediment over time. Alarmingly, much of this contamination by heavy metals is irreversible. However, the study claimed that science-based conservation measures could alleviate environmental degradation and restore the Nile delta's ecosystem to relatively healthy levels.

The researchers underscored the need for more research on the environmental impacts of using untreated water and the change in river turbidity under increased upstream damming. The study highlighted the urgency of addressing water quality in future water management policies to align with Sustainable Development Goals. Mitigation strategies addressing water pollution require increased attention, as low water quality emerges as a critical or even dominant factor contributing to water scarcity in many river basins. Controlling nitrogen pollution is identified as a challenging yet imperative aspect of these strategies. ■

CLIMATE CHANGE

HIGHPOINTS

The circulation of water in the Earth-Atmosphere system has been significantly impacted by climate change and human activities. **Most climate change vulnerable countries are also water-stressed.**

High **water stress** caused by global warming **will displace up to 700 million Africans by 2030.**

Four out of five **African countries** are **unlikely to have sustainably managed water resources by 2030.**

The climate-water link impacts the food production as well. **Heat and water stress can lead to 6-14% food production decline by 2050.**

PHOTOGRAPH: ISTOCK

WATER IN A NEW CLIMATE

Regions in Africa face the greatest expected economic losses from climate-related water scarcity

DEVASTATING LEVELS of hunger following a protracted period of drought had pushed up crime rates in Zambia's hitherto "crime-free" rural areas. The social condition was unprecedented and a cause for concern. Webster Ntambo, a 35-year-old small-scale farmer of Ntambo Village in Chief Liteta's area in Chibombo district shared his horrific experience. Already reeling from hunger, he suffered a double tragedy when thieves broke into his house and stole all he was left with – maize and mielie meal. "They steal anything, even chickens," said Ntambo, a father of two. He planted 10 kilogrammes of seed maize with the hope of harvesting enough for consumption and sale but reaped nothing due to the drought. "I did not get even a tin of maize; not even a cob to roast. I am now stuck as I don't have the capital to start anything."

His 47-year-old sister and the village headwoman, Charity Ntambo, said the recent drought was the worst in her memory. "I have never witnessed this kind of drought before. It is the worst drought I have ever experienced where one can fail to get even one bag of maize,"

headwoman Charity said. She planted 20 kilogrammes of seed and applied eight bags of fertilisers, from which she was expecting a yield of 100 x 50 kg bags of maize but got nothing due to the ongoing drought. "There is serious hunger here. People are trying to survive on garden produce but it has been difficult," Charity said. The grave food crisis has forced women and girls into prostitution to afford a meal, increasing the risk of HIV / AIDS, she added. "Women are failing to feed their children," Ntambo said, adding, "We are hearing cases of women destroying marriages very frequently and parents are also failing to control the girl-child because of hunger in homes. We are trying hard to control the situation but it is difficult."

For Richard Tomati, 61, a small-scale farmer and mechanic of Liteta village in Chibombo district, the devastating impact of drought was unbearable. "People are stealing food. By December (2024), I don't know how the situation will be," Tomati said. He was planning to put a grill door on his traditional outdoor kitchen. Beatrice Malata, the chairperson of Shimbilo Multipurpose Cooperative Society in Chibombo district, said her co-operative had not been spared. "We are witnessing an increase in thefts due to hunger. The police have just arrested a man who stole 24 panels from our cooperative society's solar hammer mill," Malata said. "This is unusual. But it is now becoming common," she said. Victoria Chimfwembe Kaombe, a 72-year-old widow and small-scale farmer from Mwachilele village in Chibombo district, had her three grandchildren taken away from her because she was unable to feed them, leaving her alone. Usually when she harvested 35 bags of maize (50 kg each), she kept 10 aside for food and sold the rest to buy other essentials and fertilisers. But in May 2024, she had nothing. Even the 10 kg beans and five kg groundnuts she had planted gave her no produce because of the intense drought. Kaombe also reported an increasing number of thefts in her village. "They steal anything from mielie meal to chickens, goats and cattle. Those with livestock are guarding them 24X7, not even sleeping." The elderly woman had to relocate her chickens for safekeeping.

Zambia is enduring climate change's impacts on the water resources. Water is not just conditional to life, but is also a conduit to the biggest contemporary threat to life — climate change

She added, "I am now scared of venturing out. They may steal my blankets."

Martin Sishekanu, an agriculture and climate change expert, acknowledged the adverse impact of drought on farming communities. "Two weeks ago, I was in Munyense in Kapiri Mposhi. People are sleeping in their fields because of the fear that their maize crop will be stolen," he said. Water stress could lead to higher cases of livestock diseases as small-scale farmers would be forced to move their animals to places where there was sufficient water, leading to crowding and uncontrolled disease spread, he added. The prolonged drought, the scientist noted, is linked to climate change. It has been observed that as climate change continues to progress with minimal mitigation measures, El Nino is expected to become more frequent and intense, according to the expert.

In March 2024, President Hakainde Hichilema declared the drought a national disaster and announced a wide range of interventions. "The declaration had been necessitated by the destruction of a million hectares of farmland, which had affected over a million households across the country," he said while declaring a national emergency.

Zambia is enduring climate change's impacts on the water resources. Water is not just conditional to life, but is also a conduit to the biggest contemporary threat to life — climate change. Whether it is the planet's changing wind patterns due to warming or the increasing extreme weather events, the climate emergency has disrupted the water cycle. It unfolds before us when we hear about water-related events like floods and droughts. Climate change results in extreme weather events like floods and spells of severe drought. This, in turn, affects water resources. For example, floods damage and contaminate water sources thus making it unsuitable for consumption. Dry spells result in crop losses and waterbodies don't get the usual

THE GREAT RIFT: AFRICA'S SPLITTING PLATES COULD GIVE BIRTH TO A NEW OCEAN, BUT WITH CONSEQUENCES

Evacuation of people and the potential loss of lives will be an unfortunate cost of this natural phenomenon

THE EMERGENCE of a new coastline is on the horizon, but not without its consequences. Scientists, in 2020, predicted a new ocean would be created as Africa gradually splits into two separate parts. The study has been recently picked up by media outlets as well. The division of the continent is connected to the East African Rift, a crack that stretches 56 kilometres and appeared in the desert of Ethiopia in 2005, triggering the formation of a new sea, according to a study published in the peer-reviewed journal *Geophysical Research Letters*.

This geological process will inevitably divide the continent, resulting in currently landlocked countries, such as Uganda and Zambia, obtaining their own coastlines in due time, which would take five to 10 million years, Christopher Moore, a doctoral student at the University of Leeds, told media. While the prospect of a new coastline is undoubtedly exciting, the process will not be without significant repercussions.

The necessary evacuation of people and the potential loss of lives will be an unfortunate cost of this natural phenomenon. However, on the upside, the emergence of new coastlines will unlock a myriad of opportunities for economic growth. These countries will have access to new ports for trade, as well as fishing grounds and sub-sea internet infrastructure, which will undoubtedly transform their economic potential. As the Somali and Nubian tectonic plates continue to pull apart from each other, a smaller continent will be created from the rift, which will include present-day Somalia and parts of Kenya, Ethiopia, and Tanzania. The Gulf of Aden and the Red Sea will eventually flood into the Afar region in Ethiopia and the East African Rift Valley, leading to the formation of a new ocean, according to Ken Macdonald, a marine geophysicist at the University of California, told the media.

This new ocean will result in East Africa becoming a separate small continent with its own unique geographic and ecological characteristics. The three plates — the Nubian African Plate, Somalian African Plate and Arabian Plate — are separating at different speeds. The Arabian Plate is moving away from Africa at a rate of about an inch per year, while the two African plates are separating even slower, about half-an-inch to 0.2 inches per year, according to Macdonald.

WHAT IS RIFTING?

The Earth's lithosphere, comprising the crust and upper part of the mantle, is divided into several tectonic plates that are not stationary but rather move in relation to each other at varying speeds. Tectonic forces not only move the plates but also have the potential to cause them to rupture, resulting in the formation of a rift and potentially leading to the creation of new plate boundaries. Rifting refers to the geological process in which a single tectonic plate is split into two or more plates separated by divergent plate boundaries. This process leads to the emergence of a lowland region known as a rift valley, which can occur either on land or at the bottom of the ocean. These rift valleys occur due to the movement of Earth's tectonic plates, noted National Geographic.

The phenomenon of rifting can be traced back at least 138 million years, when South America and Africa were divided into separate continents, according to a report by UK-based science website IFLScience. In the present day, the gradual separation of the Somali and Nubian tectonic plates is leading to the formation of a rift that could eventually lead to the creation of a new ocean basin. In the past 30 million years, the Arabian Plate has been gradually moving away from Africa, which has already led to the creation of the Red Sea and the Gulf of Aden, according to NBC News. The seismic data obtained by the researchers revealed that similar tectonic processes triggered the rift formation at the ocean's bottom. The crack was located at the intersection of three tectonic plates — the African Nubian, African Somali, and Arabian — that have been separating for some time, added the report.

Although the rifting process has been occurring for some time, the potential division made headlines worldwide in 2018 when a large crack emerged in the Kenyan Rift Valley. This highlights the ongoing process of rifting and its potential for creating a new ocean basin. The movement of tectonic plates is a fascinating geological phenomenon. While it may take millions of years to fully form a new ocean, the potential creation of a new coastline and sub-continents has significant implications for the continent's future. As we continue to study and monitor these changes, it is important to remember the power of the Earth's natural forces and the impact they can have on our planet over time.

CHALLENGES & CONSEQUENCES

Africa is the most impacted region when it comes to displacement, with a larger number of countries affected than any other continent or region. As the plates continue to split in the future, this phenomenon will result in the displacement of communities, settlements and various flora and fauna. These changes will impact their habitats due to climate change, resulting in environmental degradation. Rapid urbanisation and increased settlements will put pressure on natural resources, leading to a scarcity of water, energy and food.

Uncontrolled waste disposal will also be a significant concern. Furthermore, some species will disappear, while others will become endangered due to habitat changes. Rifts showcase a unique topography, distinguished by a chain of depressions bounded by faults and enclosed by elevated terrain. While the process of rifting may often go unnoticed, the separation of the Nubian and Somali plates can result in the formation of new faults, fissures and cracks or the reactivation of pre-existing faults, leading to seismic activity.

Additionally, the close proximity of the hot molten asthenosphere to the surface causes volcanism, further displaying the ongoing process of continental breakup. Several planetary transformations are occurring, primarily as a result of climate change. Devastating weather patterns owing to global warming are altering landscapes and rising sea levels. Although human displacement is not new, climate change exacerbates gradual and abrupt environmental crises by increasing their intensity, frequency and scope. Over a span of ten million years, seafloor spreading will gradually advance along the entire extent of the rift. This will lead to the flooding of the ocean, resulting in the African continent becoming a smaller, significant island composed of fragments of Ethiopia and Somalia, including the Horn of Africa. Although rapid occurrences such as the sudden splitting faults may lend a sense of urgency to continental rifting, the process itself is extremely slow and can go unnoticed most of the time as it progressively splits Africa.

water refills. Zambia is a water-rich country with annual rainfall in the range of 700 mm in the south and 1,400 mm in the north. The country's water endowment is more than enough to meet the country's water demands. However, there are significant variations across the country, and a strong seasonal distribution leading to water deficits. With increasing dry spells the situation becomes worse, particularly for a country that is primarily rain-fed. "Life in Zambia is becoming increasingly precarious, because climate change is unleashing more floods, droughts, and unpredictable rainfall," said Mark Smith, International Water Management Institute (IWMI)'s Director General. According to IWMI, "Drought is one of the most threatening natural hazards due to its creeping and invasive nature, which exacerbates existing systemic vulnerabilities, creates new risks and consequentially manifests as multi-dimensional hindrances to sustainable development. In Zambia, drought is a recurrent problem. Events in 1991–1992, 2015–2016, 2019–2020 and 2021–22 were particularly damaging, affecting millions of people due to crop failures, food and water shortages, livestock deaths and reduced GDP." Three of the eleven global water stress hotspots are in Africa. In the past 50 years, drought-related hazards in the region have claimed the lives of over half a million people and caused over $70 billion in losses.

Global warming has been more rapid in Africa than the rest of the world, according to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Average annual maximum temperature in northern and southern Africa is likely to be close to 4°C above normal, according to regional projections in the report released on August 9, 2021. The median temperature in these regions will rise 3.6°C when the Earth warms at 2°C above pre-industrial levels, predicted the group of scientists who authored the report. The annual minimum temperature is also projected to increase by over 2°C in some parts of northwestern Africa, the analysis showed. Southern Africa will also see a rise in minimum temperature. This will lead to warmer cold days in the future, according to the authors of the IPCC report.

Monsoon precipitation is projected to increase over Central Sahel and decrease over the far western Sahel. The monsoon season is projected to have a delayed onset and a delayed retreat, as stated in the report. At 2°C global warming, precipitation is likely to increase by 5-40 per cent in the Sahara, including parts of the Sahel. There has been an increase in monsoon precipitation during the 20th century due to warming from greenhouse gas emissions, noted the IPCC report. But this has been masked by the decrease due to cooling from human-caused aerosol emissions. West and Central Africa is likely to experience heavy precipitation and

pluvial flooding.

Several reports have noted the particular vulnerabilities of African populations to climate change. As World Food Programme (WFP) Executive Director David Beasley said "while the region has contributed nothing to climate change, it is paying the highest price." An analysis by Washington DC-based Brookings Institution said that seven out of the 10 most climate vulnerable nations in the world are located in Africa. Warming in Africa has exceeded the limits of natural variability. According to the earlier IPCC report (Assessment Report 5, AR5), the near surface temperatures had risen by 0.5°C over the past century. Despite the size and geographical spread of Africa, the only exception to the observed heating trend comes from the central and interior regions of Africa. But even here, there are problems. "It is very likely that mean annual temperature has increased over the past century over most of the African continent, with the exception of areas of the interior of the continent, where the data coverage has been determined to be insufficient to draw conclusions about temperature trends," said AR5. By the end of the century, most models show that temperatures across the continent under the "business-as-usual" scenario will be about 3-6°C higher than the average temperature observed at the end of the 20th century, which is already close to being 0.5°C more than average temperatures at the beginning. AR5 noted that the maximum change in temperature by the end of the century is likely to occur in the northern and southern parts of the continent. But the fastest rate of change is expected to occur on the western side. "However, in the tropics, especially tropical West Africa, these unprecedented climates are projected to occur 1 to 2 decades earlier than the global average because the relatively small natural climate variability in this region generates narrow climate bounds that can be easily surpassed by relatively small

The Middle East and North Africa region faces the greatest expected economic losses from climate-related water scarcity— estimated at between 6 per cent and 14 per cent by 2050

climate changes," said the AR5. While the AR5 regional profile has singled out Ethiopia and parts of eastern Africa for higher incidences of heat waves, more recent studies have suggested that the problem is likely to affect the entire continent. A study published in *Environmental Research Letters* in 2016 found that even modest warming of 2°C in global average temperatures would be enough to make heat waves a completely normal occurrence. Since Africa is situated between the Tropics of Capricorn and Cancer, it is likely to be the worst affected. "The MENA [Middle East and North Africa] region faces the greatest expected economic losses from climate-related water scarcity— estimated at between 6 per cent and 14 per cent by 2050," stated Ferid Belhaj, World Bank Vice President for the Middle East and North Africa, in a press release on August 23, 2021. But more than that, it has pushed Africa into a vicious circle of poverty, water and disease.

The circulation of water in the Earth-Atmosphere system has been significantly impacted by climate change and human activities, according to the World Meteorological Organization (WMO). The effects on the hydrological cycle are leading to droughts and extreme rainfall events and the erratic water cycles unleashed widespread disruption, burdening livelihoods and economies. The ongoing melting of snow, ice and glaciers compounded the threat, exacerbating the risk of extreme weather events such as floods. These events cast long-term consequences on the water security of millions, warned WMO's "State of Global Water Resources 2022" report, released in October 2023. The findings of the report are critical, as nearly four billion people are already experiencing severe water scarcity for at least a month every year.

High water stress caused by global warming will displace up to 700 million Africans by 2030. It will also aggravate conflicts on the continent, according to "State of the Climate in Africa 2021" published jointly by WMO and the African Union Commission. The warming is causing extreme weather events such as lingering droughts and devastating floods that is

CLIMATE CHANGE AND WATER: WISE OLD WAYS

We need to tweak traditional methods to tackle climate change

BIKSHAM GUJJA

TRADITIONAL WATER management systems, such as tanks, wells and ponds, had inbuilt sustainability and stood the test of time. Sound on knowledge, these were designed for multi-functions but could not meet the growing human needs. Their inbuilt sustainability needs to be brought back through different designs and interventions. This is a challenge.

Growing water needs of humans led to rapid extraction of surface and ground water. This put pressure on the traditional systems and they started disappearing. Where once wells, tanks and ponds stood, we now have apartments. Fragmentation of land, increase in land prices and urban expansion swallowed public and private spaces. Not that everything has been lost.

But whatever has remained has been altered and is no longer traditional or serves the purpose for which it was built. The realisation that these systems need to be revived led to many projects. Governments allocated a lot of money to protect whatever remained. There are many support groups and lobbies to protect, revive and even expand these systems. The results, however, have been mixed and it is difficult to say how much the programmes have contributed to solve the water crisis.

