THE RIGHT TO WATER AND CLIMATE CHANGE 2025 THE ARAB WATCH REPORT ON ECONOMIC AND SOCIAL RIGHTS

THE RIGHT TO WATER IN SUDAN

NAVIGATING THE INTERSECTION OF CONFLICT, CLIMATE CHANGE, AND GOVERNANCE FAILURES

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This report is published as part of the Arab NGO Network for Development's Arab Watch Report on Economic and Social Rights (AWR) series. The AWR is a periodic publication by the Network and each edition focuses on a specific right and on the national, regional and international policies and factors that lead to its violation. The AWR is developed through a participatory process which brings together relevant stakeholders, including civil society, experts in the field, academics, and representatives from the government in each of the countries represented in the report, as a means of increasing ownership among them and ensuring its localization and relevance to the context.

The seventh edition of the Arab Watch Report focuses on the right to water. It was developed to provide a comprehensive and critical analysis of the status of this right across the region, particularly in the context of climate change and its growing impacts. The information and analyses presented aim to serve as a platform for advocacy toward the realization of this fundamental right for all.

The views expressed in this publication are solely those of the author and do not necessarily reflect the positions of the Arab NGO Network for Development (ANND), Brot für die Welt, or Norwegian People's Aid.

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Dr Hisham Salaheldin is an environmental expert bridging science, policy, and practice to advance sustainability, climate adaptation, and peacebuilding in fragile contexts.
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He has strong experience in applied research and consultancy, having coordinated and led major Environmental and Social Impact Assessments (ESIAs) across Sudan's infrastructure, mining, and energy sectors. He has also contributed to the CEWARN initiative on environmental conflict risks under IGAD. His project engagement includes Sudan's National Adaptation Plan (NAP) Readiness Programme implemented by FAO, as well as RUS and SudaNext, which focus on advancing the water–energy–food nexus transition in Sudan.

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With more than 15 published works, Dr. Hassanein continues to contribute to civil engineering research, while remaining committed to building local capacity and promoting sustainable development in Sudan and beyond.

CONTENTS

ABSTRACT

This study explores the intersection of climate change, conflict, and institutional weaknesses in Sudan, focusing on how these factors collectively undermine the right to water. The research employs a mixed-methods approach, combining a structured Google Form questionnaire distributed through social media platforms with unstructured expert interviews. Key findings reveal that water access in Sudan is critically impaired by a combination of climate variability, conflict, and governance failures. Changing rainfall patterns and rising temperatures have exacerbated water scarcity, while armed conflicts have led to the weaponization of water infrastructure, including the deliberate destruction of water sources and facilities. Institutional inefficiencies and weak governance have further obstructed effective water management, leaving millions without reliable access to clean water. The study underscores the urgent need for institutional reform, climate-adaptive water management strategies, and a rights-based approach to water governance.

- **KEY MESSAGES:**

1. **Water Insecurity as a Human Rights Crisis:** Sudan's water crisis is a severe human rights issue, where conflict, climate change, and governance failures intersect to deprive millions of clean and sufficient water.
2. **Weaponization of Water Infrastructure:** Armed groups have deliberately destroyed and controlled water infrastructure, exacerbating scarcity and turning access to water into a tool of war, especially in regions such as Darfur and South Kordofan.
3. **Impact of Climate Variability:** Climate change, through rising temperatures and erratic rainfall, has intensified water scarcity, further straining fragile resources, particularly in rural and conflict-affected areas.
4. **Institutional Fragmentation:** Weak governance and fragmented water management have led to poor coordination, inefficient allocation, and an inability to respond effectively to climate- and conflict-related disruptions.
5. **Gendered Impacts:** Women and children, primarily responsible for water collection, face long and dangerous journeys, exposure to violence, and health risks from unsafe water.
6. **Need for Climate-Resilient Infrastructure:** Investments in decentralized, climate-resilient systems such as solar-powered pumps and rainwater harvesting are essential for long-term water security.
7. **Inclusive Governance and Participation:** Inclusive governance with the participation local communities, particularly marginalized groups, is crucial to ensuring equitable and sustainable water access.
8. **Policy Reforms for Water Security:** Policy reforms, including a national water law, stronger institutional frameworks, and climate adaptation strategies, are essential for protecting the right to water and improving resilience.

KEYWORDS:

Right to water; climate change; conflict; institutional weakness; weaponization of water; water infrastructure; governance reform.

01

INTRODUCTION AND GENERAL CONTEXT

Access to clean, safe, and sufficient water is a fundamental human right. This right is integral to human health, development, and dignity, and it is essential for achieving Sustainable Development Goal (SDG) 6, which emphasizes universal access to water and sanitation. However, in Sudan, the realization of the right to water is increasingly compromised due to a complex interplay of climate change, conflict, institutional weaknesses, and socio-economic inequities. The country's water crisis has evolved into a multifaceted humanitarian emergency that not only affects basic human survival but also highlights broader issues of governance, equity, and human rights (UNDP, 2022; UNEP, 2022).

Sudan's water systems, heavily reliant on the Nile River, face mounting pressures from climate change and political instability. The country's geographic diversity, from arid northern deserts to tropical southern regions, makes it particularly vulnerable to fluctuating rainfall patterns and extreme weather events, such as droughts and floods, which are further exacerbated by climate variability (Sutcliffe & Parks, 2020). These climatic stresses have led to disruptions in water supply, particularly in rural and conflict-affected areas where infrastructure is already weak or non-existent. The problem is compounded by the overextraction of groundwater and the degradation of vital ecosystems, including the drying of wetlands and soil salinization (UNHCR, 2025).

The ongoing armed conflict in Sudan, particularly since the outbreak of the civil war in April 2023, has further worsened the situation. Fighting has destroyed key water infrastructure, restricted access to water sources, and displaced millions of people. The conflict has also led to the weaponization of water resources, with belligerents targeting or blocking access to water supplies to undermine communities or exert control (OCHA, 2024). The targeting of vital water systems, coupled with the government's weakened capacity to respond, has resulted in widespread water insecurity, especially in regions such as Darfur, Blue Nile, South Kordofan, and even Khartoum, the capital (UNICEF, 2023a).

This research seeks to investigate how the confluence of conflict, climate change, and governance failures has exacerbated Sudan's water crisis, with a focus on the socio-economic and human rights implications for vulnerable communities. Specifically, the study addresses the root causes of water insecurity, the weaponization of water resources, the impacts of climate change, and the role of institutional weaknesses in water management. It also explores how these factors intersect to deepen inequalities, particularly for displaced populations, women, and children, who are disproportionately affected by water scarcity and contamination (Sax et al., 2023).

The research adopts a mixed-methods approach, combining qualitative interviews with key stakeholders, including policy-makers, water management experts, and affected community leaders, with a quantitative survey to gather data on water availability, quality, and access. The study highlights the urgent need for climate-resilient water governance and greater accountability in protecting the human right to water. The findings offer policy recommendations to enhance water security in Sudan, advocating for more sustainable, equitable, and rights-based approaches to water management, particularly in conflict-affected and vulnerable regions (UNDP, 2022).

02

WATER USE AND ALLOCATION IN SUDAN

Sudan's water is primarily sourced from the Nile Basin, groundwater, and seasonal rainfall. The Nile River is the country's most significant water source, providing over 90% of its freshwater. The Nile system, including the White Nile and Blue Nile, flows through Sudan, making it essential for irrigation, domestic use, and industrial activities. Groundwater also plays a critical role, especially in arid regions, where it is the primary source of water for agriculture and domestic consumption. However, groundwater resources are being overexploited due to inadequate regulation and increasing demand. Rainfall is another essential source, but its distribution is highly variable, with some regions, particularly in the south, relying heavily on seasonal rains for water availability (Sutcliffe & Parks, 2020).

Water use in Sudan is heavily skewed toward agriculture, which consumes more than 96% of the country's total water resources. This reflects the country's reliance on irrigated farming as a key component of its economic base, particularly in regions such as the Gezira Scheme, one of the largest irrigation projects in Africa. Agriculture in Sudan is primarily rain-fed, but a significant share depends on irrigation from the Nile, governed by the 1959 Nile Waters Agreement, which allocates a fixed volume of water annually. This water supports the cultivation of crops such as sorghum, sesame, and wheat, among others. Despite the contraction of cultivated land in recent decades, agricultural demand for water is expected to rise due to population growth and the sector's continued expansion, with projections indicating that water demand will exceed 50 billion cubic meters by 2027 (Fanack Water, 2025).

Domestic water use in Sudan accounts for only about 3.5% of total consumption, reflecting stark disparities in access. In fact, access to clean water remains a major challenge, particularly for rural populations. As of 2017, only 60.2% of the population had access to at least basic drinking water services, with significant disparities between urban and rural areas. In rural regions, where infrastructure is weak or non-existent, communities often rely on unsafe water sources, contributing to high rates of waterborne diseases and mortality (WHO, 2024).

Industrial water use in Sudan is minimal, accounting for less than 1% of total consumption. However, industrial activities, particularly oil production, agro-processing, and sugar manufacturing, are concentrated in specific regions such as Khartoum and Gezira. Despite the limited share of water used by industry, improper management of wastewater and industrial effluents poses significant risks to water quality, further compounding the water crisis, particularly in areas near mining opera-

tions and major urban centers.

