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XCEPT brings together world-leading experts and local researchers to examine conflict-affected borderlands, how conflicts connect across borders, and the drivers of violent and peaceful behaviour, to inform policies and programmes that support peace. For more information, visit www.xcept-research.org or contact us at info@xcept-research.org. The views and opinions expressed in this document are those of the authors and do not necessarily represent those of the UK government.

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Executive summary

This report illuminates the environmental dimensions of conflict in the Lake Chad region by examining how insecurity impacts the environment and how conflict dynamics are shaped by environmental factors. It is a contribution to the Climate, Peace and Security-Lake Chad Project (CPS-Lake Chad Project), a partnership led by the Norwegian Institute of International Affairs (NUPI) to study the effectiveness of the Regional Strategy for the Stabilisation Resilience and Recovery (RS-SRR). The report primarily draws from published literature, complemented by field reports of project partners who visited the Lake Chad region in late 2025 and early 2026, and by remotely conducted interviews with regional experts.

Lake Chad lies in the central Sahel, intersected by the borders of Chad, Cameroon, Niger, and Nigeria. It is an endorheic lake at the lowest point of a landlocked hydrographic catchment area that drains almost 8% of the African continent. It is a vital and life-sustaining ecosystem and water reservoir for tens of millions of people in a region characterised by water scarcity, in a climatic transition zone from the arid climate of the Sahara to semiarid and dry subhumid savannah.

The study area encompasses the lake itself as well as the surrounding region. Its arid northernmost parts receive 100mm or less of rainfall per year, while the southernmost parts on average receive around 1 000mm. Rains are highly seasonal, and patterns vary interannually, with periods of drought that can last for several years. Vegetation ranges from sparse desert to tropical woodland savannah, with rivers and wetlands around Lake Chad that support rich biodiversity. This includes a rich avian fauna and large mammals such as elephants, giraffes, antelopes and more. Lake Chad is a designated wetland of international importance (Ramsar Site).

The Sahel is one of the regions of the planet most vulnerable to climate change, facing increased unpredictability and bigger extremes of high and low rainfall. Extended droughts in the late 20th century reduced water flows into Lake Chad so severely that its surface area shrank by more than 90%. This century, the remaining pool of water has stabilised, but the current body of water is still less than a tenth of the size of the lake that existed in 1960. The former lake area is now a rich mosaic of wetlands, islands, vegetated areas, and seasonally flooded pools and oxbow lakes where water levels fluctuate by up to two metres between the wet and dry seasons. The wetland vegetation creates a rich habitat for hundreds of thousands of waterbirds, and the lake supports fisheries as well as flood-recession crop cultivation and cattle grazing.

Insurgent-led conflict and insecurity in the region is characterised by a pattern of temporally and geographically scattered localised violence against local populations, between insurgent groups, and between insurgents and counter-terrorism forces. There have been repeated localised bombings, use of landmines, armed attacks, and targeted destruction and burnings of buildings in villages and settlements.

Natural areas with dense vegetation cover and difficult-to-access terrain, such as the lake wetlands and woodlands in the region have become operational strongholds for insurgent groups, with the natural vegetation and terrain providing cover from counter-insurgency forces. Within these areas,

violent incidents and combat operations have caused local impacts on the environment, including through use of munitions, setting of fires, and the clearance of vegetation.

Furthermore, conflict in the region is interlinked with the natural resource economy. Insurgents are sustained in part by food and shelter derived from natural resources, and by financing extracted through extortion of fishermen, transhumant pastoralists, and crop farmers. Insurgent groups control access to pastures, areas suitable for crop cultivation, and fishing areas, and demand fees in return for access. They control trade networks and apply taxes in return for market access. There has been an ongoing process whereby insurgents have diversified income streams by gaining control of an increasing range of natural resources, infiltrating and extorting legitimate natural resource use, and connecting with transnational organised crime networks involved in criminal wildlife trade and illegal mining.

Threats of violence associated with extortion of pastoralists, farmers, and fishermen drive displacement, causing pressures on the environment in locations people are displaced to. These threats are also disrupting traditional resource management practices and causing conflicts between farmers and pastoralists seeking to use the same areas for grazing and crop cultivation. Climate change amplifies these conflicts by increasing unpredictability of rainfall patterns and exacerbating temporary water scarcity, with resulting pressures on remaining areas of pasture and crop land.

As such, the environmental dimensions of conflict in and around Lake Chad cannot be meaningfully analysed in isolation from social, economic, political, and cultural dimensions. Conflict in this region is playing out within a broader socio-ecological system in which the environment, climate change, natural resource economy and livelihoods, governance structures, demographic pressures, and insecurity interact in complex ways. This report, along with other outputs from the CPS-Lake Chad Project, is a contribution to an emerging systems level understanding of conflict and insecurity in the Lake Chad region. This understanding can be further consolidated in the future through multidisciplinary and participative approaches that will also be well placed to co-create effective strategies for building sustainable peace and security in the region.

1. Introduction

1.1.1 Purpose and background

This report aims to illuminate the environmental dimensions of conflict in the Lake Chad region by examining how instability and insecurity impact on the natural environment, and how conflict dynamics are shaped by environmental factors and natural resources. Thus, the research carried out for this report centred on two core aspects:

- a) how instability and insecurity impact the natural environment in the region; and
- b) how the environment, with its natural variability and anthropogenically driven changes, impacts conflict and insecurity.

The report is a contribution to the Climate, Peace and Security-Lake Chad Project (CPS-Lake Chad Project), a partnership project led by the Norwegian Institute of International Affairs (NUPI). The project is studying the effectiveness of the Regional Strategy for the Stabilisation Resilience and Recovery (RS-SRR) in the Lake Chad Basin region for preventing and managing climate-related peace and security risks. The project is exploring the interconnections between natural resource economies, climate risks, ecological change and insecurity, to support policy makers and researchers in identifying strategies and interventions for stabilisation, recovery, and building resilience in the region. This report complements other project publications (e.g. de Coning et al, 2026 a,b; Iversen et al, 2026).

1.1.2 Regional context

Lake Chad intersects the borders of Chad, Cameroon, Niger, and Nigeria. The lake, which declined significantly in size in the second half of the 20th Century (see part 2.5), is a vital and life-sustaining ecosystem and water reservoir for 40 million people in a region affected by a combination of climate change, population growth, poor management of natural resources, and security risks (de Coning et al, 2026 b).

The major security risks in the Lake Chad basin include ethnoreligious grievances, intercommunal clashes, conflicts between farmers and pastoralists, and insurgent-led violence by extremist groups such as Boko Haram and its offshoot, the Islamic State in the West Africa Province (ISWAP), which operates throughout the region (Aina & Ojo, 2025).

In response to conflict in the Lake Chad region, the countries affected by the instability and several regional and international partners, with the support of the African Union (AU), developed a Regional Strategy for the Stabilisation Resilience and Recovery (RS-SRR). The strategy was in effect from 2019 to 2024, and during 2025 the strategy was evaluated and adapted. A new version will be implemented from 2026 to 2030 (Veloz et al, forthcoming a; de Coning et al, 2026 b).

1.1.3 Study area

Geographically, the central focus of this report is the immediate area of Lake Chad (i.e. the area that was a continuous body of water until 1960, before the lake underwent a rapid decline in size - see part 2.5), and the surrounding wetlands fed by its tributary rivers. This area is prioritized because it is central to the conflict-environment-human nexus, and unless otherwise indicated, this area is what is meant by “the lake area” or “Lake Chad” in this report

However, to properly illuminate the environmental dimensions of the conflict, the environment of a broader region around the lake is also relevant, as the strongholds of insurgents and counter-insurgency efforts have moved through this wider region. Whenever the report refers to “the Lake Chad area”, “the Lake Chad region” or “the study area”, this is what is meant. We have not defined a hard geographic boundary for this broader area of interest but have instead been guided by several factors when deciding what areas to refer to in different parts of the document.

One key factor is environmental boundaries. Lake Chad lies in the Sahel region, a climatic transition zone where the southern edge of the Sahara transitions into tropical Savannah, as described in parts 2.1 and 2.2. Furthermore, the lake is located at the lowest point of the Lake Chad basin, a landlocked hydrographic catchment area that drains almost 8% of the African continent, intersecting seven countries and multiple climate zones. Where relevant, this report includes references to the wider Lake Chad basin, its river systems, and its subterranean aquifers that connect with the lake. However, the extent of this catchment area greatly exceeds the area of interest for the project that this report contributes to, so the report does not provide a comprehensive description of the environment for the whole basin.

Another factor is that the lake has, historically, been a hub for a socio-ecological system where traditional forms of natural resource use developed. This is referred to in part 2.6 as important context for understanding how natural resource use is interwoven with the conflict today. Attempting to define geographical boundaries for this socio-ecological system at different times in history would far exceed the scope of work.

Present-day administrative boundaries are of high practical relevance for this document and the CPS-Lake Chad Project. While administrative boundaries do not align with ecosystem or socio-ecological system boundaries in this region, they do shape governance, environmental management, and information gathering. Lake Chad is intersected by four countries (Cameroon, Chad, Nigeria, and Niger). Each of these countries is subdivided into administrative states, regions or provinces, the ones of relevance to the project being those around Lake Chad, shown in Figure 1:

- The region of Diffa in Niger, which intersects with the north-western part of the lake area. The administrative region extends far north towards the Sahara Desert.
- The provinces of Lac (which includes the eastern portion of the lake) and Hadjer-Lamis (which intersects the far south-eastern corner of the lake, and extends far west), in Chad.
- In Cameroon, the Far North region intersects the southern part of the lake. The North region is located immediately to the south and includes parts of the wetlands of the lake’s main tributary river. The southern parts of the Far North region intersect mountainous areas that, while not central to the geography of the conflict itself, are of significance for rainfall patterns and the seasonal patterns of water flow towards the north.
- In Nigeria, Borno state (which includes the south-western portion of the lake) contains several areas that have been strongholds for insurgents at different times, including the city

of Maiduguri, and the Sambisa forest. Yobe state to the west is also relevant and intersects wetlands that are connected to one of the lake's tributaries, and Adawama state to the south shares a border with the North region in Cameroon, sharing some of the mountain ranges that, while not central to the conflict, impact on water availability within the conflict areas.

The environmental baseline (part 2), apart from placing the lake in the context of its climate zone and hydrographic basin, also broadly describes the environment in the combined region of these administrative areas. In part 3, this document describes key natural resource-based activities that are intertwined with the conflict and that take place within this wider region.



Figure 1: Map centred on the study area, showing national borders, boundaries of administrative regions, as well as main cities, and rivers flowing into Lake Chad. Before 1960, there was a continuous body of water that extended as far north-west as the city of N'Guigmi in Niger, and as far east as the city of Bol in Lac Province, Chad. The main body of water in the lake area today lies on the border of Chad and Cameroon. The map also shows the location of the Sambisa Forest in Borno State, Nigeria, a stronghold for insurgent groups at the time of writing.

1.1.4 Methods and approach

This report is primarily based on a desk study, drawing from peer reviewed literature and accessible grey literature in English language. The published literature sources were complemented by field reports shared by project partners following their extensive fieldwork at policy and local community levels between August 2025 and January 2026. These field reports gave us access to a body of evidence based on surveys with stakeholders in the Lake Chad region. Although not primarily focused on the environment, this body of evidence provided valuable insights into the nature and dynamics of the conflict and its connections with climate and the environment.

Furthermore, the data was validated and complemented by consulting two regional experts. The interviews included specific questions about the environmental dimensions of the conflict and illuminated the interconnections between the environment and other dimensions of instability, insecurity, and responses to it. These expert interviews are referenced in the text of this document, where relevant.

For the environmental baseline description (part 2), we also carried out satellite image analysis to update an earlier version of a time series of maps showing the changes in the size of Lake Chad (Figure 3).

For the analytical approach and structure of this document, we drew from the experience of previous conflict-related environmental impact assessments developed by GRID-Arendal for the conflicts in Ukraine and Gaza (UNEP, 2022; UNEP, 2024). These impact assessments included an environmental baseline (i.e. a description of the natural characteristics of the study area), as well as an assessment of short and long-term environmental impacts of combat operations and of human displacement in response to conflict. Like the assessments for Ukraine and Gaza, this report includes an environmental baseline (part 2), and a description of the environmental impacts arising directly from combat operations (part 3.1).