Moreover, it is beyond the scope of traditional water management systems to solve the problems posed by climate change, which are of a different scale. Wherever they still exist, however, the systems can help communities adapt to the impact of climate change at local levels.

Thanks to the efforts of civil society organisations in the past two-three decades, there is awareness for protecting, restoring and revitalising traditional waterbodies across the country. In rural India, while the net area and role of traditional systems in meeting water needs has declined, there are many projects to restore them. Urban spaces too are increasingly creating provisions for water storage systems including treatment plants.

There is an interest to protect the water structures that have survived in the neighbourhood. Households now want to build structures to store rainwater with or without government support. There are several products in the markets to help households save, treat and reuse water.

These initiatives will contribute to reducing water demand and governments are incorporating them in the standard guidelines for high-end building projects. To what extent these will address the problems of climate change is difficult to say, but they surely reflect people's awareness about the need of local water storage in addressing the global problem. The underlying concept of re-using and storing water built in the traditional systems can be a great help in designing interventions to deal with the much bigger challenge of climate change and its impact on our water resources.

(Founder of AgSri Agricultural Services Private Limited.)

hitting African communities, economies and ecosystems hard. The warming has caused a disruption in the pattern of rainfall. Glaciers too are disappearing, the report said. Mount Kenya, Mount Kilimanjaro (Tanzania) and the Rwenzori mountains (Uganda) are retreating at a faster rate than the global average. Kilimanjaro could vanish by 2040 due to climate change, the WMO had warned in the State of the Climate in Africa 2020. But, the existence of these glaciers in east Africa depends on the amount of future precipitation that falls on the region. Africa's freshwater lakes have shrunk. The total surface area of Lake Chad shrunk to 1,350 square kilometres in the 2000s, from 25 000 sq km in the 1960s. Lake Chad, which is located in the Sahel region at the conjunction of Nigeria, Niger, Chad and Cameroon, is home to 17.4 million people. These countries of the Lake Chad basin are among the 10 least peaceful countries in Africa, according to the "Global Terrorism Index" report, 2020. "The drying up

of continental water bodies like Lake Chad has significant adverse impacts on the agricultural sector, ecosystems, biodiversity and socioeconomic development," said Petteri Taalas, secretary-general of WMO.

In West Africa, the WMO report of 2020 has attributed long-term decline in river flow to increase in temperature, drought, and increased water demand. Four out of five African countries are unlikely to have sustainably managed water resources by 2030, the report, which has a special focus on water, noted. Increasing demand and decreasing supply of water might worsen conflict, it said. This will result in Africa not being able to meet the United Nations-mandated Sustainable Development Goals (SDG) by 2030. Going forward, it will be very difficult for the continent to achieve goals on sustainable development unless actions are taken to address water-related concerns, the report said. Poor progress on water security will impact at least three SDG goals — poverty alleviation (SDG 1), green energy (SDG 7) and disaster risk reduction (SDG 11).

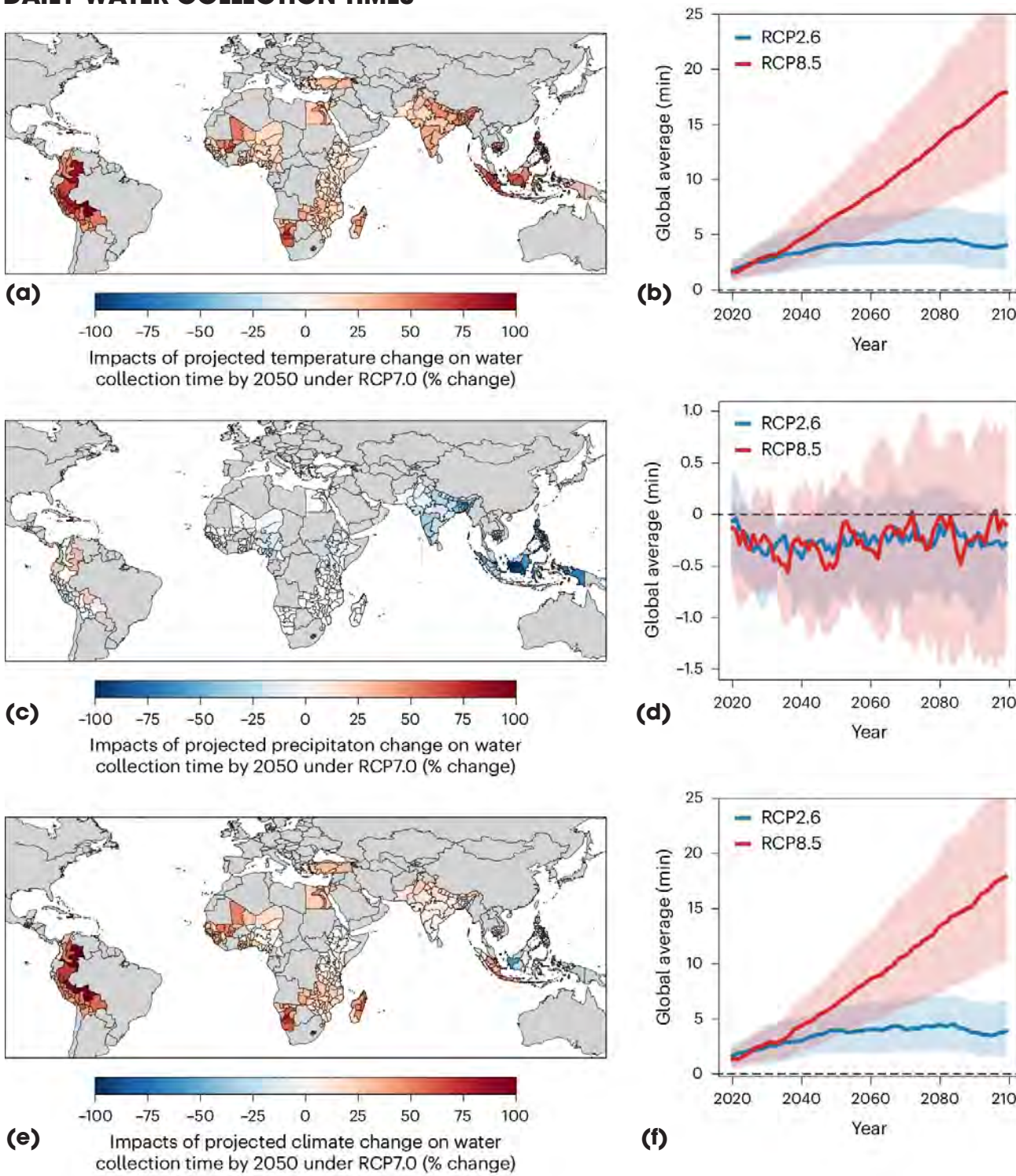
In 2021, Africa was hit by a number of high-impact events. For example, South Madagascar experienced its worst drought in four decades. Madagascar, blessed with abundant water, underwent a change in its hydrological cycle due to global warming, leading to drought and famine. In North Africa, several episodes of heatwaves and record high temperatures were seen "The worsening crisis and looming famine in the drought-stricken Horn of Africa shows how climate change can exacerbate water shocks, threatening the lives of hundreds of thousands of people and destabilizing communities, countries and entire regions," Taalas said.

Historically, a 1 °C temperature rise increased daily water collection times by 4 minutes. Reduced precipitation historically increased water collection time, most strongly where precipitation levels were low or fewer women employed. Accordingly, due to warming by 2050, daily water collection times for women without household access could increase by 30% globally and up to 100% regionally

Philip Kofi Adom, environment and energy economist, said that 50 million people in Africa would be pushed into water distress due to climate change. He explained, "It means severe water shortages in homes and industries. For example, if you used to have access to water all day, you are going to have a much lower supply — a quantity so low that it does not meet your needs. This is a demand and supply issue. There will be higher demand for water resources but because of the short supply, water prices will shoot up. Going into the future, if nothing is done, water across Africa will be very expensive."

Robert Carr, Maximilian Kotz and Leonie Wenz of the Potsdam Institute for Climate Impact Research, Member of the Leibniz Association, Potsdam, Germany, studied the effect of climate conditions on self-reported water collection times for 347 sub-national regions across four continents (including Africa) from 1990 to 2019. "Historically, a 1 °C temperature rise increased daily water collection times by 4 minutes. Reduced precipitation historically increased water collection time, most strongly where precipitation levels were low or fewer women employed. Accordingly, due to warming by 2050, daily water collection times for women without household access could increase by 30% globally and up to 100% regionally, under a high-emissions scenario," found their study that was published in journal *Nature* in June 2024. In the study, the authors mentioned that in usual time in eastern and southern Africa people spent 30 and 60 minutes respectively on water collection. "For regions in eastern and central Africa with the highest baseline water collection times, temperature rises in a high-emissions scenario would still cause increases of between 20% and 40% (by 2050)," said the study. "Most regions in Africa appear also to benefit, generally seeing reductions in water

THE EFFECTS OF PROJECTED CHANGES IN TEMPERATURE AND PRECIPITATION ON DAILY WATER COLLECTION TIMES



a,c,e, The impacts by region in 2050 under the high-emissions scenario RCP8.5, expressed as a percentage of the historical water collection time. b,d,f, The globally averaged impacts on daily water collection times in minutes for both the low-emissions (RCP2.6) and high-emissions scenario (RCP8.5) over time. Central estimates show the median and shaded areas show the likely range based on the Intergovernmental Panel on Climate Change (IPCC) likelihood classification reflecting a 66% chance. Uncertainty is derived from a Monte-Carlo procedure, which samples from the uncertainty of the empirical regression shown in Table 1 and from the 21 physical climate models from CMIP-6. a–f, The impacts of temperature (a,b), precipitation (c,d) or both temperature and precipitation combined (e,f). a,c,e, Impacts are estimated from climate changes smoothed with a 30-year running mean to show the impacts of long-term changes. b,d,f, They are shown after smoothing with a 5-year running mean to show variations at shorter timescales (Methods).

Source: "Climate change to exacerbate the burden of water collection on women's welfare globally", *Nature Climate Change*, June 21, 2024

collection time between 0 and 20%, with the exception of coastal regions in western Africa (up to 30% increases) and most of Namibia and Zimbabwe (up to 20% increases)," the study further explained.

For many countries, it is a double whammy: most climate change vulnerable countries are also water-stressed. UNICEF has been highlighting the links between climate vulnerability and water scarcity. Lack of monitoring of water, sanitation and hygiene (WASH)-related programmes, projects and policies in a third of the developing nations is a major factor driving water insecurity in the world's worst-impact countries, said UNICEF's report "Triple Threat", released in March 2023. It analysed 10 African countries where children were most affected by the convergence of three water-related threats: Inadequate water, sanitation and hygiene; related diseases; and climate hazards. The report, released just ahead of the UN Water Conference (March 22-24, 2023), called for urgent investment in WASH services to protect children. The 10 African countries facing this triple burden are Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria and Somalia — all in sub-Saharan Africa — with a combined population of 190 million children, according to the Children's Climate Risk Index 2021 by UNICEF. They are the world's most water-insecure and climate-impacted countries, experiencing water scarcity and conflicts, heat waves, flooding and cyclones. They are within the top 25 per cent of the developing countries in terms of exposure to climate and environmental hazards, shocks and stresses. They are also not on track to meet the SDGs target of universal access to basic WASH services by 2030.

For many countries, it is a double whammy: most climate change vulnerable countries are also water-stressed. UNICEF has been highlighting the links between climate vulnerability and water scarcity. Lack of monitoring of water, sanitation and hygiene (WASH)-related programmes, projects and policies in a third of the developing nations is a major factor driving water insecurity in the world's worst-impact countries

The climate-water link impacts the food production as well. Heat and water stress can lead to 6-14 per cent food production decline by 2050, correspondingly increasing the number of people with severe food insecurity by up to 1.36 billion compared to 2020, researchers have established in a new research study. Due to this, regions like China and ASEAN countries can become food importers from being net food exporters by 2050. The report "Global impacts of heat and water stress on food production and severe food insecurity", published in June 2024 in the journal Scientific Reports of the science weekly Nature, showed a decreasing trend of food production as a percentage reduction in 2050 from 2020 for different climate change scenarios.

A decrease in agricultural output causes a reduction in global food production that, in turn, increases the number of people with severe food insecurity. In India, in the worst-case scenario of climate change, food production was projected to fall by 16.1 per cent in 2050 as a result of both water and heat stress. In China, it would fall by 22.4 per cent and in the United States by 12.6 per cent. In Africa, food production was projected to decline by 8.2-11.8 per cent, 14.7 per cent for Australia and 19.4 per cent for some parts of Central America.

Globally, the number of additional people with severe food insecurity by 2050, relative to 2020, can increase between 556 million and 1.36 billion. Already, nearly 282 million people faced high levels of acute food insecurity in 59 countries in 2023, with extreme weather being the second-most significant factor driving the food crisis, according to the 2024 Global Report on Food Crisis released in April 2024. In fact, for four consecutive years, the proportion of

CLIMATE CHANGE AND WATER: FIRST VICTIMS

Research is needed to understand the social dimensions of the affected because it has the potential to shift the trajectory of the climate change debate

JULIE DROLET

CLIMATE CHANGE is affecting individuals, families, communities, societies and systems around the world. The impacts of climate change are being felt across many social, economic, environmental and political systems.

Climate change is contributing to more intense and frequent extreme weather events. Wildfires, floods, storms, extreme precipitation, drought, and extreme heat are among the most serious. Many extreme weather events contribute to increased stress on water supplies, particularly in drought conditions.

Many local governments, civil society organisations, and private sector businesses are developing plans to better prepare for more extreme weather and their social, economic and environmental impacts. At the same time, individuals are being encouraged to become more resilient in the advent of environmental disasters. Yet, resilience is not fixed or static, and can change over time depending upon the context and social environment.

Governments will continue to play an important role in providing support for services and programmes that can help individuals adapt to the effects of climate change, participate in climate transitions and engage in climate change mitigation.

Wildfires have become annual events that result in the loss of critical infrastructure, people's homes and community spaces with devastating social, economic and environmental impacts for communities. In Western Canada, it is proving very difficult for affected communities to rebuild and recover following wildfires, particularly as the recovery process intersects with the economy, health and mental health impacts, and social processes.

Given the long-term impacts of disasters on individuals and communities, there is a need to rethink how communities are supported. The 2019-2020 bushfires in Australia, fuelled by drought and high temperatures, captured the world's attention as the impacts of climate change on humans and animals were portrayed in society.

The impacts of climate change and disaster are experienced differently by men and women due to their gender roles and relationships in society. Women's caregiving roles in the household and community are affected by climate change effects on their livelihoods and resources. Women's experiences and perspectives on climate change are critical to inform climate change adaptation and mitigation policies at the local and global levels.

The impacts of climate change are experienced in communities, and the role of place has emerged as an important consideration in developing sustainability policies and recovery plans. Community members value the natural and physical environment, which are changing due to the impacts of climate change and related disasters.

People's sense of belonging and attachment to place is an important consideration that can inform climate change policies and sustainable development initiatives.

Forced migration and environmental displacement due to climate change is taking place in many parts of the world, particularly in Africa and Asia, with implications for the most vulnerable and marginalised in society. While migration is a climate adaptation strategy, it also presents challenges for all involved, from those displaced to host societies.

According to *Springer Nature*, 2019: "Estimates for the number of environmental migrants by 2050 range from 25 million to 1 billion …" Thus, climate change as a push factor and driver of migration is expected to increase in the coming years. Small Pacific islands affected by sea level rise will face migration as fresh water becomes contaminated by seawater.

Acts of civil disobedience are on the rise due to climate change. In Canada, indigenous and non-indigenous people who oppose the Coastal GasLink natural gas pipeline through indigenous territory in Northern British Columbia have effectively used blockades to disrupt rail traffic.

Ideological tensions have resulted in a polarised political and economic climate between oil and gas supporters, and environmental groups, during a time when climate change action is urgently needed. The youth-led climate strikes in 2019-2020 represent a new voice in climate activism. The Global Strike brought thousands of participants into the streets on every continent for global climate protests.

As children and youth demand action on climate change, the message is on the human — environment

connection with a focus on the most vulnerable people in society. As the impacts of climate change are experienced, there is a need for greater collaboration and partnerships to explore how to better facilitate a "just transition".

The United Nations Sustainable Development Goals, 2019, indicates: "The impacts of climate change will not be borne equally or fairly, between rich and poor, women and men, and older and younger generations." It is critical to consider how social, economic and environmental justice can be advanced using a human rights approach.

Greater attention is needed on the social dimensions of climate change, which are related to the experiences of people and communities, and how to best meet the needs of those most vulnerable and marginalised. Research is needed to better understand and address these social dimensions, which has the potential to shift the current climate change discourse.

(Professor, University of Calgary).

people facing acute food insecurity has remained persistently high at almost 22 per cent of those assessed, significantly exceeding pre-COVID-19 levels.