A critical issue in Sudan's water management is the inequitable allocation of water resources, exacerbated by regional disparities. The Nile Basin, while a vital water source, is predominantly utilized by regions along its course, leaving peripheral areas, especially in the west and east, underserved. These disparities are not only geographical but also political, with historical water agreements and government policies favoring certain regions over others (ACAPS, 2023). Additionally, the colonial legacy of water management policies and the post-independence political economy continue to shape access and distribution, contributing to conflicts and tensions over water resources (ESCWA, 2022) [Figures 1–3].

Figure 1: Precipitation in Sudan

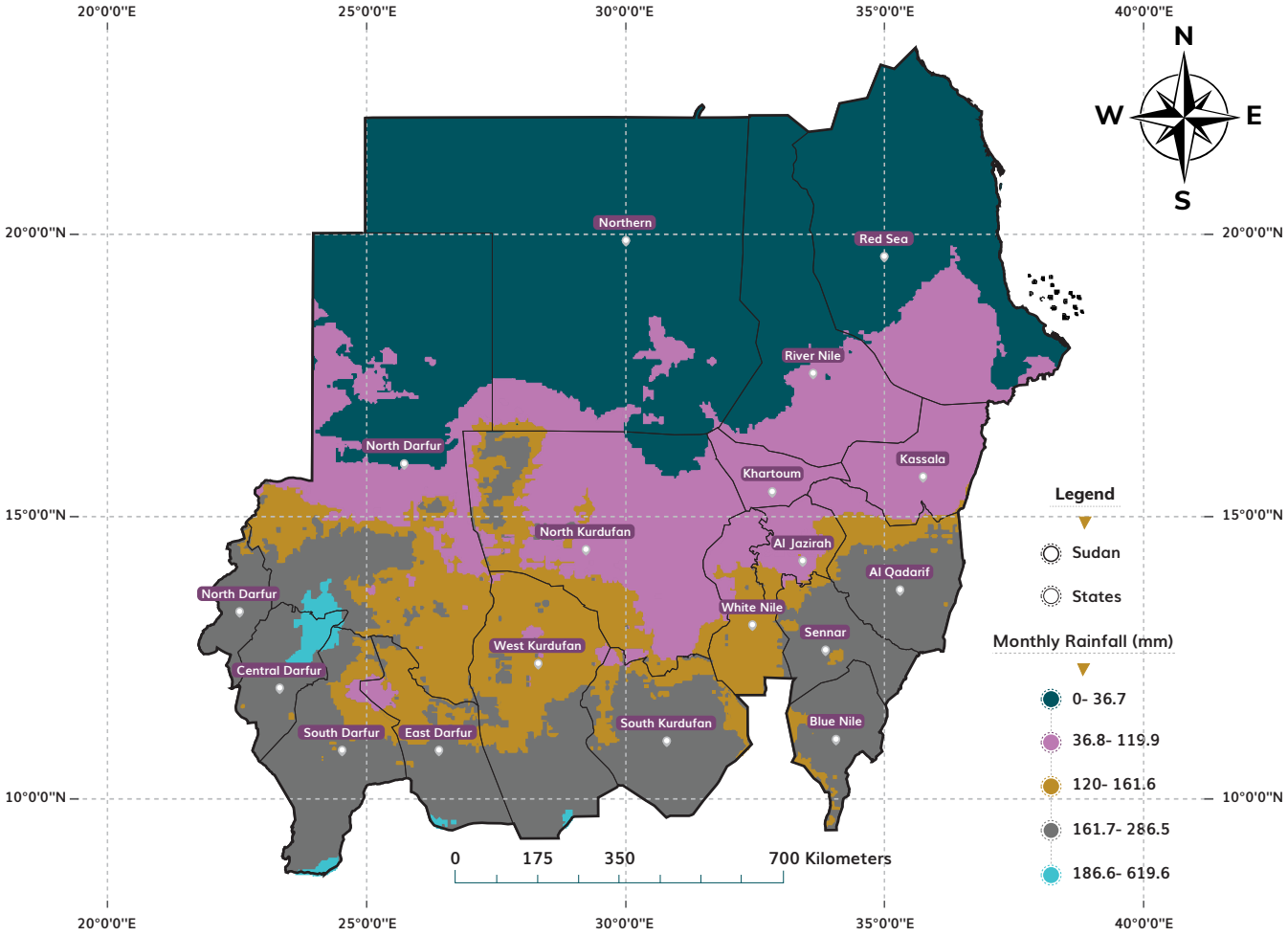


Figure 2: Agriculture Schemes

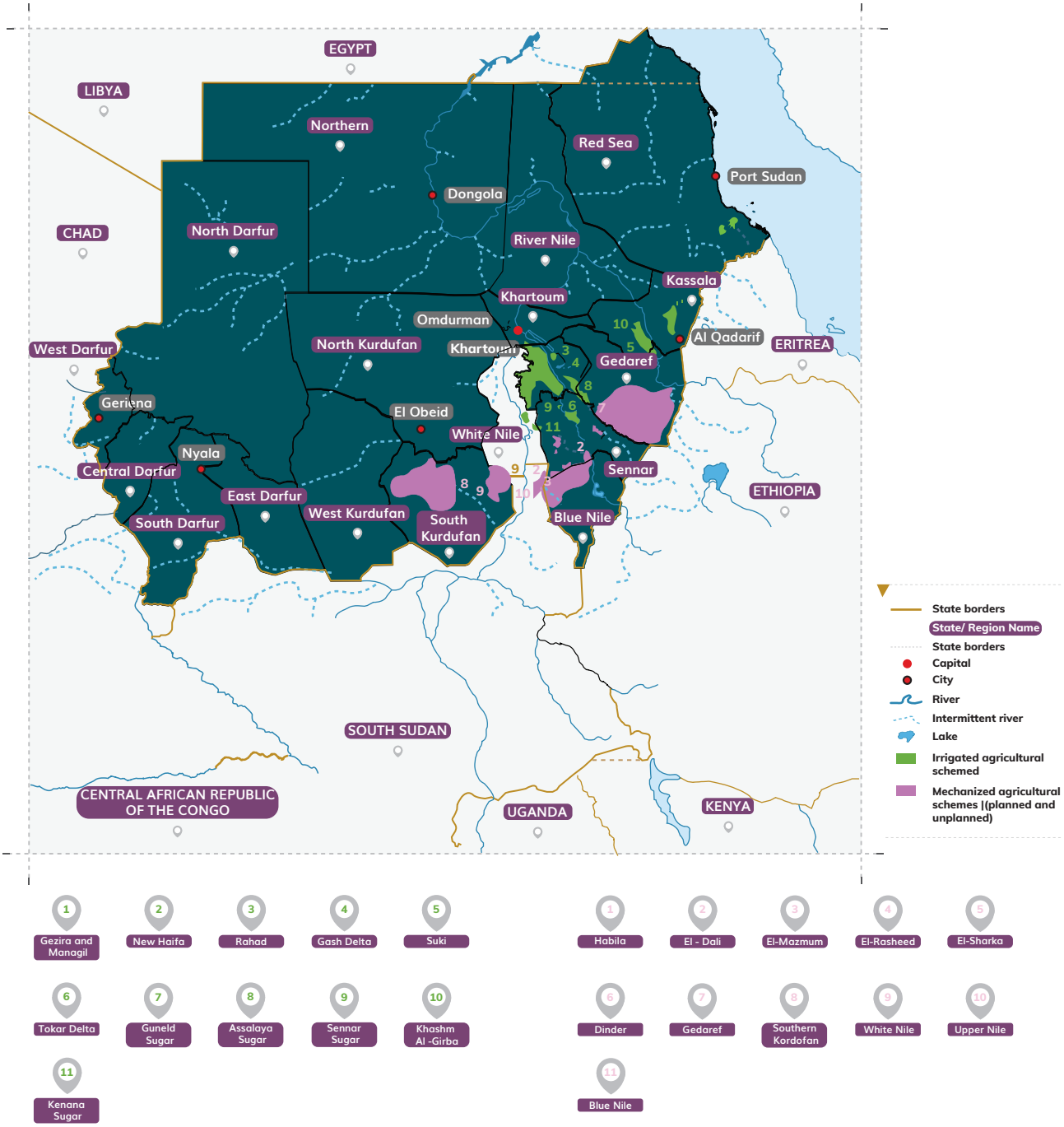
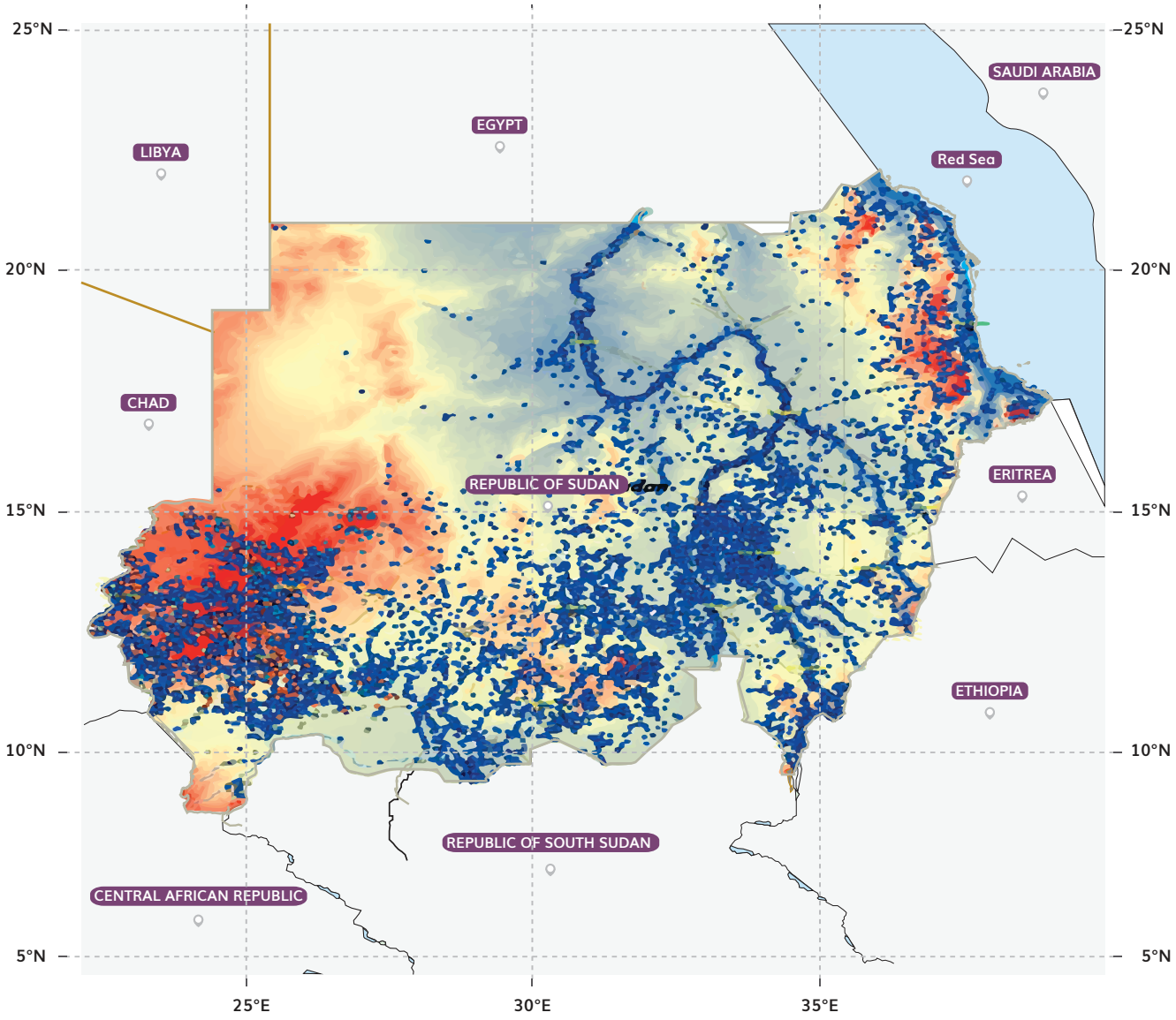


