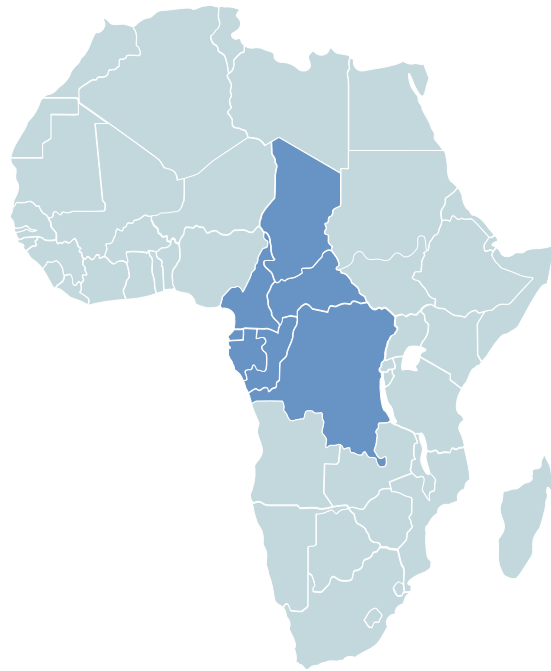


WEATHERING RISK

Africa  
Climate  
Security Risk  
Assessment

Central Africa

# Central Africa



## Summary

### KEY CLIMATE IMPACTS



**Temperature:** Since the 1960s, mean annual air temperatures over Central Africa has increased by between 0.75°C and 1.2°C, and the average air temperature is projected to rise by between 0.9°C to 3.1°C by 2080 compared to the year 2000. The magnitude of increase will vary, as temperatures in the already hotter regions further north rise by more than temperatures towards the south. In line with this, the annual number of very hot days is also projected to rise, especially in northern regions.



**Precipitation\*:** Rainfall projections in Central Africa are highly uncertain and past precipitation trends challenging to discern. Available data suggest a drying trend since the 1950s. In the future, despite a clear trend for northern Chad where precipitation is expected to increase, it is expected that the average amount of annual precipitation will remain relatively constant across most of Central Africa. However, the intensity and frequency of both heavy precipitation events and dry spells will increase across vast areas of Central Africa.



**Droughts\*:** Similar to precipitation trends, data on drought frequency and intensity are subject to uncertainty in Central Africa, both for past trends and projections. With the general decline in average precipitation amounts over the last decades, there is some evidence of an increase in droughts since the mid-20th century. Some studies point towards increased droughts in the Congo River Basin under moderate and high emissions scenarios. Even though drought occurrences are projected to be higher for



northern and southern regions of the African continent, the actual drought risk will be among the highest in some central African countries, mainly due to high vulnerability and population growth.

**Flooding and landslides:** Although a lack of observational data makes it challenging to identify past trends regarding hydrological extremes, vast areas of Central Africa are highly vulnerable to flooding and landslides. Future projections point to a climate-related increase in heavy precipitation events across all of Central Africa, indicating an increased risk of flooding and landslides in the future.

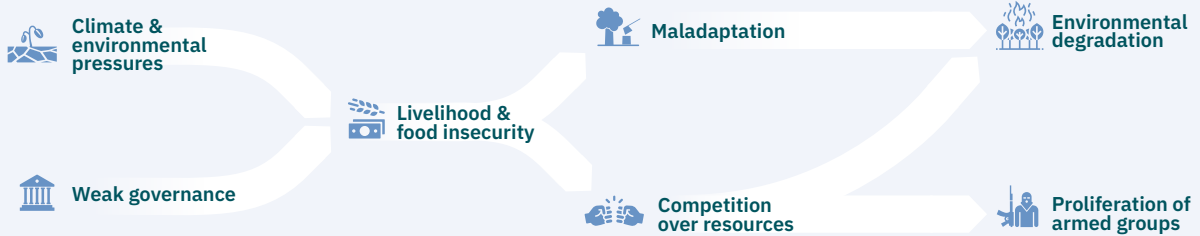


**Sea level rise and coastal vulnerability:** In response to climate change, sea levels rose at a rate of around 3.6 mm per year along the coasts of Central Africa between 1993 and 2021. Climate models project a median sea level rise of 12 cm by 2030 and around 36 cm by 2080 under a low emissions scenario, compared to 2000 levels. Under a high emissions scenario, the long-term rise will be higher, amounting to around 42 cm. Rising sea levels threaten coastal communities, and can cause erosion and saline intrusion into coastal waterways and groundwaters, leading to degradation of fertile coastal lands, as well as marine pollution, reduction in marine resources and degradation of water quality.

\* Climate projections with high uncertainty need to be interpreted with great caution. Please refer to the Annex for an explanation of uncertainty in climate projections.

## CLIMATE SECURITY PATHWAYS IN CENTRAL AFRICA

### Pathway 1: Livelihood and food insecurity driving conflict over natural resources



Climate-induced livelihood and food insecurity is driving competition over natural resources in Central Africa, particularly with regard to agriculture, pastoralism and forestry. In areas with weak or inadequate governance, concentrated pockets of natural resources, ongoing conflict and violence,

and readily available small arms, competition can quickly turn violent. Climate and environmental pressures on traditional livelihoods also drive coping mechanisms that further harm the environment and social cohesion, such as illegal mining, logging and poaching.

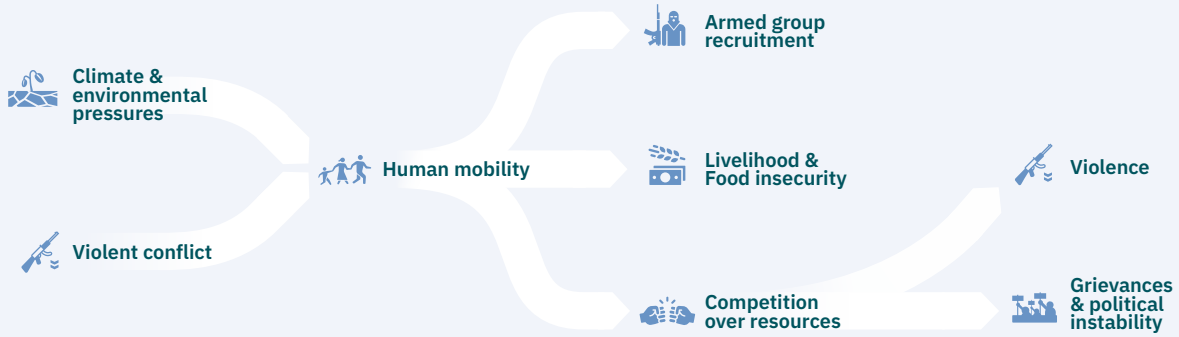
### Pathway 2: Climate impacts exacerbate the proliferation of armed and criminal groups



The proliferation of armed groups in Central Africa is already a severe threat to human security and stability in the region, especially in areas where state authority is absent, weak, causing harm and actively contributing to instability. Climate change and environmental degradation exacerbate existing socioeconomic vulnerabilities, fuelling societal grievances and marginalisation, which facilitate

the rise and growth of armed groups. At the same time, armed groups in Central Africa generate revenue by illegally taxing pastoralism and exploiting natural resources, including illicit mining, which further drives their growth, causes environmental degradation and weakens resilience to natural hazards.