It rapidly became clear that conflict and insecurity in the Lake Chad region, while less immediately devastating to the environment and built infrastructure than recent intensive combat operations in Ukraine and Gaza, are deeply intertwined with the environment and natural resources, and that the environmental dimensions of conflict in and around Lake Chad cannot be meaningfully analysed in isolation from its social, economic, political, and cultural dimensions. Conflict in this region is playing out within a broader socio-ecological system in which the environment, climate change, natural resource economy and livelihoods, governance structures, demographic pressures, and insecurity interact in complex ways.

To account for this, we have complemented the environmental impact assessment (which follows a linear, systematic logic) with a more systemic approach, using “conflict-environment-human nexus” as an overarching framing. By placing the environment in the centre of the frame, we have aimed to illuminate how the environment connects with conflict and other human elements of the socio-ecological system within which the conflict is playing out.

The main lens applied in part 3 of this document is that of the natural resource economy and its ties with the conflict, including the dependency of insurgents on environmental resources as a key source of finance (part 3.2). The insurgency is sustained in part by its enmeshment in day-to-day activities of community members working as farmers, fishers, and pastoralists – activities that are central to

community life and survival (part 3.3). The cross-cutting themes of displacement and climate change are explored in parts 3.4 and 3.5, respectively, while part 3.6 ties the environment back to broader systemic issues.

1.1.5 Constraints

While this report aims to place linkages between the natural environment and conflict within a broader systems context, it centres on the environmental dimension. Many highly significant human elements of the regional socio-ecological system (cultural, ethnic, religious, historical, political etc.) fall beyond its scope, i.e. the light this report sheds on the system does not extend far enough to bring them into view.

The desk research was constrained by information availability in the published literature, and field research by logistical challenges and resource limitations. We found that reports and websites of international agencies who are active in the region often repeat similar narratives and figures, but we were not always able to trace the information back to primary sources. This may in part be because of the constraints we were working under (including limited time, language barriers, and lack of easy access to relevant grey literature), but in part this also reflects information gaps in the literature, including a lack of comprehensive baseline data for Lake Chad and the wider study area.

There is a lack of consistent regional data coverage and time series for biodiversity data (e.g. species and habitat distribution and trends in biodiversity), environmental monitoring (e.g. water quality indicators and data on the physical, biochemical, and biological characteristics of aquatic ecosystems), and robust fisheries data (e.g. species composition, catch volumes, and stock assessments). Comparable gaps exist in relation to agriculture and pastoralism, including up-to-date maps of areas under cultivation, crop types and yields, livestock grazing areas, and the status of grazing resources. Rather than being derived from comprehensive datasets, available information is often piecemeal, collected at different times, and confined to specific countries, provinces or individual protected areas.

With respect to the conflict and insecurity in the region, there is also limited publicly available information on the environmentally relevant specifics of combat operations, such as the types and quantities of munitions used, locations of their deployment, and the environmental footprint of military infrastructure and land clearance.

Despite these constraints, the report draws together enough information to illuminate environmental aspects of conflict in the region, highlighting the relevance of environmental factors in understanding conflict and in developing strategies and interventions to build stability.

2. Environmental baseline

2.1 Climate and topography

The area of study lies within the Sahel region, where the arid climate of the Sahara transitions to semiarid and dry subhumid regions towards the south (Sahara and Sahel Observatory, 2019).

Most of the study area has relatively flat topography. The lake itself is a shallow depression, with the lowest part situated at around 280m above sea level. It is surrounded by plains that slope gently upwards to between 300-400m above sea level. The closest mountain range to the lake, the Mandara mountains, lie about 250km to the south of the lake, on the border between Nigeria and Cameroon, reaching altitudes of around 15 00m. The southernmost part of Cameroon's North Region intersects with the northern edges of the Cameroonian Highlands, a chain of extinct volcanoes reaching heights of 2 000m and above (Martin & Burgess, 2020).

Soils in the study area are characterized by a diverse mix of sand, lacustrine clay and loam. Sandy soils in the arid north gradually transition to fertile clay in the central part and the south (Lu et al, 2025).

Most of the study area is currently classed as Dry Semi-arid Hot Steppe (BSh) in the Köppen-Geiger climate classification system, with Hot Arid desert (BWh) in the northernmost part, and Dry Summer Savanna (Aw) in the south (Beck et al, 2018; Beck et al, 2023). The arid northernmost parts receive 100mm or less of rainfall per year, while the southernmost parts on average receive around 1 000mm (Siebert, 2014), with some variation due to the topography of the Mandara mountains. The following are some annual rainfall averages for different cities in and near the study area, listed from north to south (Climate Data, n.d.¹):

- Agadem (desert oasis in the Diffa region of Niger, approximately 270km to the north of Lake Chad) – 21mm
- N'Guigmi (on the northern shoreline of the former lake area) – 153mm
- Diffa (capital of the Diffa region of Niger) – 236mm
- N' Djamena (capital of Chad) – 450mm
- Maiduguri (capital of Borno state, Nigeria) – 466mm
- Gwoza (Borno state of Nigeria, on the western side of the Mandara mountains) – 849mm
- Maroua (capital of the Far North region of Cameroon) – 581mm
- Garoua (capital of the North region of Cameroon) – 664mm
- Yola (capital of Adawama state, Nigeria) – 624mm
- Ganye (in the south Adawama state, Nigeria, approximately 500km to the south of Lake Chad) – 989mm

Rainfall is concentrated in a wet season from May to October (most of the precipitation falling in July and August). Typically, no rain falls at all in any part of the area of study during the dry season from

¹ Climate Data <https://en.climate-data.org/africa/> This is a website that allows users to search for basic climate data for towns and cities around the world, including average temperature and rainfall ranges per year and month. The website uses meteorological data from the European Centre for Medium-Range Weather Forecasts (ECMWF).

November to April. Oscillations in the Intertropical Convergence Zone can cause significant fluctuations in the amount of rainfall between years (Martin & Burgess, 2020), which means that periods of drought as well as flooding events are a relatively common occurrence.

Mean annual temperatures range from about 23°C to about 28°C in the study area. Average monthly temperatures reach their annual peak in April, May or June, just before the rainiest part of the wet season, and their lowest in January, except in the southern part of the study area where lowest monthly temperatures occur at the peak of the wet season in August. The annual temperature variations are bigger in the more arid parts of the study area. The different temperature regimes across the study area are illustrated with three example cities, listed from north to south (Climate Data n.d.):

- In N’Guigmi, monthly mean temperatures reach their hottest in May and June at 33°C (with average day time maximums of over 40°C), and their lowest at 20°C in January (with an average nighttime minimum of 13°C).
- In Maiduguri, monthly mean temperatures reach their hottest at 30°C in June (with average day time maximums of 38°C), and their lowest at 23°C in January (with an average nighttime minimum of 16°C).
- In Garoua, monthly mean temperatures reach their hottest in April at 33°C with average day time maximums of 40°C and their lowest in August at 26°C (with an average nighttime minimum of 23°C).

2.2 Vegetation and land cover

Figure 2 shows a standard classification of land cover and vegetation types across the area of study. There is a natural vegetation gradient running north-south, from almost bare desert to areas with sparse shrubs and herbaceous cover, deciduous shrublands, evergreen shrublands, mosaics of shrubs and herbaceous vegetation with trees, to areas of tropical savannah with broadleaved tree cover.

This natural vegetation gradient is interrupted by the large expanses of the study area that are under agricultural cultivation, most of which are rainfed croplands cultivated seasonally. Natural features also impact on the type of land cover, most notably Lake Chad and its rivers, and the Mandara mountains on the border between Borno state in Nigeria and the Far North region of Cameroon. These are visible in Figure 2 as a patch of natural shrublands and tree cover south of N’Djamena.

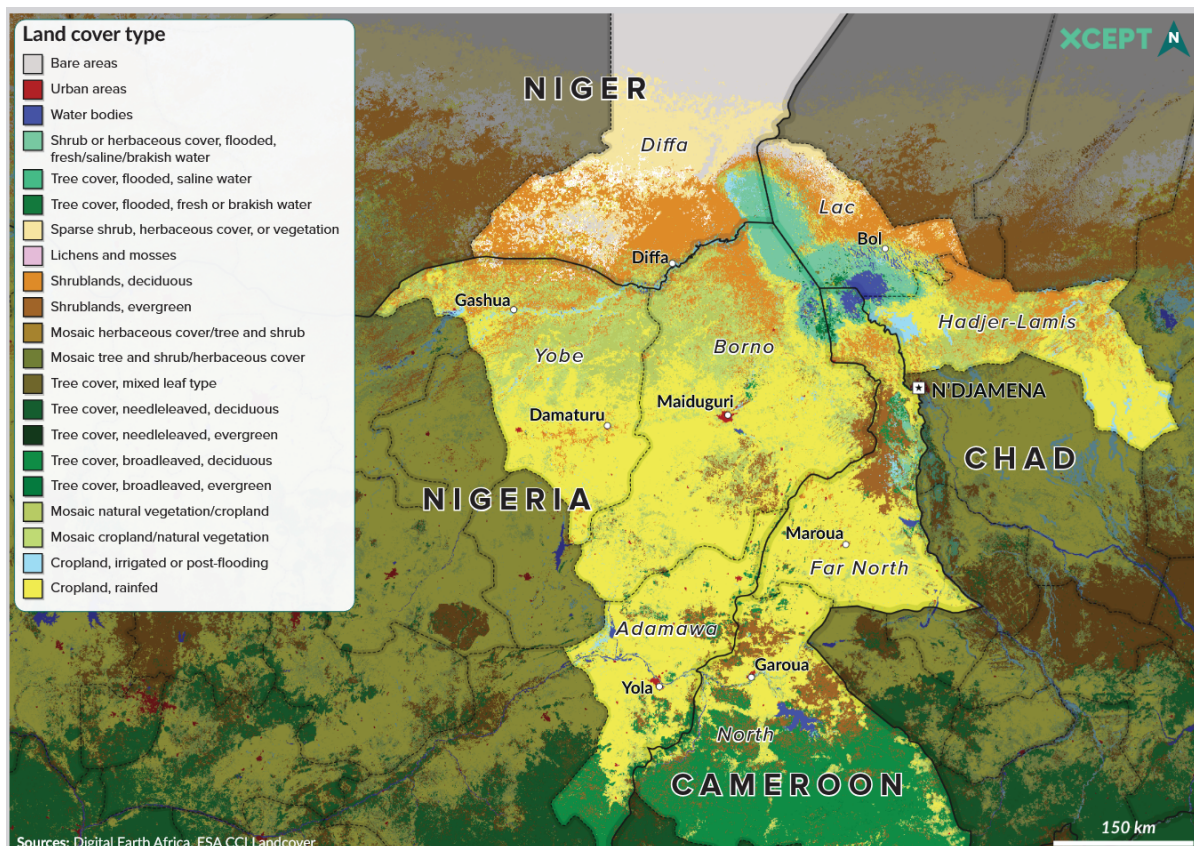


Figure 2: Main land cover (vegetation types) in the Lake Chad region, represented using a satellite-derived vegetation classification developed by ESA.

Approximately 60km to the south of Maiduguri, in Borno state, lies the Sambisa Forest. It appears in the land cover map in Figure 2 as an area with patches categorised as evergreen shrubland (marked in brown), cropland/natural vegetation mosaics (light green), and rainfed cropland (yellow). The Sambisa Forest is an important ecosystem which, in 2020, covered about 474km (Ukah et al, 2025 a). The natural vegetation consists of shrubby woodland with short trees and bushes up to a metre in height, which in many areas is thorny and dense, and therefore difficult to penetrate. Other parts of the Sambisa Forest have more open shrubland (Ukah et al, 2025 a). The most common trees and bushes in the forest are acacia, date palm, terminalia, tallow, red bushwillow, rubber, tamarind, wild black plum, jackalberry, monkey bread, birch, mesquite, baobab, shea tree, rubber vine, and whitehorn (Birdlife International, 2015).

The vegetation in the Sambisa Forest is sustained by seasonal water flows from the Mandara mountains to the east, which also create patches of marshland and surface water including lakes, ponds and streams (Ukah et al, 2025 a). It also includes built-up areas, with small towns, villages, and settlements located especially along the Gwoza – Damboa road that runs east-west through the area of the forest.