Figure 3: Human Settlements in Sudan



N
W E
S

1:2,500,000

Kilometers

Name

0 45 90 270 360

Settlement Map

Legend

- Railroad
- Roadnetwork
- Nile
- Region Map

Legend Sudan _ Settlement

- 100000 and above
- 50000 - 100000
- 10000 - 50000
- 1000- 10000
- Below 1000
- No value / Uninhabited Location

03

CLIMATE VARIABILITY AND WATER ACCESS

Sudan's water crisis is intricately linked to climate variability, with erratic rainfall patterns, recurrent droughts, and frequent floods significantly affecting water availability, particularly in rural areas. Climate change is intensifying these challenges, with rising temperatures, unpredictable rainfall, and extreme weather events making water management increasingly difficult. As a country reliant on the seasonal flow of the Nile and variable rainfall for its water supply, Sudan's agricultural productivity, water security, and livelihoods are highly vulnerable to climate stress (Gutiérrez et al., 2021).

Droughts have become more intense and prolonged, leading to severe water shortages. Between 2021 and 2023, extended dry spells significantly reduced groundwater recharge and disrupted rainfed agricultural systems (World Bank, 2022). This decline in water availability is particularly evident in areas dependent on shallow wells and the Nubian Sandstone Aquifer, which is under increasing pressure from overextraction (Ahmed et al., 2021). Prolonged droughts have made rural communities increasingly reliant on distant or unsafe water sources, heightening the risk of waterborne diseases (FAO, 2024a).

Conversely, flooding is another consequence of climate variability that threatens both water availability and quality. The 2024 rainy season brought unprecedented flooding, affecting over 4 million hectares of land, including cropland, and destroying critical water infrastructure such as wells, irrigation networks, and small dams (FAO, 2024c). Floods have contaminated shallow wells, contributed to outbreaks of waterborne diseases, and exacerbated livelihood losses in agricultural areas (IFRC, 2023). As floods and droughts alternate, they create hydrological instability that undermines water storage and groundwater recharge, weakening long-term water security (World Bank, 2022).

These shifting climatic patterns also place immense pressure on agricultural production, which is Sudan's primary water-consuming sector. Irrigated agriculture accounts for the bulk of water use, and its dependence on consistent water availability makes it highly vulnerable to both droughts and floods (Fanack Water, 2025). As rainfall becomes more erratic, agricultural communities are increasingly forced to rely on alternative water sources, including costly water deliveries or groundwater reserves that are rapidly depleting. This not only affects food security but also contributes to increased migration, as people leave their homes in search of safer and more reliable water sources (IOM, 2023).

04

IMPACT OF CONFLICT ON WATER AVAILABILITY

The ongoing conflict in Sudan has had a devastating impact on water availability, exacerbating an already fragile situation shaped by climate variability, weak governance, and environmental degradation. As the conflict intensifies, water systems, already strained by climate-induced stress, are increasingly targeted, militarized, and disrupted. These developments have transformed water from a vital resource for survival into a weapon of war, significantly undermining both physical access to water resources and the capacity of governance institutions to manage them.

Conflict has directly destroyed essential water infrastructure, including wells, pumping stations, and electricity grids necessary to maintain safe water supplies in areas such as Darfur, Kordofan, and Khartoum. Reports from humanitarian organizations indicate that armed groups have deliberately attacked this infrastructure as part of a broader strategy to deprive civilian populations of water. The systematic destruction of these resources has resulted in widespread shortages, with some regions experiencing water access rates far below minimum survival standards (Geneva Academy, 2025). These actions violate international humanitarian law, specifically Article 54 of Additional Protocol I to the Geneva Conventions, which prohibits the destruction of objects indispensable to the survival of civilians (Geneva Academy, 2025).

In addition to the physical destruction of water systems, the conflict has severely disrupted supply chains, further deepening the crisis. The targeting of water infrastructure not only prevents communities from accessing clean water but also reduces the capacity to distribute and treat it, leading to a proliferation of waterborne diseases such as cholera and dysentery. Internally displaced persons (IDPs), particularly those in camps or rural areas, are often forced to rely on contaminated or unregulated water sources, increasing health risks and suffering (WHO, 2024). As water infrastructure becomes more difficult to repair due to ongoing insecurity, these challenges are compounded by a lack of skilled labor and resources to maintain systems (UNHCR, 2024).

Displacement, a direct consequence of conflict, has further intensified Sudan's water access crisis. More than 12 million people have been displaced, many of whom have fled to areas already suffering from water shortages (UNHCR, 2025). This has placed immense pressure on urban water systems, often resulting in competition for limited resources between displaced populations and host communities. In some regions, particularly in Darfur and Kordofan, displaced families walk up to 14 kilo-

meters to fetch water from unsafe sources, exposing them to additional health risks and deepening their vulnerability (IOM, 2023). Vulnerable groups, especially women and children, bear the brunt of this burden. Women, in particular, spend significant time fetching water, which affects not only their health but also their ability to engage in education and income-generating activities (UNICEF, 2023).

The ongoing conflict in Sudan illustrates how water systems can be targeted and politicized during war, transforming water scarcity into a tool of control and punishment. This deliberate manipulation of water access underscores the need for stronger legal frameworks and humanitarian responses to protect water resources during conflict and ensure that the right to water is upheld for all Sudanese people (Geneva Academy, 2025).

05

CASE STUDIES ON WATER CONFLICT

In Sudan, the ongoing conflict has significantly exacerbated water insecurity, as water resources are increasingly contested, and access to safe drinking water is systematically obstructed. This section presents key case studies from regions such as Darfur, South Kordofan, and Blue Nile, illustrating how water scarcity, competition, and conflict converge, making water a focal point of tension and violence.