**Pathway 3: Climate impacts exacerbate challenges around human mobility, contributing to increased conflict and security risks**



Mobility has historically served as a key strategy for Central Africans to cope with and adapt to increasingly severe climate impacts and environmental stressors. This is particularly true for those whose livelihoods directly depend on natural resources, such as farmers and pastoralists. Climate change can severely worsen existing

challenges around human mobility, especially as it contributes to increased, unplanned and poorly managed movements. Climate migration and disaster-induced displacement can take different forms, either temporary or permanent, internal or international.

**Pathway 4: Loss of biodiversity and environmental degradation intensifies human insecurity and violent conflict, and vice versa**



Insecurity and violent conflict in Central Africa are deeply intertwined with and negatively affect the natural environment, as well as conservation efforts, human-wildlife relations and extractive industries. These dynamics threaten the last net

carbon sink in the world, the Congo Basin Rainforest. While these linkages are often less investigated in Central Africa, the natural environment can be considered both a driver of and a “silent victim” of armed conflict.

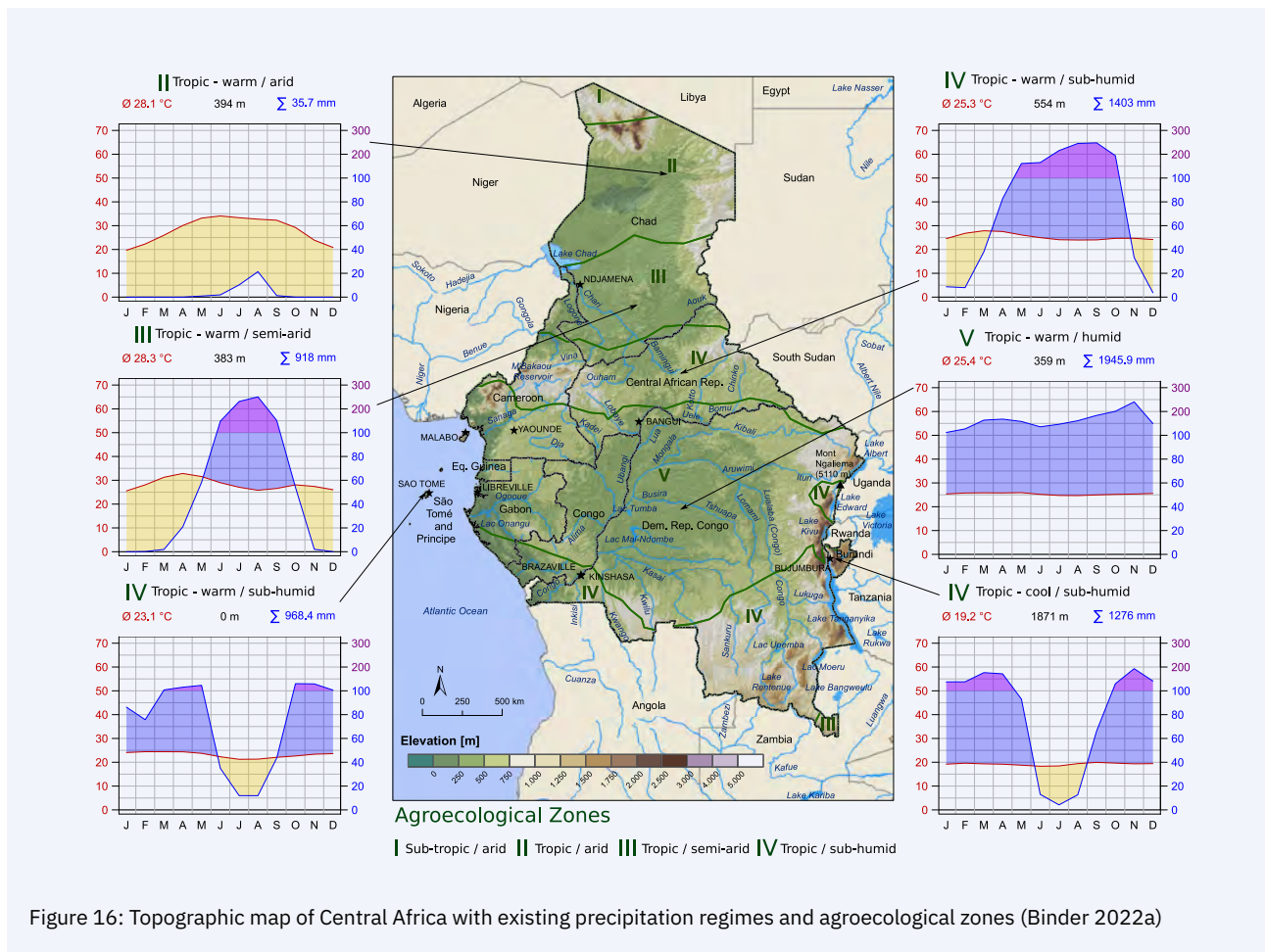
# Context

## GEOGRAPHY

The Central Africa region<sup>23</sup> consists of nine AU member states: Burundi, Cameroon, the CAR, Chad, the DRC, the Republic of the Congo, Equatorial Guinea, Gabon, and São Tomé and Príncipe. Central Africa is home to several large freshwater bodies, including major rivers such as the Congo and Ubangi, both constituting dense systems of tributaries. The Congo River is the second-largest river in the world in terms of discharge volume. An estimated 77 million people in the Congo Basin depend on its abundant water resources, accounting for about 30 per cent of Africa’s total freshwater supplies (Lossow 2017). The region also includes other large water bodies, such as Lake Tanganyika, the second largest and deepest lake in the world by water volume, spanning the entire border between Tanzania, Burundi and the DRC. Further north, Lake Albert, Lake Kivu and Lake Edward form part of the East African Rift System. Lake Chad, which borders Chad, Cameroon, Niger and Nigeria, is largely fed by precipitation further south in the humid tropics (Vivekananda et al. 2019).