2.3 Environmentally significant areas

The World Database on Protected Areas includes several internationally and nationally designated conservation sites in the study area (UNEP-WCMC & IUCN, 2026). Most notably, Lake Chad is a Wetland of International Importance (Ramsar Site). Because the lake area is divided by national borders, portions of the lake and surrounding wetlands in each country have been designated separately, creating a mosaic of four contiguous large protected areas:

- The Lake Chad Wetlands Ramsar Site in Nigeria (6 073km²)
- The Lac Tchad Ramsar Site in Niger (3 385km²)
- The Partie tchadienne du lac Tchad Ramsar Site in Chad (16 481km²)
- The Lac Tchad Ramsar Site in Cameroon (2 151km²), also a designated Wildlife Sanctuary under national protection.

Immediately to the south, the Waza Logone Floodplain in Cameroon is also a designated Ramsar Site, protecting another 7 737km². Established in 2012, it partially overlaps with the Parc National de Waza, a UNESCO Biosphere reserve that was designated in 1979, and fully overlaps with the small Kalamaloué national park on the Cameroon side of the Chari River, designated in 1968. The rich biota of the lake and the surrounding wetlands are described in part 2.5.

There is one other small national park in the Far North region of Cameroon, near the border with Nigeria, close to the Mandara mountain range. This is the Mozogo-Gokoro national park, known for its savannah landscapes and wildlife, including elephants and numerous bird species (Awazi, 2025). The site was first designated in 1932, covering just 14km² (Sani et al, 2021).

In the North region of Cameroon, there is a complex of three national parks (Faro, Bénoué, and Bouba Ndiya). Bénoué is also a UNESCO Biosphere Reserve. Together with the Mandara mountains, this portion of the study area has richly varied topography, with high mountain peaks that, while they lie beyond the central areas of conflict in the region, play a key role in capturing seasonal rainfalls and regulating water flows into the rivers and aquifers connected with Lake Chad.

The vegetation of Bénoué National Park includes several types of Sudanian woodland, dry forest, and riparian forest along the seasonal Bénoué River. It is considered a Key Biodiversity Area for its high biodiversity and importance for birds (over 300 bird species have been recorded), and it is home to forest elephants as well as eland and cheetah (KBA, 2026). Faro National Park is similarly considered a Key Biodiversity Area. It encompasses an area of Sudanian savanna with rocky massifs that reach 1 000m, and may be home to around 300 bird species as well as eland and forest elephants (KBA, 2026).

These southernmost parts of the study area overlap with the northernmost reaches of the Cameroonian Highlands ecoregion, a richly biodiverse region with high levels of endemism and great conservation significance, being home to the highly endangered lowland gorilla (One Earth, 2025).

Borno and Adawama states in Nigeria contain a very large number of nationally protected areas, including national parks and forest reserves. Many of these are small, and they are scattered throughout the Nigerian part of the area of study. The Sambisa Forest is of particular note, with several forest reserves and a game reserve having been designated in this area. The Sambisa Game Reserve is highlighted as a Key Biodiversity Area, with over 60 bird species recorded, as well as different antelope.

2.4 Climate change

The Sahel region is widely considered one of the regions of the planet most at risk from desertification (OSS, 2019). The United Nations Convention to Combat Desertification defines desertification as “land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities” (UNCCD, 2022), where “land degradation” encompasses soil erosion, deterioration of the soil, loss of biological and economic productivity, and long-term loss of natural vegetation.

The narrative of climate-change driven desertification in the Sahel is a common framing for development projects in the region, aligning with the narrative about the “disappearing” Lake Chad (part 2.5). However, the reality of climate change in the region is more complex. Ecosystems and human populations in the Sahel face increasing climate instability, with increased risks of extreme weather events (including extreme seasonal rainfall) and less overall predictability of seasonal weather patterns.

For example, Gangneron et al (2022) point out that climate data from recent decades does not show a continuous or steady downward trend in the overall amount of rainfall. Reviewing studies on rainfall from the last 70 years, they highlight that the Sahel experienced a comparatively wet period between the 1940s and late 1960s, followed by a period of severe and extended droughts in the 1970s and 1980s, and a recovery of rainfalls since the 1990s, albeit not to the levels of the previous wet decades. They also cite environmental studies showing that natural ecosystems in the Sahel are drought-resilient, and that there has been vegetation recovery and “re-greening” in many parts of the Sahel since the 1990s.

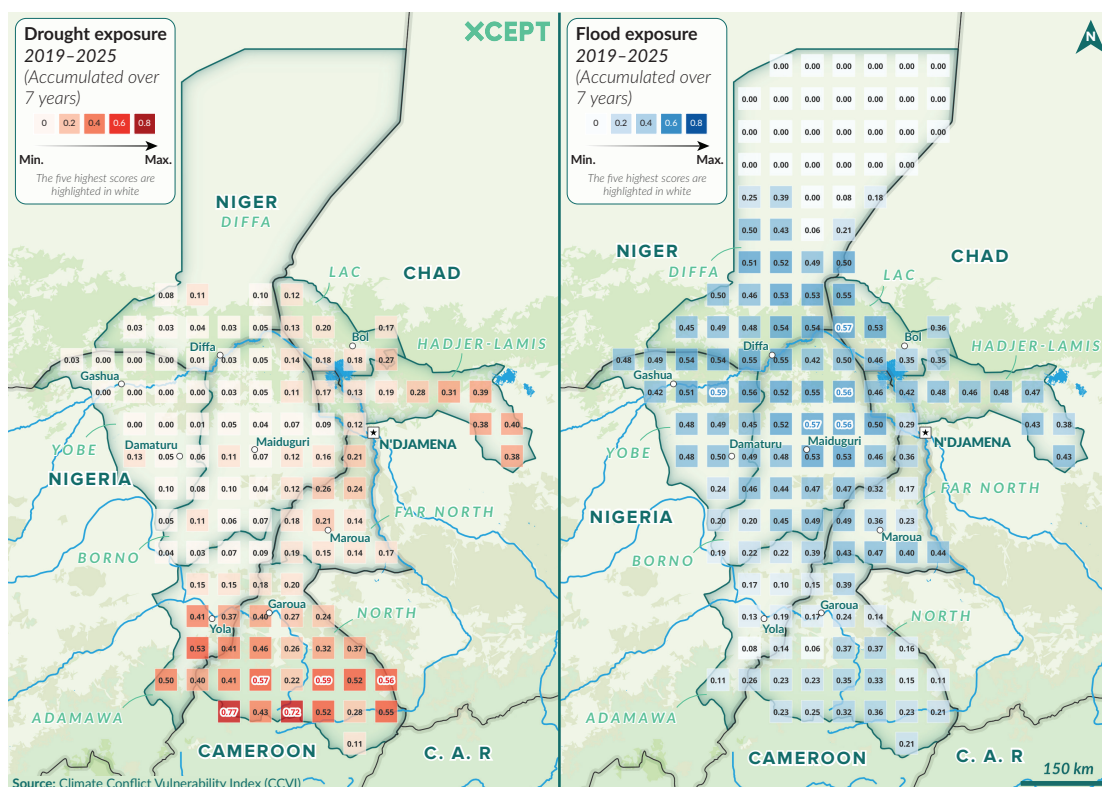


Figure 3: Drought and flood risk exposure in the study area.

The way climate change is impacting the wider region, thus, is more complex than a steady and ongoing process of desertification with loss of vegetation, soil degradation, and productivity. Climate trends instead point to the following:

- A significant average temperature increase (of around 1°C) since the 1960s, with climate models predicting a severe temperature increase (of 5°C or more, depending on emissions scenarios) by the end of this century (Gangneron et al, 2022).
- An increase in inter-annual variability in rainfall (more short-term fluctuations between wet and dry years) (Gangneron et al, 2022).
- An increase in frequency and severity of extreme rainfall events, contributing to an increase in damaging floods, with recent devastating floods occurring in the Lake Chad basin in 2020, 2022, and 2024 (Gangneron et al, 2022; Sylvestre et al, 2024; Lyammouri, 2024). Between 1970 – 1990, 17% of rainy season days had extreme levels of rainfall, but between 2001-2010 the proportion was 21% (Panthou et al, 2014).
- An increase in dry spells that interrupt the wet season (even in years that are wetter than average), which is damaging for herbaceous plants that grazing animals depend upon (Panthou et al, 2014; Gangneron et al, 2022).

These and other variables lead to climate hazards: people are suffering greater exposure to risks and impacts associated with natural events such as droughts, heavy precipitation, heatwaves and floods. Data from between 2019 and 2025 show that the highest drought exposure has been occurring in the southern part of the study region, and the highest flood exposure in the northern part of the study region (Figure 3).

The climate hazards and exposures accumulated over seven years between 2019 and 2025 are shown in Figure 4.

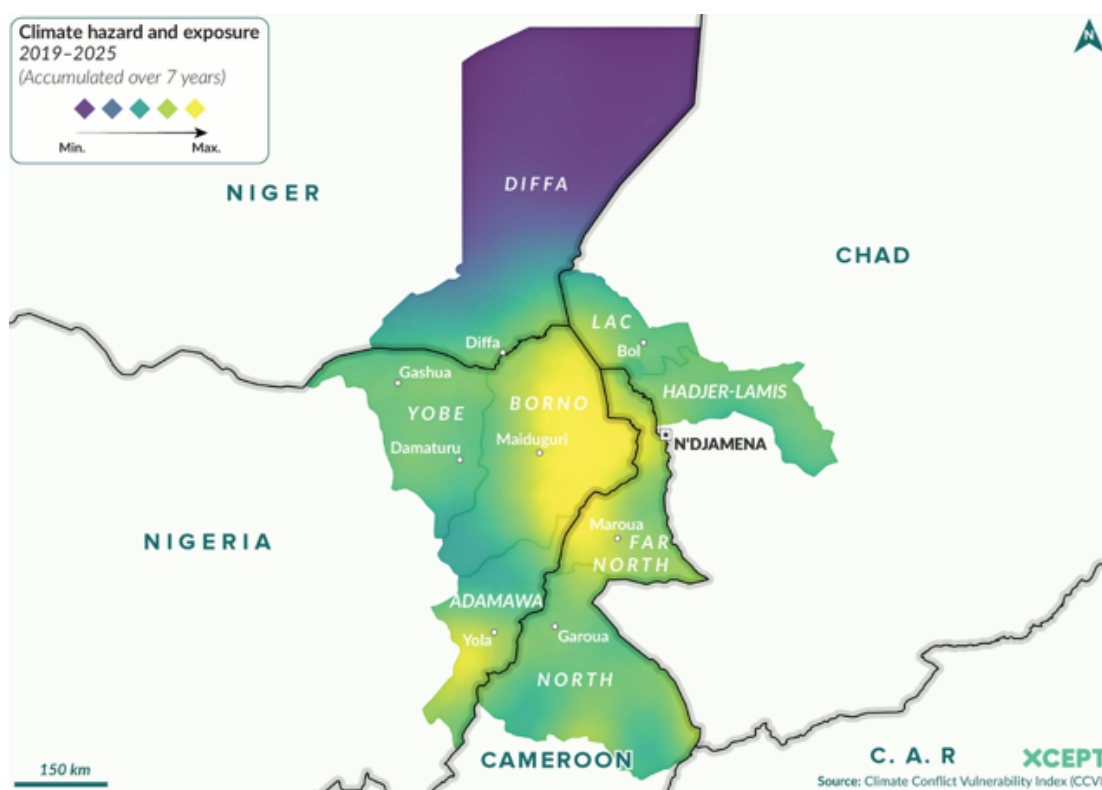


Figure 4: Climate hazards and exposure accumulated in Lake Chad region 2019-2025

Rainfall intensity is expected to increase in the future. Climate models predict an increase in average flow rates (m³/s) for rivers in the Lake Chad basin for the period from 2040 to 2060. Of particular concern is the prediction that this increase will be especially severe for peak flow values, which means that severe riverine floods like that of 2022 are likely to occur every 2 to 5 years in future (Sylvestre et al, 2024).