Weather extremes were the main driver for 18 countries, with over 72 million people facing high levels of acute food insecurity because of such extreme weather events. The month of May 2024 ended up being the warmest May on record globally for land and ocean surfaces combined, following the trend of the last 11 months, all of which broke monthly temperature records since the pre-industrial period. In fact, June is set to continue this streak of record-breaking temperatures; if it does, the month would have broken its temperature records two years in a row. In terms of prices and trade flows (exports and imports), the results of the research showed substantial increases in food prices overall, especially, for the most extreme warming scenario and in regions with high water stress. "Our results show an increased flow of trade in agricultural commodities from low to high water stress countries and regions, given (in part) by the relative regional food price changes," said the research.

CLIMATE CHANGE AND WATER SCARCITY

The erratic climate fuelled by global warming will lead to a disrupted water-cycle. This in turn will impact agriculture resulting in food scarcity. Global food production patterns would be fundamentally altered by climate change, causing food insecurity because of small shifts in seasonality and water availability, according to the "World Water Development Report" released by the United Nations on March 22, 2020. An increase in food prices would increase rural poverty, the report said. The impact of regional precipitation patterns on four major crops – wheat, soybean, rice and maize – was already projected to emerge by 2040, according to an article published by *journal Proceedings of the National Academy of Sciences* of the United States of America in May, 2019. Portions of land used to cultivate these crops in some countries would witness permanently drier conditions, whereas in others, similar land portions would face permanently wetter conditions from climate change, the report said, quoting the article. Land currently dedicated for wheat cultivation in India, for example, would get more precipitation between 2020 and 2060, under present trends in greenhouse gas (GHG) emissions. In land areas of countries like Mexico and South Africa, however, 87 and 99 per cent of the land, respectively, would receive less precipitation.

The tropics and the north would become wetter, while parts of Africa, the Americas, Australia and Europe would become drier, the report's projections showed. Longer-term shifts in temperature and precipitation and day-to-day weather variations within the next 50 to 100 years would increasingly expose agriculture and impact food security, the report points out. Major agricultural systems the world-over — including the semi-arid Indian subcontinent and the Mediterranean region in North Africa — were highly vulnerable to climate impacts.

Increased rainfall, drought and flooding coupled with higher temperatures were the climate change drivers that the monsoonal Indian subcontinent would witness. The climate change drivers include 20 years of increasing flows, followed by substantial reductions in surface water and groundwater recharge, changed seasonality of runoff and peak flows, increased peak flows and flooding, increased salinity and declining productivity. The Indus and Ganga-Brahmaputra agricultural systems would face limited room to adapt to climate

PHOTOGRAPH COURTESY: WORLD FOOD PROGRAMME

change in the first instance, the report said. The vulnerability to climate change in these systems is "very high" and "high", respectively. Non-monsoonal sub-Saharan Africa was also categorised with a "very high" vulnerability, according to the report. The region would witness declining yields because of increased rainfall variability and more frequent droughts and floods. Increased volatility of precipitation and rainfall in particular (intensity, duration and frequency), would challenge adaptive responses in some of the most productive agricultural systems, according to the report.

In October 2021, various United Nations bodies made an urgent appeal to countries to make water an integral part of the fight against climate change on the wake of the Conference of Parties (COP 26) to the UN Framework Convention on Climate Change (UNFCCC) in Glasgow. A letter addressed to heads of countries by agencies like World Meteorological Organization, World Health Organization, Food and Agriculture Organization, IFAD, UNESCO, UNICEF, United Nations Environmental Programme, UN University, the UN Economic Commission for Europe and the Global Water Partnership (GWP), said: "Accelerated action is urgently needed to address the water-related consequences of climate change that impact people and the planet." The UN agencies quoted an earlier unicef report that over one-third of the world's child population were severely exposed to water scarcity. It added, "The UN World Water development Report 2020 emphasises that water is the 'climate connector' that allows for greater collaboration and coordination across the majority of targets for climate change (Paris Agreement), sustainable development (2030 Agenda and its SDGs) and disaster risk reduction (Sendai Framework)." The UN agencies appealed to countries to "address more effectively, the water dimensions of climate change adaptation and mitigation, as provided for in an UN-agreed framework to accelerate progress towards Sustainable Development Goal 6."

They said as a priority countries should "integrate the water and climate agendas at a national level through national adaptation and resilience planning and at the regional level, through transboundary cooperation." This is one of the seven "urgent priorities" that the UN agencies have flagged for countries to take up. As weather-related disasters strike countries with greater frequency due to climate change, the lack of meteorological infrastructure like early warning systems add to the woes. One of the seven priorities suggested in the letter is to "encourage universal access to timely warnings about water-related disasters to help save lives and protect livelihoods.". ■

LAKES

HIGHPOINTS

Africa has 677 lakes, out of which 88 are listed as principal lakes. **Three of the 10 largest freshwater lakes on Earth, in terms of area and volume, are located in Africa.**

Lakes in Africa are of immense economic values. **Lake Malombe of Malawi gives ecosystem services worth US$ 124.36 million/ year** - nearly 2% of national GDP.

Climate change is causing flooding of lakes leading to crop loss and massive migration of people.

Pollution of lakes across the continent is a big concern. **High levels of contaminants negatively impact the aquatic ecosystems** and also the economic activities like declining fishery.

PHOTOGRAPH: ISTOCK

A LITANY OF GRIEVANCES

Lakes are in trouble globally, particularly in Africa

IN JUNE 2023, the United Nations High Commissioner for Refugees (UNHCR) said there were approximately 11.71 million Internally Displaced Persons (IDPS) in East and Horn of Africa and the Great Lakes (EHAGL) region as of March 31, 2023. The IDP population mainly in Burundi, Ethiopia, Somalia, South Sudan and Sudan was estimated at 75,300, 2.73 million, 3 million, over 2.23 million and over 3.7 million people respectively. The drivers of displacement are complex and varied. Some are conflict, climatic and natural disasters. In East Africa's Burundi, the majority of the displacements were due to climate-related incidents like violent winds, torrential rains and flooding. In recent years, the large and rapid rise of Lake Tanganyika caused over 84 per cent of the country's internal migration. Burundi is globally one of the 20 most climate-vulnerable countries.

Lakes are the new battlegrounds in Africa. They are impacted by climate change; face massive degradation; and increased pressure from rising population growth. Mathew Herrnegger, a senior scientist at the Institute of Hydrology and Water Management (HyWa), University of

Natural Resources and Life Sciences, Vienna, recently studied the Kenyan lakes in the East African Rift Valley on why water levels were rising. "The Kenyan lakes in the Rift have witnessed significant water level increases. Recent increases in lake areas range from 21 per cent for Lake Naivasha to 123 per cent for Solai. Homes, schools and hospitals have been flooded. A Kenyan government report estimates that about 80,000 households — 400,000 people — have been affected by the floods since 2010," Mathew observed. The study brought out how the lake ecosystem is undergoing changes and impacting local livelihoods. It said, "Human activity and changes in underground permeability have been advanced before to explain the lake level rises. The results of our study illustrate that surprisingly minor changes in the water balance are enough to explain the lake level rises. An increase of only 0.4-2 per cent of mean annual effective rainfall leads to the observed phenomena." Mathew and co-researchers found that lakes are changing fundamentally. Kenyan lakes showed low fluctuations and smaller water areas between 1984 and 2010, which have increased dramatically since 2010, the study concluded. For instance, Lake Baringo had a water area of 118km² in 1995, the lowest value from 1984 to 2020. The water area expanded by over 52 per cent in the years 2014 and 2020 to reach 195km. The water area of Lake Solai, a smaller and less-known lake south of Lake Bogoria, increased from 3km in 1984 to nearly 12km in 2014 and 2020, a four-fold increase. The Eastern Africa region has witnessed intermittent spells of drought as well as wetter periods in the past. Mathew's study said fluctuations in lake water levels were not unusual. But, he said, "What is new is the immediate risk posed by rising lake levels. Compared to the past, much higher population densities around the lakes put more people, their homes and their crops in danger."

In June 2023, another evaluation of lakes in East Africa warned that heavy rains, wind storms, and floods threaten the survival and water access of the communities living in the Lake Victoria Basin (LVB). The scientific report, published in the journal *Nature*, showed significant

Lakes are changing fundamentally. Kenyan lakes showed low fluctuations and smaller water areas between 1984 and 2010, which have increased dramatically since 2010

precipitation changes and increasing extreme climate events in the near future of the already sensitive region, affecting both its large human populations as well as endemic biodiversity. One of the largest freshwater lakes and fisheries in the world, LVB's 40 million inhabitants are strongly affected by extreme weather events such as regular flooding. In late 2019 and early 2020, Lake Victoria's water levels were observed at an unprecedented high. The massive flooding that followed in lake-adjacent areas displaced over 200,000 people in Kenya, Uganda and Tanzania. These are three of the five countries that the LVB covers, also including Burundi and Rwanda.

Lake Victoria and its surrounding wetlands and forests have faced extreme pressure and degradation due to rapid population growth, agricultural expansion, urbanisation and industrialisation. This pressure is only heightened due to LVB's modified equatorial climate: Warm and humid with long rains from March to May and short rains from October to December. Most of the recharge into Lake Victoria is from regional rainfall as the lake is fed by 23 rivers. Kagera, the largest of these, runs through Rwanda and Burundi before emptying into the lake. Regional rainfall is what regulates the water levels in the lake. The report, titled "Extreme climatic events to intensify over the Lake Victoria Basin under global warming", presented an analysis of future precipitation patterns over the LVB. The study computed mean annual and seasonal (March-May, June-August and October-December) precipitation values over the study domain. Findings suggested that significant precipitation changes were likely to occur over the LVB at the sub-seasonal scale rather than seasonal and annual. It showed an overall increase in mean daily precipitation intensity for all seasons, with more changes during the end of the century period (potential increase by 16 per cent) than the middle of the century period (potential increase by six per cent).

In the 2050s, precipitation over the study domain would increase by about five per cent for mean annual and seasonal relative to the 1985-2014 baseline periods. These changes will

CLIMATE IMPACT JEOPARDISING DELICATE BALANCE OF LAKE NATRON

Extreme weather is causing frequent flooding, compromising the lake's salinity, according to the ecologist. "The reduction in salinity

TO PROTECT Tanzania's flamingos, comprehensive and coordinated efforts are required. Conservationists advocate for stricter environmental regulations and increased public awareness. Millions of pink flamingos transform the alkaline waters of Lake Natron in northern Tanzania into a dazzling sea of fluttering feathers every day. This enchanting display, however, is under threat. Human activities and changing weather patterns are threatening the world's largest migratory bird colony, prompting environmentalists to issue a warning.

Africa's Great Rift Valley is home to some of the world's most dangerous lakes. Lake Natron in Tanzania and Lake Bogoria in Kenya are hostile to most forms of life, with surface temperatures soaring up to 40 degrees Celsius. However, these are perfect habitats for flamingos. These lakes, filled with caustic soda and hypersaline water, deter most predators but provide an unexpected haven for fascinating migratory birds.

Lake Natron, a Ramsar site on the Tanzania-Kenya border, has a unique composition of warm waters and salt, caustic soda, and magnesite deposits that provide ideal conditions for flamingos to thrive. However, this delicate equilibrium is increasingly being upset. Several factors, including agriculture, pollution, and climate change, are threatening the beauty of this unique ecosystem, according to John Sule, a senior ecologist. "Climate change is altering water levels and salinity, making it harder for flamingos to find suitable nesting sites. The population of flamingos on Lake Natron is steadily declining as fewer birds return each year due to extreme weather and encroachment," he said.

Extreme weather is causing frequent flooding, compromising the lake's salinity, according to the ecologist. "The reduction in salinity disrupts the growth of specific algae that serve as a food source for flamingos. The birds' feeding patterns and breeding success are being adversely affected, posing a serious threat to their population," said Sule. Conversely, prolonged dry seasons are also causing water levels to drop dangerously, concentrating the lake's salinity beyond what algae can tolerate and resulting in flamingo food shortages. In 2006, an Indian company proposed a soda ash extraction project at Lake Natron, which sparked global outrage and was ultimately abandoned in 2008. The threat, however, persists.

"Flamingos are incredibly sensitive to changes in their environment," said Edmund Shayo, an environmental

PHOTOGRAPH: ISTOCK

activist specialising in bird habitats. "The rising water levels are diluting the soda lakes, which drastically affects the cyanobacteria that flamingos feed on." According to Shayo, mining activities near the lake are detrimental to the birds. "The disruption caused by mining activities would most likely force them to abandon the lake. Flamingos need a quiet and undisturbed environment for nesting and any significant disturbance could drive them away, threatening their ability to reproduce and sustain their population," he said.

COMMUNITY EFFORTS

Despite the challenges, local communities are actively working to protect their pink-feathered neighbours. Yohanna Mlai, a resident of Magadini village, believes that education plays a crucial role in these efforts. By teaching pastoral communities about sustainable water practices, they aim to ensure that the lake remains a viable habitat for both flamingos and the people who depend on it. This initiative is helping to balance the needs of wildlife with those of the local human population, fostering a sense of stewardship and coexistence.

"The importance of Lake Natron's flamingos extends beyond their ecological role. They are a major attraction, drawing thousands of tourists every year," Mlai said. Tourism accounts for 17.2 per cent of the country's gross domestic product and 25 per cent of foreign exchange revenues. Flamingos' struggle for survival in Tanzania is part of a broader global pattern. Across Africa's Great Rift Valley, flamingos face similar threats at other critical breeding sites. Rising water levels and invasive plant species, fueled by climate change, are disrupting these habitats. "These birds are vital environmental indicators," said Flower Msuya, a marine biologist at the University of Dar es Salaam. "Their well-being is a reflection of the overall health of the ecosystem. When flamingos face difficulties, it indicates larger environmental issues that must be addressed."

To protect Tanzania's flamingos, comprehensive and coordinated efforts are required. Conservationists advocate for stricter environmental regulations and increased public awareness. "Protecting these birds requires a holistic approach," said Msuya. "It's about preserving their habitat, controlling pollution, and ensuring that any development around the lake is sustainable. Communities must be at the forefront of conservation efforts. Their involvement and cooperation are crucial for any long-term success." We must act now, urged Sule. "If we don't address these issues, we risk losing one of nature's most spectacular phenomena," he said.

significantly impact the region, which already sees water and water resource conflicts. The study recommends use of climate services to minimise the risk posed by the projected changes and ultimately, enhance the socio-economic wellbeing of communities in the LVB. It also showed high impacts on LVB's fish and other biodiversity. This is in addition to a previous report by the International Union for Conservation of Nature (IUCN) which warns that 76 per cent of the lake's endemic biodiversity faces the threat of extinction.

In 2021, the United Nations Environment Programme (UNEP) warned that lakes were in fact staring at a wetter future which threatens livelihoods and also can trigger migration. For instance, consider Lake Turkana, the world's largest desert lake in the arid northern region of Kenya. This lake has been predicted to be "dead" in near future as its river inflows have been drastically curtailed due to a large number of dams being built upstream. Since 1988, Ethiopia has built a series of hydroelectric dams on its main tributary, the Omo River, leading to predictions of Lake Turkana's demise.

The new UNEP study has predicted that in the next two decades climate change would result in more intense rain over Lake Turkana thus raising its levels and also causing severe flooding. This could impact the 15 million people who live on the lake shores. UNEP warned governments in Kenya and Ethiopia (both share a border with the lake) that rare floods like the ones that hit the region in 2019 and 2020 would be regular occurrences. According to the UNEP scientific study that used water resources modelling and climate change scenario analysis, "up to eight human settlements around the lake could be inundated by flooding periodically. While severe, abrupt flooding has been rare, climate change projections foresee this becoming more regular and impacting more people if adaptation measures are not put in place." "Many people think that climate change is a problem for the future," said Frank Turyatunga, Deputy Head of UNEP's Africa Office adding, "But as Lake Turkana shows, it's happening now and it's already forcing people to adapt to new conditions." There is still a mindset in Kenya that lake water levels are constantly falling, which makes planning difficult, said Tito Ochieng, Director of Water, Turkana County. "In the last two years, rising water levels in Lake Turkana have damaged pastureland,

AFRICAN COUNTRIES WITH THE HIGHEST NUMBER OF LAKES

Rank	Country	Number of Lakes	% of total number of lakes in Africa
1	Uganda	69	10%
2	Kenya	64	9.5%
3	Cameroon	59	8.7%
4	Tanzania	49	7.2%
5	Ethiopia	46	6.8%
6	South Africa	37	5.5%
7	Rwanda	29	4.3%
8	Ghana	29	4.3%
9	Morocco	26	3.8%
10	Madagascar	25	3.7%
11	Egypt	16	2.4%
12	Nigeria	16	2.4%
13	Mali	15	2.2%
14	Tunisia	15	2.2%
15	Democratic Republic of Congo	15	2.2%
16	Malawi	13	1.9%
17	Botswana	12	1.8%
18	Gabon	8	1.2%
19	Others	135	<20%
20	Total	677	100%

Source: worldatlas.com

inundated buildings and forced people to flee their homes," said Tito. UNEP study found a trend of rising water levels in eight lakes in Kenya's Rift Valley.

