



OPEN ACCESS



Shifting sands: the geopolitical impact of climate change on Africa's resource conflicts

Ivan Henrico ^a and Bohumil Doboš ^b

^aFaculty of Military Science, Stellenbosch University, Stellenbosch, South Africa; ^bFaculty of Social Sciences, Charles University, Prague, Czech Republic

ABSTRACT

This study examines the complex relationships among climate change, resource scarcity, and conflict in Africa, focusing on the regions of Darfur, Lake Chad, and South Sudan. This highlights how climate change is a threat multiplier, intensifying socio-political challenges and worsening competition over vital resources such as water and arable land. Through a comparative analysis of these regions, this paper explores how environmental degradation, combined with weak governance and ethnic tensions, has led to conflict. In Darfur, prolonged droughts and desertification have exacerbated competition between herders and farmers. At the same time, in the Lake Chad Basin, the drastic shrinking of the lake has created fertile ground for extremist groups, including Boko Haram. In South Sudan, the impacts of erratic rainfall and water scarcity have contributed to ongoing civil conflict. This paper emphasizes the importance of addressing these climate-driven conflicts through better governance, climate adaptation, and resource management. Ultimately, this study contributes to the broader understanding of how climate change exacerbates conflict in vulnerable regions and underscores the need for coordinated international efforts to mitigate these impacts.

ARTICLE HISTORY

Received 13 October 2024
Accepted 9 December 2024

KEYWORDS

Climate change; conflict;
resource scarcity; Africa;
climate adaptation;
environmental security

1. Introduction

Africa has been greatly affected by extreme weather events and conflicts exacerbated by climate change, leading to significant casualties and displacement (Dunne, 2023). In Darfur alone, decades of violence intertwined with environmental stress have caused approximately 300 000 deaths and the displacement of millions (UN News, 2023). Recent escalations have worsened the humanitarian crisis, highlighting the severe impact of climate change as a threat multiplier in fragile regions. Similar patterns of devastation are evident across the Sahel and Horn of Africa, where extreme droughts and floods have compounded socio-political instability and intensified resource scarcity. The intersection of geopolitics and climate change has become a critical concern for policymakers, scholars, and global institutions.

CONTACT Ivan Henrico  ivanh@sun.ac.za  Faculty of Military Science, Stellenbosch University, Frans Erasmus Drive, Saldanha Bay, Stellenbosch 7395, South Africa

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

Climate change is now seen as a pressing global issue with severe implications for vulnerable regions, including drought-prone areas on the African continent (United Nations Climate Change, 2020). Traditionally, geopolitics involves the study of the relationships among geography, the environment, and international politics. As climate change reshapes political and socioeconomic landscapes globally, its impact on this relationship demands deeper analysis. Defined as the long-term alteration of global or regional climate patterns, climate change influences key socio-political factors, including resource distribution, food security, migration, and conflict, that affect political stability and social fragility in sub-Saharan Africa, particularly in regions such as the Sahel, the Horn of Africa, and parts of southern Africa (Songwe & Signé, 2024; United Nations Climate Change, 2020).

Scientific consensus, as articulated by institutions including the Intergovernmental Panel on Climate Change (IPCC), confirms that rising temperatures, sea levels, and shifting weather patterns have severe global effects. The World Meteorological Organisation (WMO) reports record-breaking climate impacts (WMO, 2023), which are heightening security threats across regions like the Sahel, the Horn of Africa, and parts of North Africa, where resource scarcity and climate-induced displacement exacerbate existing conflicts. Additionally, the IPCC (2024b) underscores the urgency of addressing climate-related risks to food security, land use, and human livelihoods. Earlier research on environmental security provides a theoretical foundation for understanding how resource scarcity, often exacerbated by environmental degradation, contributes to violent conflicts. Pioneering scholars, notably Thomas Homer-Dixon (2010) Homer-Dixon et al. (2011) and Robert Kaplan (1994) have demonstrated that diminished water supplies and reduced access to arable land intensify tensions, particularly in regions experiencing rapid population growth and unequal resource access. These foundational theories are expanded upon by Skah and Lyammouri (2020), who argue that environmental scarcity, when combined with social and political stressors, escalates competition for resources, resulting in migration, political instability, and violent conflict.

This framework is visualized in Figure 1, which depicts the cyclical relationship between environmental stressors, weakened state structures, and conflict escalation. For instance, population growth and declining resource quality undermine state capacity, drive migration, and heighten socio-political instability. This dynamic is particularly evident in African sub-regions such as the Sahel, the Horn of Africa, and the Lake Chad Basin, where climate change acts as a force multiplier, exacerbating existing vulnerabilities and intensifying resource-driven conflicts.

Historical studies have revealed that changing rainfall patterns are key drivers of conflict in agricultural regions of Africa (Hendrix & Salehyan, 2012). This study explores the link between climate change and conflict, focusing on three conflict zones, Darfur, Lake Chad, and South Sudan, which are affected by climatic changes. The analysis seeks to distinguish whether climate change directly causes conflict or interacts with other factors to lead to violence. The United Nations Security Council recognizes the role of climate change in exacerbating security challenges, particularly in the Sahel, where environmental degradation intensifies socio-political vulnerabilities (Skah & Lyammouri, 2020). Disruptions in natural resources critical for local communities have reshaped socio-economic structures, intensified existing conflicts and given rise to new security threats.

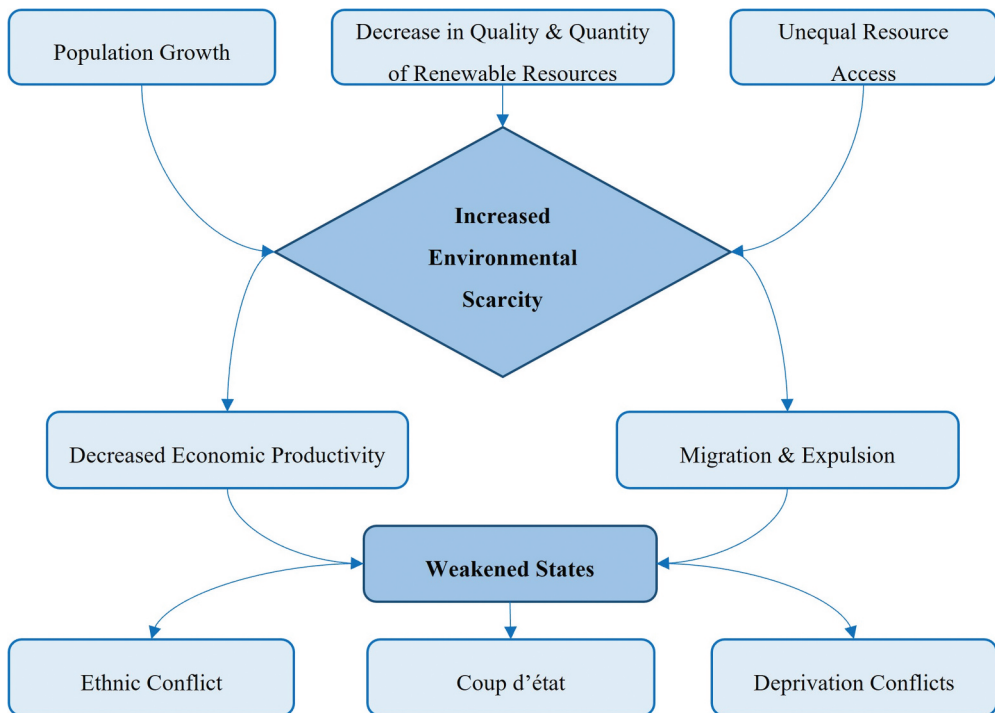


Figure 1. Sources and consequences of environmental scarcity. Source: Modified from Skah and Lyammouri (2020, p. 8).

In drought-affected regions of the African continent, climate change, migration, and conflict intertwine to create a self-reinforcing cycle. [Figure 2](#) illustrates how climate-induced factors, including drought and environmental degradation, contribute to conflicts over scarce resources, leading to migration. In turn, migration can exacerbate tensions in destination areas, driving further conflict (Abel et al., 2019). This cyclical process hinders solutions to climate-induced problems, although its direct connection to conflict remains complex.

Africa's socio-economic challenges, rooted in historical vulnerabilities, compound the effects of climate change. Barrios et al. (2010) highlighted that variability in rainfall patterns has significantly impacted agricultural growth, further destabilizing affected communities. The World Meteorological Organisation (WMO, 2021) identifies Africa as particularly vulnerable to these changes, despite contributing minimally to global greenhouse gas emissions. This creates a paradox where low contribution results in high impacts, increasing the risk of resource scarcity and conflict across the continent.

This article bridges a gap in existing research by offering a focused comparative analysis of climate-induced conflicts in three African regions: Darfur, Lake Chad, and South Sudan. While previous studies have noted the general link between climate change and conflict, this paper delves into specific socio-political dynamics and environmental triggers in these regions, examining how climate change affects conflict. Gaps in research remain, particularly in understanding how climate-induced resource scarcity interacts with governance, ethnic tensions, and livelihood disruptions. Using secondary data from

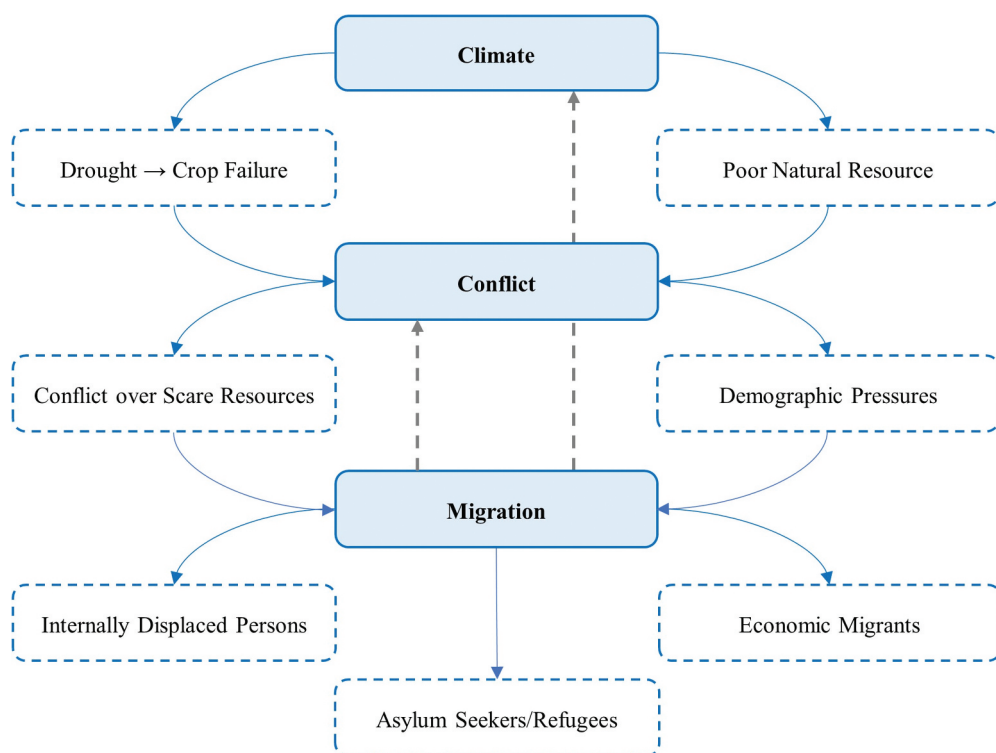


Figure 2. A conceptual Model of climate, conflict and migration. Source: Adapted from Abel et al. (2019).

climate reports and case studies, this analysis provides a nuanced perspective on the geopolitical impact of climate change on Africa's natural resources and related conflicts.