CASE STUDY 1: WATER SCARCITY AND ETHNIC TENSION IN GEDAREF (2019)

In 2019, the eastern state of Gedaref witnessed a notable case of water-related ethnic violence. During a period of political transition, water cuts were imposed in parts of the state, triggering confrontation between ethnically distinct groups competing for a nearby freshwater well. The lack of transparent water rationing, coupled with weak mediation mechanisms and pre-existing ethnic tensions, allowed the situation to escalate into violence. This conflict was not merely about access to water; it also highlighted deeper issues of marginalization and the absence of equitable resource distribution (Fanack Water, 2025).

CASE STUDY 2: PROJECT-INDUCED CONFLICT IN BLUE NILE STATE (2022)

In 2022, a donor-funded water supply project in Blue Nile State, designed to expand access to drinking water, unintentionally sparked conflict. The project failed to adequately consult local communities and was perceived by some as a political land grab disguised as development. As a result, clashes erupted between different groups, leading to the suspension of the project and deepening mistrust between the community and external actors. This case underscores the importance of conflict-sensitive project design, participatory planning, and the recognition of customary land rights in preventing such tensions (UNICEF, 2023b).

CASE STUDY 3: INFRASTRUCTURE COLLAPSE DURING THE 2023 KHARTOUM CONFLICT

The 2023 outbreak of conflict in Khartoum had a catastrophic impact on the city's water infrastructure. As fighting between rival military factions escalated, the main water treatment plant serving over five million people was destroyed or rendered inop-

erable. With power and fuel cuts making repairs impossible, many households were forced to draw untreated water directly from the Nile, drastically increasing the risk of cholera and other waterborne diseases. This situation illustrates how conflict can destabilize even basic public services, further compounding public health risks (WHO, 2024).

CASE STUDY 4: PROTRACTED DISPLACEMENT AND WATER CONFLICT IN DARFUR

In Darfur, long-standing tensions between pastoralist and agricultural communities over water resources have been exacerbated by climate change and conflict. A significant case occurred in Um Baru, North Darfur, where a borehole drilled in 2017 became a contested resource among displaced persons, host communities, and newly settled groups. The absence of sharing agreements and the collapse of local governance structures allowed disputes to escalate into violent clashes. Groundwater monitoring indicates that the region's water tables are steadily declining, intensifying competition for limited resources and contributing to overall insecurity in the area (African Water Facility, 2023). These dynamics have created an unstable water environment, with displaced populations often relying on unsafe water sources (Abdo & Salih, 2011).

CASE STUDY 5: WOMEN AND WATER IN THE BUTANA REGION

In the semi-arid Butana plains of eastern Sudan, women and girls bear a disproportionate burden of water collection. Local NGO studies suggest that in areas where rainfall has declined over the past two decades, women spend 5–7 hours a day collecting water from seasonal hafirs, which are increasingly threatened by conflict and environmental degradation. The limited involvement of women in water infrastructure planning exacerbates gender inequality, deepening cycles of poverty and restricting opportunities for women and girls .

06

WATER QUALITY, RESOURCE EXTRACTION, AND PUBLIC HEALTH

Water quality in Sudan is a critical issue, compounded by the intersection of conflict, climate change, and resource extraction. As climate variability exacerbates water stress and intensifies waterborne diseases, ongoing conflict has further degraded water infrastructure. This section explores the complex relationships between water quality, resource extraction, and public health in Sudan, focusing on how water contamination, industrial pollution, and inadequate treatment contribute to the country's health crisis.

WATER CONTAMINATION AND PUBLIC HEALTH RISKS

Water contamination is one of the most significant challenges facing Sudan. Recent surveys indicate that over 56.3% of respondents reported the presence of polluted water in their communities (UNICEF, 2023a). The most common contaminants include salinity, industrial waste, and sewage. The lack of effective water treatment infrastructure has exacerbated these issues, contributing to poor health outcomes, particularly among vulnerable populations.

Quantitative survey data show that 37.5% of respondents reported experiencing health impacts related to poor water quality. These include waterborne diseases such as cholera, diarrhea, and kidney stones, which are prevalent in communities relying on untreated water sources (WHO, 2023). The risk of disease is especially high in displacement camps and rural areas, where access to clean water is limited. Survey visualizations indicate a clear link between contaminated water sources and the prevalence of gastrointestinal diseases, with displaced persons disproportionately affected.

The lack of consistent and reliable access to water, combined with poor sanitation and hygiene conditions, has made waterborne diseases a leading cause of morbidity and mortality in Sudan. In 2023, over 11,000 cases of cholera were reported across various regions, and waterborne diseases continue to claim lives, particularly among children under five years of age (UNHCR, 2023).

RESOURCE EXTRACTION AND WATER POLLUTION

The extraction of natural resources, particularly gold mining and oil production,

has significantly contributed to water pollution in Sudan. Artisanal gold mining, which involves the use of toxic chemicals such as mercury and cyanide, has led to severe contamination of both surface water and groundwater. In areas such as Northern Sudan, the River Nile and surrounding aquifers have been polluted by mining runoff, resulting in elevated levels of heavy metals, particularly mercury (Ali et al., 2018). These pollutants not only pose serious risks to human health but also damage aquatic ecosystems, threatening biodiversity and the livelihoods of local communities that depend on these water sources for fishing and farming.

In addition to mining, oil production has been a major source of water pollution, particularly in regions such as South Kordofan. The extraction process releases brine and chemically laden "produced water" into nearby water sources, further depleting already scarce resources. The lack of regulatory oversight and enforcement has allowed these industries to operate with limited regard for environmental consequences, contributing to the degradation of water quality (Elsheikh et al., 2022).

Interviews with local community leaders indicate that mining activities have exacerbated existing inequalities by polluting water supplies that are vital for rural populations. Many affected communities are left without access to safe water, while the resources extracted from their land benefit national and foreign actors. This situation underscores the connection between resource extraction, environmental degradation, and social injustice. Communities often lack the political power or resources to address these issues, further entrenching cycles of poverty and displacement.

THE IMPACT OF RESOURCE EXTRACTION ON WATER QUALITY

The environmental impact of resource extraction in Sudan has been profound, particularly in relation to water resources. Gold mining activities have led to high levels of mercury contamination in water bodies, with concentrations in some areas exceeding 2.62 mg/kg (Ali et al., 2018). This contamination not only affects human health but also contributes to ecosystem degradation and the loss of livelihoods for communities dependent on these water sources. Similarly, the oil industry contributes to the contamination of both surface water and groundwater with toxic chemicals and heavy metals, further degrading water quality.

In regions such as River Nile State and northern Sudan, the increasing prevalence of mercury poisoning and its impacts on agriculture, health, and wildlife are alarming. For example, livestock deaths, skin diseases, and reduced crop yields have been directly linked to mining runoff contaminating water sources (FAO, 2024b). These environmental hazards also worsen the public health crisis, as affected populations are forced to rely on contaminated water, exposing them to increased risks of waterborne diseases, including cholera and hepatitis E (UNICEF, 2023a).

HEALTH RISKS AND WATERBORNE DISEASES

The combination of poor water quality and inadequate sanitation constitutes a major public health challenge in Sudan. The prevalence of waterborne diseases is directly linked to water contamination, with several regions facing severe health crises due to limited access to clean water. Waterborne diseases such as cholera, diar-

rhea, and typhoid fever are widespread, especially in conflict zones and displacement camps where water infrastructure has been damaged or destroyed (WHO, 2023).

The spread of waterborne diseases is further exacerbated by the lack of water treatment and the contamination of natural water sources with industrial pollutants and human waste. In displacement camps, where overcrowding and unsanitary conditions prevail, diseases spread rapidly, disproportionately affecting children, the elderly, and pregnant women. For instance, during the 2023 cholera outbreak, more than 10,000 people were affected, with many cases resulting in fatalities due to delayed access to medical care (UNHCR, 2023).

Efforts to address these health risks, such as the provision of water treatment chemicals and improvements in sanitation facilities, have made some progress but remain insufficient to meet the growing demand for clean water. With millions of Sudanese still lacking access to safe drinking water, it is critical to implement long-term solutions to reduce water contamination, improve water infrastructure, and address the root causes of waterborne diseases.

07

GOVERNANCE WEAKNESS AND INSTITUTIONAL CHALLENGES

Water governance in Sudan is profoundly hindered by institutional fragmentation, weak regulation, and significant underfunding. The country's water management framework involves multiple actors, from the Ministry of Irrigation and Water Resources (MIWR) to local authorities, yet coordination among these bodies is often inadequate. This lack of coherence has exacerbated the ongoing water crisis, undermining efforts to ensure equitable and sustainable access to clean water for all Sudanese people.

INSTITUTIONAL FRAGMENTATION AND WEAK COORDINATION

Water governance in Sudan suffers from overlapping responsibilities between federal, state, and local institutions, leading to confusion and inefficiencies in service delivery. The MIWR, which plays a central role in water resource management, works alongside other bodies such as the Drinking Water and Sanitation Unit (DWSU), but coordination between them remains weak (MIWR & UNICEF, 2020). The 2020–2030 National Water Transformation Plan, aimed at improving water access and sanitation, has stalled due to political instability, lack of funding, and insufficient institutional capacity (UNICEF, 2021).