In April 2024, Zimbabwe declared drought a national disaster on Wednesday, with President Emmerson Mnangagwa saying the country needs $2 billion in aid to help millions of people who are going hungry. Joshua Matanzima, a historian and social scientist who grew up at Lake Kariba, said that El Nino had nearly shrunk the human-made lake. The lake is part of the Kariba Dam in the Zambezi river basin between Zambia and Zimbabwe. He said, "Since the early 2010s, the El Nino weather pattern has induced droughts and heatwaves in the Zambezi region, causing a drop in the water levels at Lake Kariba." By April 8, 2024, the Zambezi River Authority, which owns and manages Lake Kariba, announced that water in the lake had dropped to just 13.52 per cent of its capacity. Joshua reported brewing conflicts as the lake dried up and also displacement of people. He said, "The area is already a hotspot for human-wildlife conflict. A drop in the water levels results in increased competition over water resources between people and wild animals, resulting in human-wildlife conflict. Animals that normally drink water from far-away river estuaries start approaching the parts of the lake populated by humans. Clashes between elephants, buffalo, baboons, lions and humans increase as they have to share reduced waterscapes."

Lake ecosystems: Africa is known for its lakes, a major source of freshwater. According to WORLDLAKE database, there are 677 lakes in the continent out of which 88 are listed as principal lakes. Three of the 10 largest freshwater lakes on Earth, in terms of area and volume, are located in Africa - Victoria, Tanganyika and Malawi Lakes. Many lakes are transboundary. According to UNEP, 15 principal lakes cross the political boundaries of two or more countries. Some estimates say that these lakes hold about 30,000 cubic kilometers of water, the largest volume in the world.

Lakes in Africa are following the global trajectory. Lakes cover 3 per cent of global land area and a critical part of the planet's hydrology. Lake ecosystems store around 87 per cent of the planet's liquid surface freshwater and offer a variety of ecosystem services, including fisheries and water supply. Besides, lakes support local livelihoods, fishery being the most important of the many economic benefits being reaped from these waterbodies. Lakes, rivers and wetlands hold 20–30 per cent of global soil carbon despite occupying only 5–8 per cent of its land surface. "Lakes are in trouble globally, and it has implications far and wide," Balaji Rajagopalan, a professor at the University of Colorado Boulder and co-author of a research study that lakes across the world and its findings were published in the journal Science. Balaji along with other researchers analysed satellite observations and climate data of over 30 years covering 1972 largest global lakes. Their finding was alarming: they found "significant storage declines for 53% of these water bodies over the period 1992–2020." The study concluded, "The net volume loss in natural lakes is largely attributable to climate warming, increasing evaporative demand, and human

RIVER BASINS AND LAKES IN AFRICA

Principal lakes in Africa hold 30,000 KM^3 of water

Source: "Water Resources in Africa under Global Change: Monitoring Surface Waters from Space", *Surveys in Geophysics*, April 20, 2022

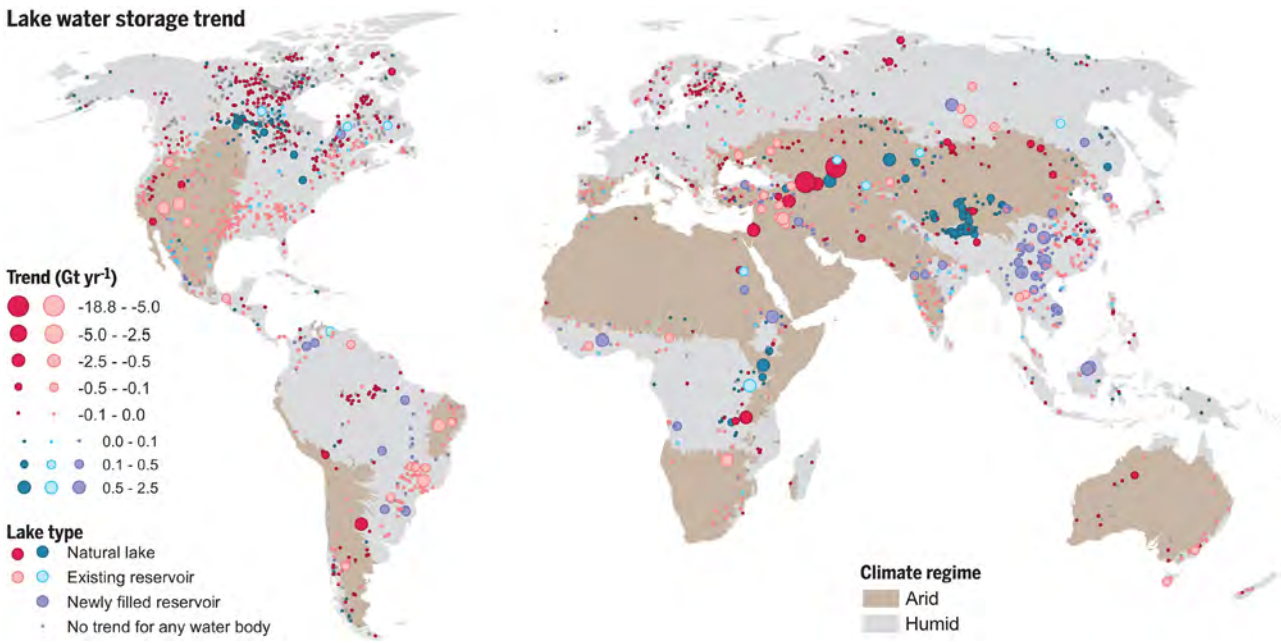
water consumption, whereas sedimentation dominates storage losses in reservoirs." "It really caught our attention that 25 per cent of the world's population is living in a lake basin that is on a declining trend," he said. The study found significant loss of lake water storage in southern Africa, besides in western Central Asia, the Middle East, western India, eastern China, northern and eastern Europe, Oceania, the conterminous United States, northern Canada and most of

South America. However, the study pointed out the rise in lake water levels in many regions including in Africa compensating for the losses in other regions. The rise in lake water levels as mentioned above has been attributed to climatic changes leading to high rainfall. The study said, "Approximately one-third of the total decline in all drying lakes is offset by lake storage increases elsewhere, largely in remote or sparsely populated areas such as the Inner Tibetan Plateau, Northern Great Plains, and Great Rift Valley."

Lakes in Africa are of immense economic values. They provide critical ecosystem services to both local and global communities. Ecosystem service is defined as "the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits." "Lakes' global ecosystem services (are valued) to be within the region of US$ 1.3–5.1 trillion annually. Their natural asset value is estimated at US$ 87–340 trillion, comparable to the monetary value of global real estate," stated Xingming Li of the Department of Economics, Bob Gaglardi School of Business and Economics, Thompson Rivers University, Kamloops, British Columbia, Canada. According to a joint study by the African Centre of Excellence for Water Management, College of Natural and Computational Sciences, Addis Ababa University, Ethiopia and the Ministry of Forestry and Natural Resources, Fisheries Department, Senga Bay Fisheries Research Center, Salima, Malawi, Lake Malombe of Malawi gives ecosystem services worth US$124.36 million/year (about 1.97 per cent of the national GDP) and US$1943.08/household/year.

Pollution of lakes across the continent is another big concern. High levels of contaminants negatively impact the aquatic ecosystems and also the economic activities like declining fishery. El hadji Sow, lecturer and researcher in the Université Cheikh Anta Diop de Dakar, studied the Pink Lake of Senegal. His research showed that the lake was about to disappear, burdened by

WIDESPREAD STORAGE DECLINE IN LARGE GLOBAL LAKES FROM OCTOBER 1992 TO SEPTEMBER 2020



Lake water storage (LWS) trends for 1058 natural lakes (dark red and dark blue dots) and 922 reservoirs (light red and light blue dots). Recently filled reservoirs after 1992 are denoted as light purple dots. All colored dots denote statistically significant trends ($p < 0.1$), whereas no significant trends are shown as gray dots. Classification of climate regimes between arid and humid regions was done using the aridity index [ratio of mean annual precipitation to mean annual potential evapotranspiration (materials and methods)].

Source: "Satellites reveal widespread decline in global lake water storage" *Science,* May 18, 2023

pollution and changes in local hydrology. The lake is unique being part of a fragile local hydrological system. It is located 6.5 metres below the sea-level. One-kilometre of sand dunes separates the lake from the sea. The lake gets its water from the seasonal water table in the dunes located at higher elevation. "Thus the sea provides most of the lake's water and all of its salt," said El hadji. The lake water doesn't have life except microscopic algae and bacteria. But it is a tourist destination and salt mining supports thousands of people's livelihoods. El hadji said, "On the southern shore, the drainage channel created in August 2022 for the disposal of wastewater and rainwater from the surrounding suburbs has led to the introduction of solid particles contributing to the lake's filling in." In his latest examination of the lake water, El hadji found extreme contamination. He reported, "We have just received the results of chemical analyses of samples collected at the end of May 2023 along these ponds. They reveal extremely high levels of nitrates —chemical compounds —in May 2023: 12,491.71 to 15,394.75 mg/l compared with 5.82 to 12.05 mg/l in December 2022. The nitrate limit set by the World Health Organization (WHO) is 50 mg/l for water to be considered potable. This sudden increase in nitrate levels is believed to be associated with the establishment of hotels in the immediate vicinity of the lake and ponds, and to the rapid, uncontrolled urbanisation of this northern part of the lake, which has no sewage system. These polluted waters flow into the lake, eventually reaching the salt, rendering it unsuitable for consumption."

Lake Victoria is a world-renowned ecologically unique waterbody and is shared by three countries—Tanzania (51 per cent), Uganda (44 per cent) and Kenya (5 per cent)—using its

The basin of Lake Victoria also supports extensive agriculture; over 70 per cent of the population in the catchment area depends on agriculture. The natural ecosystem of the lake and its flora and fauna are the basis for an expanding population and burgeoning economic activity in the region

resources for fisheries, freshwater and transportation. The lake basin supports one of the densest rural populations in the world with population density being well over 100 people per square km. It is the most heavily populated basin within the East African Rift Valley Lakes sub-region. These densely populated regions lack proper drainage and sewerage systems and thus the wastewater from these areas ends up draining in the lake via river basins. Additionally, a number of industries like breweries, sugar, soap, vegetable oil and fish processing factories operating in the lake basin do not have efficient wastewater treatment facilities. In such a scenario, untreated industrial effluent from these industries finds its way into the lake. Apart from domestic and industrial discharges, surface runoffs from agricultural lands and storm water carry nutrients and add to the pollution load of the lake. The contribution of each of these pollution sources to the pollutant loading of the lake is described in the following sections.

The lake supports the most productive freshwater fishery in the world, worth US$ 600 million annually. The basin of Lake Victoria also supports extensive agriculture; over 70 per cent of the population in the catchment area depends on agriculture. The natural ecosystem of the lake and its flora and fauna are the basis for an expanding population and burgeoning economic activity in the region. Despite being the source of livelihood for 45 million people, Lake Victoria has however suffered immensely from a variety of unsustainable human activities over the last five decades. Activities, including deforestation, poor waste management, destructive fishing practices, introduction of invasive fish, wetland encroachment, unsustainable farming practices, and uncontrolled mining, have rendered the lake into a sink for excess nutrients and untreated effluent. This has led to fish die-offs, algal blooms and the spread of the ferocious waterweed water hyacinth. Since 1989, the lake's basin has been one of the most conflict-affected regions in the world. All the countries that share the lake, especially Kenya, Uganda and Tanzania, fight

A PLAN FOR LAKE VICTORIA

Lakes are getting global attention. There are efforts now to roll out multilateral management and protection regimes for many transboundary lakes

INDIA-BASED think tank Centre for Science and Environment (CSE) and National Environment Management Council (NEMC), Tanzania conducted a multinational stakeholder consultation in Dar es Salaam on January 23, 2024 to decide on strategies to restore the lake. Lake Victoria and its flora and fauna support the livelihoods of about 45 million people. The fragile ecosystem of the heavily polluted lake could be damaged irreversibly in the absence of appropriate interventions.

CSE and NEMC have been working together for several years to develop a strategy to improve the water quality of Lake Victoria. Three countries share the lake's resources for fisheries, freshwater and transportation: Tanzania (51 per cent), Uganda (44 per cent) and Kenya (5 per cent). The January 23 event was attended by regulators from Kenya, Tanzania, Burundi, Uganda and Rwanda. Representatives from Rwanda Environment Management Authority, Burundi's Ministry of Environment, Agriculture and Livestock, Uganda's National Environmental Management Authority and Kenya's National Environmental Management Authority all attended the event. Participants from Tanzania included the NEMC, the Lake Victoria Basin Commission (LVBC), the Mwanza Urban Water Supply and Sanitation Authority (MWAUWASA), the Lake Victoria Basin Water Board, the Municipal City Council, Ministry of Water and regional offices located within the lake's Tanzanian watershed.

The meeting discussed current initiatives to improve the lake's water quality as well as future activities. It also attempted to comprehend the challenges confronting the countries that share the Lake Basin, as well as the strategies they intend to employ to restore the lake. In January 2023, CSE and NEMC released a report, "Developing an Environmental Management Strategy for Lake Victoria", which identified Mwanza town in Tanzania as a hotspot area discharging industrial effluents and municipal and solid waste into the lake. The organisations earlier released a management strategy to clean the lake and sustain its ecological integrity in Dar es Salaam, Tanzania on July 13, 2022. The research and analysis laid a roadmap for improving the water quality of Lake Victoria and making its use sustainable.

Lakes are getting global attention. There are efforts now to roll out multilateral management and protection regimes for many transboundary lakes. In March 2022, for the first time, the United Nations Environment Assembly adopted a resolution on "Sustainable Lake Management". The resolution "called on countries to protect, restore, and sustainably use lakes, while integrating them into national and regional development plans." "This is the first ever United Nations resolution specifically focusing on the sustainable management of lakes, without distinguishing between freshwater, alkaline, saltwater or soda lakes," said Lis Mullin Bernhardt, a freshwater expert with UNEP. "We hope it will help galvanize funding and efforts to protect and better manage lakes that are so important for human well-being."

over it—for its fish and water. Lake Victoria basin countries account for 20 per cent of the continent's population but 40 per cent of the battle deaths that occurred continent-wide, states a study paper published in *Ecology and Society* in 2019. These conflicts are increasing as the water levels in the lake keep falling and its resources are disappearing. New strains on the water resources have added to the tension. Samuel G Mafwenga, director-general, National Environment Management Council, Tanzania, admits that Lake Victoria has undergone severe ecological changes in the past four decades, which have led to near extinction of some of the fish species that are endemic only to the lake. Water quality has also been affected by hyacinth infestation, which causes eutrophication, and release of untreated sewage and industrial effluents, storm water and maritime transport wastes. A report by the World Bank in October 2021 as part of the "Groundswell Africa" series says that without concrete climate and development action, the five countries of the Lake Victoria basin could see between 16.6 and 38.5 million people moving within their countries in response to water scarcity, declines in crop productivity and ecosystem productivity and sea level rise, augmented by storm surge. Tanzania and Uganda are projected to have the highest numbers of internal climate migrants by 2050,

reaching 16.6 million and 12 million, it warns.

Most of the industries, in all three countries, are located in the larger towns bordering the lake; like Kampala and Jinja in Uganda, Mwanza and Musoma in Tanzania, and Kisumu in Kenya. While a majority of the Kenyan industries are reportedly equipped with effluent treatment plants, industries in Tanzania and Uganda either completely lack them or have inefficient wastewater treatment facilities. According to a report "Integrated water quality/Limnology study for Lake Victoria", 79 major industries operate in the catchment area of the lake with 25 in Kenya, 36 in Tanzania and 18 in Uganda. Tanzania has the highest share of both organic and nutrient loading into the lake due to the large number of fish processing and vegetable oil industries in the country.

Parts of the lake, especially the deeper areas, are already considered dead zones that are unable to sustain life due to oxygen deficiency in the water. Deteriorating water quality has reduced the lake's biodiversity, most notably affecting the phytoplankton and fish, and is causing hardship for populations dependent on it for their livelihoods.

Mwanza city contributes a substantial pollution load in the form of industrial effluent, domestic sewage and dumping of solid waste. It was perceived that a large swathe of Mwanza city's population disposes of domestic wastewater in the open while faecal sludge is managed by being transferred to pit-empty trucks. A significant percentage of the population, however, was found to store faecal sludge in pits and dispose of it in storm water during rain. The two rivers, the Mirongo and Nyashishi, were recognized as the major carriers of these pollutants into Lake Victoria. These rivers traverse long distances, flowing through habitation, industrial areas and agricultural fields before meeting the lake at Mwanza Bay. While the Mirongo is a carrier of domestic waste, Nyashishi mainly carries industrial effluent.