2. The African climate-geopolitics nexus: a threat multiplier in resource-driven conflict

Climate change, as a driver of geopolitical instability, has drawn significant attention in recent years. The IPCC (2024b) and the WMO (2021) both stress that climate change worsens existing geopolitical tensions by straining essential resources, including water, arable land, and food supplies. Globally, resource scarcity has contributed to conflicts in regions spanning the Middle East (water and oil), Southeast Asia (fisheries and territorial disputes), and South America (water and forests). However, conflicts in Africa are driven predominantly by local communities' need for basic livelihoods, particularly access to water and arable land, rather than hydrocarbons or minerals. Scholars, including Homer-Dixon (2010) and Von Uexkull and Buhaug (2021), argue that climate change amplifies existing tensions in vulnerable regions where resources such as water and arable land are scarce, especially with rapid population growth.

Africa's heightened vulnerability to climate change, as highlighted by Busby (2021), makes it a unique case in climate geopolitics. The types of resource scarcity affecting the continent are diverse and include water shortages, the degradation of arable land, and diminishing grazing areas. Land tenure systems play a significant

role in exacerbating resource scarcity, particularly in regions where communal landownership structures conflict with private claims or government appropriation of land for large-scale agricultural projects. Such tensions are evident in the Sahel, where erratic rainfall, prolonged droughts, and desertification intensify disputes over access to pastures and water points, often pitting herders against farmers (Larémont, 2021).

Ethno-economic factors further complicate resource allocation, as access to resources is often shaped by historical inequalities and ethnic affiliations. In many regions, marginalized ethnic groups face systemic exclusion from resource distribution, deepening socio-economic divides and fuelling grievances. This dynamic has been particularly visible in East Africa, where intercommunal violence frequently emerges over contested grazing lands and water sources (Schillinger et al. (2020). The historical relationship between farmers and herders in Africa has been disrupted by climate change, creating direct competition for shrinking resources and eroding traditional conflict resolution mechanisms. This divide can further strain the relations between ethnic groups and lead to a disproportionate exclusion based on identity basis that covers the underlying material causes of conflict such as is the case with Fulanis in the Sahel region. As (Piguet et al., 2011) noted, climate-induced poverty exacerbates these tensions, leaving communities poorer and more prone to violence.

The growing link between resource scarcity and the rise of extremism in fragile regions is thus a significant security concern. Extremist groups, including Boko Haram and Islamic State-West Africa Province (ISWAP), exploit the desperation caused by environmental stresses to recruit members and expand their influence. Ide et al. (2016) highlight how these groups capitalize on displacement and economic hardship to destabilize already fragile regions, deepening cycles of poverty and violence. Weak governance further exacerbates these issues, as power vacuums allow extremist groups to establish footholds and undermine state authority (Freeman, 2017). This dynamic not only destabilizes local regions but also has broader implications for international security. The United Nations Security Council has called for more international cooperation to address the root causes of climate-related conflicts, emphasizing the importance of addressing resource scarcity, strengthening governance, and building resilience (United Nations, 2021a, 2021b).

Although Africa contributes only two to three percent of global greenhouse gas emissions (IPCC, 2022), it faces significant and magnified impacts of climate change due to a combination of geographic vulnerabilities, socio-economic challenges, and institutional weaknesses. The WMO (WMO, 2021, 2023) reported that climate change is driving significant alterations in rainfall patterns, rising sea levels, and increasing temperatures across the continent. These changes exacerbate food insecurity, intensify water scarcity, and fuel resource-driven conflicts. For example, the African Development Bank (AfDB, 2022) noted that Africa loses an estimated 4–12% of its GDP annually because of climate-related disruptions in agriculture, further compounding economic vulnerabilities.

Comparatively, Southeast Asia and the Pacific Islands face significant challenges due to climate change, with rising sea levels and intensified tropical storms posing serious threats. However, Africa's heightened vulnerability stems from its heavy reliance on rain-fed agriculture, weak infrastructure, and limited adaptive capacity, as highlighted by

Busby (2021). For example, over 90% of agricultural activities in sub-Saharan Africa depend on rainfall, making the region uniquely susceptible to erratic precipitation and prolonged droughts (FAO, 2021). Poor governance, pervasive corruption, and weak institutions further magnify impacts by limiting the effectiveness of climate adaptation policies and disaster response mechanisms (Schillinger et al., 2020).

The disproportionate burden is also reflected in mortality and displacement figures. According to the Internal Displacement Monitoring Centre (IDMC, 2023), Africa accounted for 7.5 million new internal displacements caused by climate-related disasters in 2022, more than double the figures reported for Europe or North America. Similarly, climate-related mortality rates in Africa are among the highest globally, with heatwaves, droughts, and floods collectively claiming thousands of lives annually (UNEP, 2019b).

Figure 3 highlights the contrasting temperature trends for global land and Africa between 1910 and 2024. While both regions exhibit consistent warming, global temperatures have increased at a rate of $+0.14^{\circ}\text{C}$ per decade, with accelerated warming evident since the 1980s. Africa, although warming slightly more slowly at $+0.12^{\circ}\text{C}$ per decade, experiences disproportionate impacts due to its socio-economic vulnerabilities. Reliance

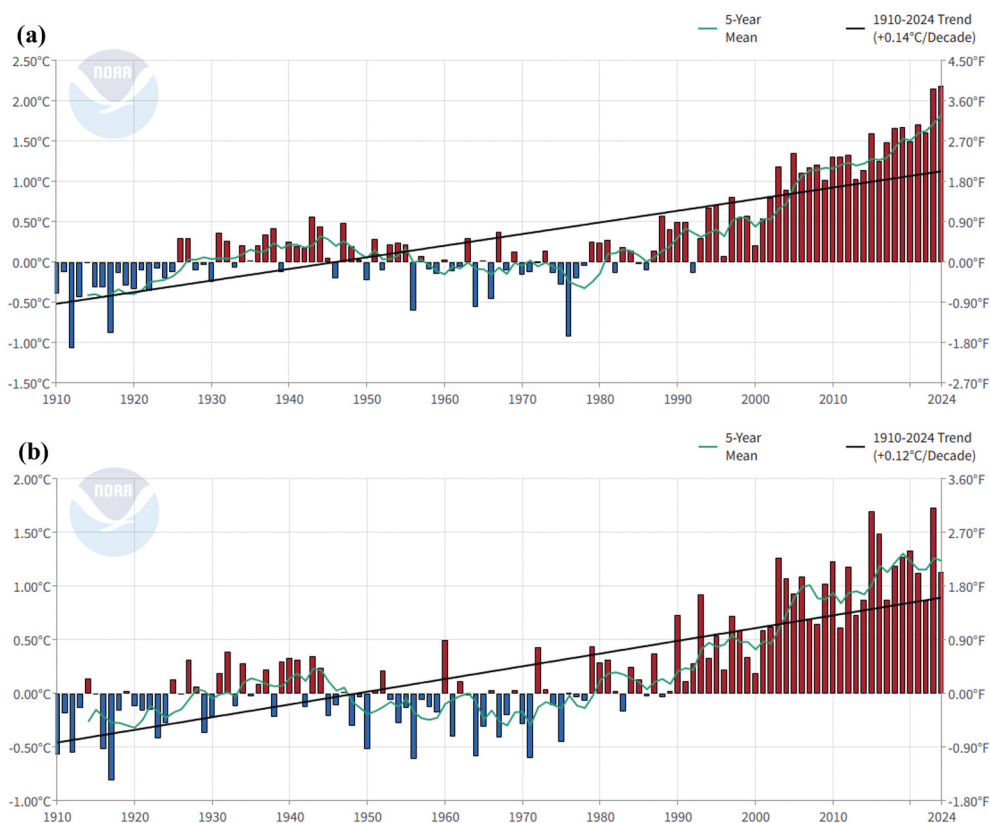


Figure 3. Comparative analysis of global (a) and Africa-specific (b) land temperature anomalies from 1910–2024. The black trendlines indicate a steady increase in average temperature. The red bars represent annual temperature anomalies, whereas the green line represents the 5-year moving average. *Source:* NOAA (2024).

on rain-fed agriculture, exposure to desertification, and limited capacity for adaptation exacerbates the effects of rising temperatures, particularly in drought-prone areas such as the Sahel and Sudan. These trends underscore the urgent need for targeted climate adaptation strategies to address the compounded challenges posed by warming in Africa.

The Paris Agreement (global initiative) highlights the need to reduce emissions and enhance resilience. However, as the IPCC (2024a) emphasizes, more must be done, especially in developing regions. Without significant financial and technical support, African nations will continue to face rising climate-induced conflict. African countries, especially those in the Sahel, need resources to adapt to the climate crisis. The future of conflict in Africa depends on their ability to adapt to growing climate threats (UNEP, 2019a). As Ferguson (2019) argues, addressing climate vulnerability in Africa requires integrated efforts that combine climate adaptation, resource management, and governance reform.

3. Study area

This study focuses on the Sahel region and its surrounding areas, where the relationships among climate change, resource scarcity, and conflict are particularly evident. The Sahel is a vast semi-arid region spanning over 5 900 kilometres from the Atlantic Ocean to the Red Sea, encompassing parts of countries such as Senegal, Mauritania, Mali, Niger, Chad, and Sudan (UNISS, 2023). It serves as a critical climatic and ecological transition zone between the Sahara Desert to the north and more fertile regions to the south. This region is particularly vulnerable to environmental degradation, including desertification, drought, and increasingly erratic rainfall patterns, which pose severe risks to communities reliant on rain-fed agriculture and pastoralism (Kazeem, 2024). This dynamic is further complicated by socio-political factors, as climate change exacerbates existing vulnerabilities, leading to increased competition over scarce resources and contributing to instability (Tesfaye, 2022). The interplay of environmental stressors and weak governance structures has created a nexus of climate change, development challenges, and conflict fragility in the Sahel, which demands integrated responses (Asafu-Adjaye, 2014). For this reason, three conflict regions from this area are selected as case studies.

Within this broader region, the article examines specific areas that exemplify the impact of climate change on substantive natural resources and the ensuing conflicts. First, Darfur in western Sudan, where prolonged drought and desertification have exacerbated ethnic tensions and competition over land and water. The region's geography, dominated by the volcanic Marrah Mountains and expansive plains, has traditionally supported both agricultural and pastoral livelihoods. However, environmental degradation has significantly reduced access to water and arable land, leading to violent competition between nomadic herders and sedentary farmers.