The inability of Sudan's institutional framework to effectively manage water resources has resulted in inequitable allocation, often favoring large-scale agricultural and industrial projects at the expense of rural communities. This imbalance is compounded by the withdrawal of donor support and ongoing political instability, which have hindered long-term strategic planning (CSPA, 2023).

LEGAL GAPS AND WEAK ENFORCEMENT OF THE RIGHT TO WATER

Sudan's legal framework for water governance is outdated and lacks enforcement capacity. The 1995 Water Resources Act, intended to establish a comprehensive national water policy, remains largely unimplemented (ESCWA, 2022). Additionally, the 2007 Integrated Water Resources Management (IWRM) policy has never been fully adopted, leaving significant gaps in legal protection for the right to water (ACAPS, 2023). This regulatory vacuum allows powerful sectors, such as large-scale agriculture and resource extraction, to exploit water resources, often at the expense of vulnerable communities.

Interviews with community leaders indicate that many rural populations face significant barriers in asserting their right to clean water due to limited legal empowerment and weak enforcement of water laws. In many areas, Water User Associations (WUAs) and village development committees are poorly funded and lack the training or legal authority needed to manage local water resources effectively (Abdo & Salih, 2022). This situation is further compounded by the ongoing conflict, which has eroded the capacity of state institutions to ensure water security for all.

IMPACT OF RESOURCE EXTRACTION ON WATER ACCESS

The role of resource extraction in exacerbating water insecurity is significant. In regions such as Darfur and South Kordofan, unregulated mining and oil extraction have led to the depletion and contamination of groundwater resources. The use of toxic chemicals such as mercury and cyanide in gold mining has polluted water sources, rendering them unsafe for consumption and undermining local livelihoods (Elsheikh et al., 2022). Moreover, the lack of environmental safeguards in the oil and mining sectors allows these industries to exploit water resources with limited consideration for long-term sustainability or public health (FAO, 2024b).

Testimonies from local communities indicate that resource extraction often takes precedence over the provision of clean water, with powerful corporations receiving preferential access to water resources, while rural communities are left to rely on unsafe and unsustainable sources. This pattern of exploitation has resulted in significant environmental degradation and social unrest, as marginalized groups are increasingly excluded from decision-making processes related to water governance.

ROLE OF INTERNATIONAL DONORS AND AGENCIES

International donors and agencies play a critical role in Sudan's water sector, particularly in conflict-affected areas where local institutions have collapsed. However, their interventions have often been limited in scope and sustainability. For example, the World Bank's Sudan Integrated Water Management Project, which aimed to strengthen institutional capacity for climate-resilient water management, was disrupted by political instability and conflict (World Bank, 2021b). Similarly, humanitarian organizations such as UNICEF have made significant strides in providing emergency water supplies to displaced populations, but these efforts are often short-term and fail to address the systemic governance challenges underpinning Sudan's water crisis (UNICEF, 2023b).

Despite these challenges, international agencies have been crucial in filling the gaps left by the government, especially in areas where local authorities have been unable or unwilling to provide basic services. However, reliance on external actors highlights the limitations of Sudan's institutional capacity and underscores the urgent need for comprehensive reform to ensure sustainable and equitable water access in the long term.

08

SOCIO-ECONOMIC AND HUMAN RIGHTS IMPLICATIONS

Water insecurity in Sudan is intrinsically linked to socio-economic and human rights issues, particularly as the country grapples with the compounded effects of climate change, ongoing conflict, and institutional fragility. Access to clean and safe water is not only a basic human need but also a human right that directly affects livelihoods, health, and dignity. However, in Sudan, the denial of this fundamental right exacerbates poverty, gender inequality, and social exclusion, while impeding the country's development and progress.

WATER SCARCITY AND SOCIO-ECONOMIC INEQUALITY

Sudan's vulnerability to climate change has heightened the challenges of water scarcity. The country experiences significant rainfall variability, prolonged droughts, and flash floods, all of which worsen water access and availability across both urban and rural areas. In rural Sudan, water infrastructure remains underdeveloped, particularly in conflict-affected regions such as Darfur, South Kordofan, and Blue Nile. The destruction of water points, compounded by displacement, weak governance, and inadequate investment, limits water availability and impedes access to sanitation (UNDP, 2022). These shortages force communities to rely on unsafe sources, contributing to severe health risks, including waterborne diseases such as cholera and dysentery (Plate 1).

This water scarcity has far-reaching socio-economic consequences. Agriculture, which employs the majority of Sudan's population, is heavily affected by the lack of irrigation water. Crop failures and food insecurity push communities further into poverty, while the financial burden of purchasing water from informal vendors exacerbates economic inequality (World Bank, 2021a). In many rural areas, the cost of water can consume a significant share of household income, further deepening socio-economic disparities.

GENDER INEQUALITY AND THE BURDEN ON WOMEN AND CHILDREN

In Sudan, water collection is primarily the responsibility of women and children, placing a significant burden on them, particularly in rural and conflict-affected regions. Women and girls often travel long distances, sometimes up to 5 kilom-

eters daily, to fetch water, exposing them to physical exhaustion and gender-based violence (Sax et al., 2023). This task not only consumes valuable time but also prevents girls from attending school, thereby hindering their educational opportunities and reinforcing gender inequality (UNICEF, 2022). Moreover, the lack of adequate sanitation facilities in many areas, especially in displacement settings and refugee camps, further exacerbates the gendered impacts of water insecurity, as women are disproportionately affected by inadequate menstrual hygiene conditions.

WATERBORNE DISEASES AND HEALTH RISKS

The lack of access to safe water has direct consequences for public health. Waterborne diseases, including cholera, diarrhea, and typhoid, are prevalent in areas with inadequate sanitation and contaminated water sources. According to the World Health Organization (WHO, 2003), limited access to safe drinking water remains a leading cause of preventable illness and death, particularly among vulnerable populations such as children under five. In displacement camps and informal settlements, where water is often scarce or unsafe, outbreaks of cholera and other diseases are common, exacerbating existing health crises (UNICEF, 2021). The spread of these diseases results in significant health burdens, including increased morbidity and mortality, particularly in overcrowded settings.

HUMAN RIGHTS DIMENSIONS

The socio-economic and human rights implications of water insecurity in Sudan are severe, as the country's failure to provide access to safe, sufficient, and affordable water constitutes a violation of international human rights frameworks. The right to water, as outlined in the International Covenant on Economic, Social and Cultural Rights (ICESCR), is integral to the right to an adequate standard of living and the realization of other human rights, including the rights to health, education, and an adequate living environment (UNGA, 2010). In Sudan, the inability to ensure access to clean water undermines these rights, particularly for marginalized groups such as women, children, and rural communities.

In line with SDG 6, which calls for universal access to water and sanitation, Sudan's failure to ensure equitable access exacerbates existing socio-economic inequalities. The lack of coordination among government agencies and the absence of a comprehensive national water policy have left millions without access to safe water (MIWR & UNICEF, 2020). This fragmentation and institutional weakness, coupled with the absence of robust enforcement mechanisms, further hinder efforts to address the water crisis in a sustainable and equitable manner.

DRIVERS OF WATER INJUSTICE

The primary drivers of water injustice in Sudan include ongoing conflict, institutional weakness, and resource extraction. Armed conflict disrupts water infrastructure and restricts access through blockades and violence. In many regions, water has been used as a weapon of war, with warring factions targeting water points

or denying access to certain populations (Abdo & Salih, 2022). The governance system remains fragmented, with overlapping responsibilities between ministries and weak enforcement of water laws. Resource extraction activities, particularly in agriculture and mining, have further exacerbated water scarcity by monopolizing water resources and polluting water sources, thereby marginalizing vulnerable communities (FAO, 2024b).

Plate 1: Water distribution market using carts and donkeys

09

DATA COLLECTION SECTION: STRUCTURED QUESTIONNAIRE AND UNSTRUCTURED INTERVIEWS

AThe data collection process for this case study on the intersection of the right to water and climate change in Sudan employed a mixed-methods approach to gather both quantitative and qualitative data. A structured online questionnaire and unstructured expert interviews were used to capture a wide range of perspectives. This methodology allows for a broad overview of water access issues while also providing a deeper understanding of the institutional, environmental, and socio-economic factors contributing to water insecurity in Sudan.

The structured questionnaire, developed using Google Forms, was disseminated through various social media platforms, including LinkedIn, Facebook, and WhatsApp. This enabled outreach to a diverse group of respondents, including individuals from affected communities, local leaders, government representatives, and civil society organizations. The questionnaire focused on several key themes, including water access, water quality, climate change impacts, and health outcomes related to water scarcity and pollution.

In addition to the questionnaire, unstructured interviews were conducted with key informants such as policymakers, water management experts, and community leaders. These interviews provided richer and more detailed insights into governance challenges, community adaptation strategies, and the socio-economic impacts of water insecurity.

This dual approach, combining quantitative surveys and qualitative interviews, provides a comprehensive view of Sudan's water crisis, allowing for both broad statistical insights and an in-depth understanding of underlying dynamics.