The industries that abstract water or discharge wastewater into Lake Victoria are required to obtain a water use permit and a water discharge permit respectively from the Lake Victoria Basin Water Board (LVBWB). As per the data received from LVBWB, 13 industries currently have the permit from the board to discharge wastewater into the lake

Mwanza region has seven districts, of which Nyamagana and Ilemela districts (which comprise Mwanza city) are the major industrial hubs. These two areas which are in close proximity in total have 51 industries out of which only 26 industries operate with a valid EIA/EA certificate (information provided by NEMC). Out of two areas, Ilemela district houses the major chunk of industries—26 out of total 51—followed by Nyamagana district, with 13 industries; the remaining 12 are spread in different areas. Fish processing is the major industrial sector operating in these two areas, contributing 41 per cent of the share, followed by plastic recycling and packaging and hotels. All the industrial sectors mentioned above are water intensive, which implies that they require large amounts of water for their processing, and consequently generate significant amounts of wastewater. The source of water intake for these industries is either supply water from the Mwanza Urban Water Supply and Sanitation Authority (MWAUWASA) or Lake Victoria; the discharge of wastewater is also into one of the above sources. All the water-polluting industries are required to have adequate wastewater treatment plants to ensure no untreated wastewater is discharged outside the industrial premises. The industries that abstract water or discharge wastewater into Lake Victoria are required to obtain a water use permit and a water discharge permit respectively from the Lake Victoria Basin Water Board (LVBWB). As per the data received from LVBWB, 13 industries currently have the permit from the board to discharge wastewater into the lake.

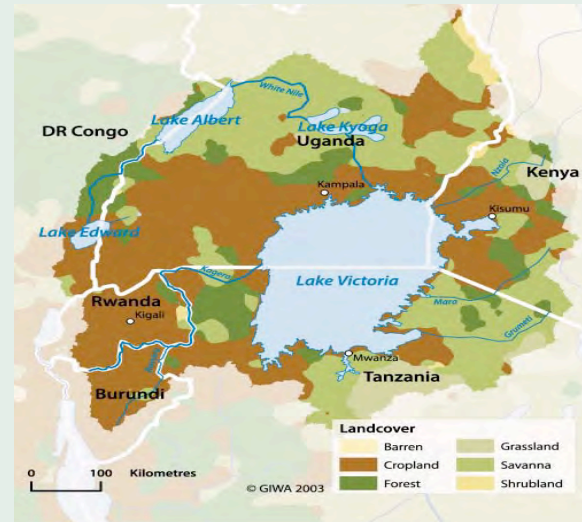
Many such industries are housed in Nyakato Industrial Area, located in Ilemela district of Mwanza, with the Nyashishi River on one side and Lake Victoria on the other. Some prominent

ENVIRONMENTAL CONCERNS OF LAKE VICTORIA

1. CATCHMENT DEGRADATION

Communities in the Lake Victoria basin are involved mostly in crop production of maize, rice, sugar, coffee, tea, cotton, bananas, sorghum, millet, groundnuts and horticultural products. Agriculture employs about 75 per cent of the workforce and forms the basis of their economic viability. However, increasing urbanization and agriculture in the region has led to higher demand for land. More land is cleared to meet these demands, leading to change in land use in the basin. The map shows that majority of the areas around the lake basin have been converted into croplands and forest cover is minimal.

Existence of wetlands and littoral zones is closely connected to the ecological health of Lake Victoria. Wetlands are also important in terms of fish breeding, exchange of nutrients with the lake and as filters, trapping incoming sediment and pollutants. However, extensive wetlands around the lake have been destroyed through conversion to agricultural land, excavation for sand and clay, mining activities and their use as disposal sites. It was estimated that about 75 per cent of Lake Victoria's wetlands had been affected significantly by human activity, and about 13 per cent had been severely damaged.



Source: "Development of Environmental Management Strategy Towards Sustaining Ecological Integrity of Lake Victoria", *Centre for Science and Environment,* 2022

2. EUTROPHICATION

Eutrophication is one of the biggest ongoing problems of Lake Victoria. Catchment degradation and pollution are the primary causes of eutrophication. The problem of eutrophication is also aggravated by massive growth of water weeds and invasive plants in river catchment areas as a result of increased nutrient loading from surface runoffs. Likewise, clearing of riparian vegetation, which acted as filters, for agriculture practices has led to erosion and deposition of nutrient-rich sediments from agricultural runoff and deforested zones directly into the lake. In addition, discharge of untreated wastewater in rivers also ends up adding BOD and nutrients in the lake. This has resulted in widespread eutrophication in the lake leading to spurred growth of algae and aquatic weeds. The growth of algae adversely impacts the lake by depleting oxygen levels thereby decreasing aerobic flora and fauna and inhibiting navigation. Nearly the entire perimeter of the lake is experiencing hyper-eutrophication, or extremely poor water quality, whereas the rest of the lake had poor or fair water quality, and there were no zones of good water quality detected in the lake.

3. INFESTATION OF WATER WEED

Water hyacinth, an invasive alien species, has a high growth rate, produces large quantities of long-lived seeds that can survive up to 30 years and weed populations can double every 5–15 days at temperatures between 25–27.5°C. The weed covers the lake surface, especially along the shoreline, with serious impacts on the livelihoods of local fishermen and farming communities. About 80 per cent of the Ugandan shoreline has been affected by this problem. Some initiatives have been taken by Lake Victoria Environmental Management Project (LVEMP) to control the water hyacinth infestation and the weed infestation had been reduced by approximately 80 per cent by the year 2000. However, after 2005, the weed infestation again increased to about 30 per cent of the 1998 coverage.

4. LOSS IN BIODIVERSITY

The lake originally had a multi-species fishery, mostly dominated by perch-like fish called Cichlids. In the 1950s, two new fish species namely Nile Perch and Nile Tilapia were introduced to the lake with an aim to improve the declining stocks of indigenous species. However, an explosive population growth of Nile Perch later caused extinction of approximate 300 fish species (due to predation).
The change in the species composition of the lake had important economic effects as the Nile Perch found a ready international market. Processing and export industries have grown around the lake. Fast-growing population and advanced fishing methods have led to over-fishing and abusive fishing practices threatening the sustainability of the fisheries. Even though Nile Perch might have provided economic benefits, its presence has disrupted the natural balance of the lake's ecosystem. The subsequent decrease in the number of algae-eating fish, due to their predation by the Nile Perch, allows the algae to grow at an alarming rate, thereby choking the lake. This in turn results in depletion of oxygen levels, thereby inhibiting survival of aerobic life in the deeper parts of the lake.

5. OUTBREAK OF WATERBORNE DISEASES

Waste is discharged in nearby water bodies and makes people susceptible to waterborne diseases. Waterborne diseases represent more than half of all disease incidences in Tanzania and more than 80 per cent of disease incidence in rural areas. More than 1.7 million episodes of diarrhoea are reported annually in Tanzania and children are at greatest risk. Diarrheal disease was the 4th ranked cause of child mortality in Tanzania in 2006. Faecal contamination of potable water sources is most prevalent in the proximity of populated urban areas.

Source: Centre for Science and Environment, Delhi, India

industries are Tanzania Breweries Ltd, Serengeti Breweries Ltd, Nyanza Bottling Co. Ltd, Nile Perch Fisheries Ltd, Mwatex Ltd, SBC (T) Ltd, Sayona Drinks Ltd, etc. Apart from Tanzania Breweries, all other industries discharge the effluent from their plant into a common drain that meets the Nyashishi stream. On the way, effluent-laden water from the drain is used for agricultural purposes by the people living in the vicinity.

Large-, medium- and small-scale gold mining sites also add a high amount of pollution to the lake. Although these sites are not situated close to Lake Victoria, they are operational near some rivers which drain into the lake. Geita and Mara regions are the major hubs of gold mining activities. Mara River, one of the seven rivers flowing into the lake from Tanzania, is a major source of pollution in terms of heavy metals coming from gold processing activities. Few studies have reported presence of heavy metal contamination in fish.13 However, studies monitoring mercury and other heavy metals around mining sites are limited and thus the number of people at risk from mercury in water and food is unclear.

It is evident that industrial effluent, municipal wastewater (treated and untreated) and solid waste are eventually deposited in Lake Victoria via Mwanza Bay. The three riverine systems of Nyashishi, Mirongo and Magogo act as carriers of this pollution load to the Mwanza Bay. Besides the riverine system, there are drains carrying untreated sewage and directly discharging into the Bay. Thus, Mwanza Bay receiving pollution load as a sink is bound to be impacted. The impact is seen in the form of algal boom, loss of fishes, and decrease in fish diversity and water hyacinth. Another indicator that shows the impact of pollution in Mwanza Bay is the decrease in its transparency. As per data provided by the Tanzania Fisheries Research Institute (TAFIRI), deep-water transparency in Mwanza Bay has seen a sharp decrease from 7.5 m in 1927 to 3.3 m in 2020. Similarly, its transparency in shallow water has decreased from 2.3 to 0.3 m in the same period. The decrease in transparency is related to chlorophyll A concentration; the higher the chlorophyll A, the lower the transparency. The high concentration of chlorophyll A is indicative of eutrophication. ■

RAINWATER HARVESTING

HIGHPOINTS

Africa is rainwater-dependent. Close to **95% of Africa's food production uses only rainwater.**

Africa, the second driest continent in the world, loses most of its well-endowed rainwater. **Rainfall constitutes just 20% of the continent's renewable water** resources indicating very low harvesting and recharge.

One can harvest as much as **1 million litres of water from a hectare of land** with 100 millimetres (mm) of rainfall a year.

According to UNEP, "Overall the quantity of **rain falling across the continent is equivalent to the needs of 9 billion people**."

PHOTOGRAPH COURTESY: MUONDE TRUST

DYING WISDOM

Rainwater harvesting has the potential to eradicate water poverty in Africa

TANZANIA IS a study in contrast. Despite being home to approximately 25 per cent of the world's freshwater resources, it could see a water-stressed future. It has abundant water resources. Tanzania has an area of about 945,000 square kilometres (sq. km) of which 883,500 is land and 61,500 sq. km is covered by water. Nine major river basins form part of the country. The country manages its water demand through its rivers Pangani, Wami, Ruvu, Rufiji and Ruvuma; lakes Nyasa, Rukwa, Tanganyika and Victoria; and internal drainage basins of Lake Eyasi, Lake Manyara and the Bubu depression; and its southern coast. The rivers are largely perennial barring a few that are intermittent and ephemeral. Tanzania has approximately 600 dams of which 20 have a total capacity of 1,000,000 cubic metres (m^3). The dams produce electricity to the tune of 561 megawatt (MW). Most of them have operational water levels. The largest lake in Africa, Lake Victoria, and the deepest lake in the world, Lake Tanganyika, lie on the boundaries of Tanzania. Around 5.7 per cent of the country is covered by three large lakes—Lake Victoria, Lake Tanganyika and Lake

Nyasa. There are also other smaller lakes in the country. The country cannot be considered water stressed as the large lakes can cater to its population. Its freshwater resources cater to its hydroelectric power needs. Wetlands spread over 85,000 hectares support the economy and their degradation will lead to severe economic losses to the country. Still, a large part of its rural population lacks access to water sources.

But the country is completely rain dependent. Its rivers are all rain-fed. Water supply in Tanzania—both surface and groundwater—is rainwater based. More than 70 per cent of the population live in rural areas and depend to a large extent on groundwater reserves, mostly rainwater seeping into aquifers. In addition, groundwater is used for domestic purposes in peri-urban and urban areas, where there is no distribution network. While urban areas depend on borewells, rain-fed shallow wells are common in most of the country. Almost 65 per cent of the groundwater is used for domestic supplies. An increase in population growth and industrial and agricultural activities has increased the demand for water. Studies also show that climate change is affecting rainfall patterns and Tanzania will be water stressed soon in spite of having several large waterbodies. Its fast-growing urbanisation is directly linked to over-extraction of groundwater. This will put yield and sustainability of groundwater abstraction in some parts of the country into question, especially in hard-rock areas where groundwater recharge is low. An example is the Dodoma region, where there are non-functional taps in many Local Government Areas and sustainability of the source is low.

Thus, rainwater harvesting and recharging the groundwater sources is of paramount importance to the country's water security. Recharge of groundwater improves both quality and quantity of reserves. Rural areas need to implement groundwater recharge structures efficiently as more than 90 per cent of Tanzania's rural water schemes are dependent on groundwater. But there are challenges. The temporal and geographical distribution of water

Tanzania gets most of its rainfall in two to three months of the year and for the remainder depends heavily on groundwater, which is difficult to access. Rainfall pattern is also highly variable

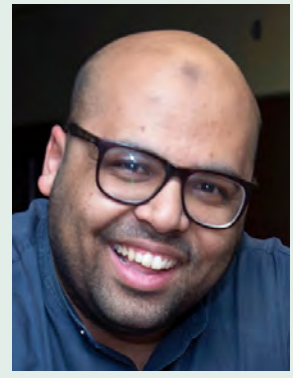
in Tanzania is not well distributed. Several areas do not have sufficient water supply despite abundant freshwater reserves. Rainfall distribution is also highly variable; southern Tanzania gets most of its rainfall in two to three months of the year and for the remainder depends heavily on groundwater, which is difficult to access. Rainfall pattern is also highly variable. The highlands in southwest Tanzania receive 1,200 mm per year of rainfall while the internal drainage basin receives less than 600 mm per year of rainfall.

Slowly, the country is gearing up to harvest its rainwater to tide over the impending water scarcity. Various national policies and programmes for the water sector in Tanzania do focus on rainwater harvesting and conservation to make the country water secured. The Tanzanian water sector is influenced by strategies such as Tanzania National Development Vision, 2025, and the National Strategy for Growth and Reduction of Poverty (NSGRP also known as MKUKUTA in Kiswahili), where the country has committed to access to safe water for all. To achieve the targets of Tanzania Development Vision, 2025 and MKUKUTA by 2010, the National Water Sector Development Strategy (NWSDS, 2006) was laid down with the aim of conserving and utilizing alternative resources and removing disparities across the water sector. Collaboration was required for the ministry with the regional administration and the local government (PMO-RALG, the Ministry of Health and Social Welfare, and the Ministry of Agriculture and Food Security). Further, the strategy aimed at reshaping and increasing sector financing through a smooth and manageable institutional arrangement. The National Water Sector Implementation Plan was established for implementing objectives of NWSDS within a five-year time frame. The strategy was eclipsed by the Water Sector Development Programme (WSDP) (which was essentially a framework to implement multiple standalone water supply

AN ANCIENT SYSTEM THAT COULD BRING WATER TO DRY AREAS

An ancient system of drawing water from aquifers—*qanat* system—could help Africa's dry areas facing water shortages

GAATHIER MAHED



SOME OF Africa's dry areas face serious water shortages due to minimal rainfall. An ancient system of drawing water from aquifers, the "*qanat* system", could help. There are bodies of water underground known as aquifers, some of which can be found at the tops of valleys or near mountains. A *qanat* system taps these aquifers and, using underground tunnels, moves the water, using gravity, over many kilometres. The tunnel then exits at a lower-lying area. When the water exits the tunnel, farmers can use it to irrigate their crops. People can also access the water along the stretch of the tunnel using wells.

It's a system that's managed by everyone and its benefits are shared. Everybody has a vested interest and a role to play. Community bonds can be strengthened — in stark contrast to tensions we see over water resources today. It's a highly complex communal system to manage. Laws governing the system have existed since the 9th century. These laws relate to the construction and proximity of *qanat* tunnels to each other. They also govern the exits of the qanats. For instance, land owners at the exits can use the water first and must aid in managing them.

Where did it come from and where is it used?

The *qanat*s have been used for centuries in arid and semi-arid parts of north Africa, the Middle East and Asia, where water supplies are limited. It's known by a variety of names, "*foggara*" in north Africa, "*falaj*" in Oman and "*qarez*" in parts of Asia. It's thought to have been developed in Persia in the first millennium BC. As the Islamic Empire spread across the Arabian Peninsula, the Levant, north Africa and parts of Europe from 661 to 750 CE, so did knowledge about *qanat*s. Today, some of the region's *qanat* systems, like those

SH RASHEDI / UNESCO

The Persian Qanat: Aerial View, Jupar, Bagh-e Shahzadeh (Mahan)

in Iran, are protected under heritage status. Some of these qanats, although declining in number, are still used. They are largely protected for historical and cultural reasons.

Why is it not being more widely used?

There are several reasons why the tunnel system is not more widely used in Africa. *Qanat*s need to be built somewhere with the right geological formations. These generally seem to be fractured sandstones. The level of groundwater is also important for the flow of water in the qanat. The volume of water in the aquifer stems from the rainfall in the mountainous regions. *Qanat*s can only be built where there's a slope, like a mountain or a valley. And the slope must have a specific angle. If it's too steep, erosion of the *qanat* will occur and it will collapse. If it's not steep enough the water will not flow fast enough and could become chemically altered due to interaction with minerals in the ground. The digging of the tunnel and development of the system over large areas of land is labour intensive and can take many years. The *qanat*s cover many kilometres and need to be maintained every year, by cleaning out the silt build-up.

Knowledge of building *qanat*s and maintaining them is being lost. People have migrated from rural areas to cities and adopted boreholes in certain areas instead. Some *qanat*s are drying up due to over exploitation of the water resource.

Why should the system be used more widely?

In most instances people in arid areas drill wells to access groundwater. These boreholes have a lifespan and eventually new wells have to be drilled. Pumps and materials don't last forever and wells can get clogged by microbial organisms and fine material in the subsurface. First, the *qanat* is sustainable as it works with gravity and no electricity is needed. It can even be used to create clean energy. For instance, in Iran cold air that comes out of *qanat* tunnels is used to cool the interior of large buildings. Second, water lost to evaporation is minimal in comparison to surface water supplies. Third, it can have a wide scale impact. *Qanat*s are multiple kilometres long and once this water hits a floodplain, it can irrigate multiple hectares of land. Fourth, it fosters social cohesion. Many people, with different skills, are involved in maintaining the system. Fifth, the lifespan of the system extends beyond that of a deep water well, which is only about 20 years. Tunnels do not clog as easily as wells.