Second, the Lake Chad Basin, straddling Nigeria, Chad, Niger, and Cameroon, has experienced severe environmental stress. Once a vast freshwater lake, Lake Chad has shrunk by more than 90% since the 1960s due to overuse, mismanagement, and climate change. Skah and Lyammouri (2020) noted that the environmental degradation of Lake Chad has had profound implications for regional security. This reduction has triggered mass displacement, worsened food and water scarcity, and created fertile ground for the

rise and operation of violent non-state actors in various regions within African states (Cilliers & Cilliers, 2015a, 2015b; Nkomo & Buchanan-Clarke, 2020; Ramdeen, 2017).

Finally, South Sudan, while geographically mostly south of the Sahel, faces similar climate-induced pressures, including erratic rainfall and severe water scarcity. The White Nile and Sudd wetlands are vital water sources for the country, but they have been disrupted by both droughts and flooding. These environmental stresses have contributed to intensifying conflicts between rival communities, particularly with respect to water resources, exacerbating the country's already fragile political situation.

4. Climate change as a force multiplier in resource conflicts

When examining the ways in which climate change exacerbates conflicts in Africa, it becomes evident that environmental stressors, including resource scarcity and degradation, consistently amplify socio-political tensions. These case studies collectively illustrate how climate change acts as a catalyst, intensifying pre-existing conflicts and contributing to instability across the continent.

4.1. Darfur

Darfur experiences a tropical climate characterized by distinct wet and dry seasons. The wet season typically lasts from June to September, with rainfall ranging from approximately 300 mm in the northern areas to 1,000 mm in the southern areas. During the dry season, temperatures often exceed 40°C, resulting in heightened evapotranspiration rates that significantly exacerbate drought conditions (World Bank, 2021). The increase in temperature and decrease in precipitation over 1979–2023, as illustrated by Figure 4, highlight the growing impacts of climate variability.

These extreme climatic factors illustrated in Figure 4, coupled with the region's socio-political vulnerabilities, make Darfur highly susceptible to resource scarcity and conflict. The conflict in Darfur is often cited as one of the earliest modern examples of how climate change can catalyse conflict. Environmental degradation has exacerbated ethnic and political tensions, especially in regions dependent on natural resources. Scholars, notably De Juan (2015), have extensively documented how prolonged droughts, desertification, and reduced access to fertile land and water heightened competition between nomadic herders and sedentary farmers. This was in the context of the presence of many gold deposits that further increased the power contest among local warlords and the government over the economic benefits (Berridge et al., 2022).

In the Darfur region, which covers vast plains and includes the volcanic highlands of the Marrah Mountains, the availability of pastureland and agricultural fields has drastically decreased due to a combination of environmental and socio-political factors. Over the past few decades, the region has experienced severe fluctuations in rainfall patterns and recurring droughts, contributing to a significant reduction in rainfed agricultural lands. A study by Altoom et al. (2023) reported overall accuracies ranging between 94.7% and 96.9% and kappa statistics greater than 0.90, indicating that pastureland decreased by 1 922 349.06 hectares between 1984 and 2019. Additionally, rainfed agriculture on sandy soils experienced a substantial decline of 658,568.61 hectares between 2004 and 2009. Another critical factor exacerbating this reduction is the ongoing, long-term natural

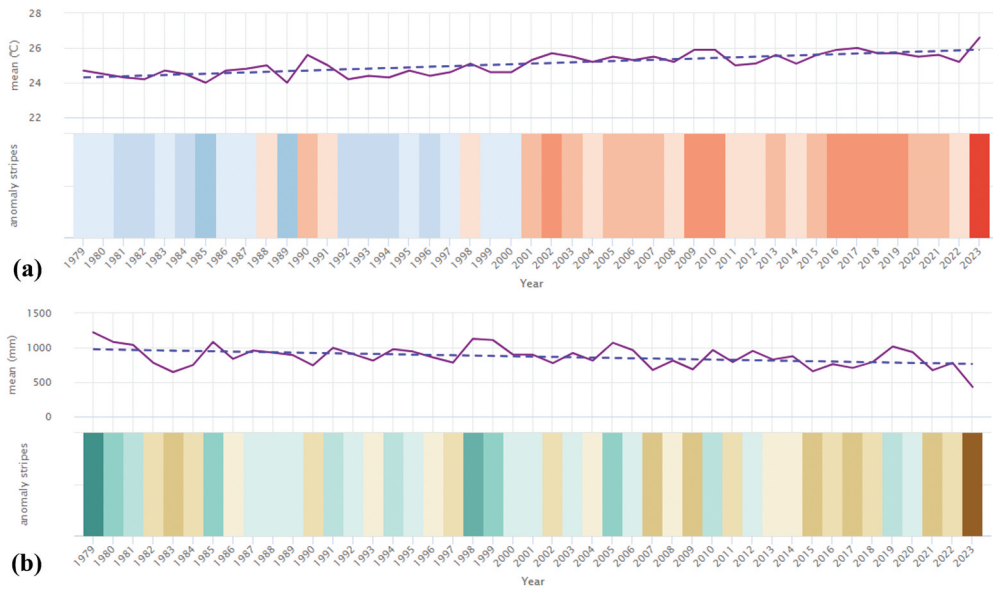


Figure 4. Mean yearly temperature (a) and precipitation (b) trends and anomalies for the Central Darfur region from 1979–2023. The temperature graph (a) shows a steady upward trend, with warming stripes transitioning from cooler years (blue) to warmer years (red) in recent decades, reflecting the ongoing impacts of climate change. The precipitation graph (b) indicates a slight downward trend, with green (wetter years) and brown (drier years) stripes highlighting increasingly erratic rainfall patterns and growing drought stress. *Source:* Meteoblue (2024a).

expansion of the Sahara Desert, which has advanced southwards at an estimated rate of approximately 500–1,000 metres per year in some areas (Niang et al., 2014; Nigam & Thomas, 2020). This desertification process, driven by a combination of natural climatic variability and human activities (e.g. overgrazing and deforestation), has reduced the availability of arable land and pasture across the Sahel, including Darfur (Nigam & Thomas, 2020). As the desert encroaches, agricultural soils become increasingly unsuitable for cultivation, further compounding the pressures on local communities reliant on rainfed farming and livestock rearing. The combination of desertification and erratic rainfall has heightened resource competition and socio-political tensions in the region, contributing to the ongoing cycles of conflict and displacement (Kazeem, 2024). While many adaptation strategies were developed by local communities or in collaboration with external partners, these cannot be effectively applied in the conflict-ridden areas, strengthening the climate-conflict nexus.

The degradation of natural resources has contributed to heightened ethnic tensions, intensifying competition over land and water (Burke et al., 2009; Olanrewaju et al., 2020). The Sudanese government, by arming and supporting militias including the Janjaweed, later turned into Rapid Support Forces, exacerbating these tensions. The Janjaweed militia played a central role in the conflict by targeting sedentary farming communities, often with government backing. Their actions deepened ethnic divides and exploited existing resource-based tensions, particularly over arable land and water. By employing tactics of violence and intimidation, the Janjaweed contributed to the mass displacement

of communities, intensifying the competition for scarce resources and further destabilizing the region (De Juan, 2015; UNEP, 2007). These militias targeted opposition communities, further intensifying the struggle for scarce resources. Manipulation of tribal and ethnic divisions, particularly involving the Fur, Zaghawa, and Masalit communities, deepened the socio-political dimensions of the conflict, creating a volatile situation ripe for violence. The conflict's escalation was partly driven by external actors, with Libya, under Gaddafi's regime, providing arms and support to opposition groups in Sudan or Chad waging a proxy conflict with the Sudanese government in the border regions. We can observe reappearance of this pattern in the current Sudanese conflict that began in 2023 which is further fuelled by the external meddling of some Gulf States like the United Arab Emirates and Saudi Arabia, or Russia. This interventions intensify local disputes over already scarce resources, further complicating efforts to achieve peace and stability (Berridge et al., 2022). The cross-border presence of these groups added an additional layer to the conflict, which consists of the power competition between Khartoum and N'Djamena. These factors remained relevant even after the civil war in Darfur was concluded with the fall of the Omar Bashir government. The contemporary restart of violence in the region tied to a wider civil war in the country is conditioned by the same factors – regional geopolitics, ethnic tensions, access to gold deposits, and environmental factors.

Post-conflict environmental assessments highlight how environmental degradation has compounded social and political instability in Sudan (UNEP, 2007). Long-term environmental stress, including drought and desertification, has been identified as a key driver of armed conflict in Sudan and other regions (Raleigh & Urdal, 2007; UNEP, 2007). These findings fit the pattern of decreasing access to water resources that leads to resource contests between communities, further increasing the level of violence. Table 1 summarizes the complex drivers of the Darfur conflict, including environmental factors, socio-political tensions, and resource scarcity, and illustrates how these factors interact to create a cycle of conflict in the region (Roettinger, 2019; Sakr, 2023).

This table highlights the multifaceted nature of the Darfur conflict, underscoring how environmental challenges, particularly climate-induced degradation, intersect with

Table 1. Key drivers of the conflict in Darfur and their interconnected nature.

Drivers of Conflict in Darfur	Description
Environmental Degradation	Prolonged droughts, desertification, and reduced access to water and fertile land have severely impacted agricultural productivity.
Ethnic Tensions	Long-standing divisions between nomadic herders and sedentary farmers have been exacerbated by competition over scarce resources and access to gold deposits.
Political and Armed Group Exploitation	The Sudanese government has been accused of fuelling conflict by arming militias, such as the Janjaweed, to destabilise opposition groups. Additionally, external actors like Libya, Chad, UAE, Saudi Arabia, or Russia have contributed to the escalation by supplying arms to opposition groups, further intensifying local disputes over resources already strained by climate change.
Resource Scarcity	Limited access to water and arable land has intensified local conflicts, forcing communities into violent competition.
Displacement	The environmental and political instability has led to mass displacement, further straining resources and exacerbating tensions.
Weak Governance and Social Infrastructure	The lack of effective governance and infrastructure has hampered efforts to mitigate environmental stress and reduce violence.

socio-political issues. These dynamics demonstrate how resource scarcity can aggravate already fragile socio-political landscapes, transforming localized tensions into broader, protracted conflicts.

4.2. Lake Chad – resource scarcity and extremism

The Lake Chad Basin has experienced severe climatic stress since the 1960s, with rainfall decreasing significantly over the past few decades. The reduction in annual rainfall, ranging between 300 mm in the northern areas and 1 000 mm in the southern parts, has significantly reduced the lake's size over time. Rising temperatures have compounded these challenges by increasing evapotranspiration rates, which further reduce water availability and intensify desertification processes. Mean yearly temperature and precipitation trends from 1979–2023 are illustrated in Figure 5. This climatic instability has profound implications for livelihoods in the region, where communities rely heavily on water for agriculture and fishing (Pham-Duc et al., 2020).