Considering the presence of numerous water bodies, most Central African countries boast abundant freshwater resources. The total amount of renewable water available per capita per year is 154,632 m<sup>3</sup> in DRC (highest per capita freshwater availability on the African continent), 76,406 m<sup>3</sup> in Gabon and 19,942 m<sup>3</sup> in the CAR. This is in stark contrast to arid Chad and mountainous Burundi, where water resources are limited to 2,865 m<sup>3</sup> and 1,087 m<sup>3</sup> per person per year, respectively (FAO 2019a). In light of the water stress threshold of 1,700 m<sup>3</sup> per person per year, Burundi’s per capita freshwater availability is low.

The Congo Basin is surrounded by highlands and mountains to the northwest, on the border between Nigeria and Cameroon, and especially to the east, where the East African Rift System hosts some of Africa’s highest mountain ranges and the largest lakes. Off the western equatorial coast in the Gulf of Guinea lie volcanic islands, including Bioko, part of Equatorial Guinea, and the island nation of São Tomé and Príncipe. The latter, consisting of two mountainous islands formed by extinct volcanoes, is the second smallest African state (CIA 2022).



Central Africa is also characterised by dense humid forest, with the Congo Basin forest the second largest continuous tropical forest track after the Amazon (for more information see the Congo Basin box).

Central Africa comprises several diverse agroecological zones with specific temperature and moisture regimes. These range from arid conditions in the Sahara Desert in northern Chad to tropic-arid and semi-arid in the Sahel and Savannah regions in the south of Chad to mostly tropical, sub-humid to humid conditions in the Congo Basin. The migration of the Intertropical Convergence Zone strongly affects precipitation patterns across Central Africa, as its seasonal shift determines the wet and dry seasons (Binder 2022a). Areas north and south of the equatorial zone experience higher seasonal variability with distinct rainy seasons. The length of the rainy season and annual rainfall amounts decrease south and north of the equator. The ocean, in combination with other influences such as relief and vegetation, leads to various local climates near the coasts (Haensler et al. 2013).

#### SOCIOECONOMIC SITUATION

Central African economies are highly focused and dependent on natural resources, making them vulnerable to climatic stress and environmental impacts (World Bank 2021c). Apart from São Tomé and Príncipe, Gabon, and the Republic of the Congo – where the majority of the population works in the service industry<sup>25</sup> – in all other Central African countries agriculture accounts for the highest percentage of employment (AU and OECD 2022). The agricultural sector is mostly rainfed and consists largely of subsistence farming for local production, with limited regional or international export. Agricultural employment is also largely informal, with informal employment accounting for 90 per cent of total employment in Central Africa in 2018 (ILO 2020).

Despite the high percentage of employment in agriculture, the sector is far from the most profitable for Central African economies. The domestic value added content resulting from the exploitation of mining products is considerably higher than that of other sectors (AU and OECD 2022). Apart from São Tomé and Príncipe, Central Africa is rich in natural resources including oil, cobalt, gold, diamonds, uranium, manganese, copper and forestry resources. Oil drilling is the main foreign exchange earner in six countries in the region: Chad, Cameroon, the Republic of the Congo, the DRC, Equatorial

Guinea and Gabon (UNECA 2020). Copper, oil and bituminous minerals account for the lion's share of Central Africa's total exports – nearly 87 per cent in Chad, over 61 per cent in the Republic of the Congo and 63 per cent in Equatorial Guinea. The DRC is widely considered to be the richest country in the world regarding natural resources and untapped mineral deposits, particularly cobalt, diamonds, gold and copper (AU and OECD 2022).

Central Africa is one of the African subregions that is the least integrated into global value chains. However, there are significant differences between the individual countries. For example, the Republic of the Congo and Gabon are more integrated in global value chains through their extractive sectors (AU and OECD 2022). In both countries, this trend is primarily attributed to the dependence on the oil sector, which constitutes the majority of exports. Furthermore, the diversification plan pursued by the Gabonese government has yielded beneficial outcomes by fostering the development of new value chains, particularly evident in the agriculture, food processing, and timber sectors (AfDB 2021). On the other hand, countries such as the CAR, Chad and Burundi participate comparatively less in global value chains (AU and OECD 2021).

Despite the abundance of natural wealth in Central Africa, populations remain very poor overall. This is due to the unequal distribution of income from this natural wealth. Inadequate skills development and low productivity are hobbling the competitive edge and economic diversification potential of Central African countries, and most Central African countries face long-term development issues (UNECA 2020). The UNDP's Multidimensional Poverty Index ranks Central African countries among the lowest in the world (UNDP and OPHI 2022). Similarly, in the UNDP's Human Development Index, three out of the five lowest scoring countries in the world are located in Central Africa: Chad, the CAR and Burundi (UNDP 2022a). In the World Bank's Ease of Doing Business rankings, the 20 lowest scoring countries include six countries from Central Africa, with the CAR, the DRC and Chad scoring the lowest within Central Africa (World Bank 2023a).

23 This report uses the African Union's classification system for geographic regions ([https://au.int/en/member\\_states/countryprofiles2](https://au.int/en/member_states/countryprofiles2)).

24 The climate graphs display temperature and precipitation values, which are averaged over an area of approximately 50 x 50 km.

25 In São Tomé and Príncipe, Gabon, and the Republic of the Congo, the retail and wholesale sector is a significant source of employment, accounting for more than 40 per cent of all jobs (AUC/OECD, 2022a).

In general, the state of food security provides a reliable indicator of socioeconomic development within a region. In Central Africa, the levels of food insecurity are among the worst in Africa, comparable with Eastern Africa. In 2022, the prevalence of undernourishment was estimated at more than 29 per cent for the region (57 million people), an increase of nearly seven per cent compared to 2010 and the highest regional rate in Africa (FAO et al. 2023).