Finally, the quality of water coming from the mountains is much better than water on the plains. It'll have lower salinity and be better for crops and people.

(Gaathier Mahed, Senior lecturer, Nelson Mandela University)

projects). Water Sector Development Plans (WSDPs) WSDP-1 and WSDP-2 have been among the largest ventures aimed at improving Tanzania's water resources, governance, service delivery and capacity building.

The Government of Tanzania is also trying to promote rainwater harvesting through various policies such as MKUKUTA and WSDP. They have mandated demonstration sites in health centres, schools, etc. and post 2011; all new constructions have been mandated to have rainwater harvesting systems. According to the National Water Policy (NAWAPO) 2002 and Water Resources Management Act No. 11 of 2009, the management of water resources is divided into five main levels: national level, basin level, catchment level, district level, and community level, which is the lowest level and integrates users of the same source. The Act outlines the powers and functions of the boards, catchment committees and water users' associations responsible for the management of water resources.

Like Tanzania, Uganda is another example of how a water-abundant country facing scarcity can look up to rainwater harvesting to sustain the rising water demands. Uganda, a landlocked country, occupies 241,550.7 km^2 of land. The country is endowed with abundant water sources. Open water and swamps constitute 41,743.2 km2 of area. In other words, about 16 per cent of the total land area comprises wetlands and open water. Uganda receives an annual water supply of 66,000 million cubic metres (MCM) in the form of rain and inflows. Since direct rainfall is the most important source for water resources in Uganda, understanding the spatial and temporal variability of rainfall is paramount when assessing water availability. As in any other country, water availability in Uganda determines the local water resources, land-use potential and population distribution.

The largest supply of water for rural Uganda comes from spring water, followed by boreholes, shallow wells with hand pumps. In Uganda, 61 per cent of the country's water is from groundwater sources accessed from springs and boreholes around Lake Victoria and south-western Uganda. Groundwater is the major source of water supply in rural Uganda,

including in semi-arid and arid areas. It is generally found in weathered or fractured basement rocks and has a yield of 0.5–80 m^3 per hour. There has been groundwater use since the 1930s through the construction of deep boreholes, shallow wells and protected springs. On average, 1,200 tubewells and 900 shallow wells are constructed annually in Uganda. Approximately 40,000 deep boreholes, 16,000 shallow wells and 30,000 protected springs have been constructed in the country mainly for rural domestic water supply. Boreholes and shallow wells are normally installed with handpumps.

Groundwater reserves are hence the main source of supply for rural areas. Gravity-flow water, surface water and stored rainwater also supply water to villages and small towns that are categorized as rural. The increase in demand for water supply in Uganda as a result of high population growth as well as agricultural and industrial expansion has triggered unplanned groundwater development and use in many parts of the country. This has put future yield and sustainability of groundwater abstraction in some parts into question, especially in the north-eastern and south-western parts, where natural recharge of groundwater is low compared to the rest of the country. There are reports of poor-quality groundwater mainly due to inadequate sanitation facilities—in many areas high nitrate and bacteriological contamination of groundwater have been reported. High fluoride and iron and manganese above permissible limits have also been found in the groundwater due to natural reasons, impacting public health and the economy of Uganda. It has been noted that there has been a reduction in the area and quantity of water in waterbodies, the big recharge bodies in the country, thereby reducing the chances of natural groundwater recharge.

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Uganda receives fairly high rainfall except in parts of north-eastern and south-western regions. Natural groundwater recharge in Uganda is also quite high except in areas that receive low rainfall compared to current volumes of groundwater abstraction—water removed from aquifers without considering return flows or leakage—and will not be a limiting factor in groundwater development for a few years. There is, however, a need to carry out more detailed recharge and water balance studies in the country to ensure that groundwater development is carried out in a sustainable manner. The Government of Uganda started an assessment of groundwater in 1996 to fully understand the nature, extent and reliability of the country's groundwater resources. The study provided information on the distribution and behaviour of aquifers, groundwater recharge, aquifer vulnerability to pollution and impact of motorized abstraction on groundwater resources. A conceptual model of groundwater dynamics has also been developed.

Reports in early 2000 about groundwater assessments in three catchments— namely Ruizi, Wamala and Victoria—concluded that groundwater resources were declining. According to a report of the monitoring and assessment department of the Directorate of Water Resources Management (DWRM), the causes of decline include global warming, changes in land use, especially deforestation, unsustainable water withdrawals, poor catchment management, prolonged droughts, reduced rainfall in the catchment. According to the latest (2013) government report, in 2009 the demand in some parts of south-east Uganda was very high. These areas are also those reporting low recharge. Data from the latest assessment report suggests that by 2030 demand for domestic water in rural areas and small towns can safely be

PHOTOGRAPH: WINNIE BOTHA

met by groundwater in most of the country where the utilisation rate is less than 15 per cent. Exceptions include Wakiso, which is undergoing rapid urbanisation in the vicinity of Kampala, as well as the Kampala–Entebbe corridor. It is, however, likely that by 2030 these newly urbanised areas will be supplied by the Directorate of Water Resources Management with water from Lake Victoria in which case the use of groundwater will be substantially lower than suggested by this study. The demand for groundwater should not increase in Jinja since water pumped from Lake Victoria is an obvious alternative source or in Mbale where gravity-based systems from Mount Elgon could be used. Utilisation rates are expected to be high in Ibanda (30 per cent of the groundwater by 2030), a small district with a high population density and unfavourable geomorphological conditions, and in a cluster of districts in south-western Uganda, where groundwater utilisation rates of around 20–25 per cent are projected. Although these districts do not currently face acute water shortages, some sub-counties may experience them in the future. The 2013 report also added that the estimated renewable groundwater resource exceeded the projected demand for domestic water but shortages may arise at the local scale, particularly for areas with high population density.

To achieve sufficient quantities of clean water through the year, judicious use of available water along with water-conservation measures should be taken up. Many villages face water scarcity not only due to long spells of drought but also due to contaminated sources of water. It is important to ensure sustainability of sources of water through effective management of demand and supply of water. According to the government's own report, the projected rate of groundwater use is relatively high in several districts in south-western Uganda. The report says that there is currently no acute shortage but that these districts are approaching a critical

situation where groundwater availability in some sub-counties may require special attention. In the absence of sufficient data, the report suggests ban of groundwater use for purposes other than drinking. The main reason for this crisis is limited awareness about the methods of augmentation of groundwater and poor community participation in water security plans at the village level.

Sustaining a source for water supply requires specific interventions for source sustainability, optimal use and management of water sources. To strengthen the source of water, there is a need to prepare a budget— with an assessment of the amounts of water available and analysis of its demand and supply. The most practised mode of rainwater harvesting is storing rooftop rainwater. According to a 2013 government report, the government has for long placed little emphasis on this type of rainwater harvesting as preference was accorded to the construction of springs, shallow wells, deep boreholes and piped-water supply. It is now, however, being recognized as one of the key solutions to providing accessible and safe water, particularly in rural areas. There is a deliberate effort by the Ministry of Water and Environment (MWE) to promote rainwater harvesting for households, institutions and communal water-supply systems.

EVOLUTION OF RAINWATER HARVESTING

Historically, as social intelligence grew, people realised that human society cannot grow without the bounties of rainwater extending from the wet months to the dry months. Thus grew the resourceful tradition of water harvesting. Wells were an important source of irrigation in groundwater-rich regions, but people learnt to harvest groundwater in other ingenious ways too, especially where water in general and groundwater in particular, were scarce. The

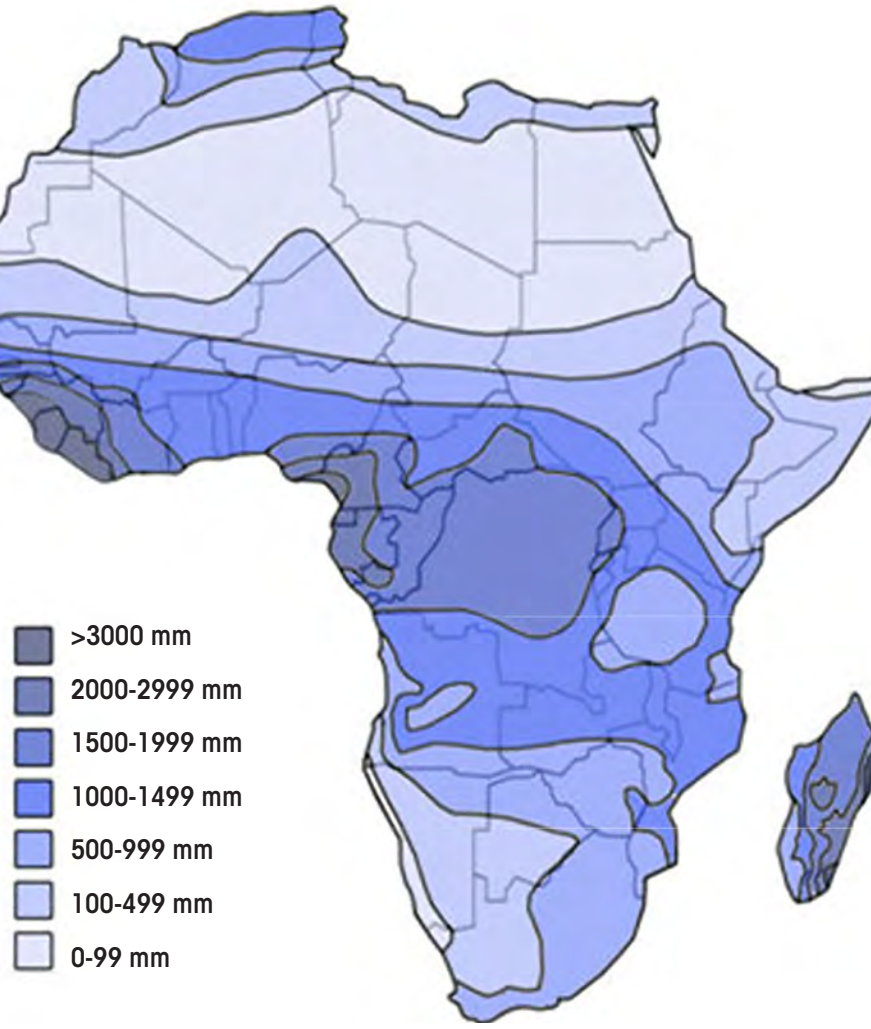
It is challenging to plan modern systems for villages due to high costs involved. People in rural areas continue to depend to a large extent on traditional systems of water-harvesting structures for both irrigation and drinking water. "Traditional systems" do not connote old and decrepit structures but they are distinct from large capital-intensive, government managed structures

principle of water harvesting is to conserve rainwater—according to local needs and geophysical conditions—where it falls. In the process, groundwater is also recharged. Traditional water-harvesting systems meet domestic and irrigation needs of people. There is ample evidence to show that community management of traditional systems ensured that basic minimum requirements of all individuals were met.

Over the last 150 years or so, the world has seen two major shifts in water management. One is that individuals and communities have steadily given over their role almost completely to the state even though more than 150 years ago no government anywhere in the world provided water. The second is that the simple technology of using rainwater has declined and in its place exploitation of rivers and groundwater through dams and tubewells has become the key source of water. As water in rivers and aquifers is only a small portion of the total rainwater, there is an inevitable and growing and, in many cases, unbearable stress on water from rivers and groundwater.

It is challenging to plan modern systems for villages due to high costs involved. People in rural areas continue to depend to a large extent on traditional systems of water-harvesting structures for both irrigation and drinking water. "Traditional systems" do not connote old and decrepit structures but they are distinct from large capital-intensive, government managed structures. Modern systems have, apart from their high monetary costs, enormous ecological costs too. Use of water generated by them usually goes against the basic norms of sound agro-climatic planning. Traditional community-based structures contribute to social cohesion and

PATTERN OF AVERAGE RAINFALL ON THE AFRICAN CONTINENT



Source: "Climate Change and Water Resources of Africa: Challenges, Opportunities and Impacts", *African Climate Policy Centre , United Nations Economic Commission for Africa,* 2011

self-reliance. The responsibility of taking decisions and action should be left to individuals, groups and local communities working together, encouraging economic independence and optimization of local resources at the micro-level. Traditional systems use low-cost, user-friendly techniques and are easily kept in good operational condition by local communities. Building water harvesting structures to augment or conserve a groundwater source is a simple task—any contractor with some money can do it. But building an effective structure that launches the process of self-management in village communities is a much more difficult task. Rainwater harvesting demands a new approach to governance itself—a participatory form of governance rather than a top–down bureaucratic one.

Dependence on the state has also meant that costs of water supply are high; with cost recovery being poor the financial sustainability of water schemes has run aground; and, repairs and maintenance is abysmal. With people having no interest in using water carefully, the sustainability of water resources has itself become a question mark — problems we see across the board today. As a result, there are serious problems with government drinking water supply schemes. Community-based rainwater harvesting — the paradigm of the past — has in it as much strength today as it ever did before. Just the simple richness of rainwater availability that few of us realise because of the speed with which water, the world's most fluid substance, disappears.

AFRICA: THE POTENTIAL

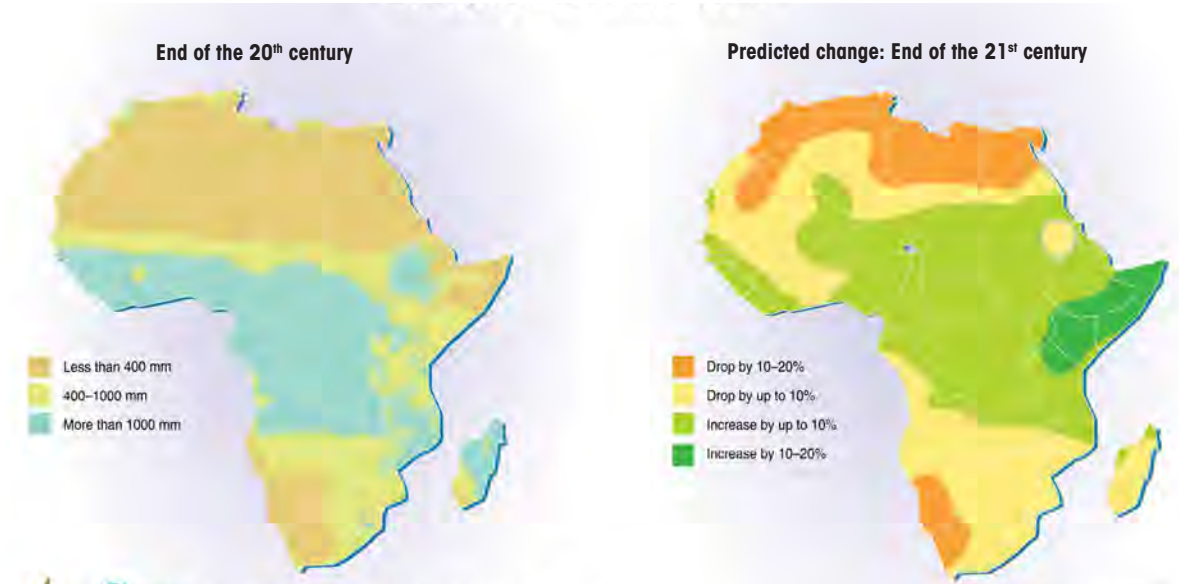
Africa is a "green-water-dependent" continent. Green water is the rain that falls on fields and is captured by soils temporarily. When it seeps into ground, flows to rivers and accumulates in waterbodies that can be harvested/pumped out and further used is called the blue water. Close to 95 per cent of Africa's food production uses only rainwater. As there is a lack of water availability and also unsuitable geographical features, only 5.5 per cent of arable land is suitable for irrigation. Ironically, notwithstanding the fact that Africa is the second driest continent of the world, it also loses most of its well-endowed rainwater. In comparison to its precipitation, the runoff is extremely low. Rainfall constitutes just 20 per cent of the continent's renewable water resources indicating very low harvesting and recharge. In a study published in journal *Nature* in March 2015, Johan Rockström and Malin Falkenmark of the Stockholm Resilience Centre noted, "Ninety-five per cent of Sub-Saharan agriculture depends on 'green water': moisture from rain held in the soil. In large parts of the continent, most rain evaporates before it generates 'blue water', or run-off, so little of it recharges rivers, lakes and groundwater." "Most farming communities are a long way from rivers and cannot use irrigation. Arid deserts and semi-arid savannahs comprise 40% of the region's land area. These receive too little surface run-off (less than 100 millimetres a year) to grow maize (corn), rice, millet and sorghum (which requires at least 400 mm per year) using irrigation alone," said the researchers in the *Nature* study.