According to Skah and Lyammouri (2020), the Lake Chad Basin exemplifies how climate change acts as a threat multiplier in fragile regions. The shrinking of Lake Chad offers a stark example of how environmental degradation can lead to severe resource scarcity, conflict, and the rise of extremism. Once a critical source of water for approximately 40 million people, Lake Chad has lost more than 90% of its surface area since the 1960s due to climate change, overuse, and mismanagement (see Figure 6). This water

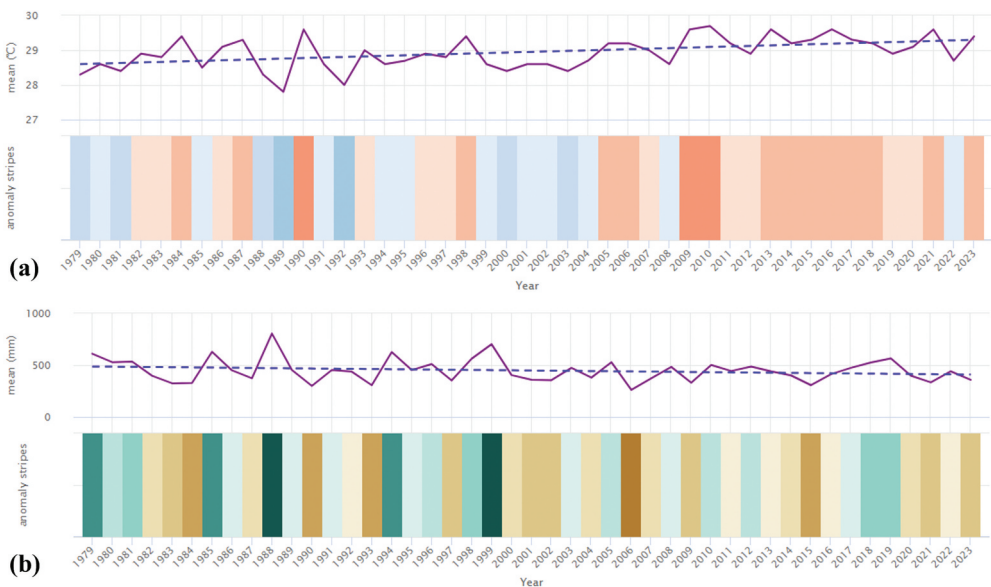


Figure 5. Mean yearly temperature (a) and precipitation (b) trends and anomalies for the Lake Chad region from 1979–2023. The temperature graph (a) shows a nearly horizontal trendline, indicating minimal long-term warming, with warming stripes transitioning from cooler (blue) to warmer (orange and red) years in recent decades. The precipitation graph (b) also displays a near-flat trendline, reflecting no significant change in rainfall totals over time. Yearly variability is highlighted by alternating green (wetter years) and brown (drier years) stripes, illustrating the unpredictability of water availability. *Source:* Meteoblue (2024c).

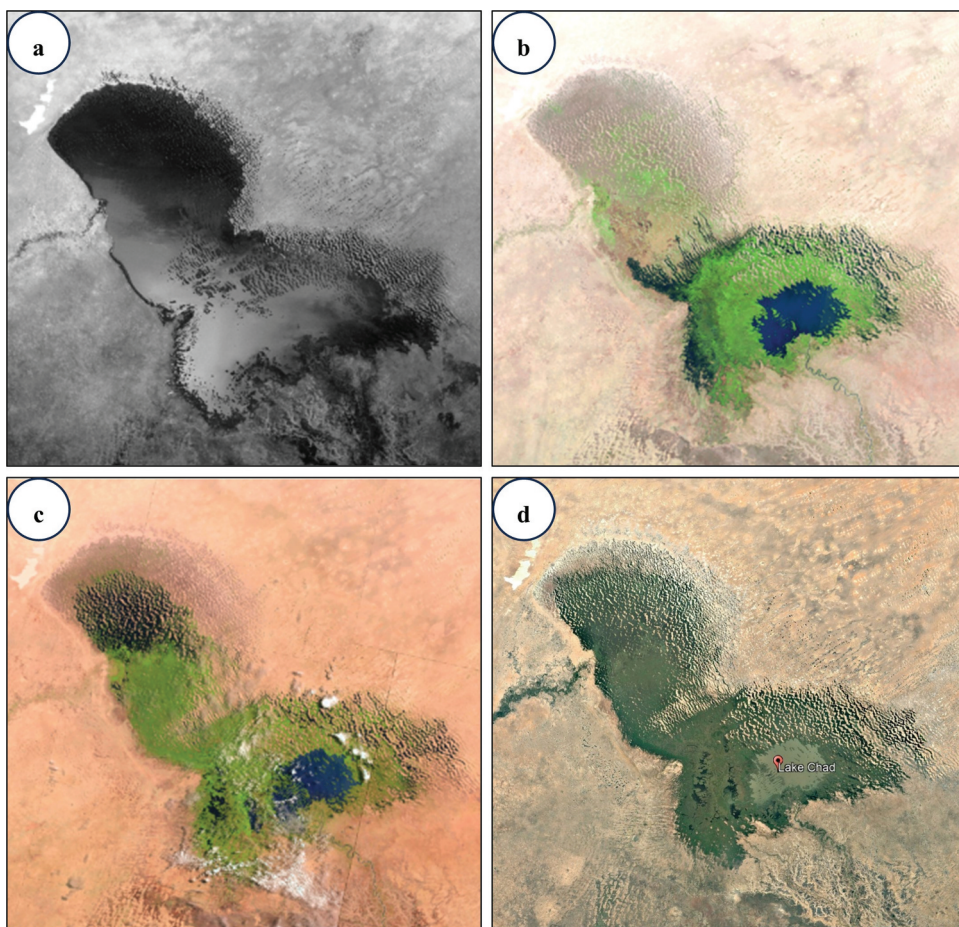


Figure 6. Comparison of Lake Chad surface area among 1963 (a), 1987 (b), 2013 (c) and 2020 (d), revealing significant shrinkage due to climate change, overuse, and mismanagement. The drastic reduction in water volume highlights the environmental degradation that has contributed to resource scarcity and conflict in the Lake Chad Basin. Images (a – c) were sourced from Jedwab et al. (2023), and image (d) was sourced from Google Earth Pro.

crisis has directly affected agricultural production and fishing, which are key livelihoods for communities in the region (Gleick, 2014; Sambo & Sule, 2024). In addition, Okpara et al. (2015) noted that this environmental degradation has created significant barriers to agricultural production and fishing, both of which are key livelihoods for communities around the lake. This is the context of the misuse of the local population by rebel forces, which use the Lake Chad economy for financing.

The resulting resource scarcity has led to increased local conflicts over access to water and land. The displacement of millions of people due to environmental stress has provided fertile ground for extremist groups (e.g. Boko Haram/ISWAP), who exploit economic desperation and socio-political vulnerabilities. Boko Haram/ISWAP have strategically exploited the economic desperation and social disintegration caused by climate stress. These groups use violence to control access to dwindling resources,

including water and arable land, while recruiting members from displaced and marginalized communities. Their actions disrupt local livelihoods, further hinder regional cooperation, and perpetuate cycles of violence and poverty in the region (Skah & Lyammouri, 2020). The conflict in the Lake Chad Basin has affected approximately 17 million people living in areas impacted by violence between non-state armed groups and military forces. Of this number, 2.5 million people have been displaced across the region, and more than 10 million people are dependent on humanitarian aid for survival (Frontières, 2020). While developing in the context of socio-economic and political marginalization of peripheries, especially in Nigeria, these extremist groups create a feedback loop, where resource scarcity and extremism further destabilize the region, making it difficult for communities to recover and adapt (Ide et al., 2016).

The loss of more than 90% of the lake's water has led to severe socio-economic impacts, including reduced agricultural productivity and disrupted fishing industries, forcing communities to compete for dwindling resources. As water resources have diminished, local conflicts over land and water have escalated, whereas mass displacement has created fertile ground for extremist groups. Boko Haram, for example, exploited the desperation caused by environmental degradation and displacement to recruit individuals from vulnerable communities (Skah & Lyammouri, 2020). The lack of regional cooperation between countries such as Nigeria, Chad, Cameroon, and Niger has hindered effective climate adaptation and conflict resolution efforts, further destabilizing the region. The chronic inability of states, including Chad and Nigeria, to control their border regions further reduces the ability of communities to escape the cycle of violence and climate change-induced poverty.

The International Organisation for Migration (IOM) noted that the lack of effective governance and comprehensive strategies to address both climate change and resource management has exacerbated the situation. The failure to build resilience against environmental stress has allowed extremist groups to exploit these vulnerabilities. The situation might necessitate an international intervention to be resolved (WMO, 2021). This is unlikely, given the failures of similar missions in Mali and other comparable countries. The environmental stress in the Lake Chad Basin has resulted in more than 2.7 million displaced individuals and 3.6 million people facing food insecurity, creating a significant humanitarian crisis (Skah & Lyammouri, 2020). International aid has been instrumental in addressing humanitarian needs, but the failure to implement long-term resource management strategies has perpetuated dependency and tension (Jedwab et al., 2023). This crisis highlights the complex relationships among climate change, migration, and extremism in fragile regions.

Table 2 presents an highlighted analysis of the major factors contributing to conflict in the region (Vivekananda et al., 2019b). This shows that environmental degradation is a key factor, focusing on the drastic reduction in Lake Chad's water levels, which has severely impacted livelihoods, particularly agriculture and fishing. This depletion of natural resources has escalated ethnic tensions, as competition among farmers, herders, and fishermen over limited water and land has increased. The table also underscores the Political and Armed Group Exploitation, with Boko Haram taking advantage of the instability, causing further displacement and resource strain. Additionally, resource scarcity is identified as a central driver, where the decreasing availability of fertile land and water forces communities into violent

Table 2. Key drivers of the conflict in Lake Chad and their interconnected nature.

Drivers of Conflict in Lake Chad	Description
Environmental Degradation	Reduction in Lake Chad's water levels has severely impacted livelihoods and access to resources.
Ethnic Tensions	Tensions between farmers, herders, and fishermen have escalated due to competition for diminishing resources.
Political and Armed Group Exploitation	Boko Haram/ISWAP's presence has intensified violence and instability, leading to further displacement and resource strain.
Resource Scarcity	Decreased availability of water and fertile land has pushed communities into violent competition over remaining resources.
Displacement	Conflict and environmental degradation have displaced millions, creating humanitarian crises and increasing tensions.
Weak Governance & Social Infrastructure	Lack of coordinated response and limited infrastructure have hindered conflict resolution and adaptation efforts.

competition. This is compounded by Displacement, where both conflict and environmental factors have displaced millions, leading to significant humanitarian crises and rising tensions. Finally, the table highlights weak governance and social infrastructure, where the lack of coordinated regional responses and underdeveloped infrastructure has hindered efforts to resolve the conflict and build resilience to environmental and social challenges. This table offers a clear framework for understanding the interconnected nature of the environmental and socio-political drivers of the Lake Chad conflict.

4.3. South Sudan – water stress and civil conflict

South Sudan experienced an average temperature increase of approximately 1°C between 1975 and 2020, reflecting the broader warming trends observed across the African continent. The country's tropical climate features wet and dry seasons, with the wet season extending from March to October and peak rainfall occurring between June and September. However, rainfall patterns have become increasingly erratic, with some regions enduring prolonged dry spells, whereas others face intense flooding. These climatic shifts strain the nation's reliance on rain-fed agriculture and pastoral livelihoods, contributing to cycles of displacement and conflict (World Bank, 2021).