### DEMOGRAPHICS AND MOBILITY

Central African countries have some of the fastest growing and youngest populations in the world, causing severe demographic pressures and socio-economic challenges (World Bank 2023f). The total population of Central Africa is close to 170 million people, with the median age estimated around 17 years old. About half of the population is urban. The DRC has the highest population number (89 million), followed by Cameroon (26 million) and Chad (16 million). Countries such as São Tomé and Príncipe (219,000), and Equatorial Guinea (1.4 million) are the least populated. Over the last two decades, the annual population growth rate for Central Africa has remained relatively stable at around three per cent (UNDESA 2022b).

As intra-regional mobility is limited because of dense vegetation and the lack of interconnecting roads, the majority of Central African migrants move to other African regions or other continents. In 1983, the Economic Community of Central African States (ECCAS) adopted the Protocol on Freedom of Movement and Rights of Establishment of Nationals of Members States. This protocol includes provisions for freedom of movement, residence and establishment for all citizens in the ECCAS region. However, the protocol has not been fully implemented. In practice, the free movement of people is only allowed in a few member states and remains highly susceptible to inter-state relations.

### POLITICAL INTEGRATION

All member states are part of the ECCAS, even though some countries are also members of other regional communities, such as the *Communauté économique et monétaire de l'Afrique centrale*, the SADC and the East African Community (EAC). Despite existing regional entities, Central Africa has long suffered from a lack of regional integration. Many countries have stronger ties outside the region, partly due to low levels of intra-regional trade and limited transportation infrastructure

(Ndione 2014). Central African countries are politically integrated through the ECCAS, which works on a number of pillars, including peace and security, the common market, environment and natural resources, land use planning and infrastructure, gender, and human development.

Finally, some Central African countries are also members of multiple regional organisations. For example, Burundi is a member of both the EAC and ECCAS, and the DRC is a member of the EAC and SADC in addition to being an ECCAS member state. The CAR, the DRC, Congo and Burundi are also members of the International Conference on the Great Lakes Region (ICGLR). Although the ICGLR does not have an explicit focus on climate and environmental security, its legally binding Pact on Security, Stability and Development lists 10 protocols, including one on the illegal exploitation of natural resources (ICGLR 2006). Furthermore, the ICGLR Peace and Security Programme recognises the risk of environmental conflicts and the negative effects of climate change on human security (ICGLR 2023).

### PEACE AND SECURITY

Multiple Central African countries, including the DRC, the CAR, Burundi, Cameroon and Chad, are experiencing or have experienced in recent years intra-state conflict. Many also have multiple armed and insurgency groups active within their territories. For example, in eastern DRC, an estimated 120 armed groups operate with diverse interests and objectives, directly and indirectly contributing to prolonged insecurity in the wider region, which has displaced millions of civilians over the years (Kivu Security Tracker 2021). Meanwhile, Cameroon is beset in a violent conflict between the government and separatists from the English-speaking minority. The conflict, which started in 2017, has killed over 6,000 people and displaced more than 700,000 people. At the same time, Cameroon faces a reinvigorated Jihadist insurgency with deadly attacks in the Lake Chad area. The war with Boko Haram, centred in the Far North, has killed thousands of civilians and displaced hundred thousands, and triggered the rise of vigilante self-defence groups (ICG 2023).

Central African countries have hosted several international military interventions aimed at protecting civilians, addressing the threat of armed groups and supporting national stabilisation efforts (Palik et al. 2022). For example, the DRC has hosted a UN peacekeeping presence since 1999, with

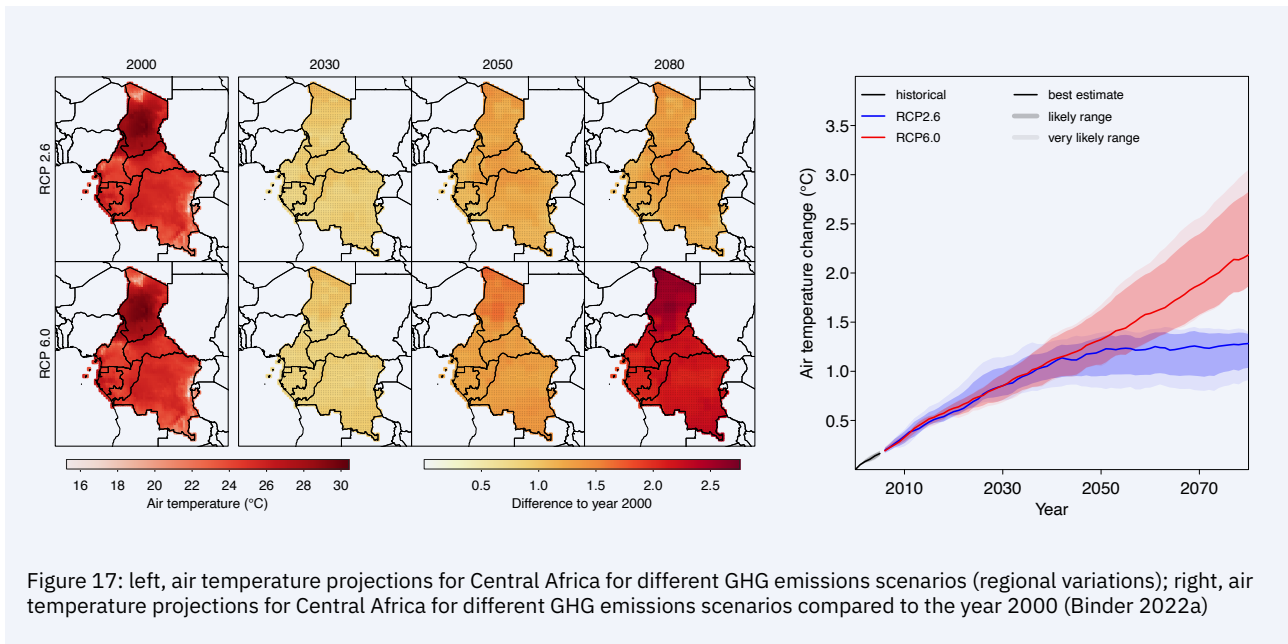


Figure 17: left, air temperature projections for Central Africa for different GHG emissions scenarios (regional variations); right, air temperature projections for Central Africa for different GHG emissions scenarios compared to the year 2000 (Binder 2022a)

the current deployment of the UN Organization Stabilization Mission in the DRC (MONUSCO). In 2022, with violence once again inflamed in eastern DRC, the EAC decided for the first time in its history to deploy a regional force, consisting of troops contributed by Kenya, Burundi, Uganda and South Sudan (Russo 2022). Similarly, the CAR deploys a UN stabilisation mission (MINUSCA) and has hosted numerous international peace operations in the past.