What is the potential of rainwater harvesting in Africa? First, let's look at the standard rainwater potential a small piece of land offers. Imagine you have a hectare of land and you receive 100 mm of water in the year (common for most of the continent). One can harvest as much as 1 million litres of water — enough to meet drinking and cooking water needs of 182 people at a liberal 15 litres per day. Even if you are not able to capture all that water — this would depend on the nature of rainfall events and type of runoff surface, among other factors — you could still, even with rudimentary technology, capture at least half-a-million litres a year. According to a calculation by the Delhi-based advocacy and research think-tank Centre for Science and Environment (CSE), Sub-Saharan Africa has rainwater harvesting potential of 13,365,000 million cubic metres. To make sense of this estimated potential, it is nearly 44,550 times the average volume of water that flows through the Nile River per day.

African countries suffering or facing water shortages as a result of climate change have a massive potential in rainwater harvesting, with nations like Ethiopia and Kenya capable of meeting the needs of six to seven times their current populations

In November 2006, a seminal study on the rainwater potential of the continent startled the world. The study done by the UN Environment Programme (UNEP) and the World Agroforestry Centre found, "African countries suffering or facing water shortages as a result of climate change have a massive potential in rainwater harvesting, with nations like Ethiopia and Kenya capable of meeting the needs of six to seven times their current populations, the UNEP study estimated." "The figures are astonishing and will surprise many," said Achim Steiner, the then UNEP Executive Director. As per this study, "the overall the quantity of rain falling across the continent is equivalent to the needs of 9 billion people, one-and-half times the current global population." About a third of Africa was deemed suitable for rainwater harvesting if a threshold of 200 millimetres of arrival rainfall, considered being at the lower end of the scale, was used. "Africa is not water scarce," it concluded. "The rainfall contribution is more than adequate to meet the needs of the current population several times over. For example Kenya would not be categorized as a 'water stressed country' if rainwater harvesting is considered. The water crisis in Africa is more of an economic problem from lack of investment, and not a matter of physical scarcity." "Over the coming years we are going to need

CHANGES IN AVAILABLE WATER IN AFRICA



Source: "Climate Change and Water Resources of Africa: Challenges, Opportunities and Impacts", *African Climate Policy Centre , United Nations Economic Commission for Africa,* 2011

a range of measures and technologies to capture water and bolster supplies," Steiner said. "Conserving and rehabilitating lakes, wetlands and other freshwater ecosystems will be vital and big dams, if sensibly and sustainably designed and constructed, may be part of the equation too. "However, large-scale infrastructure can often by-pass the needs of poor and dispersed populations. Widely deployed, rainwater harvesting can act as a buffer against drought events for these people while also significantly supplementing supplies in cities and areas connected to the water grid," he added.

Let us look at the relevance of village-based rainwater harvesting from yet another point of view. The key component of water management is "storage" especially in countries where the rain is seasonal and most of the rains are experienced in a few months. This water can be captured in: a) large reservoirs with large catchments by building large dams, b) in small tanks and ponds with small catchments, or c) by storing it in a way that it percolates down into the ground and gets stored as groundwater. In fact, there is strong scientific evidence to show that village-scale rainwater harvesting will yield much more water than big or medium dams, making the latter an extremely cost-ineffective and unscientific way of providing key water needs especially in dry areas. Some very instructive lessons can be learnt from the work of Israeli scientist Michael Evenari who has produced the best corpus of knowledge on this subject from the bone-dry Negev desert where the average annual rainfall is a mere 105 mm. Evenari was intrigued by the fact that the ancient Israeli civilisation had built towns right in the middle of the Negev desert with their own agriculture and water supply systems — much like the towns of Jodhpur and Jaisalmer that the enterprising Marwaris developed in the Thar desert of India. Both the Israelis and the Marwaris used the rain they received with great ingenuity to meet their food and water needs. In his effort to reconstruct the ancient farms of the Negev, Evenari came up with a very surprising finding: Water harvested from small watersheds per hectare of watershed area was much more in quantity than that collected over large watersheds. In hindsight this makes eminent sense because water collected over larger watersheds will have to run over a larger area before it is collected and a large part will get lost in small puddles and depressions, as soil moisture and through evaporation.

It seems water-stressed areas host the poorest population as well whose livelihood is critically linked to agriculture and livestock. In sub-Saharan Africa, almost 500 million people live in dry zones — deserts, grasslands and bush savannahs — in countries such as Mali, Niger and Zimbabwe. Another 245 million live in slightly wetter zones with forest savannahs, for example in large parts of Tanzania and Zambia, where run-off is still too low to irrigate fields.

TRADITIONAL RAINWATER HARVESTING TECHNIQUES

Various communities have historically employed different techniques for capturing and storing rainwater

SUSAN MASILA

RAINWATER HARVESTING is an ancient practice across Africa, including Kenya, where traditional methods are still in use today. In Kenya, various communities have historically employed different techniques for capturing and storing rainwater:

- **Water pans and earth dams:** these are shallow ponds or excavated areas designed to collect runoff rainwater. Traditionally, they are built using local materials like clay and lined with grass or other organic materials to reduce seepage.
- **Rock catchments:** in arid regions like Kitui, people use natural rock outcrops to collect rainwater. Channels are carved into the rock to direct water into reservoirs or tanks.
- R**oof catchments:** thatch roofs in rural areas have historically been used to direct rainwater into storage containers made from locally available materials such as gourds and clay pots.
- **Sand dams:** these are structures built across seasonal riverbeds. They trap and store water in the sand behind them, which slowly percolates into the groundwater, recharging aquifers and providing a source of water during dry periods.

Harvested rainwater can be utilised in various ways, both at small-scale (household or community) and large-scale (institutional or agricultural) levels. Here are some key uses:

- **Domestic Use:** drinking and cooking, washing and cleaning, toilet flushing.
- **Garden Watering:** rainwater is ideal for watering gardens, lawns, and potted plants and small farms, harvested rainwater can be used for irrigating crops, thereby enhancing food security.
- **Livestock Watering & Animal Husbandry:** Providing water for livestock, such as chickens, goats, cows, and other animals.
- **Emergency Use (backup supply):** stored rainwater serves as a backup water supply during droughts, water shortages, or disruptions in the mains water supply.
- **Agricultural Irrigation.**
- **Industrial Use** (process water and manufacturing).
- **Public and Institutional Use:** schools and hospitals, parks and recreational facilities, watering public parks, sports fields, and recreational facilities.
- **Community Water Supply.**
- **Environmental Management:** recharging groundwater & reducing runoff and erosion.

There are several types of rainwater harvesting systems in existence relevant to specific agro-climatic zones.

FOR ARID AREAS:

- **Sand Dams:** By trapping water in riverbeds, sand dams facilitate the percolation of water into the groundwater system. This technique has been used successfully to rejuvenate seasonal rivers in Kenya.
- **Terracing:** Building terraces on slopes slows down runoff, allowing more water to seep into the ground.
- **Planting Trees:** Trees improve soil structure and increase water infiltration.
- **Zai Pits:** Small pits are dug and filled with organic matter to capture and hold rainwater, promoting infiltration.

FOR MOUNTAINOUS AREAS:

- **Contour ploughing:** Ploughing along the contour lines reduces runoff and erosion.
- **Terracing:** Creating terraces on slopes helps in water retention and soil conservation.
- **Water harvesting structures:** Building small dams and ponds to capture runoff water.

FOR DESERT AREAS:

- **Sand Dams:** Effective in trapping and storing rainwater in sandy riverbeds.
- **Fog Nets:** Nets are used to capture water from fog and dew, which condenses and is collected for use.
- **Mulching:** Using organic materials to cover the soil reduces evaporation and conserves moisture.

Traditional and indigenous water management systems have significant potential to meet water demands due to their sustainability and adaptability. Many traditional methods are low-cost and can be scaled up easily with community involvement. They use locally available materials and are environmentally friendly. These methods are often deeply rooted in local traditions, making them more acceptable to communities.

Several countries recognise the value of traditional practices and incorporate them into modern water

management policies. The Kenya government and non-governmental organisations have been promoting sand dams and terracing as part of their water conservation strategies. Ethiopia uses traditional terracing and agro-forestry techniques to combat soil erosion and enhance water conservation. In India, the revival of traditional water bodies and rainwater harvesting structures are a key part of water conservation policies. By integrating these traditional methods with modern technology and policies, countries can create effective and sustainable water management systems to address increasing water demands.

(Susan Masila is currently a Consultant WASH Engineer at Amazi Water, Burundi)

According to the World Bank's "The Hidden Wealth of Nations: The Economics of Groundwater in Times of Climate Change" report: "In Sub-Saharan Africa, untapped groundwater irrigation potential could be key to improving food security and poverty reduction. Little land is irrigated there, but local shallow aquifers represent over 60 per cent of the groundwater resource, and 255 million people in poverty live above them."

A SITUATION ANALYSIS

Countries across Africa have been promoting rainwater harvesting and groundwater recharge as key parts of their respective water policy. Water scientists from the West African Center for Water, Irrigation and Sustainable Agriculture, University for Development Studies, Ghana, and Tuscia University, Italy, in August 2023 said, "Even though RWH techniques have been used for a long time, going back more than 4000 years, renewed interest has emerged due to the increase in available water resources and the effects of climate change, in particular in African arid and semi-arid lands." Here are a selected few case studies that show the potential of rainwater harvesting.

Tanzania: Lucy Michael, a 16-year-old student at the Kingani Secondary School in Tanzania's eastern Bagamoyo district, suddenly felt a stabbing pain in her stomach, forcing her to vomit continuously. "I felt dizzy and confused," she recalled. Diagnosed with typhoid fever and chronic stomach ulcers, her doctor attributed the conditions to consuming dirty water. Like many schools in Tanzania's Coastal Region, Kingani has repeatedly experienced water crises. Salination has impacted the waterbodies leaving them unfit for human consumption. But, there is no alternative. "If you don't have the money to buy bottled water, the last choice is usually to drink salty water," Michael said. Seawater intrusion, the movement of saltwater into freshwater aquifers, is causing fresh water to become tainted. This phenomenon occurs due to reduced stream flow, often caused by severe drought or rising sea levels, and is threatening freshwater sources along the East African coast. Coastal communities across Tanzania are facing a serious challenge as salty water taints freshwater sources. Scientists attribute this problem to climate change, as higher sea levels inundate wetlands and low-lying areas, increasing the salinity of rivers and underground water aquifers. "When freshwater is tainted by dissolving salts, it becomes potentially dangerous for human consumption since salty water contains high concentrations of dissolved solids and inorganic matter," warned Jason Raphael, a water engineer at the Bagamoyo District Council.

Under a rainwater harvesting project supported by UNEP, the water situation at Kingani School has improved. "We have enough rainwater stored in the tank for our daily use," Michael said. Sylolian Stephen, the deputy head teacher of the school, said the rainwater harvesting system had dramatically transformed the school. "Students spent many hours searching for water instead of studying. Not anymore," he said. The rainwater harvesting project, involving rooftop guttering and large storage tanks, has solved the school's water problems. The school had a stable water supply through the rainwater stored. At Kingani, 15-year-old student Hadija Juma stood proudly beside the newly built rainwater harvesting tank. "This tank has transformed our lives," she said. "It was very hard to wash clothes with salty water, but now, we have a steady supply of water."

As part of its broader push to address growing water scarcity in urban and rural areas, the

PHOTOGRAPH: ZUBERI MUSSA

east African country has adopted a rainwater harvesting policy to promote sustainable and efficient use of rainwater. Under the policy, aiming to cope with the worsening impacts of climate change, the government is implementing various initiatives to scale up rainwater harvesting, such as constructing large-scale reservoirs in public institutions including schools and hospitals, training local communities, and providing subsidies for rainwater harvesting equipment. "We are committed to ensuring every family can access and use rainwater effectively," said Mwajuma Waziri, permanent secretary at the ministry of water. "By investing in these initiatives, we will secure water resources for our communities and enhance our resilience against climate change."

Various rainwater harvesting systems are being implemented across Tanzania by public and private sectors, each designed to suit the local environment and community needs. "Rooftop harvesting is efficient and cost-effective. It utilises existing structures and provides clean water for household use," said JitihadiRajabu, a senior water engineer at the Ministry of Water. "Water harvesting is crucial for Tanzania, especially as we face increasing climate variability," said MengisenyKaseva, professor of environmental engineering at Ardhi University. "By capturing and storing rainwater, we can ensure a reliable water supply during dry periods, which is essential for both agricultural and domestic use." According to him, water harvesting initiatives provide immediate relief and contribute to long-term sustainability. "These initiatives help recharge groundwater, reduce soil erosion, and improve water quality. They are a vital part of our strategy to adapt to climate change and secure water resources for future generations." Kaseva encouraged scaling up water harvesting initiatives, citing their proven benefits and the urgent need to address the water crisis. "Expanding these projects can significantly enhance water availability in rural and urban areas and empower communities." He called for increased investment and collaboration among stakeholders to support these efforts. "Government, private sector, and local communities must work together to scale up water harvesting initiatives. With adequate funding, training, and technology, we can make a substantial impact." At the Kingani School, 37-year-old teacher Joyce Lweno shared how

rainwater harvesting had benefited her community. "Our school now has enough water for students, even during dry spells," she said. "It's amazing how something as simple as collecting rainwater can make such a big difference."

At Nyandira village in Tanzania's eastern Morogoro region, farmers have adopted traditional water harvesting systems to reduce soil erosion and increase crop yields. "We dig trenches carefully, making sure they follow the land's natural slope. The bunds we build help keep the water in place, allowing it to seep into the ground. It's a simple method, but it works perfectly," said Baraka Mkumbo, a farmer. The traditional rainwater tapping methods, known as fanyachini and fanyajuu—Swahili for "make down" and "make up," respectively -- are effective in retaining water and preserving land fertility, helping farmers cope with drought. Fanyachini involves digging trenches along the contours of a hillside and using the excavated soil to build a barrier on the downhill side. This method slows down water runoff, allowing it to seep into the soil and reduce erosion. The trenches, typically one meter deep and two meters wide, are spaced at intervals depending on the slope of the land. In contrast, fanyajuu involves digging ditches and throwing the excavated soil on the uphill side of the trench, forming ridges that help trap rainwater and direct it to the root zones of crops. These ridges are often reinforced with vegetation to prevent erosion and enhance water retention. "Before we started using fanyachini, our fields would dry up quickly after the rains," recalled Peter Ulanga, a farmer from Hombolo village in Dodoma. "Now, we can grow a variety of crops even during the dry season." The Ministry of Agriculture is promoting these techniques through training

As part of its broader push to address growing water scarcity in urban and rural areas, the east African country has adopted a rainwater harvesting policy to promote sustainable and efficient use of rainwater

programmes and by providing resources to communities.

The Tanzanian government has recognised the potential of rainwater harvesting and has incorporated it into its national water strategy. However, observers said there was still much work to be done. Increased investment is needed to expand the reach of rainwater harvesting systems. Additionally, continuous education and capacity-building efforts are essential to ensure the sustainability of these projects.

Ethiopia: In the last two decades, droughts have affected several areas of the country, leading to ponds, wells, streams and lakes drying up or becoming extremely shallow. Many Ethiopians living outside of the cities collect water from these shallow water sources, which are often contaminated with human and animal waste, worms, or disease. Water borne illnesses, such as cholera or diarrhea, are the leading cause of death in children under five years old in the country. Children in rural Ethiopia are forced to collect water every day from springs, small streams and shallow wells and helping their families earn their living have resulted in only 45 per cent of kids attending primary school in the country. Keeping in mind this, the Ethiopian water and energy ministry has launched a national rain water harvesting initiative dubbed as "My Dam at My Door". The project is credited with hugely increasing access to clean drinking water to almost 70 per cent of the country, according to the ministry of water and energy. Abraha Adugna, the water resources management state minister, indicated that the rainwater collection initiative had enabled over 4 million people to get access to clean drinking water and the project had contributed to bring the total number of people who have access to clean water to 74.6 million in Ethiopia. "Rainwater may also provide a solution when the water quality is low or varies during the rainy season in rivers and other surface water resources. Traditional sources are located at some distance from the community. Collecting and storing water close to households improves the accessibility and convenience of water supplies and has a positive impact on health. It can also strengthen a sense of ownership," he said. Moreover,

he underscored that the availability of water from sources such as lakes, rivers and shallow groundwater could fluctuate strongly, which could be mitigated by collecting and storing rainwater to be used in periods of water shortage.

Yilma Seleshi, a hydrologist at the Technology Faculty of the Addis Ababa University, said that for sustainable agricultural development of the country, water harvesting technologies have their contribution. "They can be constructed and managed by the community with minor technical know-how. The right choice of the water harvesting technique for the specific locality is required," he pointed out.

Zimbabwe: Zimbabwe has suffered recurring droughts for decades. But some resilient farmers in the country's increasingly arid zones have adapted to the changing climate by harvesting rainwater. These low-cost, scalable methods are proving effective in making farming viable. Zimbabwe, the Southern African nation that was once considered the continent's bread basket through its rain-fed agriculture, is now increasingly relying on food imports as the country suffer from recurrent droughts, the most recent being the El Nino-induced 2023-2024 drought that resulted in an 80 per cent crop failure.

However, for the people of Mazvihwa area in Zvishavane, an arid district in south central Zimbabwe, both wet and dry years make no difference to their situation as their arid area at most receives 400 mm of rain annually, which – due to its distribution pattern and the very high temperatures – is inadequate to make sustainable rain-fed farming possible. Traditionally, farming in this area was always concentrated in wetlands, but as the population grew, some of the villagers had to gamble with dryland farming, usually focusing on drought resistant crops like sorghum and millet as crops like maize (corn) were out of the question.