STRUCTURED QUESTIONNAIRE FINDINGS

The structured questionnaire generated quantitative data from a diverse group of participants on water access, quality, climate change impacts, and the relationship between water scarcity and health. Below is a summary of the key findings (Figures 4–9).

WATER ACCESS AND QUALITY

- **Primary Water Source:** A significant proportion of respondents (56.3%) reported using public water networks, followed by boreholes or hand pumps (21.9%) and water tankers (12.5%). A smaller group (6.3%) relied on rivers or natural water sources.
- **Water Availability:** A substantial share of respondents (31.3%) reported having access to water for fewer than four hours per day. In contrast, only 25% had access to water 24 hours a day, indicating serious challenges in maintaining a consistent water supply.
- **Water Quality:** Water quality was rated poorly, with an average score of 2.5 on a scale from 1 (poor) to 5 (excellent), reflecting significant concerns regarding safety and cleanliness.

WATER POLLUTION

- **Pollution Issues:** Over half of respondents (56.3%) reported experiencing water pollution. Common pollutants included sewage (21.9%), chemical waste (9.4%), and industrial or agricultural waste (9.4%). Many respondents (62.5%) also reported other forms of contamination, such as high salinity and sedimentation, often linked to inadequate infrastructure or filtration systems.
- **Health Impact:** A notable proportion of respondents (46.9%) reported experiencing health issues directly linked to water quality, including gastrointestinal infections, diarrhea, typhoid, urinary infections, and kidney stones.

CLIMATE CHANGE IMPACTS

- **Climate Phenomena:** Rising temperatures (40.6%) and changing rainfall patterns (21.9%) were cited as the most prominent climate-related changes affecting water availability. These shifts exacerbate both water scarcity and contamination, particularly in areas already affected by conflict.
- **Adaptation Projects:** Only 12.5% of respondents reported involvement in local adaptation initiatives, such as solar-powered water systems or Integrated Water Resources Management (IWRM) strategies, highlighting a significant gap in the implementation of adaptive solutions.

CONFLICT AND DISPLACEMENT

- **Impact of Conflict:** A majority of respondents (81.3%) indicated that armed conflict and displacement have significantly affected water access. The destruction of water infrastructure was the most frequently reported consequence (59.4%), followed by the denial of access to water sources (15.6%).

HEALTH AND DISEASE

- **Waterborne Diseases:** A majority (59.4%) of respondents reported experiencing waterborne diseases, with diarrhea, cholera, and typhoid being the most common. Many respondents directly linked these health issues to poor water quality.

UNSTRUCTURED INTERVIEWS FINDINGS

In addition to the quantitative data collected through the questionnaire, unstructured interviews with key informants provided qualitative insights into the governance, environmental, and socio-economic factors affecting water access in Sudan.

INSTITUTIONAL AND GOVERNANCE CHALLENGES

- Weak Institutional Framework: Many interviewees pointed to a fragmented and inefficient institutional framework for water management. The Ministry of Water Resources and Irrigation was frequently described as having limited capacity and facing coordination challenges, particularly in conflict-affected areas.
- Legal Framework Deficiencies: Several experts highlighted the absence of a clear and enforceable legal framework for protecting the right to water. Despite Sudan's commitments under international law, these provisions are rarely enforced, especially during periods of conflict.

IMPACT OF CONFLICT ON WATER INFRASTRUCTURE

- Deliberate Destruction: Interviewees from conflict-affected regions such as Darfur and South Kordofan reported that armed groups deliberately target water infrastructure, further exacerbating the crisis. The destruction of water treatment plants and pumping stations leaves communities without reliable access to safe water.

CLIMATE CHANGE AND RESOURCE EXTRACTION

- Climate Variability: Experts noted that Sudan is experiencing significant changes in rainfall patterns and rising temperatures, complicating water management. The lack of adequate infrastructure to address these changes further exacerbates water scarcity, particularly in rural and conflict-affected areas.
- Resource Extraction: Unregulated resource extraction, particularly gold mining, was identified as a major contributor to water pollution. The use of hazardous chemicals such as mercury and cyanide has led to the contamination of nearby water sources, further degrading water quality.

COMMUNITY COPING MECHANISMS

- Adaptation Strategies: Many communities, particularly in rural areas, have resorted to using river water, which is often contaminated. The lack of access to safe water sources forces reliance on unsafe alternatives, increasing vulnerability to waterborne diseases.

The data collected through the structured questionnaire and unstructured interviews paint a picture of a severe water crisis in Sudan, compounded by conflict, climate change, and governance failures. The findings show that water access is inconsistent, with many respondents facing irregular and poor-quality supply. The

destruction of water infrastructure, coupled with climate-related pressures and resource extraction, has intensified water scarcity, leaving many communities without access to safe water. The interviews further highlight governance weaknesses and institutional fragmentation that hinder effective water management. These findings underscore the urgent need for action to address water insecurity through improved governance, strengthened infrastructure, and climate-adaptive strategies.