## Climate change and impacts<sup>26,27</sup>

The entire Central African region is highly vulnerable to climate-related impacts. According to the ND-Gain Climate Vulnerability Index, which compares the vulnerability of different countries to climate change and their readiness to improve resilience, Chad is the most vulnerable to and least prepared country for climate change in the world. The CAR and Guinea-Bissau follow in second and third place, respectively, while the DRC ranks fifth, last in the rating (ND-Gain 2022). Similarly, according to the World Risk Index, Central Africa is the most vulnerable region in Africa to natural hazard-induced disasters,<sup>28</sup> even though it is far less exposed than Northern Africa, which has the highest exposure to natural hazard-induced disasters on the continent. In terms of coping and adaptive capacities to natural hazard-induced disasters, Central Africa scores the lowest among all African regions. Three out of the five most vulnerable countries in the world are located in Central Africa,

namely Chad (second most vulnerable country after Somalia), the CAR (the fourth most vulnerable after South Sudan) and the DRC (the fifth most vulnerable country) (Atwii et al. 2022).

### CLIMATE CHANGE

#### Air temperature

Since the 1960s, mean annual air temperatures over Central Africa has increased by between 0.75°C and 1.2°C (IPCC 2022). Depending on the climate change scenario, the average air temperature is projected to rise with high certainty by between 0.9°C to 3.1°C by 2080 compared to the year 2000 (very likely range). The magnitude of increase will vary, as temperatures in the already hotter regions further north will rise comparatively more than those towards the south (Binder 2022a).

In line with rising mean annual temperatures, the annual number of very hot days is also projected to rise. A sharp increase is expected over the CAR, southern Chad, northern Cameroon and southern DRC (see Figure 17). Hot days in coastal areas in the west and areas bordering the lakes (in the east of the DRC and western Burundi) will rise comparatively less. In São Tomé and Príncipe, daytime temperatures will not exceed the 35°C threshold in either scenario (Binder 2022a).

26 Please refer to the Annex for guidance on how to read the plots and for an explanation of the concept of uncertainty in climate projections.

27 The summary of the key climate impacts in this section is based on: Binder L. 2022. Climate Change in Central Africa. Berlin: Potsdam Institute for Climate Impact Research.

28 These include earthquakes, cyclones, droughts, sea level rise, tsunamis and floods.



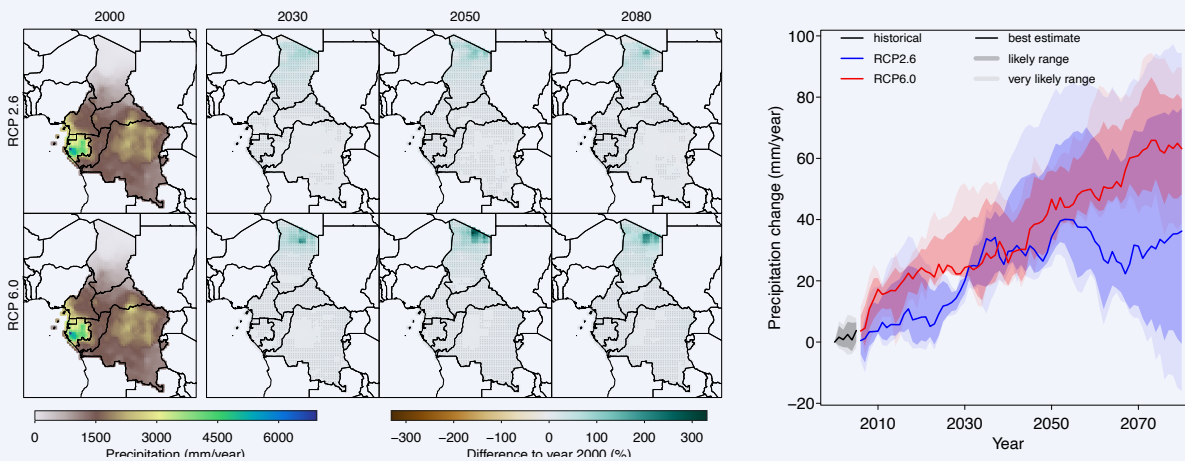


Figure 18: left, precipitation projections for Central Africa for different GHG emissions scenarios (regional variations); right, annual mean precipitation projections for Central Africa for different GHG emissions scenarios, compared to the year 2000 (Binder 2022a)

## Precipitation

Due to a lack of meteorological observations<sup>29</sup> across the entire region, rainfall estimates are uncertain and past precipitation trends challenging to discern. Available data suggest a drying trend since the 1950s. The increase in droughts also affected the Congo Basin region between 1979 and 2014. This raised concerns as it has been associated with a decline in water storage and forest productivity (Zhou et al. 2014; Nicholson et al. 2022).<sup>30</sup> Compared to the 1979–2014 period, and especially to the recent dry period of 2000–2014, a return to wetter years was observed between 2016 and 2020, which could be related to warming of the land and oceans (Nicholson et al. 2022). However, rainfall estimates for the Congo Basin for recent decades vary, partly due to a lack of observational data (Binder 2022a).

Precipitation projections over Central Africa are highly uncertain. As the plots below illustrate, precipitation will primarily increase over northern Chad (see Figure 18). This finding is congruent with studies pointing towards a substantial increase in rainfall over the Sahel over the next few decades (Schewe and Levermann 2022). Despite a clear trend for Chad, many other areas are subject to uncertainties over the direction of change, though it is expected that the average annual amount of precipitation will remain relatively constant across most areas (except for Chad). However, the precipitation characteristics are projected to change. Heavy precipitation events will increase, while the frequency of dry spells during the rainy

season has also been projected to rise across most of the Congo River Basin (Haensler et al. 2013; Karam et al. 2022).

## Drought

According to the Emergency Events Database (EM-DAT), between 1950 and 2023, the number of drought disasters in Central Africa was lower compared to other African regions. However, Burundi and Chad registered a relatively high number of drought-related deaths (EM-DAT n.d.). In line with this, an index that measures social vulnerabilities to droughts ranked Burundi and Chad among the six most drought-vulnerable countries in Africa, along with Somalia, Niger, Mali and Ethiopia. This high susceptibility is the result of multiple vulnerability factors, including water availability and management, economic welfare and institutional capacities, and the availability of agricultural infrastructures and technologies (Naumann et al. 2014).