South Sudan's climatic trends provide a clear indication of the challenges posed by climate change, particularly in terms of increasing temperatures and fluctuating precipitation patterns. Analysis of the climate data for Juba, the capital region, highlights critical changes from 1979–2023, which are representative of broader trends across the country (Figure 7). The observed upward trend in mean annual temperatures and the decline in total annual precipitation underscore the growing intensity of climate-related stressors, with significant implications for resource availability and livelihoods.

Since gaining independence in 2011, South Sudan has experienced a series of violent episodes intertwined with fragile peace efforts. Clashes over Abyei and South Kordofan erupted shortly after independence, followed by the devastating Pibor massacre in late 2011. The civil war ignited in December 2013, with violence in Juba claiming 1,000 lives. Subsequent events, such as the 2014 Bentiu massacre and the deadly aftermath of Riek Machar's flight from Juba in 2016, marked periods of heightened violence. Attempts at peace, including the 2015 ARCSS and the 2018 R-ARCSS, brought hope but failed to halt

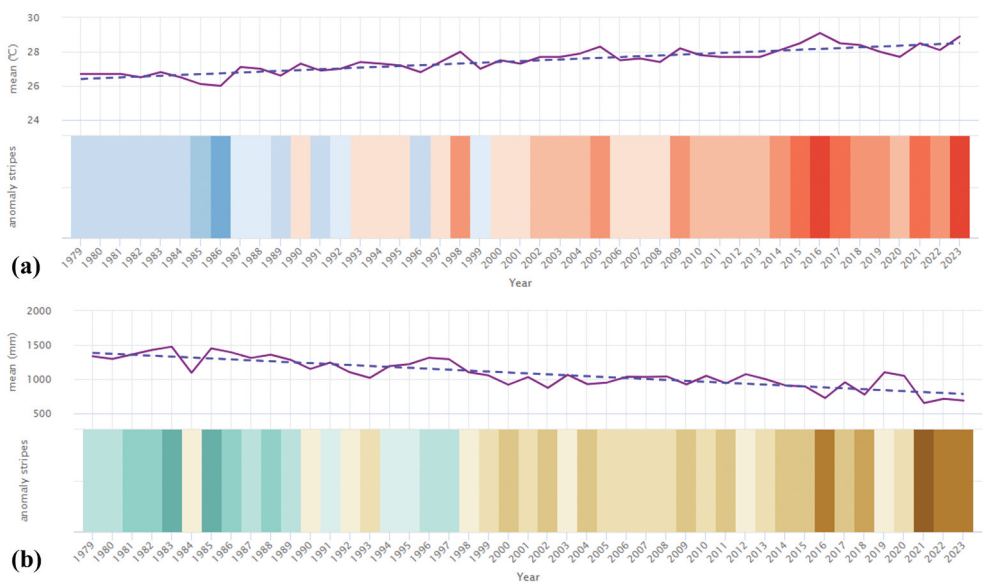


Figure 7. Mean yearly temperature (a) and precipitation (b) trends and anomalies for Juba, South Sudan, from 1979–2023. The temperature graph (a) shows a clear upward trend in mean annual temperatures, reflecting the impacts of climate change, with a shift from predominantly cooler years in the early 1980s to significantly warmer years from the 2000s onwards, as illustrated by the warming stripes. The precipitation graph (b) reveals a downward trend in mean annual total precipitation, indicating drier conditions over time. The precipitation stripes illustrate annual variability, with green representing wetter years and brown indicating drier years. *Source:* Meteoblue (2024b).

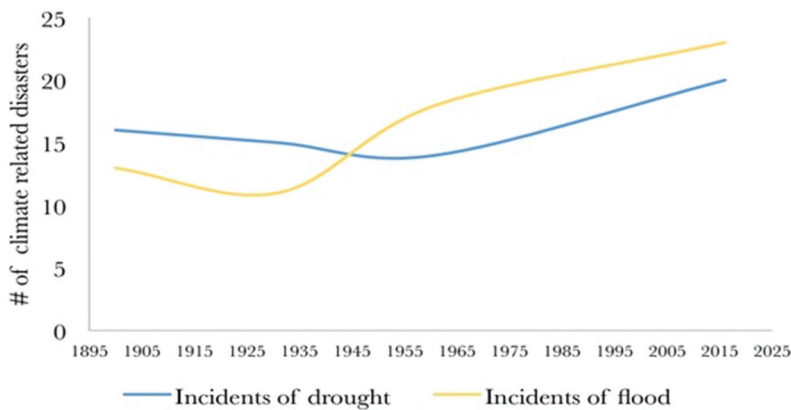


Figure 8. Incidents of floods and droughts in South Sudan, 1900–2017. *Source:* Tiitmamer et al. (2022).

ongoing displacement and insecurity. These events, compounded by resource pressures and environmental stressors, illustrate the complexity of South Sudan’s conflict dynamics (ACLED, 2024; African Centre for Strategic Studies, 2019; UNHCR, 2023).

Figure 8 (below) illustrates the trends in climate-related disasters, particularly droughts and floods, between 1895 and 2017. From these data, it is evident that the

number of flood incidents began rising sharply from the 1970s onwards, surpassing drought occurrences around the same period. This increase in extreme weather events placed considerable pressure on South Sudan's already fragile resources, particularly water and arable land. In regions dependent on rain-fed agriculture and livestock – Jonglei and the Upper Nile being notable examples – environmental stresses have directly contributed to inter-communal clashes, displacement, and violent confrontations over resources.

South Sudan's history from 2011 to 2019 reveals a close link between environmental shocks and conflict dynamics. The onset of the civil war in December 2013 coincided with severe drought conditions that exacerbated food insecurity and heightened tensions among ethnic groups competing for dwindling resources. This pattern of violence and environmental stress is evident in events such as the April 2014 Bentiu massacre, which occurred amidst escalating political instability and resource scarcity. Despite efforts to stabilize the nation through the 2015 ARCSS and 2018 R-ARCSS peace agreements (Onapa, 2019), implementation has been hindered by ongoing environmental degradation. Devastating floods and recurring droughts have displaced millions, destroyed livelihoods, and intensified competition over critical resources such as land and water. For example, the widespread flooding of 2019 displaced 700 000 people, destroyed crops, and triggered renewed clashes between displaced communities and host populations. These cycles of drought and flooding have not only aggravated violence but have also complicated peacebuilding efforts, highlighting the critical need for integrated climate adaptation and disaster management strategies to support conflict resolution and long-term stability in South Sudan.

Climate-related disasters have led to heightened competition for access to critical water supplies, particularly the Nile River, which is vital to both agricultural and pastoralist communities (El-Fadel et al., 2003; Maystadt & Ecker, 2014; Merem et al., 2020). Control over the Nile has become a key point of contention, not only between ethnic groups but also between political factions seeking to consolidate power. Political and military groups have strategically sought control over water resources, exacerbating tensions and fuelling civil conflict. Ethnic militias in South Sudan have exploited the fragility caused by water scarcity and extreme weather events to assert control over resources. These groups, frequently aligned with political factions, employ violence to consolidate power and secure access to essential resources, including water and arable land. Their activities have transformed localized disputes into broader conflicts, exacerbating ethnic tensions and undermining peace efforts (Pinaud, 2021; Tiitmamer et al., 2022). Pastoralist groups, facing increasingly erratic rainfall, have been forced to migrate in search of water, often clashing with agricultural communities over dwindling resources. This migration, driven by water stress, has transformed localized disputes into larger-scale ethnic and political conflicts (Searchinger et al., 2019). The combination of environmental degradation and weak governance structures has made South Sudan particularly vulnerable to such conflicts, as local disputes over water have escalated into broader, more violent confrontations.

When considering the various interrelated factors that act as drivers of conflict in South Sudan, it becomes clear that environmental degradation, resource scarcity, and

Table 3. Key drivers of the conflict in South Sudan and their interconnected nature.

Drivers of Conflict in South Sudan	Description
Environmental Degradation	Extreme weather events such as prolonged droughts and increasing floods have reduced access to water and arable land, worsening resource scarcity.
Ethnic Tensions	Competition between ethnic groups, especially between pastoralists and farmers, has been exacerbated by dwindling water resources and erratic rainfall patterns.
Political and Armed Group Exploitation	Control over critical water supplies, particularly the Nile River, has become a focal point of contention, with political factions and militias exploiting resource scarcity to consolidate power.
Resource Scarcity	Reduced availability of water and arable land has led to violent clashes between communities, intensifying local and national conflicts.
Displacement	Recurrent droughts and floods have displaced millions of people, creating a humanitarian crisis and increasing competition over resources in host communities.
Weak Governance & Social Infrastructure	The lack of effective water management infrastructure and governance has compounded the impacts of environmental stress, fuelling ongoing conflict.

socio-political tensions are deeply intertwined. [Table 3](#) summarizes these key drivers, illustrating how they interact to exacerbate ongoing violence and instability in the region.

In rural areas, competition for access to water for agriculture and livestock has intensified, with frequent violent clashes between communities. [UNDP \(2024\)](#) warned that without substantial investment in water management infrastructure and climate resilience strategies, South Sudan will likely continue to experience protracted conflicts driven by resource scarcity.

4.4. Implications for resource conflict and geopolitics

These case studies illustrate how climate change acts as a force multiplier in regions already plagued by socio-political instability. In each case, environmental degradation exacerbates competition for natural resources, particularly water and arable land, which are central to both livelihoods and political power. These conflicts are often framed in and based on ethnic divisions or political grievances, but at their core, they are also deeply connected to resource scarcity driven by changing climate conditions. Climate change does not lead to conflicts in stable regions but magnifies existing tensions and problems.

Furthermore, the rise of extremist groups in the context of resource scarcity, as observed in the Lake Chad Basin, underscores the broader security implications of climate change. The growing recognition of climate security highlights how climate stress exacerbates existing vulnerabilities, pushing fragile regions into conflict ([Busby \(2021\)](#)). Extremist ideologies thrive in regions where millions are displaced and traditional livelihoods eroded, creating an environment of desperation and marginalization. These specific conditions are exacerbated by climate change. This has not only regional but also global security implications, as these areas have become hotspots for violent extremism and forced migration.

Governance failures compound these challenges. Governments in these regions often lack the capacity or will to implement effective climate adaptation and resource management strategies, leaving communities vulnerable to both environmental stress and conflict. Research underscores that global environmental politics are increasingly shaped by

the security implications of climate change, particularly in regions with fragile governance (Ide et al., 2016). These are often located at peripheries, which are in many cases under only judiciary control of the central government, which holds limited power projection capacities (Herbst, 2000; Jackson & Rosberg, 1982). This underscores the need for more robust climate governance frameworks at the national and international levels to mitigate the risks posed by climate-induced resource conflicts.

The implications of these conflicts extend beyond the specific regions in question. Climate security in regions like the Sahel has become a growing concern for international organizations, as climate-induced resource conflicts destabilize entire regions (UNDP, 2024). Africa faces interconnected challenges driven by climate change, and the geopolitical instability that results from these conflicts threatens to spill over into neighbouring regions, exacerbating migration flows and security concerns globally. Without urgent and coordinated action to address the underlying environmental and political drivers of these conflicts, the continent is likely to face increasing instability, with repercussions for the broader international community.