Overall, these trends are indicating a destabilisation of the climate, with less seasonal and interannual predictability, and an increase in the frequency of events that endanger infrastructure, pastures, crops, and human lives. The following quote bears out how humans are already experiencing the impacts of climate change in and around Lake Chad:

“... climate nowadays is indecipherable to the inhabitants of Lake Chad: it rains when it should not, temperatures soar burning your nostrils and the level of the lake is constantly changing, covering and uncovering different islands every day, flooding croplands and drying pools that become barren and unproductive due to natron, a mineral akin to salt.” (WFP, 2020).

2.5 Lake Chad

2.5.1 Lake Chad hydrology: A disappearing lake?

Lake Chad is a shallow endorheic lake, meaning it sits in a landlocked drainage basin that has no outflow to other basins or the ocean. The Lake Chad basin covers almost 8% of the African continent. The hot, arid climate means that evaporation rates are high, and the water level of the lake is impacted by temperature, precipitation in the region, and water abstraction for the purpose of irrigation (GWP, 2011).

Lake Chad's biggest tributary is the Chari/Logone river system (referred to as the Chari River in this document). The river flows into the lake from the south, with a watershed of approximately 90 000km² covering parts of Chad, Sudan, Cameroon, and Central African Republic (Mahmood et al, 2020). An estimated 80-90% of the water in the lake flows in via the Chari River, which enters the southern part of the lake at the border between Chad and Cameroon (Bader et al, 2010; Fokeng et al, 2024; Gao et al, 2011).

The second biggest tributary is the Yobe river (also known as the Komadougou-Yobe), which flows east-west and drains into the north-eastern part of Lake Chad at the border between Nigeria and Niger, and contributes an estimated 2% of the water in the lake (Fokeng et al, 2024; Gao et al, 2011). Rainfall in the direct area of the lake is estimated to contribute around 10% (Ramsar, n/d).

The lake is connected to a groundwater system (phreatic aquifer) that flows south-west. Water from the bottom of the lake seeps through the ground into this aquifer, which means that the lake recharges groundwater in the Sahel (Isiorho & When, 1996). The groundwater recharge has recently been attributed to a residual effect from lake Mega-Chad, a much larger lake (covering 2.5 million km²) that formed in the Lake Chad basin during the African Humid Period in the late Pleistocene and early Holocene epoch (Vassolo et al, 2022).

Figures 1 and 2 (parts 1.1.3 and 2.2) both show one main body of open water located at the mouth of the Chari River. The vegetation cover map in Figure 2 shows some smaller scattered areas of open water to the east of it, surrounded by a much larger area marked as a mix of flooded areas, shrubland, and tree cover. The difference in appearance of the lake's water body in these two figures

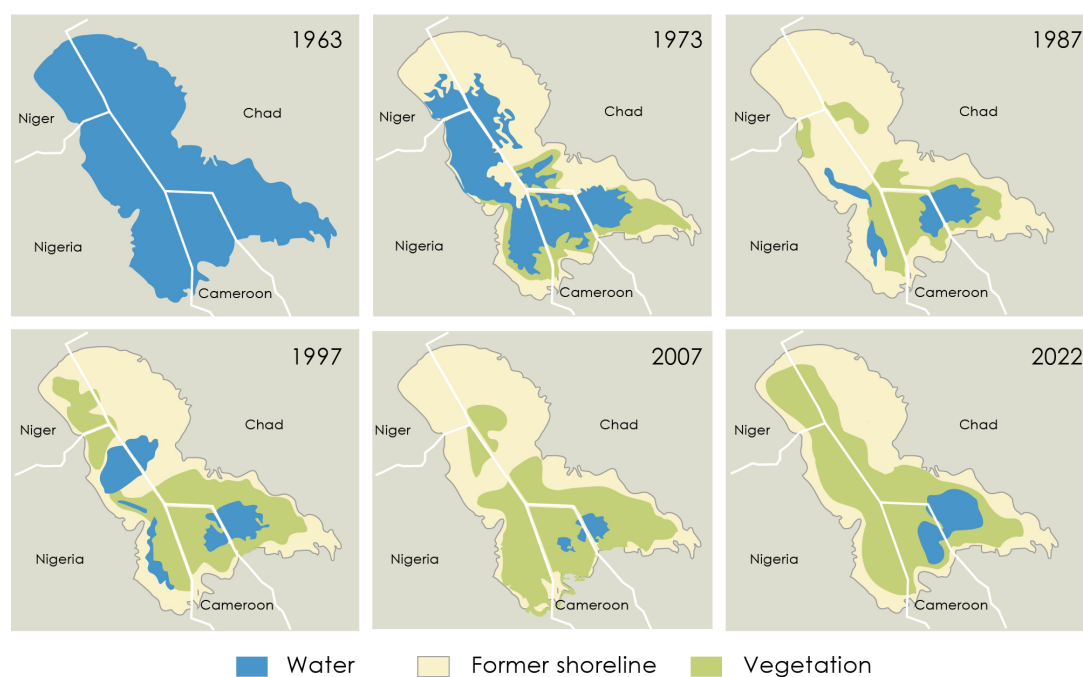
reflects the fact that the lake is a dynamic water body. It has seen dramatic changes in surface water levels both over geologic timescales and, in the last 50 years, due to changing climate, droughts, and water abstraction for irrigation.

Lake Chad is often described as a “disappearing lake” (UNEP, 2018). Figure 5 shows how the area of the lake covered by a continuous body of water diminished significantly in the decades following the 1960s, when the lake had a body of open water with a surface area of around 25 000 km² (Fokeng et al, 2024), reaching as far north as the city of N’Guigmi in Niger. In terms of its surface area, in 1960 it was ranked as the sixth biggest freshwater lake in the world (Vivekananda et al, 2019).

However, the lake basin is extremely shallow - the lake today has an average depth of less than 2m and a maximum depth of around 10m (ILECF, n/d). Furthermore, rates of evaporation are high (estimated at 2 000 to 2 300mm per year) (GWP, 2011; Martin & Burgess, 2020). As a result, periods of drought in the 1970s and 1980s (see part 2.4) and consequent reductions in river flow caused an extraordinarily rapid shrinkage in the lake’s surface water extent as the water levels dropped (Olowoyeye & Kanwar, 2023).

Figure 5 illustrates that around 1973, the water levels decreased far enough for the water body to split into a northern and southern pool, separated by a barrier that today is covered by vegetation. The average surface area of open water over the period from 2003 and 2022 has been 2,475km² (Fokeng et al, 2024), meaning the lake is now less than a tenth of its extent in the 1960s.

However, Figure 5 also illustrates that in the last 20 years, the extent of the open water body in the southern part of the lake area has been increasing again, as the overall amount of rainfall in the region has increased. While the area of continuous open water in the remaining southern pool is a fraction of the lake’s size in 1960, the “disappearance” trend has been reversed, with the recently expanded southern pool now being a stabilized feature (Gbetkom et al, 2022).



This collection of maps has been sourced from a series of satellite images provided by NASA Goddard Space Flight Center:
<http://www.gsfc.nasa.gov/gsfc/earth/viron/lakechad/chad.htm>
Initial map by Philippe Rekacewicz; updated by GRID-Arendal, 2026

Figure 5: Changes to Lake Chad water, shoreline and vegetation coverage 1963-2022

Beyond the southern pool, most of the lake area today is a rich mosaic of seasonally variable flooded areas, vegetated areas, and permanently exposed islands. Some of the vegetated areas and islands are cultivated for crops (Ramsar, n/d), many containing small villages and settlements. Water levels can rise by 1-2 metres in the wet season, with the size of the flooded patches increasing significantly, especially near the river mouths. Rather than having fully disappeared, the northern pool now forms part of this seasonally variable partially flooded mosaic landscape (Birkett, 2000). Water flow into the northern area from the Yobe river is impacted not only by rainfall patterns, but also by human activities in the Yobe catchment. Upstream dam construction, particularly the Tiga and Challawa dams, decreases water flow (Pham-Duc et al, 2020; Boso, 2025).

2.5.2 Lake Chad biota

Much of the area of the 1960s lake now has permanent vegetation cover (Pham-Duc et al, 2020). The major vegetation types of the Lake Chad Wetland include grasses, sedges, floating macrophytes, and shrubs. The Chadian portion of the Ramsar site contains a variety of wetland types, with areas of open water, islets, sandbanks, polders, and oases. In the drier parts of the landscape, high levels of evaporation lead to pools containing a concentration of the minerals present in the lake water, creating temporary and permanent "natron" pools. The northern edges of the former lake area are surrounded by cordons of sand dunes, with shifting sand dunes ("erg") in the north-east, as the driest part of the lake (Ramsar, n/d).

The wetland vegetation forms rich habitats that are of international importance for a great variety of Palearctic migrating waterbirds, including the vulnerable marbled teal, as well as the northern pintail, garganey, gull-billed tern, reed cormorant, ruff, and marabou stork. The lake may support as many as 200 000 birds at times (Ramsar, n/d). The lake contains around 150-180 fish species and supports important fisheries in the area (Ramsar, n/d; Sarch & Birkett, 2000).

We found limited published information on water quality in the lake. Satellite image analysis by Hamit et al (2023) revealed seasonal variability in the levels of chlorophyll and turbidity in the water pools, as a function of seasonal rainfall patterns and temperature variation. Turbidity levels were found to rise during the rainy season, indicating influx of suspended matter from flooding rivers, while the chlorophyll levels (indicative of high phytoplankton productivity) were highest towards the end of the dry season, coinciding with the peak in temperature, while chlorophyll levels were low in the cooler winter months. This pattern points to seasonal eutrophication in some parts of the lake, at the end of the dry season when water levels are at their lowest and temperatures are high. However, Sarch and Birkett (2000) state that because of the lake's shallowness, oxygen levels are high throughout its waters, and that levels of biomass are naturally high.

The lake area supports the endemic Kouri Ox, which is threatened by extinction. There are also populations of other endangered species like the African clawless otter, red fronted gazelle, and the African bush elephant. The area also provides a refuge for hippopotamuses and the Nile crocodile during the dry season (Ramsar, n/d).

The floodplains and wetlands of the Chari River, immediately to the south of Lake Chad, are another designated Ramsar site as well as a UNESCO Biosphere reserve and Important Bird Area, and home to large mammals such as savannah elephants, giraffes, warthogs, gazelles, several antelope

species, and lions. Like the lake itself, these wetlands also support a rich avian fauna (Foguekem et al, 2010; Scholte et al, 2022).

2.6 The importance of Lake Chad's environment to humans

Lake Chad is the biggest body of water in the Sahel and is of immense importance to all life in the region. It supports livelihoods and regulates water supply for millions of people. The lake acts as a hydrological reservoir and retention system that safeguards water supply throughout the year, despite the high variability in rainfall patterns, by recharging groundwater, retaining water and sediments, and helping to control flooding (Ramsar, n/d).

The lake has historically been an important social and economic hub for a population of tens of millions of people (Ramsar, n/d). As of 2021, the human population in the eight conflict-affected territories was approximately 22 million (LCBC, 2025; Onuoha et al, 2023).

The lake supports significant fisheries, with more than half of the 300 000 fishers in Chad living around the lake (Ramsar n/d). In addition to fisheries, the lake and the surrounding wetlands support crop agriculture (cereals, legumes), provide pasture for grazing livestock (cattle, sheep, and camels), and more specific industries like the production of blue algae *Arthrospira platensis* (spirulina) and natron (Ramsar, n/d).

Wooded areas in the wider region are a source of natural products such as charcoal and wood fuel, wildlife and wild herbs products. Natural products such as balanite oil and gum arabic are traditionally harvested. In some parts of the study area, there are gold deposits and gold mining takes place (Magrin & de Montclos, 2018; ASA, 2025).

3. Conflict-environment-human nexus

3.1 Environmental impacts of violence and combat operations

Based on information from field reports and interviews, conflict in this region is characterised by a pattern of temporally and geographically scattered, localised violent incidents by insurgent groups against local populations, between insurgent groups, and between insurgents and counter-terrorism forces. There have been repeated localised bombings, use of landmines, armed attacks, and targeted destruction and burnings of buildings in villages and settlements (Bellingcat, 2018; Ukah et al, 2025 b).