With the general decline in the average amount of precipitation over recent decades, there is some evidence of an increase in meteorological, agricultural and ecological droughts across Central Africa between 1950 and 2012 (Seneviratne et al. 2021). During this period, the Congo River Basin experienced a significant increase in the frequency and severity of droughts due to a combination of declining rainfall and hotter climatic conditions. Consequently, the Congo River Basin has been identified as a global drought hotspot (Spinoni et al. 2019).

In general, however, the drying trend in the region is subject to uncertainty, along with the precipitation trends of the last few decades. Similarly, future changes with regard to drought frequency in Central Africa are uncertain (Seneviratne et al. 2021; IPCC 2022), though some studies point towards increased droughts in the Congo River Basin under moderate and high emissions scenarios (Karam et al. 2022). Even though increases in future drought occurrences are projected to be higher for northern and southern regions of the African continent, the actual drought risk will be among the highest in some Central African countries, mainly due to high vulnerability and population growth. This high drought risk is an especially acute concern in Chad, the CAR and the DRC (Ahmadalipour et al. 2019).

### Flooding and landslides

Hydrological extremes in the region are also of concern. Central Africa is particularly vulnerable to flooding events. Although a lack of observational data makes it challenging to identify past trends regarding hydrological extremes, the large-scale flooding in Cameroon and Chad in 2022 was exacerbated by climate change (World Weather Attribution 2022). Similarly, the rise in water levels in Lake Tanganyika has led to devastating damage, loss of life and displacement for Congolese and Burundian communities (Davies 2021; Johri 2022). Future projections point to a climate-related increase in heavy precipitation events across the entire Central African region, including the Congo River Basin, indicating an increased risk of flooding for the future (Binder 2022a).

According to the ECCAS Risk Atlas, the areas at highest risk of river flooding in Central Africa are located in the Lake Chad Basin, including along the Chari and Logone rivers in Chad, and along the Congo River and its tributaries. Kinshasa (the DRC) is among Central Africa's most vulnerable cities to flooding caused by rain and is also highly vulnerable to riverine flooding. Landslides are most prevalent in Cameroon, notably in western areas of the country; in the Great Lakes region, especially around Lake Kivu; and in western border regions of Burundi and Rwanda. In urban areas, the Central African cities with the highest risk of landslides are Brazzaville (Republic of the Congo), Libreville (Gabon) and Mbuji Mayi (the DRC) (ECCAS 2021b).

### Sea level rise and coastal vulnerability

In response to climate change, sea levels rose at a rate of around 3.6 mm per year along the coasts of Central Africa between 1993 and 2021. This rate

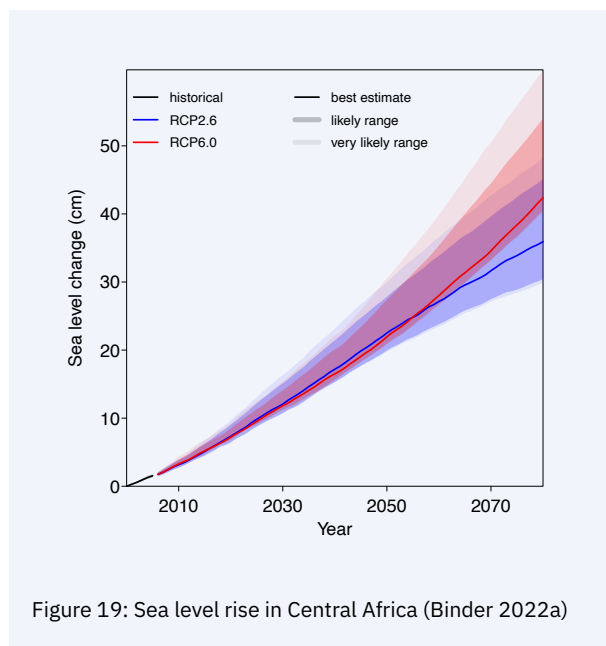


Figure 19: Sea level rise in Central Africa (Binder 2022a)

is above the global mean sea level rise of 3.3 mm per year for the same period (WMO 2022). Climate models project a median sea level rise of 12 cm by 2030 and around 36 cm by 2080 under RCP2.6, compared to the year 2000. Under RCP6.0, the long-term rise will be higher at around 42 cm. Rising sea levels threaten coastal communities, and can cause erosion and saline intrusion into coastal waterways and groundwaters (Binder 2022a). This can lead to degradation of fertile coastal lands, as well as marine pollution, reduction in marine resources and degradation of water quality, which are all essential for the livelihoods of coastal communities.

Finally, infrastructure along the Central African coast lacks resilience to climatic shocks and could deteriorate rapidly with increasing coastal pressures (Nguenke and Adewumi 2020). The Central African cities considered the most vulnerable to coastal flooding are Douala (Cameroon), Pointe Noire (Republic of the Congo) and Port Gentil (Gabon) (ECCAS 2021a).

29 For example, with many meteorological stations having fallen into disuse or now obsolete, the climate of the CAR is one of the most poorly monitored in the world.

30 It should be noted that forest degradation and the related decline in ecosystem services in the Congo Basin are also largely impacted by human activities. For example, in the DRC, shifting cultivation has been identified as the major cause of primary forest loss. Conflict has increased illegal logging, mining and hunting as people seek refuge in forests (Shapiro et al. 2021).

## Climate security risk pathways

### LIVELIHOOD AND FOOD INSECURITY DRIVING CONFLICT OVER NATURAL RESOURCES

Climate-induced livelihood and food insecurity are driving competition over natural resources in Central Africa, particularly in agriculture, pastoralism and forestry. With large areas of the region lacking effective governance and containing concentrated pockets of natural resources, as well as suffering from ongoing conflicts, violence and readily available small arms, competition can quickly turn violent. Climate and environmental pressures on traditional livelihoods also drive coping mechanisms that further harm the environment and social cohesion, such as illegal mining, logging and poaching.