Figure 4: Affiliations of respondents

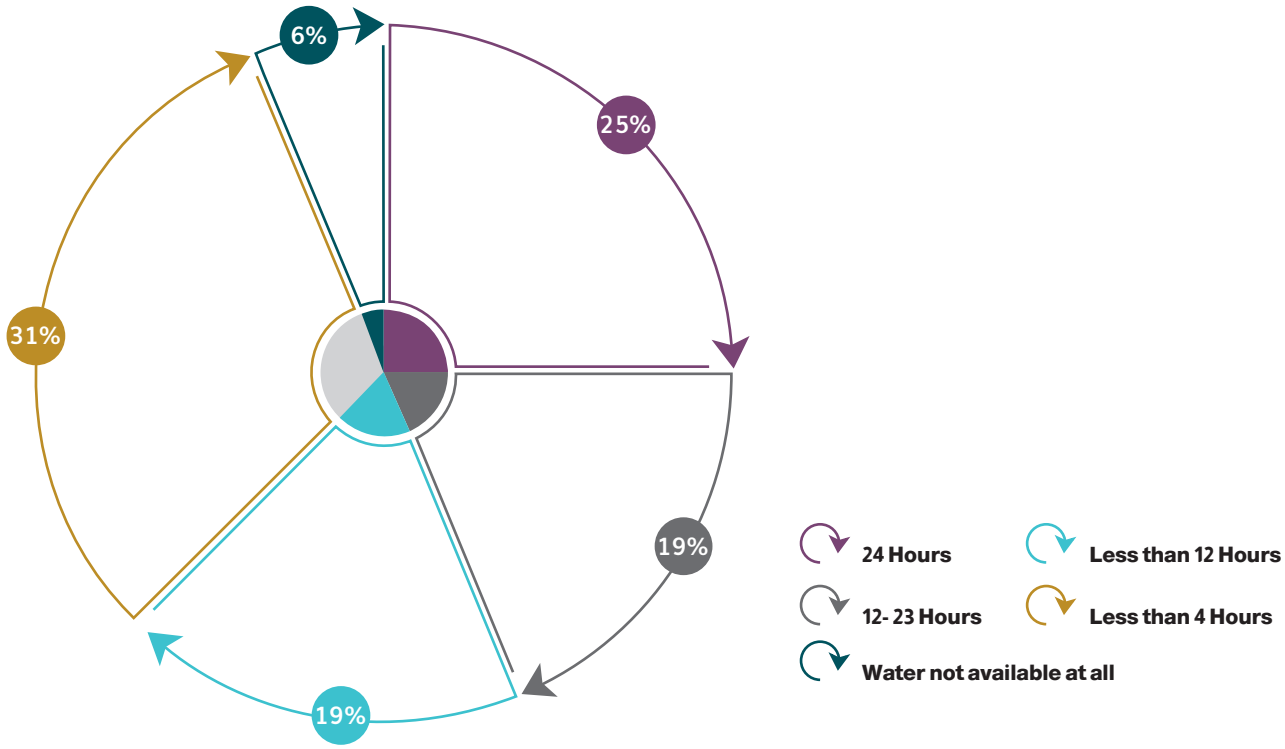


Figure 5: Water availability

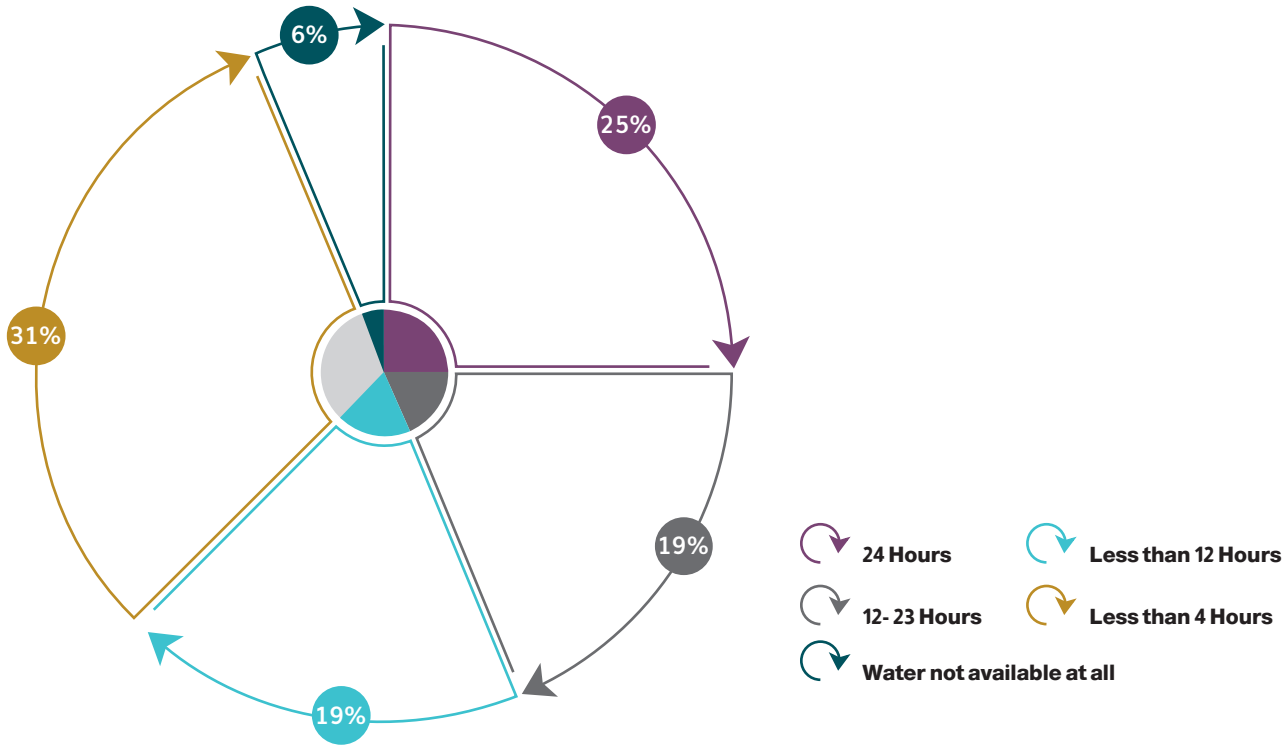


Figure 6: Types of water pollution encountered by respondents

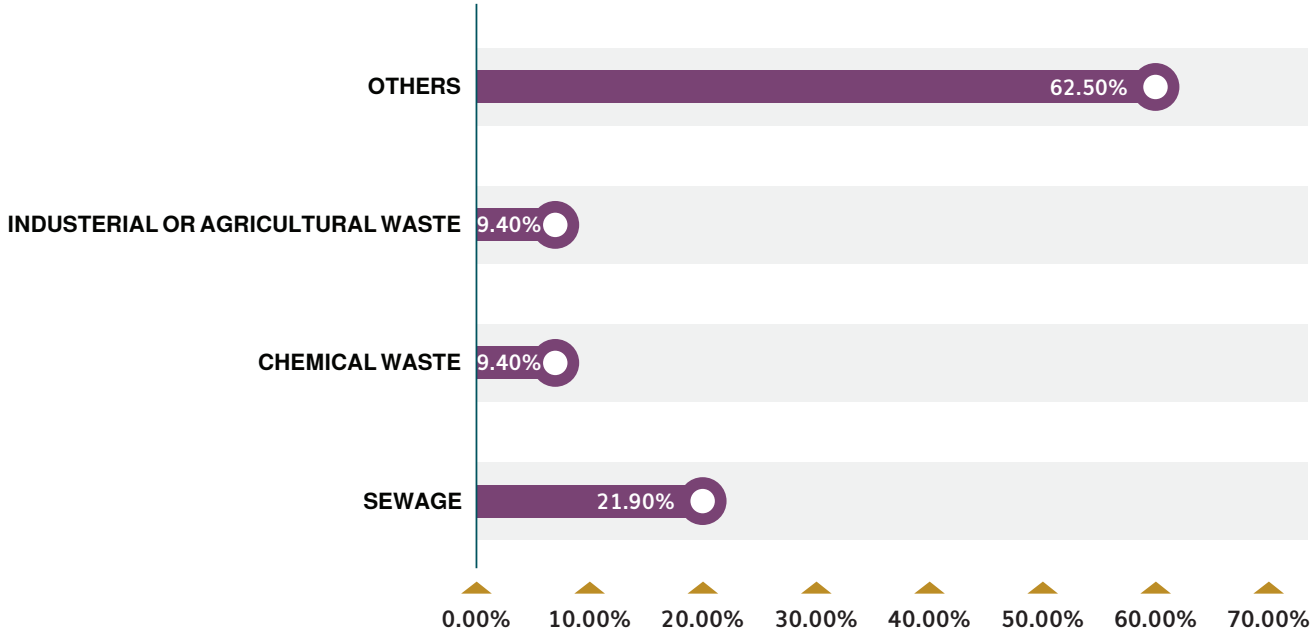


Figure 7: Water quality rating

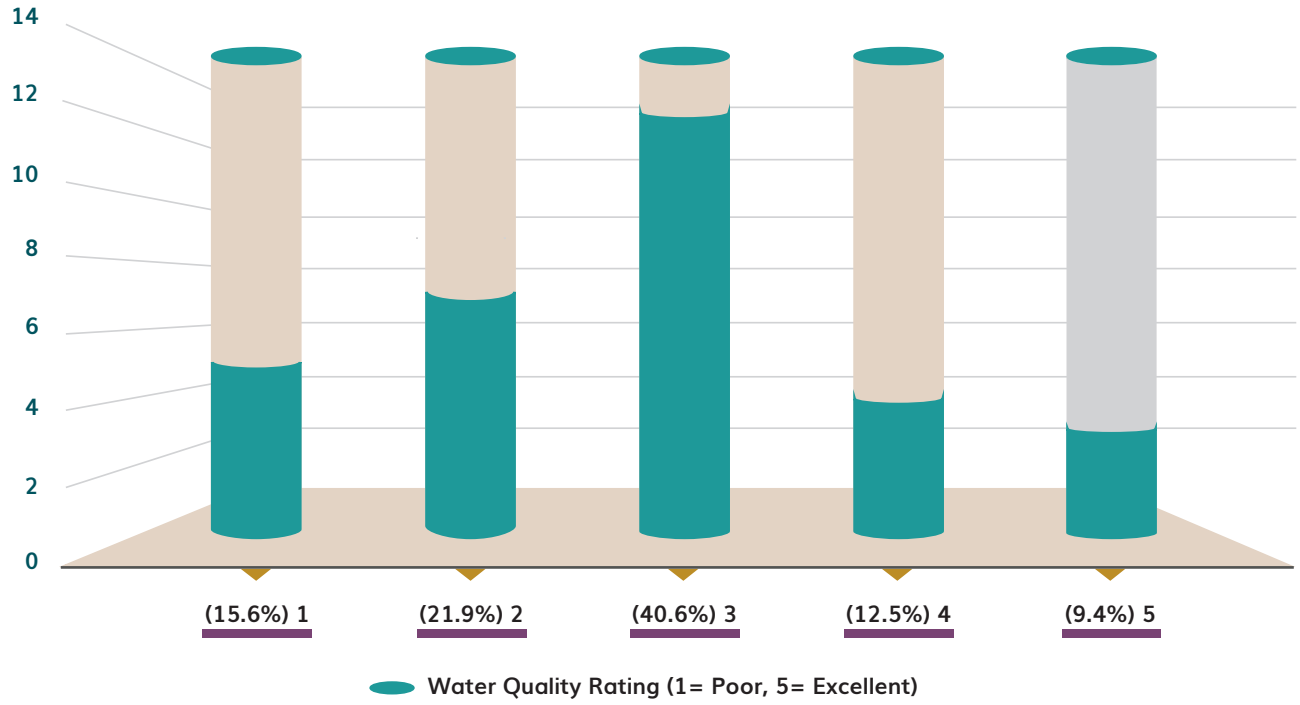


Figure 8: Conflict and displacement effects

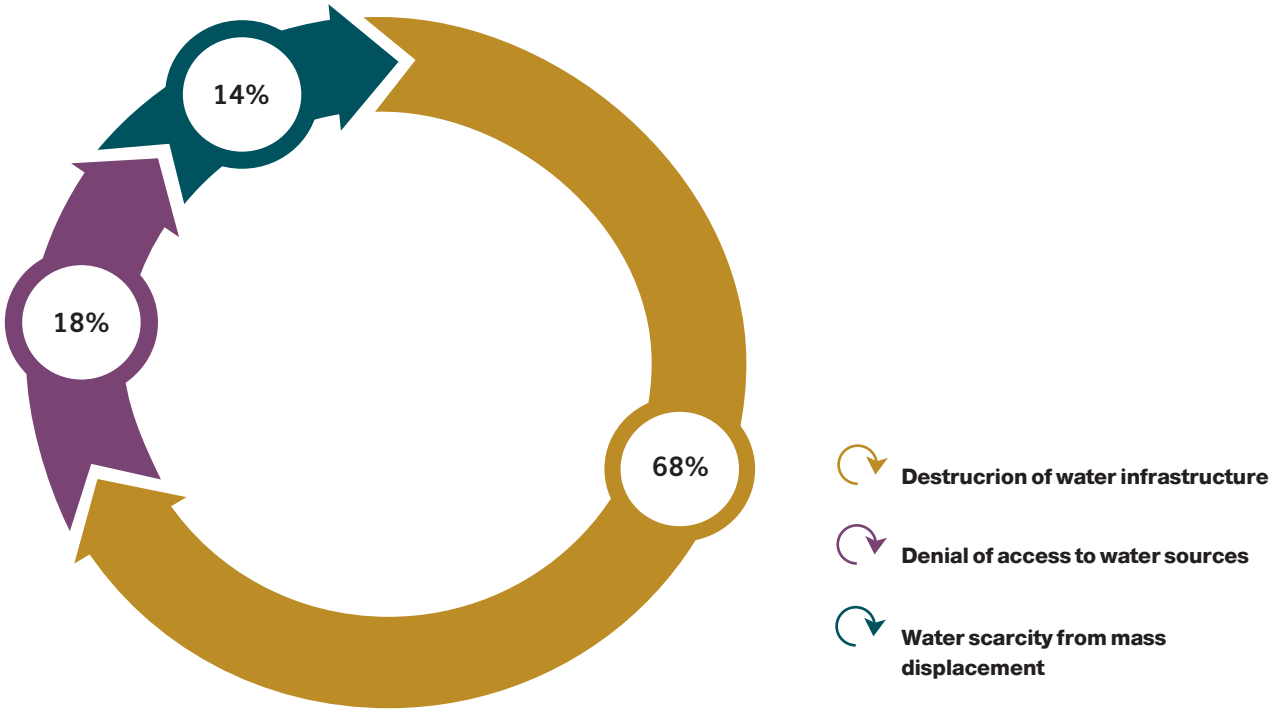
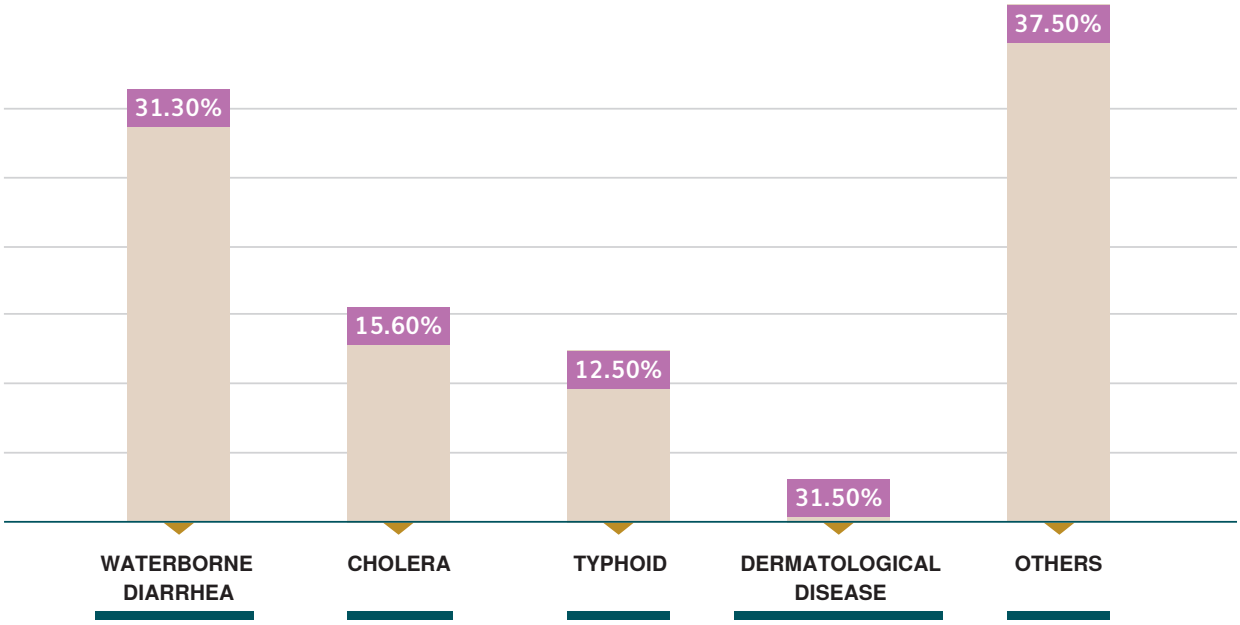


Figure 9: Health issues related to water quality



10

ADAPTATION STRATEGIES AND INSTITUTIONAL FRAMEWORKSS

Sudan's water crisis is exacerbated by both climate change and ongoing conflict, highlighting the urgent need for adaptive solutions. To address these challenges, various community-driven and policy-oriented measures are being explored. These include both short-term emergency responses and long-term strategies aimed at strengthening resilience to climate variability. Through a combination of local adaptation strategies, improved governance, and climate-resilient infrastructure, Sudan can begin to rebuild its water management systems to meet both current and future demands.

COMMUNITY-DRIVEN ADAPTATION STRATEGIES

In rural Sudan and conflict-affected areas, communities have developed innovative, grassroots solutions to address water scarcity and pollution. One of the most widely employed methods is **rainwater harvesting**, a technique that collects and stores rainfall for domestic use. This approach, particularly in regions such as Darfur and South Kordofan, has enabled communities to establish more reliable water sources when traditional ones are unavailable or destroyed during conflict. **Solar-powered pumping systems** are also gaining traction, providing a renewable energy source to extract water from boreholes and reducing dependence on diesel generators. In addition, communities have adopted **simple water filtration methods**, using locally available materials to reduce waterborne diseases caused by contamination.

POTENTIAL POLICY REFORMS FOR CLIMATE-RESILIENT INFRASTRUCTURE

To complement community efforts, several policy reforms are essential for building climate-resilient water infrastructure. First, **investment in infrastructure rehabilitation** is critical. Prioritizing the repair and maintenance of existing systems, such as pumps, boreholes, and water treatment plants, will strengthen resilience to both climate change and conflict. Furthermore, **climate-resilient designs**, including solar-powered water pumps and sand dams, should be integrated into new infrastructure projects, particularly in areas prone to extreme weather conditions, such as northern Sudan.

Government-led policy reforms should also promote the **decentralization of**

water management. Empowering local governments and communities to manage water resources can improve both access and governance. Establishing **clear legal frameworks** that define water rights, usage, and conflict resolution mechanisms will support a rights-based approach to water access and enable communities to better navigate water scarcity challenges.

ADVOCATED POLICIES FOR LONG-TERM SOLUTIONS

- **Strengthening Water Governance and Coordination:** Establish a centralized and empowered national water authority to oversee water-related activities and ensure effective management at local and regional levels. At the same time, promote accountable decentralization by ensuring that the central and local governments have the capacity and resources to manage water systems effectively.