Based on information from interviews and literature, the location of operational strongholds of insurgents has shifted. In 2013, the main stronghold of Boko Haram was in the city of Maiduguri, in Nigeria's Borno state. In the last decade, counter-terrorism measures have pushed them out of the urban environment into areas that are less accessible. The main operational strongholds for Boko Haram and other insurgent groups are now located in Lake Chad, with its networks of wetlands and islands, and in the Sambisa Forest (Ahamdu & Maiangwa, 2020; Jamiu, 2026; Okoli, 2019; Olaniyan 2018; Ukah et al, 2025 b).

Euaa (2021) describes in-fighting between Boko Haram, ISWAP, and smaller insurgent groups in the region to gain control over areas like Lake Chad, that are remote or difficult to access by counter-terrorism forces. This indicates that remote areas with natural vegetation cover (and potentially higher conservation value) may be particularly at risk from direct impacts of insurgency and combat operations.

Violent incidents cause direct impacts on the local environment where they occur. Interviews mentioned physical damage and disturbance of the ground, the use of ammunition, as well as the cutting down of vegetation along key routes by counter-insurgency forces to increase visibility and security. Ahamdu and Maiangwa (2020) review sources describing that since insurgent strongholds moved into wetland areas of Lake Chad, jihadists have overrun settlements on the many islands in the lake, as well as larger towns and villages around the former lake boundary. The scale of the violence and insecurity has led to millions of people abandoning these areas, with knock-on environmental consequences (part 3.4).

Okoli (2019) describes Sambisa Forest as a stronghold for insurgents and their logistical and technical infrastructure, including command, armoury, detention camps, and artisanal bombing factories. The comparatively dense and thorny vegetation cover of this area makes it less accessible and provides a degree of cover for terror groups. Ukah et al (2025 a) carried out satellite analysis of vegetation and land cover in the Sambisa Forest, which indicated disturbance to the natural vegetation and 23.2 % increase in built-up areas within the forest between 1994 and 2019. The authors associated this increase with activities by Boko Haram as well as military counter-insurgency measures.

Expert interviews highlighted that counter-terrorism measures cause environmental impacts. For example, Nigerian military forces clear land around their key installations and main supply routes. The cutting down of trees and vegetation improves the safety of their operations by removing cover for insurgents along these important routes.

The expert interviews also highlighted environmental impacts associated with the construction of garrison towns, heavily fortified areas serving as an operational base for Nigerian counter-insurgency troops as well as safe harbour for internally displaced people fleeing violence. One example is the town of Monguno in Borno state, north of Maiduguri, which had been experiencing violence and insecurity from insurgents until 2021, when fortifications were implemented by Nigerian security and the Civilian Joint Task Force (CJTF) – an armed community group working alongside the Nigerian military (Center for Civilian in Conflict, 2022). The expert interviews described that protective trenches around garrison towns damage vegetation and create soil erosion and dust, and that the influx of displaced people into garrison towns place the immediate surroundings under increased pressure to meet food, water, and sanitation needs. Yayla and Yahaya (2023) state that the garrison town strategy largely abandons the countryside, freeing that space for uncontrolled activities.

There is limited information on quantities and types of ammunitions used in violent incidents in the Lake Chad region. Nevertheless, the interviews highlight the widespread use of improvised explosive devices which, apart from the human cost, cause physical damage to the environment as well as pollution of soil and groundwater from heavy metals and other toxins contained in the explosives and their casings. These devices also pose a physical threat to wildlife.

Nigeria was declared landmine free in 2011, about a decade after acceding to the Convention on Landmine Clearance. It is now facing a renewed threat from improvised landmines in its northeastern regions (Soumahoro, 2025). These landmines are one type of improvised explosive device used extensively by armed terrorist groups. While the scope of this report does not include an assessment of human casualties of conflict in the region, buried landmines pose a particular risk that is connected with natural resource use. Community members who engage in seasonal cultivation of crops in different areas, move around the landscape with livestock, or access the fishing grounds are particularly exposed to risk of injury and death. In 2024, 10 people were killed on their way to Lake Chad when their vehicle ran over a mine believed to have been placed by jihadists (VOAAfrica, 2024). A total of 613 casualties were reported from January to September in 2024 (Soumahoro, 2025), providing an indication of the extent to which these devices are used.

3.2 Natural resources as revenue streams

The expert interviews emphasized the importance of the natural resource economy as a source of finance for insurgent groups, often in connection with organised crime. For example, Interviewee 1 stated that Boko Haram controls access to key resources in the lake area, as well as trade in extracted resources, charging fees to those who need access to grazing land, fertile farmland, or lake fisheries. Interviewee 2 added that Boko Haram has established connections with illegal mining operations in parts of Nigeria, and with illegal wildlife trade operations, as further streams of financing.

Interviewee 1 saw the origins of the conflict as being rooted in social discontent with unfair distribution and access to resources, in the context of scarcity, making control over environmental

resources one of the main drivers of criminal activity, violence, and the wider conflict. The interviewee's perspective was that religion is used by insurgents as a vehicle to channel this discontent, that financial gain from resource control was always a priority for them, and that the infighting between different groups like Boko Haram and ISWAP is more about control over fisheries in Lake Chad than about religious disagreements: *“There is a criminalisation of jihad, or a jihadization of crime in the region – many people call themselves Boko Haram.”*

An important part of understanding the environmental dimension of the conflict, therefore, means understanding the natural resource economy in the region, and the ways in which it is interwoven with insecurity and conflict. Part 2.6 mentioned the significance of Lake Chad as a traditional socio-economic hub in the Sahel, rich in life-sustaining environmental resources. The study area continues to be rich in natural resources, ranging from fish, pasture for livestock, areas suitable for the cultivation of cereals and beans, to natural vegetation sources of wood and charcoal, game, and mined resources (part 3.3). Livestock herds provide the basis for leather production. There are also less well-known nature-derived products like gum arabic and natron – and Lake Chad is the world's largest supplier of spirulina (Ramsar, n/d). This wealth of natural resources and wildlife products is exploited directly or indirectly by armed insurgent groups to generate income (Magrin & de Montclos, 2018; ASA, 2025; Atar, 2025; Enact, 2025), including through extortion and taxation of local populations, fishers, farmers, and herders (Security Context, 2024; Enact, 2025).

This is reflected in the statements of interviewees, who spoke about extortion of farmers, fishers and pastoralists, and of insurgent groups controlling access to fishing grounds and areas suitable for crop cultivation. The interviewees described a progressive and ongoing infiltration of insurgent groups into different parts of the natural resource economy, beginning with the main agro-pastoral activities and fishing, and then moving into artisanal mining, wood and charcoal production, as well as partly illegal wildlife and wild product trafficking to generate revenue (ASA, 2025). The pattern of infiltrating increasing numbers of revenue streams appears to be ongoing, with gum arabic gaining in significance over the last years (Atar, 2025). This indicates that both the legal and illegal natural resource economy in the lake area and wider region is now closely tied into the economy of the conflict. Professor Freedom Onuoha put it as follows:

“When the terror group Boko Haram first emerged, their financial model was based on donations, and then it continued with membership fees by paying dues. As the States started to use military and intelligence responses to squeeze its funding schemes, the group moved to armed robbery, but over time, as they began to settle into these territories, they began to expand their source of funding through extortion. Regarding environmental resources, they impose taxes and levies on three major activities – agriculture, fishermen, and herders.”

The threats of physical violence that come with financial extortion have indirect impacts on the environment in that they are a big factor in displacement of human populations. Interviews highlighted that in areas where insurgents gain hold, farmers, fishermen and pastoralists who refuse to pay fees are often forced out of communities. This causes environmental pressures in safer areas they move to, and fuels conflicts between farmers and pastoralists who increasingly compete for space (see part 3.3.1).

It is challenging to obtain an estimate of how much money insurgent groups extract from the natural resource economy through extortion and fees. Estimates from Nigeria indicate that from 2015 to 2018, Boko Haram made between US\$ 5-10 million from taxation, bank robberies, donations from

other terrorist groups, and kidnapping for ransom (Security Context, 2024). Other sources estimate that the group was able to secure about US\$ 70 million from various illicit activities between 2006 and 2011 (Radford, 2021). However, these sources don't specify the portion derived specifically from natural resources.

3.3 Key environmental resource-based activities and the conflict

3.1.1 Livestock farming

A large proportion of the population in the Lake Chad region depends on transhumant pastoralism for their livelihoods. Transhumance is form of mobile pastoralism in which herders move their livestock to follow seasonal rainfall patterns and the growth of pastures in different parts of the region at different times. Approximately 80% of the livestock breeding in the Lake Chad region involves mobile pastoral systems (GIZ, 2025).

In the dry season, the exposed areas of the lakebed provide vital grazing areas that attract transhumant herders and their stock. Over 300 000 cattle and 100 000 sheep and goats grazed in the vicinity of the lake prior to the 1972–1975 drought (BirdLife International, 2026).

Historically, transhumant pastoralists moved across the region, crossing borders to move with the rains. They coexisted with sedentary farmers, avoiding conflicts through the mediation of traditional authorities. One expert interviewee described that pastoralists paid a tax to traditional authorities for each head of cattle. In return, the traditional authorities ensured that the timing of crop cultivation matched with the needs of the pastoralists, harvesting crops in time for grazing cattle to move through the fields on their routes to and from seasonal pastures.

In recent years, there has been increasing conflict between pastoralists and sedentary farmers. Climate change is making rains more unpredictable, and rapid population growth of people and livestock puts pressure on grazing areas and increases competition for resources. Olowoyeye and Kanwar (2023) highlight that over the same period that the lake size shrank by 90%, the riparian countries around the lake experienced an 80% increase in population and a 75% increase in animal production.

Interviewees further highlighted that the population increase and the presence of internally displaced people in some areas increases the amount of area needed for crop cultivation, including areas that were previously used as livestock routes, with conflicts arising when cattle are moved through what are now cultivated fields. The interviewees mentioned that some of this conflict has threatened to turn violent, with armed people chasing or removing pastoralists e.g. from Chad to Cameroon.

In addition to the extortion described in part 3.2, one interviewee highlighted that Boko Haram have rustled cattle from Fulani herders in the Lake Chad area. An in-depth analysis of cattle rustling by insurgent groups in the Lake Chad area by Okoli (2019) describes that this is a wide-spread practice and an important source of finance for armed conflict. The author highlights that it is rooted in cultural traditions of cattle raiding among groups of herders that historically served as rites of passage and a means of herd redistribution, sanctioned by elders. However, with population growth and climate change increasing competition for resources, this practice became infiltrated and taken over by organised crime, and then by Islamist terrorist groups as a source of financing. Ojewale and

Tayo (2025) also highlight the cultural and social traditions of cattle raids as an important factor that has enabled these practices to be taken over by criminal and terrorist groups.

Ahmadu (2019) highlights that Boko Haram's infiltration of organized cattle rustling began around the early 2010s, when Boko Haram moved their operational strongholds from the city of Maiduguri to the Sambisa forest and the lake area due to Nigerian counter-terrorism measures. Ahmadu and Maiangwa (2020) highlight the following key factors that facilitate the cattle rustling business by Islamist terrorist groups in the Lake Chad area:

- The strategic avoidance by Boko Haram of using electronic financial transactions, as cattle can be stolen and sold for cash.
- The crucial importance of the lake area as dry season pasture, concentrating large numbers of herders and livestock within the area that is also an operational stronghold for the insurgent groups.
- The absence of strong governance from official authorities in the inaccessible terrain of the Sambisa forest, and the lake area itself.
- Boko Haram's access to weaponry.
- Porous borders that facilitate the movement of rustled cattle across national boundaries.
- Readily available local markets for rapid selling of stolen livestock for cash, with high market value for cattle.

Their analysis, the findings of which are echoed by Ojewale and Tayo (2025), illustrates how several environmental factors (naturally seasonal rainfall, climate change, the high importance of wetlands as dry season pasture, the physical qualities of the natural terrain and vegetation) are interwoven with economic, cultural, political, and logistical factors to facilitate the persistence of insurgent strongholds in Lake Chad and Sambisa Forest. The natural environment shaped transhumant pastoralism in the area, and anthropogenic environmental changes have co-created the conditions that have enabled organised criminal networks and insurgent groups to establish livestock crime as an income stream.

Ojewale and Tayo (2025) further underline that cattle rustling transcends national borders. It takes place not only in Lake Chad itself but also in surrounding regions, such as Waza National Park. Several insurgent groups are involved, including ISWAP, Boko Haram, separatist groups and unidentified armed groups, and there are strong links between cattle rustling and other forms of organised crime and violence.