#### **Increasing competition over natural resources**

Competition and tensions over natural resources are increasing across Central Africa. In Burundi, for example, an estimated 90 per cent of the population live from subsistence agriculture based on rain-fed production methods, which are under pressure from climate change and other environmental challenges. At the same time, the country is experiencing a very high population growth rate and is densely populated, which further intensifies competition for natural resources (UNOCA 2022). A major driver of conflict in Burundi is disputes over land ownership, which are worse in areas where people who were displaced due to insecurity have returned to find they have lost access to their property and, consequently, become entangled in competition over scarce land resources. Burundi's legal framework and practices restrict women's access to land ownership, making them especially vulnerable (IOM 2021a).

Intense agriculture, major deforestation and the wide-scale use of pesticides have reduced soil productivity and led to erosion. Water pollution from agriculture is one of the main environmental problems, as it affects lake water quality and ecosystems, which has an adverse effect on fishing. When climate pressures increase, these tensions and vulnerabilities are expected to worsen, increasing the risk of violent conflict (UNOCA 2022). For example, in the DRC's western Kwamouth territory, cycles of attacks and reprisals occurred due to longstanding disputes over chieftaincy power and land rights in 2022 and 2023. While these conflicts were primarily the result of customary tax disputes, conflict along ethnic lines in Kwamouth could worsen in the future as resources become scarcer (HRW 2023a).

Another example of this dynamic involves the Lake Chad Basin, which is the basis for millions of people's livelihoods, including fishing, farming, pastoralism and agriculture. The surrounding population is heavily dependent on the lake and surrounding environment. It is estimated that around 90 per cent of people's livelihoods in this area are climate sensitive (Vivekananda et al. 2019). However, around the Lake Chad Basin, water security has been under constant threat due to hydroclimatic variability, population growth, the unpredictability of water demand-supply dynamics, increasingly frequent and intense natural hazard-induced disasters (e.g. drought), and socio-cultural complexities acting as direct or indirect drivers of conflicts over land and water (Asah 2015; Sayan et al. 2020) (see detailed discussion of climate security risks in the Lake Chad Basin box).

The DRC, the CAR, Chad and Cameroon face increasing competition over natural resources, which regularly escalates into violence and conflict. Typically, this type of conflict is highly localised, playing out either within or between livelihood groups. For example, in the Far North of Cameroon, due to climate change and more specifically the considerable variability in the surface water of Lake Chad, fishers and farmers tend to dig large trenches to retain the remaining water from the river so that they can fish and farm. However, muddy trenches trap and sometimes kill livestock, leading to hostilities between herders, and fishers and farmers (UNOCA 2022). While this type of intercommunal violence often appears small-scale, it has the potential to quickly escalate. In 2021, violent clashes over scarce resources displaced thousands inside Cameroon and forced more than 30,000 people to flee to neighbouring Chad (UNHCR 2021).

Similarly, competition over livelihoods and natural resources can intensify when demographic pressures increase, especially between displaced persons and host communities (UNOCA 2022). Violent competition over natural resources often remains under the radar as the international community and governments tend to focus on national-level peace processes. In the CAR, conflicts between herders and farmers in rural areas constitute a conflict-within-conflict, which further destabilises the country and often passes overlooked at the political level (ICG 2014).

#### **Food insecurity**

Livelihood insecurity in Central Africa is often-times directly linked to malnutrition and hunger.

In 2022, some 39 per cent (76 million) of Central Africans were estimated to be severely food insecure and 78 per cent (154 million) moderate or severely food insecure. Furthermore, 37 per cent of Central African children (under 5 years old) experience stunting, by far the highest proportion across all African regions. The increase in hunger in Central Africa is primarily driven by food inflation and increasing costs of imports, but also extreme climate events (FAO et al. 2023). While different livelihood sectors have always coexisted in Central Africa, tensions within and between groups can increase when climate change affects the availability of and access to natural resources. In such circumstances, people resort to adaptive practices that harm others, which leads to erosion of social cohesion and drives further conflict (UNOCA 2022).

### **Mining**

Another important livelihood that is closely interlinked with climate and environmental security is mining. The DRC is often considered the world's most geologically blessed country, with untapped deposits estimated at USD 24 trillion (Global Edge 2023). Despite this potential wealth, the DRC has been unable to leverage these as transformative assets to promote socioeconomic and human development, which is partly due to the weakened governance structures resulting from decades of colonial resource extraction policies and conflict (Katunga 2006). The extraction of natural resources, which are frequently exported without contributing significantly to domestic industry or other sectors, benefits only small groups, exacerbating what is already a dire and highly unequal socioeconomic situation. For example, vast amounts of gold extracted through artisanal mining is smuggled out of the DRC through neighbouring countries, leading to economic losses and a lack of benefits for local communities (USAID 2021).

Mining often involves illicit networks, including armed groups for which the mining and/or taxation of mining activities is an important financing source (Vinke et al. 2023). This is further aggravated by rising international demand for minerals. In this context, competition over the extraction and control of these resources often turns violent. Extracting these resources puts tremendous pressure on the country's biodiversity, with pollution, deforestation and soil erosion threatening biodiversity (Pattison 2022). Tropical rainforests such as the Congo Basin are proven global hotspots for

mining-related deforestation (Hund et al. 2023). For example, weak or inadequate governance structures partly originating from colonial rule and conflict in the DRC are major obstacles to protecting the country's forests from the expansion of both legal and illegal mining, which are key causes of deforestation (Schneider 2020; Auffredou 2022).

Extractive industries threaten ecosystems and environmental conservation efforts in Central Africa. The region is home to several protected areas, including transboundary conservation initiatives such as the Trinationale Dja-Odzala-Minkébé and Sangha Tri-National complexes, which cover areas of Gabon, Cameroon, the CAR and the Republic of the Congo. Both protected areas are under enormous pressure from illegal artisanal miners, mostly mining for gold and diamonds, but also semi-industrial mining. Artisanal miners move into the forests, and often into protected areas, without any authorisation. The mining sector has become one of the main drivers of deforestation and defaunation, operating with high levels of impunity in both parks. Environmental impacts are disastrous and range from erosion to the diversion of watercourses through siltation, as well as ecosystem pollution, poaching and fragmentation of wildlife habitats. In particular, human and ecosystem health is highly vulnerable to mercury pollution, which is a consequence of gold mining. For example, an estimated 15 tonnes of mercury are used annually in the DRC's artisanal gold mining operations, which has devastating effects on aquatic systems, among other ecosystems, and human health (UNEP 2017a; Kanyinda et al. 2020). Across Central Africa, and especially near or within protected areas, artisanal mining is extremely poorly regulated, without legal frameworks that formalise and empower authorities to control activities (Tchoumba et al. 2021).