- **Investment in Climate-Resilient Infrastructure:** Prioritize the rehabilitation of existing systems (pumps, boreholes, treatment plants) before constructing new ones. Introduce climate-resilient infrastructure, including rainwater harvesting, solar-powered pumps, and sand dams, to improve water access, particularly in arid regions.
- **Improve Data Collection and Resource Planning:** Launch a nationwide water mapping initiative to assess availability, usage, and access gaps. Invest in hydro-meteorological monitoring systems to improve drought prediction and water planning, enabling more efficient resource allocation.
- **Community Participation and Local Ownership:** Ensure the inclusion of local communities, especially women and marginalized groups, in water governance and decision-making processes. Support the development of Water User Associations or cooperatives to strengthen community management of local water points.
- **Climate-Resilient and Conflict-Sensitive Approaches:** Design water projects with a conflict-sensitive approach, particularly in regions with histories of ethnic and resource-based tensions. Water access initiatives should also serve as peacebuilding tools by supporting shared infrastructure that fosters cooperation and reduces tensions among and within communities.

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CONCLUSION

The intersection of climate variability, armed conflict, and governance failures has created a profound crisis in Sudan's water sector. These factors are deeply interconnected, undermining the right to water and exacerbating socio-economic inequalities. Climate change, through rising temperatures, erratic rainfall, and desertification, has intensified water scarcity, while ongoing conflict has destroyed critical infrastructure and displaced millions. Institutional fragility, combined with weak coordination between federal and local authorities, has further compounded these challenges, leaving vulnerable populations without reliable access to clean water.

This case study highlights the urgent need for comprehensive reforms in Sudan's water governance. Adaptive solutions, such as climate-resilient infrastructure, decentralized water management, and community-driven adaptation strategies, must be prioritized. These measures should be supported by robust legal frameworks that recognize water as a fundamental human right and ensure that access is equitable, safe, and sustainable.

Going forward, it is essential for both the Sudanese government and the international community to adopt a rights-based approach to water management. Strengthening institutional frameworks, enhancing accountability, and prioritizing climate adaptation are critical to securing water access, particularly in conflict-affected and marginalized regions. Continued technical and financial support from the international community will be vital to rebuilding systems and ensuring that all Sudanese people, especially women, children, and displaced populations, can access their basic right to water.

Ultimately, Sudan's water crisis presents an opportunity to transform water from a source of conflict and vulnerability into a foundation for peace, stability, and resilience, with the right to water at its core. With appropriate policies and sustained investment, Sudan can move toward a more equitable and sustainable future for all.

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