The Global Initiative Against Transnational Organized Crime has highlighted that cattle rustling is central to the conflict economy in another area of the Sahel (the tri-border area between Burkina Faso, Ghana and Côte d'Ivoire), where violent Islamist groups use money from the sale of stolen cattle to purchase weapons and other resources (Global Initiative, 2025). The same source stresses that these groups build legitimacy and grass-roots support by embedding themselves within herder communities, protecting livestock in areas where they have the most influence.

What emerges is a picture where the economies of Islamist insurgents in the Sahel are deeply enmeshed with cultural traditions, organised crime, and the wider natural resource-based economy that most people in the region depend upon for their survival.

3.3.2 Crop farming

Crop farming is affected by the conflict both directly and indirectly. It is a vital activity for communities in the food-insecure area of Lake Chad, where 80-90% of the population rely on agriculture (livestock production, crop farming, and fisheries) for their food and livelihood (FAO, 2017). Like fisheries (see below), crop cultivation is predominantly carried out at small scale as part of subsistence livelihoods. Cultivation uses traditional farming practices that are highly dependent on water availability from rainfall and the fluctuating water levels of the lake. The use of agro-chemicals (pesticides, artificial fertilizers) or improved hybrid seeds is limited (Alhassan et al, 2021).

Small-scale farming provides vital food for local communities in a region that is repeatedly highlighted as being food insecure due to climate variability, the impacts of severe weather and climate change (see part 3.5), and the conflict (FEWS NET, 2022, 2025, 2026).

Most of the agriculture in the lake area depends on flood irrigation, where crops are planted close to receding water edges (recession cropping), utilising water retained in the ground from wet season flooding. The main crops cultivated through recession cropping are cereals (maize, rice, wheat) and vegetables (Alhassan et al, 2021). Maize provides food as well as animal feed and fuel. It is the most important staple crop in the lake area, making up 80% to 90% of agricultural production in the region (Olowoyeye & Kanwar, 2023).

Nilsson et al (2016) described and mapped crop production in the Chadian portion of the lake in detail. Lake recession farming is mostly located on the raised part of the former lakebed that separates the northern and southern pools but also occurs more widely around the archipelagos on the eastern side of the lake.

Farming communities in upstream areas and the villages and settlements are scattered around the edges of the former lake practice rainfed agriculture during the wet season (Nilsson et al, 2016; Alahassan et al, 2021), growing millet, sorghum, cowpea and groundnut in sandier soils with less water retention capacity. Sorghum is planted using both rainfed and recession cropping methods, annually yielding an estimated 150 000 tonnes of grain (BirdLife International, 2026). Recession cultivation of wheat also takes place, and other crops include cowpeas, groundnuts, and vegetables.

Irrigation schemes were built in the southern part of the lake in the 1970s and 1980s, but their expansion was largely halted as the severe shrinkage of the lake became evident (Olowoyeye & Kanwar, 2023 and references therein). Some irrigated rice cultivation continues in the Far North of Cameroon, in the floodplains of the Chari River system (FEWS NET, 2025), and around Bol in Chad. Upstream dams, especially the Tiga dam in Kano state in Nigeria, on a tributary of the Yobe River system, still capture and provide water for crop irrigation upstream of the study area (ibid).

Moving beyond the lake towards the south, the terrain becomes more varied, and a wide variety of crops (including potatoes, onions, garlic, soya, tubers) are grown in the savannah and mountain areas of Cameroon's Far North and North provinces, and Nigeria's Borno and Adamawa states (FEWS NET, 2025).

As highlighted in part 3.3.1, population growth and growth in livestock, have, in combination with increasingly unpredictable patterns of rainfall, created conditions that lead to increased conflict between livestock herders and sedentary pastoralists (e.g. Olowoyeye & Kanwar, 2023).

Conflict and insecurity disrupt farming practices in different ways. For example, in Borno state, recent intensification of counter-terrorism measures against ISWAP and Boko Haram has triggered population movements. Improvised explosive devices used by insurgents have restricted access to areas where recession crops are planted. A pattern of repeated displacement and ongoing interference with community access to farming areas due to insecurity during crucial planting seasons has placed many people in food emergency, with the conflict and instability hampering the provision of aid (FEWS NET, 2026). Flooding, particularly localised flash flooding, has compounded these issues by causing loss of crops and farmland as well as further displacement of people (FEWS NET, 2025).

3.3.3 Fisheries

There were some 180 fish species in Lake Chad reported in 2000 (Batello, 2004), but this number has drastically reduced over the last decades due to the recession of surface waters and anthropogenic activities. The fisheries of Lake Chad are an important source of livelihood for the surrounding communities, taking place within the wetlands, seasonally flooded areas, temporary pools, and permanent water bodies of the lake basin itself, as well as within the wetlands and water bodies of its tributary river systems (Béné et al, 2003; Magrin & de Montclos, 2018).

Okeke-Ogbuafur et al (2023) review the history of fisheries in Lake Chad, citing sources documenting that until the 1960s, small-scale subsistence fisheries provided an important source of nutrition for local populations, but catches were relatively low (up to 20 000 tonnes per year). This changed in the 1960s, with fisheries increasingly being carried out as a source of cash income, and an influx of fishers to the area. Sources cited in their review indicate a peak of annual catches in the early 1970s of up to 220 000 tonnes per year.

Several authors, including Eriegha et al (2019) and Okeke-Ogbuafur et al (2023), mention a lack of reliable time-series data on fisheries in the lake, with financial constraints and security risks due to the instability and violence in the region hampering monitoring and data gathering. Nevertheless, evidence indicates that the shrinking of the lake between the 1960s and 2000s had a devastating impact on fisheries. Not only did the shrinking lake provide less suitable habitat for fish, but physical access to fisheries also became harder as water receded from the fishing towns and villages located on the former shoreline. For example, the town of N'Guigmi, located in Niger on the north-eastern shore of the former lake, was an important centre of Kanuri fishing communities in the mid-20th Century. However, by the 1970s, the shoreline of the lake was 85km away (Jedwab et al, 2023).

The town of Bol, capital of Lac province in Chad, in the north-eastern part of the lake, was historically a significant centre for trade and fishing (UNDP, 2024). Jedwab et al (2023) highlight that the spatial distribution of the relative significance of fishing to local economies shifted during the period of rapid lake shrinkage. Most of the remaining areas of open water are in the south of the former lake basin, meaning that Cameroon and Nigeria have easier access to remaining fisheries than the towns along the northern and north-eastern parts of the former shoreline in Niger and Chad.

Recent sources cited by Okeke-Ogbuafur et al, (2023) state that around five million households surrounding the lake continue to rely on fishing as a key source of income and nutrition, but that lake fisheries are not productive enough to sustain their needs. Béné et al (2003) and Eriegha et al (2019) highlight that many of these households operate diversified livelihoods, engaging in small-scale

farming as well as fishing depending on season, with the same areas cultivated and fished depending on levels of inundation.

As part of their study, Béné et al, (2003) carried out detailed research into the role of fishing for livelihoods of rural communities who fish parts of the lake and adjacent wetland and river systems. Their main conclusions were that, at the time, fishing represented a vital “last resort” for the poorest to gain access to nutrition, as well as providing a leverage for wealthier households to generate a cash income. They point out that, unlike farming, fishing is an activity that can yield almost instant cash returns.

More recently, Okeke-Ogbuafur et al (2023) interviewed lake fishers in Borno state in Nigeria to understand their perspectives on the current problems of Lake Chad fisheries. The interview respondents highlighted what, in their view, are the three main causes of the decline of fish stocks in Lake Chad:

- Climate change: the lake becomes smaller and muddier, leading to reduced fish species diversity and fewer fish.
- Boko Haram: people displaced by the conflict lost previous livelihoods, with many turning to fishing to try to make a living.
- Overfishing of small fish through using nets with small mesh size, and lack of effective fisheries management and enforcement.

BirdLife International similarly highlighted the lack of enforced regulation of the lake fisheries as a cause of overfishing, including the use of small mesh sizes that remove smaller fish, depleting stocks of the key commercial species *Alestes baremoze*, which have been severely depleted since 1971 (BirdLife International, 2026).

Several of the sources cited here (including Ramsar, n/a; Béné et al, 2003; Eriegha et al, 2019; Okeke-Ogbuafur et al, 2023) emphasize the role of traditional authorities in fisheries management, including the control of access to specific pools and stretches of water, the sale of access rights, and the taxation of returns. The same applies to control of farming rights on many parts of the receding lakebed (Ramsar n/a).

However, these traditional ways of managing fisheries have become undermined by the ongoing insecurity in the area. A report published by the Konrad Adenauer Foundation describes that the lake with its many islands has become a stronghold for Islamist terrorist groups, who control many of the islands and access to their local resources, including fisheries. “*From these islands, they spread terror along the shores. Moving in boats, they raid villages and attack fishermen, forcing them to collaborate. Time and again, jihadists kill or abduct village elders in order to seize power themselves.*” (Laessing, 2025).

Media reports highlight that the conflict impedes fishing activity in different ways, with knock-on impacts for the fishing trade and fishing communities. Terror groups use control of fishing grounds as a tool to pressure local community members into tolerating or supporting their activities: Local populations find themselves forced to either find alternative livelihoods or work for the militant groups (BBC, 2020). On the other hand, counter-terrorism measures have also impeded access to fishing grounds by authorities imposing bans on fishing boats and fish selling, depriving Boko Haram of an incomes stream and to limit their movements and supply routes across the lake (WB, n/a;

Dauda & Garba, 2017). The reports of security threats to fishers, and of fishing being controlled as a source of financing by terrorist groups, align with statements made by interviewees for this report (see part 3.2).

3.3.4 Mining

Nigeria is rich with valuable geological deposits, including gold. In the states of Yobe and Borno, there are deposits of diatomite, glass sand, gypsum, and bentonite (Omotayo, 2023). Artisanal and small-scale gold mining exceeds industrial mining, and most of the gold mined in Nigeria is not declared (Ummel & Schulz, 2024).

Cameroon is less rich with commercial geological resources than Nigeria. The far North province does not indicate deposits of minerals or other resources. However, there are gold deposits in the middle and south-east of the country (Anselme et al, 2018).

Niger is a key source for deposits like gold, oil, uranium, coal, gypsum, limestone, salt, and silver. Gold mining is prevalent in the Agadez, Tahoua and Tillaberi regions, beyond our area of study (African Mining Union, 2025).

The main mineral resources in Chad are gold, uranium, natron and limestone, with natron mining activities concentrated around Lake Chad (African Mining Union, 2025). As the lake has diminished in size, natron deposits have become available, creating economic opportunity.

Gold mining financially sustains extremist groups and bandit networks in the region (ASA, 2025; Igwe, 2021; Cenozo, 2025; UNODC, 2023). Exploiting weak governance, networks of traders and smugglers move illicit commodities such as arms and gold from informal mining operations across porous national borders between Nigeria, Niger, Chad, and Cameroon, connecting with other hubs in Libya and Sudan, creating illicit financing streams for insurgents (ASA, 2025; Cenozo, 2025). Since 2022, informal mining operations located beyond the study region in Nigeria have become connected with the war economy around Lake Chad (Cenozo, 2025).

In Nigeria, approximately 1 759 small-scale informal mining sites were identified by the Ministry of Mines before mining activities expanded in recent years (The Daily Times, 2019). The gold-bearing areas in the northern part of Nigeria, such as Zamfara province, are some distance away from the areas where Boko Haram operates. However, Boko Haram exchanges arms (including those looted from the military) with commodities from the mining activities. The magnitude of this illicit trade is unknown, but there has been an expansion of illegal gold mining in North-West Nigeria, with Katsina and Zamfara Province as epicentres. This expansion is linked to Boko Haram activities (Onuoha, 2022).

Similarly, in Niger, artisanal and small-scale mining has also become a source of financing for extremist groups. However, it is unclear whether these groups are linked to the violence in the Lake Chad region (AMU, 2025; UNODC, 2023).

Illegal mining activities cause significant degradation of the environment (Tambol et al, 2023). Mercury and cyanide are used in the gold extraction process, and land clearing in these areas prevents the regeneration of natural resources. Mercury pollution has significant health implications, causing damage to the brain, kidneys, lungs, and immune system, with particularly devastating

effects on women and children. After exploitation, the mines continue to degrade the environment, as they are not properly closed and remediated.