5. The role of external actors in climate-induced conflicts

Climate-induced conflicts in Africa are not only shaped by local socio-political and environmental factors but also significantly influenced by the interventions and policies of external actors. Non-governmental organizations (NGOs), foreign governments, and international bodies have played both constructive and disruptive roles in these dynamics.

Médecins Sans Frontières and the Red Cross are among the NGOs that frequently work to mitigate the immediate impacts of resource scarcity and displacement driven by climate change. In the Lake Chad Basin, these organizations have provided critical humanitarian aid, including food, water, and shelter, to displaced populations, helping to reduce the risk of conflict over scarce resources (Frontières, 2020). However, the uneven distribution of aid has occasionally led to resentment among underserved communities, inadvertently exacerbating tensions and prolonging existing conflicts (Vivekananda et al., 2019a). Additionally, the NGOs and universities aid local communities with adaptation of the agricultural production on the climate change. This process is, however, negatively affected by the ongoing conflicts.

Foreign governments have also intervened in these conflict zones, often pursuing geopolitical interests under the guise of aid. In Darfur, the Libyan government played a destabilizing role by exporting revolution and supplying resources to armed groups, thereby prolonging local conflicts (De Juan, 2015). Similarly, in Chad, the spillover effects of Libyan interventions and cross-border ethnic affiliations have aggravated tensions, creating a feedback loop where climate stress magnifies political fragilities (Roettinger, 2019). The external influence of numerous Middle Eastern countries and Russia in Sudan or the Sahel conflict zone further intensifies the conflicts.

The United Nations have recognized the climate-security nexus, with the UN Security Council describing climate change as a 'threat multiplier' in vulnerable regions such as the Sahel (United Nations, 2021a). While UN peacekeeping missions in Sudan have aimed to address the consequences of such conflicts, they have often faced criticism for their limited capacity to address governance deficiencies and resource mismanagement

(UNEP, 2007). Moreover, the UN's inability to prevent cross-border spillovers from conflicts in Chad and Darfur, or in collaboration with European missions to stabilize situation in Mali, Burkina Faso and Niger underscores the challenges of coordinating responses to interconnected crises (UNDP, 2024).

International aid further complicates these dynamics. While often presented as a solution to alleviate suffering, aid programmes are sometimes tied to strategic geopolitical interests. For example, in the Lake Chad Basin, aid distribution has disproportionately favoured areas of strategic importance to donor nations, exacerbating divisions among local communities and fuelling further tensions (Skah & Lyammouri, 2020). These examples demonstrate the dual-edged nature of external interventions, where well-intentioned efforts can sometimes deepen existing conflicts.

6. Discussion

The analysis of Darfur, Lake Chad, and South Sudan reveals the complex relationships among climate change, resource scarcity, and conflict in fragile regions. Climate change acts as a force multiplier, intensifying socio-political tensions, particularly where governance is weak and agriculture depends on water and land access.

6.1. *Climate change as a force multiplier*

The term force multiplier accurately encapsulates how climate change intensifies existing stressors – poverty, ethnic tensions, and political instability. In the case of Darfur, the conflict between sedentary farmers and nomadic herders was not new; however, as De Juan (2015) explained, prolonged droughts and desertification exacerbated the competition over land and water, igniting conflict. The environmental stress placed on these already fragile relationships escalated the situation, leading to mass displacement and violence.

The shrinking of Lake Chad, as outlined by Okpara et al. (2015), is a direct result of both climate change and human mismanagement. Droughts and growing-season anomalies have been shown to increase the likelihood of conflict, particularly in regions dependent on agriculture (Von Uexkull et al., 2016). The dwindling of water resources has led to increased tensions between communities that rely on agriculture, fishing, and herding for survival. The ISWAP and other rebel groups exploited the desperation and displacement of communities, leading to a security crisis that extended beyond the immediate region. They additionally further strain the resources available to the local communities.

In South Sudan, erratic rainfall and water stress have led to competition over vital water resources, intensifying the civil conflict caused by political disputes masked by ethnic identities (Pinaud, 2021). The absence of adequate water management systems, combined with the fragility of the political system and an almost complete lack of state building, has transformed environmental stress into violent confrontations, particularly between pastoralists and farmers. As UNEP (2019a) reported, the escalation of conflicts over water exacerbates existing ethnic divisions, creating a vicious cycle of violence, displacement, and further environmental degradation.

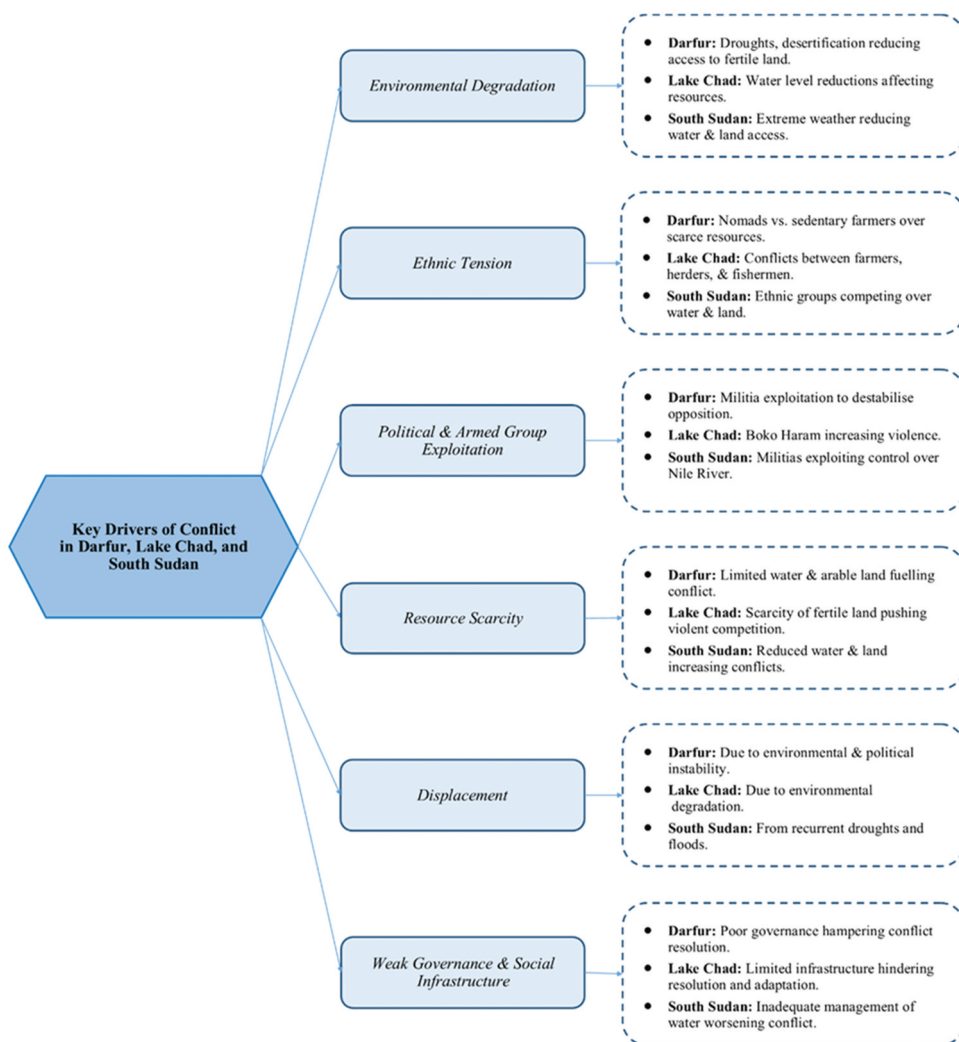


Figure 9. Key drivers of conflict in Darfur, Lake Chad, and South Sudan.

As highlighted in Figure 9 (below), the key drivers of conflict in Darfur, Lake Chad, and South Sudan include environmental degradation, resource scarcity, ethnic tensions, displacement, and weak governance. This interconnected framework helps illustrate how climate change acts as a force multiplier in fragile regions. By intensifying resource scarcity and increasing sociopolitical vulnerability, these factors contribute to protracted violence and instability across the three regions. Figure 9 visually represents the multi-dimensional nature of these conflicts and underscores the need for comprehensive responses to mitigate the impacts of climate change in these fragile settings.

6.2. Implications for resource conflicts and geopolitical ramifications in Africa

The studied cases show that climate change did not create new conflicts but rather intensified pre-existing instabilities. As water and land, which are essential for livelihoods, become scarcer due to climate change, competition for these finite resources heightens socio-political tensions, leading to conflicts that can spiral into widespread violence, as seen in Darfur, Lake Chad, and South Sudan. This competition is not just a local issue. In the Sahel, severe water stress and desertification lead to resource scarcity and mass migration. Displaced populations seek refuge in urban centres or across borders, straining local resources and contributing to regional instability, further destabilizing areas already facing similar tensions.

The geopolitical implications of climate change and resource conflict extend beyond the immediate regions affected. Climate-induced conflicts in Africa, particularly in fragile regions – Sahel, the Horn of Africa, and West Africa – have ripple effects across the continent and globally, causing widespread displacement and severely impacting livelihoods that are dependent on agriculture, livestock, and fishing. Over 10 million people in the Lake Chad Basin, spanning Chad, Nigeria, Niger, and Cameroon, require humanitarian assistance because of the combined effects of conflict, climate change, and poverty (Ehiane & Moyo, 2022; Jedwab et al., 2023). Additionally, as of 2020, the UNHCR reported that approximately 2.3 million people were displaced in the region (Usigbe, 2019). This displacement strains local resources and fuels regional instability, as migrating populations seek safety and sustenance, complicating governance, increasing competition over dwindling resources, and exacerbating conflict across West and Central Africa.

The presence of extremist groups in regions affected by climate-driven conflicts, for example Boko Haram/ISWAP in the Lake Chad Basin, exacerbates instability. The rise of extremist ideologies in areas where the state fails to provide basic services (e.g. water, food, and security) enables these groups to gain footholds, complicating counter-insurgency efforts. As these conflicts escalate, they threaten regional stability and may spread into other parts of Africa.

The broader geopolitical consequences of climate-induced conflict are also global. European countries, for example, have seen rising numbers of African refugees and migrants, increasing political and social pressures. However, these migrants generally do not come from the regions most affected by climate change, as long-distance migration is limited. Destabilized areas often serve as transit routes exploited by organized smuggling groups. This has implications for international relations, development aid, and security policies, as nations worldwide are forced to address two of the root causes of migration – climate change and conflict.

Addressing these challenges requires multifaceted solutions, including investments in climate adaptation, better water management, and conflict resolution strategies that consider environmental factors. Without these interventions, the impacts of climate change will continue to affect not only Darfur, Lake Chad, and South Sudan but also Africa and the world. These crises highlight the urgent need for global cooperation and sustainable solutions.

While the regional implications of climate-induced conflicts are profound, their ramifications extend far beyond Africa, influencing global migration patterns, international security, and economic stability.