In the 1960s, what the Rhodesian colonial era (1890-1980) administration meant to be punishment to the late Zephaniah Phiri (1927-2015) turned into a blessing in disguise for the smallholder farmers in the country's arid regions. After being detained for years for his political activism against colonial domination, Phiri was released from detention and confined to an arid 8-acre piece of land in the Mazvihwa area. Blacklisted for any formal employment, Phiri was left with only two options: either to adapt or perish. He opted for the former. Phiri started experimenting with many water conservation methods for his crops. He started capturing runaway water from hill slopes, directing it into deep trenches he had dug in his crop fields at the bottom of the hill. For this, he was arrested three times by the colonial administration on

PHOTOGRAPH COURTESY: MUONDE TRUST

charges of "farming in a waterway". However, the administrators were intrigued by Phiri's continued defiance and his bountiful harvests even during the severe drought of 1972-73. So, a few officials visited his farm, where they were impressed by his water harvesting method, resulting in charges against him being dropped. Buoyed by the confidence from this official approval, Phiri started digging deep pits to store large quantities of water for future use. By 1983, Phiri's two water storing pits had a combined capacity of 1.5 million liters, allowing him to farm his land throughout the year.

Seeing Phiri's success, fellow smallholder farmers in Mazvihwa started learning these rainwater harvesting techniques in the 1980s. Today they are popular among farmers in many arid and semi-arid regions of Zimbabwe. By the time Phiri died in 2015, more than 10,000 people, both Zimbabweans and foreigners, had visited his farm to learn from his water management techniques.

Muonde Trust, a non-profit working to advance indigenous innovation in Mazvihwa has since expanded on Phiri's work to promote rainwater harvesting. Daniel Ndlovu, research officer of Muonde Trust, said rainwater harvesting has become the mainstay of successful smallholder farming in the Mazvihwa area.

"These water harvesting techniques have become so useful for those of us in arid areas because the rains that we receive are never enough for serious farming," said Ndlovu. "In the past it was not possible to grow crops that require a lot of water like maize. But with these techniques, some farmers actually have enough water to last until the start of the next rainy season." He said the area received just 200 mm of rainfall in the 2023 rainy season. Zimbabwe's rain season starts in November and lasts until March. It is during the seven dry months that

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the harvested rainwater is crucial for the farmers. In 2022 alone, representatives from 34 organisations visited Muonde Trust to get first-hand information and knowledge on water harvesting and other conservation programmes.

For over a decade, George Nyamadzawo, a professor of soil and environmental science at the Bindura University of Science Education (BUSE) in Zimbabwe, has worked with smallholder farmer communities in the Marange area, another arid area on the eastern part of the country, to implement water harvesting programmes. According to Nyamadzawo, over 50 per cent of rainwater is lost by surface runoff and evaporation, with only 15-30 per cent retained by the soil, which is insufficient for crop production. In this area, average rainfall is 200 mm per year and maize yields are as low as 0.4 tons per hectare, more than three times lower than the national average (1.39 t/ha).

Nyamadzawo started with 20 farmers in 2014 who worked on structures to capture runoff water from the rocky catchment. These included the diversion of runoff water into the field through contour channels, the installation of cross-ties along contour channels, the fortification of contour channels with infiltration pits, and the use of in-field water harvesting techniques such as ridging and sub-surface water-nets. He said as a result of these measures, soil and water loss from runoff reduced by more than 50 per cent and 75 per cent, respectively within five years. "When we started, we were just looking at ways of adapting to climate change in semi-arid regions. We were promoting tied contours, infiltration pits and other water harvesting technology as methods that can be used by farmers in dry regions such as these," Nyamadzawo said. "After integrating tight contours and infiltration pits, we managed to

increase crop yields to at least 3 t/ha." Some of the farmers have realized maize yields of 4-6 t/ha while vegetable production also increased 10-fold. Nyamadzawo has been involved in the training of some 5,000 lead farmers on water harvesting using tied contours and in-field water harvesting for climate change adaptation and mitigation, and the establishment of 63 farmer learning centres (FLC) or demonstration sites at which lead farmers were trained.

In the aftermath of the 2023-24 poor rains, the government of Zimbabwe has undertaken to prioritise irrigation development to decisively move away from overreliance on rain-fed agriculture. After noticing the success of Nyamadzawo's projects in Marange, the Ministry of Land, Agriculture, Water, Fisheries and Rural Development has pledged to establish 900 pilot and learning sites to demonstrate the principles of integrated rainwater harvesting and soil health improvements, and to repeat this success across the country. Peter Makwanya, a climate change expert, said as a climate change adaptation or mitigation tool, rain-water harvesting helped ameliorate adverse economic and environmental situations. "Communities such as ours (Zimbabwean), which previously did not practice rainwater harvesting on a wide-scale due to formerly abundant water resources, need to be made aware on how best they can seriously engage in this water saving technique," Makwanya said.

Malawi: In the heart of Southern Africa, Malawi serves as a testament to the harmonious blend of traditional wisdom and natural resources. With its rolling landscapes and lush valleys, the country is now trying to encourage societies to rely on indigenous water harvesting systems to sustain communities through the dry seasons. The Rainwater Harvesting Association of Malawi (RHAM) has developed over 200 "calabash" rainwater harvesting systems across the country since 2021. These systems are designed to collect and store rainwater during the rainy season, ensuring a steady supply of water for agriculture

The calabash system, a traditional method of water collection and storage, remains in existence due to its numerous advantages. Its cost-effectiveness is particularly noteworthy, as it allows rural communities to implement and maintain these systems without incurring prohibitive expenses

and domestic use throughout the year. Carol Kaitano, a member of the association, said the calabash system involves constructing large, calabash-shaped cisterns using local materials such as sand, cement, and clay bricks.

"Clay bricks are used to construct a calabash mould with a globe like bottom. The cement cistern is constructed inside this mould, reinforcing with chicken wire mesh. At the final stage of the construction process, the masons remove the clay blocks of the mould. The clay bricks can be used several times. Sometimes, cement blocks can be used instead of clay bricks depending on preference," Kaitano Said. She added the cisterns are designed to collect rainwater from rooftops or surface runoff and key engineering aspects include catchment area, filtration system, and storage capacity and distribution mechanism. "Filtration system removes debris and impurities while the distribution systems look into simple gravity-fed or hand-pump systems to distribute the stored water for irrigation and domestic use. That's the engineering behind it," she added. According to RHAM each cistern can hold between 5,000 to 20,000 litres of water. Communities have been trained on maintenance and proper usage of these facilities.

Kanyumbu village is one such village that has adopted this water harvesting system. It is a community-led initiative with the Group Village Head playing a key role in overseeing the system's implementation. "Through the training on system maintenance to ensure sustainability, we were given leadership roles and ownership as a community. We make sure that water is distributed equally and prioritize agricultural needs and domestic usage," said the

PHOTOGRAPH: WINNIE BOTHA

Group Village Head of Kanyumbu. "With the 2023-2024 annual rainfall between 900-1,200 mm, each cistern collected significant amounts of water. On average, a 10,000-liter cistern filled multiple times during the rainy season," Kaitano said. Kaitano added that looking at the agricultural impact, the availability of water has significantly transformed the way communities manage and grow their crops. The consistent and reliable water supply has enabled these communities to cultivate a variety of crops throughout the year, greatly reducing their dependency on unpredictable and often insufficient rainfall. Studies have demonstrated that there has been a remarkable 30-40 per cent increase in crop yields as a direct result of this steady water availability. This improvement not only enhances food security but also boosts the local economy by enabling farmers to sell surplus produce in nearby markets. She further explained that each cistern, a crucial component of this water supply system, can serve multiple households. In some cases, a single cistern provides water for up to 10 families, effectively supporting both domestic needs, such as cooking, cleaning, and drinking, and agricultural irrigation. This shared resource fosters a sense of community cooperation and ensures that even the most vulnerable families have access to essential water.

The calabash system, a traditional method of water collection and storage, remains in existence due to its numerous advantages. Its cost-effectiveness is particularly noteworthy, as it allows rural communities to implement and maintain these systems without incurring prohibitive expenses. The system's success is also attributed to active community involvement

and the backing of various stakeholders, including local governments, non-profit organizations, and international development agencies. Together, these factors make the calabash system an accessible and sustainable solution for rural areas, ensuring long-term benefits for the communities it serves.

The Malawi government, through the Ministry of Water and Sanitation, has been actively involved in identifying and assessing surface water resources across the nation to support water development, protection, and conservation efforts. This comprehensive approach ensures that valuable water resources are sustainably managed and safeguarded for future generations. The Ministry also provides efficient hydrological advisory services to the public and various clients, offering expertise and guidance to optimise water usage and address challenges related to water scarcity and distribution. Abida Mia, the Minister of Water and Sanitation, highlighted the government's ambitious plans to expand the existing water systems to more villages, ensuring that even the remotest communities benefit from reliable water access. Mia emphasised that with proper scaling and implementation, the calabash system could significantly alleviate water scarcity issues faced by rural areas in Malawi.

Kenya: Despite its strikingly beautiful landscape, the main and virtually the only news that comes from this remote region of Kenya to the outside world is about unending community conflicts, sparked by deadly violence over water and pastures resources or theft of livestock. Just like it happens in most of the arid North Rift Valley and Northern Kenya in general, communities here season-in season-out engage in bloody fighting that results in not only loss of lives, mainly livestock, but displacement of communities-the elderly, women, children and the disabled included. While cattle raids-in reality communal large scale cattle thefts between rival communities is the major driver, access to water sources for livestock followed by ownership of grazing fields are the other causes of the age old violence that bedevil the scenic hills of Elgeyo-Marakwet and neighbouring counties.

In the midst of the chaos and unknown to many, there is a big story of ingenuity of centuries old innovation that is the Marakwet Escarpment Furrow Irrigation System, a masterpiece in conserving and managing water for irrigation and beyond. So old is the irrigation marvel that

PHOTOGRAPH: MAINA WARURU

it is believed to be more than 500 years old, a testimony to the role of rarely appreciated indigenous knowledge in water harvesting and use. Located on the Marakwet escarpment at an elevation of 1,500 metres above the valley floor of Kerio valley, the furrows could easily be mistaken for galleys dug out by rainwater runoff. However, the old engineering marvel running across and down the scenic ridges that form the escarpment, has for centuries ensured that this semi-arid is food secure, a rare feat in this part of Kenya.

Over the years, the system has capitalised on rivers flowing into the area from the distant Cherangany hills, using gravity to supply water to the irrigation furrows in the plains below, spreading it along a breadth of more than 40 kilometres, and allowing residents to grow a variety of vegetables, paw paws, mangoes, bananas, sorghum and millet. "This is besides water for domestic use and for livestock, a treasured source of both wealth and prestige among the Marakwet people, a community that practises mixed subsistence farming," said Wesley Kipchumba, a farmer and community member in Tot area. "These furrows have ensured that this area is always green and farmers have some food for their families even in the driest years unlike other places in this region," boasted the 64-year old.

The traditional water system besides being a lifeline has become a source of pride for the community, who share the canals along clan lines, with each clan contributing money and labour to carry out maintenance works, he adds, regretting that he cannot recall the last time the villages received government support for maintaining the irrigation scheme. It is recognition of this ingenuity that the United Nations Educational Scientific and Cultural Organisation (UNESCO) in 2023 designated the furrows a tentative world heritage site, one of the few in the world and perhaps the only in Africa.

The Marakwet Escarpment Furrow Irrigation System, a masterpiece in conserving and managing water for irrigation and beyond. It is believed to be more than 500 years old. Located on the Marakwet escarpment at an elevation of 1,500 metres above the valley floor of Kerio valley, the furrows could easily be mistaken for galleys dug out by rainwater runoff

"The technology of furrow construction is complex; it involves the use of trunks, wood and stones laid on top of each other and with the support of mortar and leaves. From their sources, furrows follow weak or lower points passing through hills and valleys". UNESCO describes the canals. "Due to scarcity of water, the inhabitants of the area have over the years developed land use systems based on their perception and knowledge of the fragile ecological base. To reconcile the competing demands for water use, the Marakwet evolved a unique technique of managing water rights that took into consideration the needs of each clan," noted the UN agency. This water management system operates on "non-bureaucratic principles" that ensure the furrows provide water for both human and animal consumption as well as for irrigation", it adds. It appreciates that the community has developed sophisticated techniques for managing water flows, maintaining the canals, and in optimising agricultural productivity in a harsh environment.

"The original furrows were constructed more than 500 years ago by a people who mysteriously disappeared as the present inhabitants, the Marakwets, migrated into the area. The Marakwets showed a high level of ingenuity in expanding and improving the system; taking the water across ridges and over valleys to places many miles from its original course," said the area's County government who promotes the systems as a tourist attraction, adding that reaching the nearest of the well secured infrastructure would take no less would take no less than an hour of climbing up the escarpment.

While the scheme stands out in terms of age and innovation, different communities in

PHOTOGRAPH: MAINA WARURU

Kenya have traditionally used different harvesting and storage practices, based among others on availability of the commodity in a given area, said Wangai Ndirangu, a water engineer and consultant with Be Associates in Nairobi. The practices applied by a community are intricately linked to land use systems in a given area, and many have worked perfectly over the years ensuring water is sustainably available. "So you find that communities in semi-arid northern Kenya regions where land is mainly used to keep livestock, water management systems are directly linked to range management", "this primarily driven by the need to have adequate water for animals," the Jomo Kenyatta University of Agriculture and Technology lecturer explained. "For the reasons the systems in place here are more elaborate and have been practiced for a very long time," he notes giving the example of the Borana indigenous systems in northern Kenya and Southern Ethiopia, where range management is an integral part of water planning and use, owing to the arid area nature of the region.

The systems have stood the test of time and have been adapted over centuries to cope with the harsh climatic conditions, said Francis Muhoho, conservationist and chairman, Bathi Water Resources Users Association in Central Kenya. These include Sand Dams primarily used in arid and semi-arid counties of South Eastern Kenya, usually simple, low-cost stone barriers built across seasonal riverbeds catching water during the rainy season, to slow down runoff and increase groundwater recharge. In hilly areas of central Kenya communities use Rock Catchment systems, where natural rock surfaces are used to collect rainwater runoff, which is then channeled into surface reservoirs mostly in places with rocky terrain, he explained.

Earth dams and pans, excavated depressions designed to collect and store storm water during the rainy season, are essential for providing water for livestock and domestic use during the dry periods common in semi-arid areas of Eastern Kenya. They are complemented by shallow wells dug by communities to access groundwater. The wells are often lined with stones or other materials to prevent collapse, the activist adds. "These systems have been passed down through generations and continue to play a vital role in ensuring water security in many

Kenya, a drought prone Horn of Africa country, has hundreds of planned but stalled conventional harvesting and storage projects across the country valued at over US$22 billion. The country risks losing the opportunity for attaining Sustainable Development Goals number 2, 6 and 7 on ending hunger and food security, provision of clean drinking water and on clean energy respectively

Kenyan communities. They are often complemented by modern water harvesting techniques to enhance water availability and resilience to climate change," he said. He added, "These traditional rainwater-harvesting practices have been perfectly sustainable for many years. The reason for this is that they are compatible with local lifestyles, local institutional patterns and local social systems".

The systems are still largely communally owned and managed and engineering in many cases is driven by indigenous knowledge, now increasingly being recognised as vital. "The recognition is directly related to the growing realisation that locally generated knowledge can be used to change and improve agriculture and natural resource management," he opined. According to Violet Matiru of Millennium Community Development Initiatives, an environmental and natural resources management membership community group, while many systems have survived for centuries, the only reason they have done so is due to lack of interference from authorities, rather than owing to support from the quarters. Where the authorities have sought to play a role in management of such systems, the result has been "commoditisation" of the resource putting it out the reach of many or total collapse of the schemes, she said.

According to Kenya National Harvesting and Storage Strategy 2020-2025 developed in 2021, over two-thirds of the country receives less than 500mm of rainfall per year and 79 per cent has less than 700mm annually. Only 11 per cent of the country receives more than 1,000 mm per year making harvesting inevitable to bring water closer to the people and contribute to the right to water. "Rainwater harvesting has been carried out in Kenya since 1900's but only gained momentum in the last few decades with aggravation of water scarcity. Rainwater harvesting is key in building resilience occasioned by weather variability and climate change," the document noted.

Harvesting practices include, "impounding" of surface runoff, roof harvesting, stored in tanks, Pans, on farm retention structures, subsurface dams, underground in aquifers and retention of water in the soil as moisture. It acknowledges that "Kenya needs to have a strategic reserve of water stored for use during emergencies and unforeseen periods of drought. This can only be achieved through integrated planning, sustainable financing and water harvesting and storage infrastructure development."

Overall Kenya, a drought prone Horn of Africa country, has hundreds of planned but stalled conventional harvesting and storage projects across the country valued at over US$22 billion. They include dams and water pans at the feasibility, design, proposal or different implementation stages. The country risks losing the opportunity for attaining Sustainable Development Goals number 2, 6 and 7 on ending hunger and food security, provision of clean drinking water and on clean energy respectively. ■

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