There is little information on other mining activities and their links to terrorist groups in the region, although certain natural resources, such as natron, may be attractive for exploitation, specifically in areas with limited control and access.

3.3.5 Forest and woodland resources

Part 2.3 highlights that beyond the lake basin itself, the study area has a rich diversity of different landscapes and ecosystems. The wetlands, mountains and savannah ecosystems to the south are home to birds and large mammals, many of which are hunted for meat and ivory. Trees provide a source of wood and charcoal.

The focus in this part is on the Sambisa Forest which, as outlined in part 3.1, is a stronghold for insurgents (Ahmadu, 2019; Ahmadu & Maiangwa, 2020; Ojewale & Tayo, 2025).

The importance of the forest and its resources was highlighted both in the interviews and in the literature. Interviews revealed that jihadist groups cut down trees to use wood as cooking fuel and as a cash crop, hunt wild animals for food or to sell for cash, and use open areas within the woodland for grazing cattle (including rustled cattle, see part 3.3.1). Interviews highlighted that these activities are tied to violence, and that kidnapped children have been taken to this area as labour to look after cattle.

The Sambisa Forest has witnessed a decrease in wildlife. The wildlife loss includes large mammals, such as elephants, which have been hunted over the past decades for illegal trade in ivory. In 2024, the Ministry of Environment's Director of Forestry and Wildlife announced that there are no elephants in the Sambisa forest (IFMNews, 2024). Recent reports reveal that the decline in elephant populations is a contributing factor in a shift in hunting practices towards warthogs, which are poached mainly for meat, but with additional benefits arising from the sale of their tusks (Umar, 2025).

Expert interviews highlighted links between Boko Haram and organized crime groups involved in wildlife trafficking, with the terrorist groups generating revenue by imposing taxes on transactions carried out by organised crime networks operating in the illegal wildlife trade (Umar, 2025) in the same way that they extort farmers, pastoralists, and fishermen (see part 3.2).

3.4 Impacts cross-cutting theme: Displacement

Displacement in the Lake Chad region is driven by multiple conflict-related and environmental factors and is characterized by significant transboundary movements. As of April 2025, Cameroon, Chad, Niger, and Nigeria were hosting an estimated over 6 million affected individuals encompassing internally displaced people, returnees, and refugees crossing international borders (IOM, 2025). Within the area of study, the main reason for displacement is insurgent violence, with a much smaller proportion of people displaced for environmental reasons such as floods (Figures 6 and 7). Borno district is the most affected, with 100% of displacement shown as conflict-driven, while Yobe district

in Nigeria and the Far North of Cameroon have the highest percentage of displacement driven by climate (Figure 6).

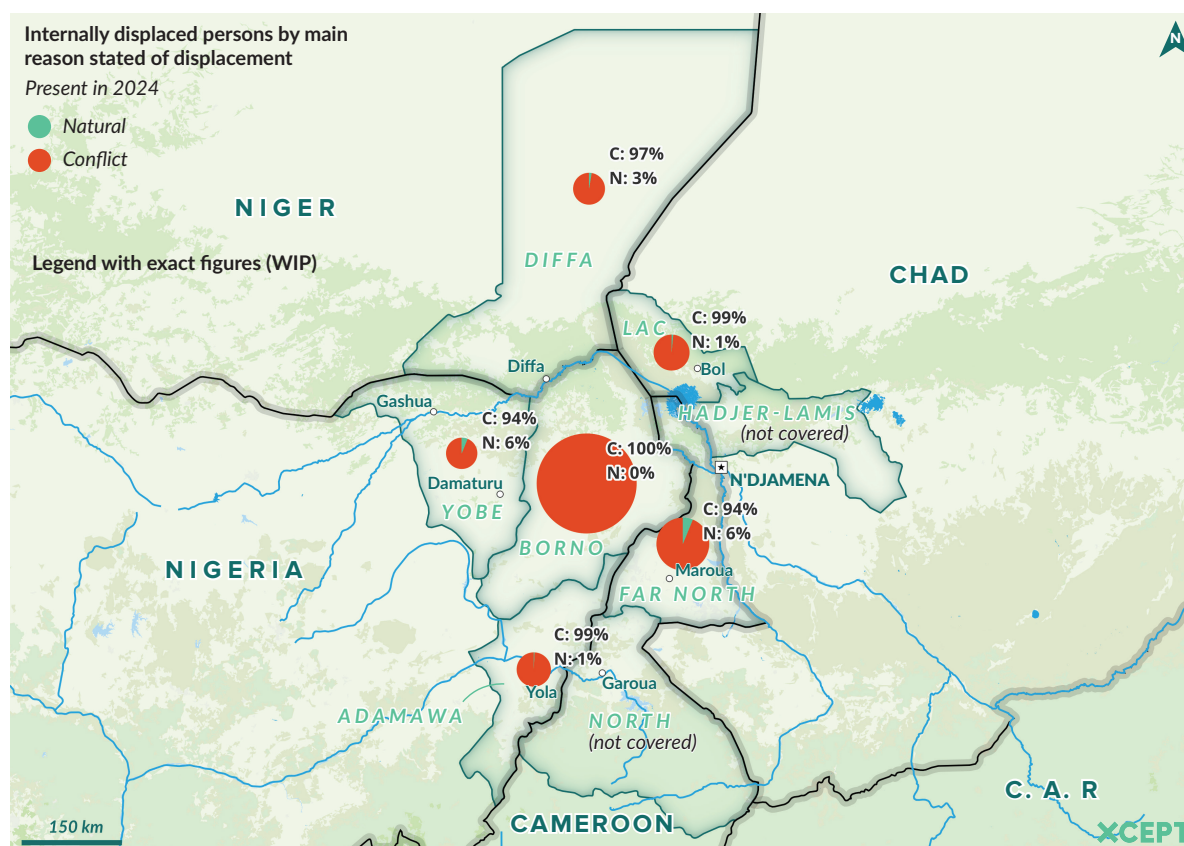


Figure 6: Internally displaced persons by main reason stated of displacement, in 2024.

Displaced people may be accommodated in large refugee camps, or they settle in or around existing villages, towns and cities, or seek refuge in unaffected area by clearing natural habitats for new settlements. Some displaced people migrate multiple times. There are feedback loops in which the scarcity or degradation of natural resources causes tensions, while conflict in turn leads to further displacement. When needs of displaced populations are not properly addressed, they may generate further tension between new arrivals and host communities, and place additional pressure on the environment. Kamta et al (2021) examined dynamics between displaced people and host communities in northeast Nigeria and found that most respondents opposed the presence of newcomers.

There is a substantial body of literature providing an overview of internally displaced persons caused by conflict or climate-related factors (Lyammouri & Bozsogi, 2025; IOM, 2025). However, fewer studies analyse tensions and disputes, such as intercommunal clashes, as well as the environmental ramifications of displacement. Environmental pressures may arise from the provisions of essential services such as sanitation and solid waste management, the construction of new housing, overexploitation of water resources, and activities to sustain livelihoods.

Field visits carried out by project partners identified issues linked to ecosystem degradation. Research by the project group in N’Guigmi and Diffa in Niger in December 2025 indicated that forest and bushes in certain areas have been significantly affected by deforestation, partly due to repeated displacement of communities. Tree cutting serves both as a source of household energy use and for income generation through the production of charcoal. While these issues were identified and addressed in a timely manner by local authorities, deforestation remains a common consequence of displacement. Bush and forest fires were also reported from the same region.

In addition, displacement increases pressure on wildlife and wild plant species. Although these linkages are under-researched, Carenton et al (2024) established a link between conflict and the overexploitation of waterbirds. Maazou et al (2023) conducted a survey in Mainé-Soroa and N’Guigmi (Diffa region of Niger) and found that refugees, in addition to local communities, exert pressure on herbaceous food species.

Intercommunal clashes may lead to further displacement, putting additional pressure on the environment. Scholte et al (2022) shed light on the example where 2 500 pastoralists, with an estimated 35 000 cattle, sought refuge in the western floodplains of the Waza National Park in Cameroon. The move resulted in human-wildlife conflict, and the displacement hampered ongoing nature preservation and protection efforts within the protected area (Tumenta et al, 2026).

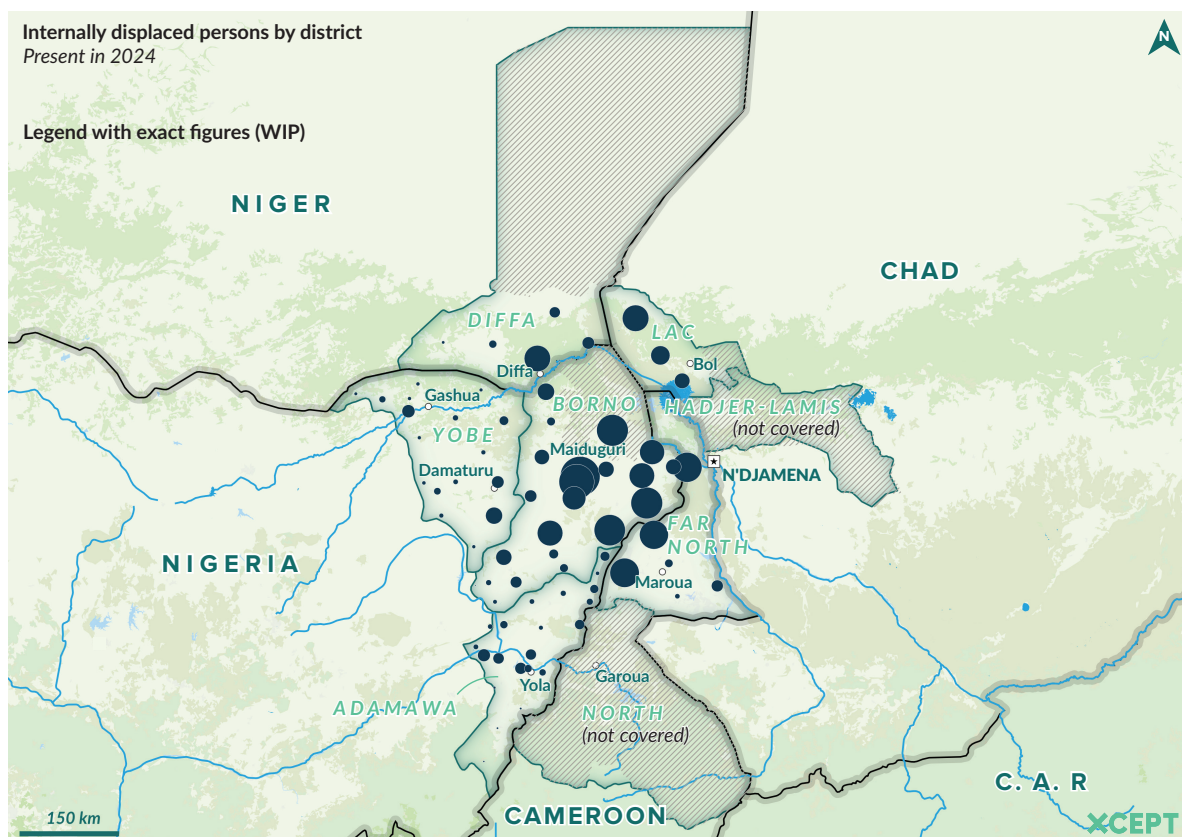


Figure 7: Internally displaced persons by districts, in 2024.

3.5 Cross-cutting theme: Climate change

There is a wealth of literature on climate change and its current impacts in the Lake Chad region and the wider Sahel (Ehiane & Moyo, 2022; Onuoha et al, 2024, Lyammouri et al, 2025; Iversen et al, 2026; Okpara & Yunus, 2025; de Coning et al, 2026 b; see also part 2.4). This report does not seek to replicate or duplicate the existing body of work, but we underline that climate change is a recognized stressor in the study region, and that climate change vulnerabilities in the Lake Chad region cut across the environmental dimensions of the conflict.

The pressures associated with climate change create tension and conflict between different communities by exacerbating scarcity of natural resources – land, water and food – including local and temporary scarcity tied to seasonally variable water availability. Interviewees highlighted that pressures related to climate change amplify the tensions between local communities and internally displaced people, and between pastoralists and farmers, as described in earlier parts of this document.