6.3. Global ramifications of climate-induced conflicts in Africa

Climate-induced conflicts in sub-Saharan Africa have far-reaching implications that extend beyond the continent, affecting international stability, economic systems, and global governance. These conflicts often drive mass migration, disrupt trade routes, and create conditions conducive to transnational terrorism, highlighting the interconnected nature of modern global challenges.

The displacement caused by climate-induced conflicts has contributed to increased migration flows from Sub-Saharan Africa through the Sahara-Sahel region to Europe and other parts of the world. For example, conflicts in the three studied conflicts have forced millions of individuals to flee their homes, with some seeking asylum in Europe and opened their territories to illegal flows from other parts of the continent. This has placed significant strain on European nations, exacerbating social and political tensions and fuelling debates over immigration policies and border security (UNHCR, 2023). The rise in migration also increases the likelihood of human trafficking and exploitation, complicating international efforts to address these crises.

Resource conflicts in specific African regions disrupt local and global supply chains, particularly for critical commodities – oil, gold, uranium, and agricultural products. For example, instability in South Sudan, a major oil-producing nation, has impacted global oil prices, whereas conflicts in the Sahel not only affect the export of agricultural goods but also pose challenges to the extraction and trade of uranium, a strategically significant resource for global energy production and nuclear security. Additionally, the diversion of international aid and resources to address these conflicts strains the budgets of donor countries, limiting their willingness to invest in global development initiatives (World Bank, 2021).

The proliferation of violent non-state actors (e.g. Boko Haram) in the Lake Chad Basin and other extremist groups, poses a global security threat. These groups exploit the instability created by climate-induced conflicts to expand their networks and carry out transnational operations. Their activities not only threaten nations in West and Central Africa but also have ripple effects on global security, particularly in regions where these groups have ideological or operational linkages (Skah & Lyammouri, 2020).

The international community's response to climate-induced conflicts underscores the limitations of current global governance structures. While organizations like the United Nations and the African Union have launched peacekeeping and humanitarian initiatives, the absence of coordinated, long-term strategies has impeded effective resolution. Climate-induced conflicts in Africa demonstrate the need for a comprehensive global framework that integrates climate resilience, conflict resolution, and sustainable development (UNEP, 2007; WMO, 2021).

Addressing the global ramifications of climate-induced conflicts in African sub-regions requires a collective effort. This includes increasing investments in climate adaptation strategies, enhancing international cooperation to manage migration flows, and strengthening global governance mechanisms. The interconnected nature of these issues highlights the importance of viewing Africa's climate-induced conflicts not as isolated incidents but as global challenges requiring a unified response.

7. Conclusion

This paper explores the geopolitical implications of climate change for resource conflicts in Africa. Climate change exacerbates existing socio-political tensions by intensifying competition for scarce resources. The case studies of Darfur, Lake Chad, and South Sudan illustrate how environmental stresses, combined with weak governance, can lead to violence and displacement.

More granular data are needed to understand how climate change interacts with socio-political factors to drive conflict in Africa. Future research should focus on developing early warning systems that predict conflict hotspots on the basis of climate variability and resource availability while also examining how regional and international institutions can help mitigate the impact of climate change on vulnerable African communities. Climate change acts as a threat multiplier, intensifying existing vulnerabilities, such as poor governance and socio-economic inequality. For example, the shrinkage of Lake Chad has fuelled conflicts over resources, displaced millions, and contributed to the rise of violent extremism. This scenario highlights the need for not only environmental interventions but also robust governance and socio-economic support to address the destabilizing effects of climate change in fragile regions.

In conclusion, addressing the complex relationship between climate change and conflict in Africa requires comprehensive and integrated strategies. Strengthening governance, building climate resilience, and implementing sustainable resource management are essential steps to mitigate the impact of climate change on socio-political stability. By focusing on these areas, Africa can better navigate the challenges posed by climate-induced conflicts and promote long-term peace and security.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Ivan Henrico  <http://orcid.org/0000-0002-1080-5107>

Bohumil Doboš  <http://orcid.org/0000-0001-8862-2768>

References

- Abel, G. J., Brottrager, M., Cuaresma, J. C., & Muttarak, R. (2019). Climate, conflict and forced migration. *Global Environmental Change*, 54, 239–249. <https://doi.org/10.1016/j.gloenvcha.2018.12.003>
- ACLED. (2024). *Data and analysis on political violence and protest events*. Armed Conflict Location & Event Data Project. <https://acleddata.com/>
- AfDB. (2022). *African economic outlook 2022: Supporting climate resilience and a just energy transition in Africa*. African Development Bank. <https://www.afdb.org/en/documents/african-economic-outlook-2022>

- African Centre for Strategic Studies. (2019). *Timeline of South Sudan peace agreements and violence*. Retrieved October 6, 2024, from <https://africacenter.org/spotlight/timeline-of-south-sudan-peace-agreements-and-violence>
- Altoom, M. B., Adam, E., & Ali, K. A. (2023). Mapping and monitoring spatio-temporal patterns of rainfed agriculture lands of North Darfur State, Sudan, using earth observation data. *The Land*, 12(2), 307. <https://doi.org/10.3390/land12020307>
- Asafu-Adjaye, J. (2014). The economic impacts of climate change on agriculture in Africa. *Journal of African Economies*, 23(suppl_2), ii17–ii49. <https://doi.org/10.1093/jae/eju011>
- Barrios, S., Bertinelli, L., & Strobl, E. (2010). Trends in rainfall and economic growth in Africa: A neglected cause of the African growth tragedy. *The Review of Economics and Statistics*, 92(2), 350–366. <https://doi.org/10.1162/rest.2010.11212>
- Berridge, W., Lynch, J., Makawi, R., & De Waal, A. (2022). *Sudan's unfinished democracy: The promise and betrayal of a people's revolution*. Hurst Publishers.
- Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A., & Lobell, D. B. (2009). Warming increases the risk of civil war in Africa. *Proceedings of the National Academy of Sciences*, 106(49), 20670–20674. <https://doi.org/10.1073/pnas.0907998106>
- Busby, J. W. (2021). Beyond internal conflict: The emergent practice of climate security. *Journal of Peace Research*, 58(1), 186–194. <https://doi.org/10.1177/0022343320971019>
- Cilliers, J., & Cilliers, J. (2015a). Future (im) perfect? Mapping conflict, violence and extremism in Africa. *Institute for Security Studies Papers*, 2015(287), 24. <https://doi.org/10.2139/ssrn.2690080>
- Cilliers, J., & Cilliers, J. (2015b). Violent Islamist extremism and terror in Africa. *Institute for Security Studies Papers*, 2015(286), 32. <https://doi.org/10.2139/ssrn.2690116>
- De Juan, A. (2015). Long-term environmental change and geographical patterns of violence in Darfur, 2003–2005. *Political Geography*, 45, 22–33. <https://doi.org/10.1016/j.polgeo.2014.09.001>
- Dunne, D. (2023). *Analysis: Africa's extreme weather has killed at least 15, 000 people in 2023*. Carbon Brief. Retrieved September 20, 2024, from <https://www.carbonbrief.org/analysis-africa-unreported-extreme-weather-in-2022-and-climate-change/>
- Ehiane, S., & Moyo, P. (2022). Climate change, human insecurity and conflict dynamics in the Lake Chad Region. *Journal of Asian and African Studies*, 57(8), 1677–1689. <https://doi.org/10.1177/00219096211063817>
- El-Fadel, M., El-Sayegh, Y., El-Fadl, K., & Khorbotly, D. (2003). The Nile River Basin: A case study in surface water conflict resolution. *Journal of Natural Resources and Life Sciences Education*, 32(1), 107–117. <https://doi.org/10.2134/jnrlse.2003.0107>
- FAO. (2021). *The state of food security and nutrition in the world 2021*. Food and Agriculture Organisation. Retrieved November 27, 2024, from <https://www.fao.org/publications/sofi/2021/en/>
- Ferguson, P. (2019). Discourses of resilience in the climate security debate. *Global Environmental Politics*, 19(2), 104–126. https://doi.org/10.1162/glep_a_00500
- Freeman, L. (2017). Environmental change, migration, and conflict in Africa: A critical examination of the interconnections. *Journal of Environment & Development*, 26(4), 351–374. <https://doi.org/10.1177/1070496517727325>
- Frontières, M. S. (2020). *Lake Chad Crisis: In depth*. <https://www.msf.org/lake-chad-crisis-depth>
- Gleick, P. H. (2014). Water, drought, climate change, and conflict in Syria. *Weather, Climate, and Society*, 6(3), 331–340. <https://doi.org/10.1175/WCAS-D-13-00059.1>
- Hendrix, C. S., & Salehyan, I. (2012). Climate change, rainfall, and social conflict in Africa. *Journal of Peace Research*, 49(1), 35–50. <https://doi.org/10.1177/0022343311426165>
- Herbst, J. (2000). *States and power in Africa: Comparative lessons in authority and control* (Revised, 2nd ed., Vol. 149). Princeton University Press. <http://www.jstor.org/stable/j.ctt9qh05m>
- Homer-Dixon, T. F. (2010). *Environment, scarcity, and violence*. Princeton University Press. <https://doi.org/10.1515/9781400822997>
- Homer-Dixon, T. F., Boutwell, J. H., & Rathjens, G. W. (2011). Environmental change and violent conflict: Growing scarcities of renewable resources can contribute to social instability and civil strife. In G. Machlis, T. Hanson, Z. Špirić, & J. McKendry (Eds.), *Warfare ecology: A new synthesis for peace and security*, NATO science for peace and security series C: Environmental security (pp. 18–25). Springer. https://doi.org/10.1007/978-94-007-1214-0_3