Climate change-related events such as floods and droughts, and their impacts – such as displacement, resource scarcity, and the unpredictability that limits the application of local knowledge – have already intensified over the last decade (e.g. Ehiane & Moyo, 2022; Onuoha et al, 2024; Lyammouri et al, 2025; Iversen et al, 2026). On a broader regional scale, climate change amplifies food insecurity, which has reached critical levels in the study area. A combination of climate change related droughts and conflict has forced people to change not only their crop cultivation practices but also entire social organizations (Batello, 2004).

The IPCC climate change scenarios for the Lake Chad region predict worsening climatic instability, variability, and extreme weather, including increased severity of flooding events (IPCC, 2023). The significance of climate change as an amplifier of conflicts and instability is therefore likely to increase for future generations, unless climate-sensitive adaptation and mitigation strategies are implemented.

Another report written for the CPS-Lake Chad Project (de Coning et al, 2026 b) prioritises the climate-conflict lens by exploring links between climate change, insecurity, and peacebuilding strategies, complementing the natural resource economy lens applied here. Both reports recognize the importance of taking a systems perspective: whether the environmental dimensions of the conflict are viewed primarily through the lens of the natural resource economy or through the lens of climate change, the ecological aspects cannot be understood in isolation from social aspects (de Coning et al, 2026 b). Figure 8 illustrates these linkages by overlaying climate change vulnerability with data on violence and displacement in the region.

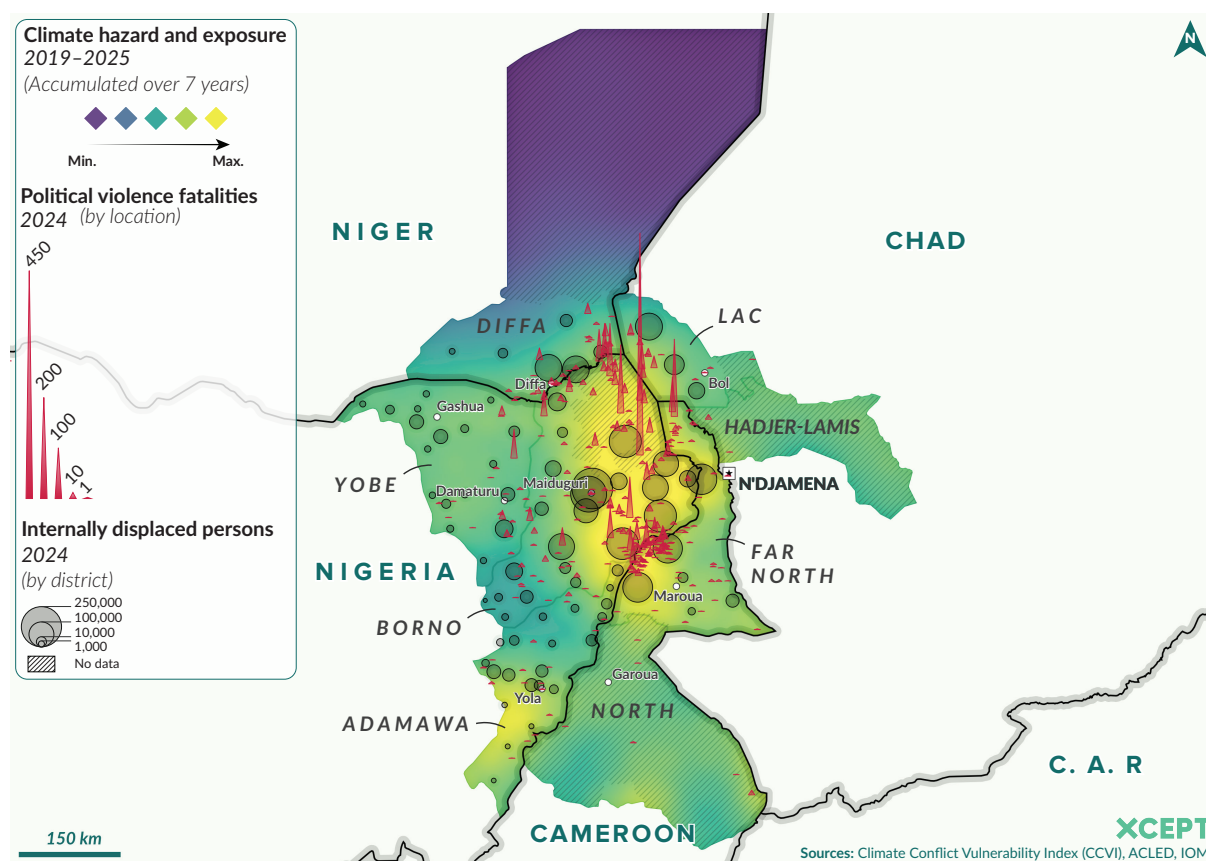


Figure 8: Climate hazards, conflict and displacement nexus.

3.6 An emerging socio-ecological systems perspective

The natural environment in the Lake Chad region is inherently variable and complex. The region spans across an ecological transition zone from desert to savannah environments, and it is located within the inter-tropical convergence zone where rainfall is highly seasonal and characterized by interannual variability, making floods and drought periods an inherent part of normal rainfall patterns. The natural ecosystems in this region are adapted to high variability in the availability of water, with intermittent scarcity of this key resource that all life depends upon.

Lake Chad represents a year-round reservoir of water, food, and pasture, with its richness of natural resources making it not only an ecological hub but also a human hub (socially, culturally and economically). For humans, the edge of the desert can be regarded as the edge of survivability. Like ecosystems, social systems in this region historically had to shape themselves around variable rainfall and periods of water scarcity.

While the analysis of social and cultural systems in the study area was beyond the scope of this report, our research on environmental factors nevertheless found human traditions and institutions are closely adapted to the environment. For example, Bénét et al (2003) describe fishing, farming, and herding as three closely integrated activities in the lake area, closely intertwined with a complex land- and waterscape where receding floods after the end of the wet season create temporary ponds and oxbows, swamps, and marshes, and flooding creates areas of open water that are fished. Thus,

the same patch of the lake basin can become a cultured field, a grazing area, and a fishing ground, depending on the season and the timing in the flood cycle. Historically, social systems evolved to make areas intermittently available to different activities and groups of people, including between different ethnic groups, with traditions and institutions to prevent and resolve conflicts around accessing shifting and variable natural resources.

Like de Coning et al (2026 b), we found that understanding the environmental dimensions of the conflict needs a systems perspective that centres the relationships between system elements and illuminates non-linear impacts of environmental factors or changes on conflict dynamics. Further project outputs echo this finding. Veloz et al (forthcoming b) identified three intertwined feedback loops that make the conflict in the region persistent: Resource-Scarcity, Scarcity-Conflict, and Insurgency-Grievance. The foundational loop links climate change to environmental degradation and the erosion of community resilience, environmental scarcity translates into localised violence and all together this creates fertile conditions for insurgency. These feedback loops reinforce each other and create a system resistant to simple interventions, which indicates the need for systemic approaches towards stability. Our research complements these analyses by identifying the natural resource economy as another integral element interwoven with conflict and insecurity in the Lake Chad Basin.

The findings of Galli *et al* (2022), who explored the impacts of water availability on conflict in the region, underline the importance of systemic approaches, highlighting that water availability (an environmental factor) is inextricably linked to socio-economic conflict drivers. The authors found that water scarcity alone did not directly drive violent conflict, but that violent conflict was impacted by spatial and temporal patterns of water and land resource availability (e.g. water and land suitable for cultivation) combined with the need for livelihoods and dynamics of socio-political processes.

Nkiaka et al (2024) similarly found that meaningful connections between water scarcity and conflict in the region could only be identified when different scientific water scarcity metrics were combined and analysed in the context of human demographics. In both cases, the authors found that placing their respective analyses of water availability in a wider socio-ecological systemic context proved more illuminating to the role of water in conflict dynamics than attempting to analyse connections between water and the conflict in isolation from other parts of the system.

Another important lens through which to look at environmental aspects of conflict in the region is the history of European colonialist resource extraction that severely disrupted traditional economies and institutions around natural resource management in the lake basin (Stewart, 2025). Stewart's work highlights that colonialist logic continues to shape approaches to economic development aid that prioritize the cultivation of cash crops or extraction of natural resources for export out of the region, as a source of income and economic growth, instead of strengthening local economies or traditional resource management approaches. This, Stewart (2025) argues, has contributed to destabilisation and injustice in the region. While beyond the scope of this report, the relevance of colonial and postcolonial histories to the environmental conflict dimensions warrant further attention as part of systemic approaches.

Okpara and Yunus (2025) reviewed English language academic work on the nexus between climate change and conflict in the Lake Chad region, finding separate bodies of work in different academic disciplines (including geography, political science, peace science, and earth and environmental sciences). They highlight a shift in the literature over time, with older studies taking a more

deterministic approach and more recent work taking more multi-factorial and multi-causal approaches, with authors increasingly recognising the significance of factors that fall beyond their respective disciplinary areas of expertise. Among the socioeconomic factors frequently mentioned in the literature are demographics (including population growth), governance deficits, politics, corruption, poverty and food insecurity, while on the environmental side, natural resources are repeatedly highlighted as important context for climate change.

As such, this report, along with other outputs from the CPS-Lake Chad Project, can be seen as a contribution to an emerging socio-ecological systems understanding of conflict and insecurity in the Lake Chad region.

4. Conclusions

This report provides a baseline environmental context for understanding conflict in the Lake Chad region and illuminates some of the ways in which conflict is impacting the environment. It also provides insights into the ways in which conflict and insurgencies in the region and intertwined with the use and exploitation of natural resources, illuminating regular, legal parts of the natural resource economy as well as environmental crime and illicit trade in natural resources. Climate change is highlighted as a particularly important cross-cutting factor that amplifies many of the issues identified. Despite the existence of significant information gaps, the report fulfils its aim of illuminating the environmental dimension of conflict in the region, complementing other outputs of the CPS-Lake Chad Project.

Our findings support other studies highlighting that it is virtually impossible to meaningfully describe or understand that environmental dimensions of conflict in this region in isolation from social, historical, and cultural context. We have viewed environmental information through the framing of a “conflict–environment–human nexus”, recognizing a complex socio-ecological system where conflict is interwoven with environmental conditions as well as economic and social dynamics. We have found that systems thinking can overcome simplified narratives (such as that of the “disappearing lake”) that mask more complex realities and avoid becoming trapped by deterministic approaches that obscure nonlinear dynamics.

Like other studies, our research has been constrained in several ways and has only illuminated a small part of a much bigger system. Our perspectives as individual researchers and authors are constrained by our backgrounds and subject expertise. A definitive description of the socio-ecological system may not even be realistically achievable, given that the way in which the system elements, linkages and boundaries are defined depends on the many different lenses that it can be viewed through.

We believe that the best way to continue building collective systems-level understanding is by embracing multidisciplinary and participative research. It is clear from our work and from the literature that systemic analysis of socio-ecological connections requires expertise from multiple disciplines. Furthermore, the experience of conducting this research has underlined the crucial importance of local knowledge. The interviews, albeit very limited in number and scope, proved to be an invaluable source of information, as did the field reports provided by project partners who were able to travel to the region and reach out to local stakeholders. The review by Okpara and Yunus (2025) strongly emphasise the value of co-creating knowledge and of inclusive research approaches that integrate different forms of knowledge. Integrating environmental science with social science, conflict analysis, and local knowledge systems strengthens understanding as well as the policy relevance of the generated outputs.

It is clear to us that, while there are big information gaps in published scientific literature, relevant knowledge and expertise exists in the region, without which it will be impossible to build a collective understanding of conflict and insecurity, or build successful strategies to build sustainable peace. Many authors cited here have stressed the importance of co-designing any such strategies or interventions with members of the affected communities. The same message emerged clearly from interviewees: Interventions aimed at improving environmental sustainability, peace and stability

must be co-designed with affected communities. Not only do these communities hold the best understanding of the system and of what solutions will be feasible and meet their needs, but local ownership of solutions is also a matter of justice and inclusion, and vital for avoiding the replication of post-colonial or neocolonial dynamics of externally driven interventions for environmental sustainability, development, and peacebuilding.

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