- Ide, T., Michael Link, P., Scheffran, J., & Schilling, J. (2016). The climate-conflict nexus: Pathways, regional links, and case studies. In H. Brauch, Ü. Oswald Spring, J. Grin, & J. Scheffran (Eds.), *Handbook on Sustainability Transition and Sustainable Peace. Hexagon series on human and environmental security and peace* (Vol. 10, pp. 285–304). Springer. https://doi.org/10.1007/978-3-319-43884-9_12
- IDMC. (2023). *Global report on internal displacement 2023*. Internal Displacement Monitoring Centre. <https://www.internal-displacement.org/global-report/grid2023>
- IPCC. (2022). Climate change 2022: Impacts, adaptation, and vulnerability. *Intergovernmental panel on climate*. Cambridge University Press. Retrieved November 25, 2024, from <https://www.ipcc.ch/report/ar6/wg2/>
- IPCC. (2024a). *Climate change, 2021: The physical science basis*. Retrieved September 21, 2024, from <https://www.ipcc.ch/report/ar6/wg1>
- IPCC. (2024b). *Special report on climate change and land*. Retrieved September 21, 2024, from <https://www.ipcc.ch/srccl>
- Jackson, R. H., & Rosberg, C. G. (1982). Why Africa's weak states persist: The empirical and the juridical in Statehood. *Cambridge University Press*, 35(1), 1–24. <https://www.jstor.org/stable/2010277?origin=JSTOR-pdf>
- Jedwab, R., Haslop, F., Zarate, R., & Rodriguez Castelan, C. (2023). *The effects of climate change in the poorest countries: Evidence from the permanent shrinking of Lake Chad*. IZA discussion paper No. 16396. <https://ssrn.com/abstract=4547701>
- Kaplan, R. D. (1994). The coming anarchy. *The Atlantic Monthly*, 273(2), 44–76.
- Kazeem, O. S. (2024). Climate change and violent conflict in the Sahel and Lake Chad Basin. *Journal of Contemporary International Relations and Diplomacy*, 5(1), 74–85. <https://doi.org/10.53982/jcird.2024.0501.05-j>
- Larémont, R. R. (2021). Climate change and conflict in the Western Sahel. *African Studies Review*, 64(4), 748–759. <https://doi.org/10.1017/asr.2021.114>
- Maystadt, J.-F., & Ecker, O. (2014). Extreme weather and civil war: Does drought fuel conflict in Somalia through livestock price shocks? *American Journal of Agricultural Economics*, 96(4), 1157–1182. <https://doi.org/10.1093/ajae/aau010>
- Merem, E., Twumasi, Y., Wesley, J., Olagbegi, D., Crisler, M., Romorno, C., Alsarari, M., Isokpehi, P., Hines, A., Ochai, G., Nwagboso, E., Fageir, S., & Leggett, S. (2020). Issues in transboundary water use in the River Nile Basin Area of Africa. *World Environment*, 10(2), 27–44. <https://doi.org/10.5923/j.env.20201002.01>
- Meteoblue. (2024a). *Climate change in Central Darfur, Sudan*. Retrieved November 30, 2024, from https://www.meteoblue.com/en/climate-change/central-darfur_sudan_8394436
- Meteoblue. (2024b). *Climate change in Juba, South Sudan*. Retrieved November 30, 2024, from https://www.meteoblue.com/en/weather/historyclimate/change/juba_south-sudan_373303
- Meteoblue. (2024c). *Climate change in Lake Chad Basin (13.058°N, 14.521°E)*. Retrieved November 30, 2024, from <https://www.meteoblue.com/en/weather/historyclimate/change/13.058N14.521E>
- Niang, I., Ruppel, O., Abdrabo, M., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). *Africa, climate change 2014: Impacts, adaptation and vulnerability-contributions of the working group II to the fifth assessment report of the intergovernmental panel on climate change*. 1199–1265.
- Nigam, S., & Thomas, N. P. (2020). The Sahara Desert Hydroclimate and expanse: Natural variability and climate change. In M. I. Goldstein & D. A. DellaSala (Eds.), *Encyclopedia of the World's biomes* (2020th ed., pp. 201–212). Elsevier.
- Nkomo, S., & Buchanan-Clarke, S. (2020). *Violent extremism in Africa: Popular assessments from the 'Eastern Corridor'*. *Afrobarometer policy paper*. https://www.afrobarometer.org/wp-content/uploads/migrated/files/publications/Documents%20de%20politiques/ab_r7_policypaper65_violent_extremism_in_the_east_africa_corridor.pdf, 65
- NOAA. (2024). *Global land and Africa temperature anomalies, 1910–2024*. National Oceanic and Atmospheric Administration. Retrieved December 1, 2024, from <https://www.noaa.gov/>

- Okpara, U. T., Stringer, L. C., Dougill, A. J., & Bila, M. D. (2015). Conflicts about water in Lake Chad: Are environmental, vulnerability and security issues linked? *Progress in Development Studies*, 15(4), 308–325. <https://doi.org/10.1177/1464993415592738>
- Olanrewaju, F. O., Joshua, S., & Olanrewaju, A. (2020). Natural resources, conflict and security challenges in Africa. *India Quarterly: A Journal of International Affairs*, 76(4), 552–568. <https://doi.org/10.1177/0974928420961742>
- Onapa, S. A. (2019). South Sudan power-sharing agreement R-ARCSS: The same thing expecting different results. *African Security Review*, 28(2), 75–94. <https://doi.org/10.1080/10246029.2019.1680402>
- Pham-Duc, B., Sylvestre, F., Papa, F., Frappart, F., Bouchez, C., & Crétaux, J.-F. (2020). The Lake Chad hydrology under current climate change. *Scientific Reports*, 10(1), 1–10. <https://doi.org/10.1038/s41598-020-62417-w>
- Piguet, E., Pécoud, A., & de Guchteneire, P. (2011). Migration and climate change: an overview. *Refugee Survey Quarterly*, 30(3), 1–23. <https://doi.org/10.1093/rsq/hdr006>
- Pinaud, C. (2021). *War and genocide in South Sudan*. Cornell University Press.
- Raleigh, C., & Urdal, H. (2007). Climate change, environmental degradation and armed conflict. *Political Geography*, 26(6), 674–694. <https://doi.org/10.1016/j.polgeo.2007.06.005>
- Ramdeen, M. (2017). Countering terrorism and violent extremism in Africa. *Conflict Trends*, 2017(2), 49–56.
- Roettinger, J. (2019). *A critical assessment of the link between climate change and violent conflict in the context of sub-saharan Africa: The case of Darfur*. University of Cape Town.
- Sakr, S. (2023). *Climate change and Darfur: A holistic security approach* (capstone project). American University in Cairo. <https://fount.aucegypt.edu/capstone/174>
- Sambo, U., & Sule, B. (2024). Climate change, depletion of Lake Chad, and its impacts on agricultural output, food security, and social order in the Sahel. In R. Baikady, S. M. Sajid, V. Nadesan, J. Przeperski, M. R. Islam, & J. Gao (Eds.), *The Palgrave handbook of global social change* (pp. 1–23). Springer International Publishing. https://doi.org/10.1007/978-3-030-87624-1_11-1
- Schillinger, J., Özerol, G., Güven-Griemert, Ş., & Heldeweg, M. (2020). Water in war: Understanding the impacts of armed conflict on water resources and their management. *Wiley Interdisciplinary Reviews: Water*, 7(6), e1480. <https://doi.org/10.1002/wat2.1480>
- Searchinger, T., Waite, R., Hanson, C., Ranganathan, J., & Matthews, E. (2019). *Creating a sustainable food future: A menu of solutions to feed nearly 10 billion people by 2050*. (978–1–56973–963–1). <https://www.wri.org/research/creating-sustainable-food-future>
- Skah, M., & Lyammouri, R. (2020). *The climate change-security nexus: Case study of the Lake Chad Basin*. Policy center for the new south. Retrieved September 20, 2024, from <https://www.policycenter.ma>
- Songwe, V., & Signé, L. (2024). Africa growth initiative. *Foresight Africa Podcast*. <https://www.brookings.edu>
- Tesfaye, B. (2022). Climate Change and Conflict in the Sahel. *Discussion Paper Series on Managing Global Disorder No. 11* November 2022. Council on Foreign Relations: Centre for Preventive Action. https://cdn.cfr.org/sites/default/files/report_pdf/Climate%20Change%20and%20Conflict%20in%20the%20Sahel.pdf
- Tiitmamer, N., Mayai, A. T., & Mai, N. H. (2022). *Climate change and conflicts in South Sudan*. JSTOR. <https://www.jstor.org/stable/pdf/resrep20118.pdf>
- UNDP. (2024). *Climate resilience can Be a catalyst for Peace and prosperity in the Sahel*. United nations development programme (UNDP) climate promise. Retrieved September 7, 2024, from <https://climatepromise.undp.org/news-and-stories/climate-resilience-can-be-catalyst-peace-and-prosperity-sahel>
- UNEP. (2007). *Sudan post-conflict environmental assessment*. UN Environment Programme (UNEP). Retrieved September 8, 2024, from <https://www.unep.org/sudan/sudan-post-conflict-environmental-assessment>
- UNEP. (2019a). *Global environment outlook 6*. Retrieved September 9, 2024, from <https://www.unep.org/resources/global-environment-outlook-6>

- UNEP. (2019b). *Global environment outlook 6: Healthy planet, healthy People*. United Nations Environment Programme. Retrieved November 29, 2024, from <https://www.unep.org/resources/global-environment-outlook-6>
- UNHCR. (2023). *Refugee data and global trends report*. United Nations High Commissioner for Refugees. Retrieved December 2, 2024, from <https://www.unhcr.org/>
- UNISS. (2023). *Geography of the Sahel. United nations integrated strategy for the Sahel*. Retrieved November 28, 2024, from <https://uniss-sahel.org/geography/>
- United Nations. (2021a). *Climate change 'aggravating factor for terrorism': UN chief*. Retrieved September 22, 2024, from <https://news.un.org/en/story/2021/12/1107592>
- United Nations. (2021b). *People, countries impacted by climate change also vulnerable to terrorist recruitment, violence, speakers tell security council in open debate*. Retrieved September 22, 2024, from <https://press.un.org/en/2021/sc14728.doc.htm>
- United Nations Climate Change. (2020). *Climate change is an increasing threat to Africa*. Retrieved September 21, 2024, from <https://unfccc.int/news/climate-change-is-an-increasing-threat-to-africa>
- UN News. (2023). *Explainer: How Darfur became a 'humanitarian calamity and catastrophic human rights crisis'*. United Nations. Retrieved November 29, 2024, from <https://news.un.org/en/story/2023/12/1144787>
- Usigbe, L. (2019). *Silencing the guns: Drying Lake Chad Basin gives rise to crisis - food insecurity, conflicts, terrorism, displacement and climate change effects compound challenges*. Retrieved October 6, 2024, from <https://www.un.org/africarenewal/magazine/december-2019-march-2020/drying-lake-chad-basin-gives-rise-crisis>
- Vivekananda, J., Wall, M., Sylvestre, F., Nagarajan, C., & Brown, O. (2019a). *Shoring up stability: Addressing climate and fragility risks in the Lake Chad Region*. Berlin: adelphi. Retrieved September 19, 2024, from <https://shoring-up-stability.org/wp-content/uploads/2019/06/Shoring-up-Stability.pdf>
- Vivekananda, J., Wall, M., Sylvestre, F., Nagarajan, C., & Brown, O. (2019b). *Shoring up stability: Addressing climate and fragility risks in the Lake Chad Region*. Berlin: adelphi. <https://shoring-up-stability.org/wp-content/uploads/2019/06/Shoring-up-Stability.pdf>
- Von Uexkull, N., & Buhaug, H. (2021). *Security implications of climate change: A decade of scientific progress* (Vol. 58). SAGE Publications Sage UK.
- Von Uexkull, N., Croicu, M., Fjelde, H., & Buhaug, H. (2016). Civil conflict sensitivity to growing-season drought. *Proceedings of the National Academy of Sciences*, 113(44), 12391–12396. <https://doi.org/10.1073/pnas.1607542113>
- WMO. (2021). *State of the global climate 2020*. Retrieved September 10, 2024, from <https://wmo.int/publication-series/state-of-global-climate-2020>
- WMO. (2023). *2023 shatters climate records, with Major impacts*. <https://wmo.int/news/media-centre/2023-shatters-climate-records-major-impacts>
- World Bank. (2021). *Climate adaptation and economic transformation in Sub-Saharan Africa*. Retrieved December 2, 2024, from <https://openknowledge.worldbank.org/server/api/core/bitstreams/34f98cfe-b27b-58ad-a0cb-99568577e730/content>