### **CLIMATE IMPACTS EXACERBATE THE PROLIFERATION OF ARMED AND CRIMINAL GROUPS**

The proliferation of armed groups in Central Africa is already a severe threat to human security and stability in the region, especially in areas where state authority is absent, weak, causing harm and actively contributing to instability. Climate change and environmental degradation exacerbate existing socioeconomic vulnerabilities, fuelling societal grievances and marginalisation, which facilitate the rise and growth of armed groups. At the same time, armed groups in Central Africa generate revenue through illegally taxing pastoralism and

exploiting natural resources, including illicit mining, which further drive their growth, cause environmental degradation and weaken resilience to natural hazards.

### **An advantageous operating environment**

First, armed groups proliferate, as they can operate more easily in fragile and conflict-affected environments where the state has little to no authority and lacks legitimacy. As climate change can weaken governance, it can also play to the advantage of actors that undermine state authority. Second, livelihood insecurity caused by, among other factors, climate change makes people more vulnerable to recruitment into armed groups (Nett and Rüttinger 2016). When livelihood sectors such as agriculture and pastoralism come under intense pressure, armed groups profit by providing affected people access to illicit income-generating activities such as mining, as well as by collecting illegal taxes and extortion. Armed groups can also bolster their legitimacy by providing basic services, which the state may not provide, such as protection, humanitarian assistance or access to basic goods. These services can assist communities affected by climate impacts to adapt, which enables armed groups to gain popularity and recruit more people (UNOCA 2022).

In the Lake Chad Basin, climate change has compounded core drivers of the conflict and deepened the humanitarian crisis. Negative experiences with state interventions in the region have also increased local grievances (Iocchi 2020). These feedback loops play into the ability of armed opposition groups' efforts to recruit, retain and re-recruit people, especially young people (Ifabiyi 2013; Vivekananda et al. 2019). Being a member of an armed group often provides vulnerable young people access to better socioeconomic conditions and perspectives, as well as a sense of belonging and meaning. Many young men and women, especially those who are displaced or who have lost their livelihoods due to climate insecurity, see a life in armed groups as more dignified, with more opportunities to gain status, power and respect (Moaveni 2019; Vivekananda et al. 2019). Similarly, in the CAR, young people in rural communities have been vulnerable to armed group recruitment, especially when armed groups can offer seemingly better socioeconomic opportunities and provide protection to livelihoods such as cattle or farmland (de Brier et al. 2020; Semba 2021).

### **Contestations around the exploitation of natural resources**

In countries such as the CAR and DRC, armed groups are primarily focused on gaining profits from illicit natural resource exploitation, for example, by creating illegal taxation and roadblocks to profit from the industry (Jaillon et al. 2018; Brier et al. 2023). In some cases, armed groups control mines and directly manage extraction. It is important to note that national security forces and state agents are also intertwined in illicit trade through similar mechanisms used by non-state actors, often maintaining close links with transnational organised criminal networks involved in large-scale smuggling and money laundering (Matthysen et al. 2019). Key products include gold, timber, charcoal, 3T minerals, diamonds and wildlife. Shifts in access and the availability of natural resources can also exacerbate harmful and illicit exploitation by armed groups (UNEP et al. 2015).

This appears especially evident when governmental actors increase pressure on networks of illicit exploitation. Research in the DRC illustrates key mechanisms through which contestations around illegal resource exploitation interact with armed conflict and conservation efforts. For example, armed groups often seek to hamper conservation efforts in order to gain revenue from illegal resource exploitation. In addition, mining in and near protected areas in the DRC has fostered competition between political-military networks, involving both state agents and non-state actors, and creating new and exacerbating existing violent competition (Verweijen et al. 2022). On the other hand, conservation efforts can exacerbate conflict through increased deployment of enforcement agencies, which can affect conflict dynamics (Verweijen and Marijnen 2017). State agents responsible for environmental protection often also engage in environmental crime, facilitating illegal access to resources and engaging – either collaboratively or in competition – with armed groups. This is a particular risk when state agents receive poor salaries, or when salaries are not paid on time or at all (Schouten et al. 2022).

### **Maritime security**

Coastal economies are important sources of revenue for some Central African countries. For example, São Tomé and Príncipe's economy depends almost entirely on the coastal zones. However, infrastructure along Central African coastal areas is generally in poor condition and threatened by climate pressures, such as coastal erosion, sea

level rise and human activities, such as dredging and pollution (UNESCO and IOC 2020). Environmental degradation is known to be one of the main drivers of illegal, unreported and unregulated fishing, as well as overfishing and maritime crime, such as arms, drugs and human trafficking, and piracy and armed robbery at sea. These maritime threats can fuel violence and corruption, and result in the proliferation of armed groups and criminal networks, especially in densely populated, highly vulnerable coastal areas of Central Africa (Walker 2021; UNOCA 2022).

#### **CLIMATE IMPACTS EXACERBATE CHALLENGES AROUND HUMAN MOBILITY, CONTRIBUTING TO INCREASED CONFLICT AND SECURITY RISKS**

Mobility has historically been a key strategy for coping with and adapting to increasingly severe climate impacts and environmental stressors for Central Africans. This is particularly true for those whose livelihoods depend directly on natural resources, such as farmers and pastoralists. Climate change can severely worsen existing challenges around human mobility, especially as it contributes to increased, unplanned and poorly managed movements. Climate migration and disaster-induced displacement can take different forms, either temporary or permanent, internal or international.

#### **Pastoralism and transhumance**

An important point to note is that human mobility – whether in the form of seasonal migration, economic migration or transhumance – is by no means a new phenomenon in Central Africa, as it has long been a key livelihood strategy. Pastoralism is a major economic activity in many countries in Central Africa, including Cameroon, the CAR and Chad. According to Chad's 2017–2021 National Livestock Development Plan, the sector accounts for between 30 per cent and 50 per cent of the country's exports, excluding oil. Livestock production is estimated to involve 40 per cent of the working population (CNUCED 2019).

Even though pastoral migration patterns change from country to country, as well as within countries, climate and environmental pressures increasingly shape these dynamics. Pastoral movements are either pendular (moving from one point to another, and returning by the same path) or circular (following a loop), but rarely random. However, with climate change and increased environmental pressures, the direction of these movements has become highly unpredictable, including

for pastoralists themselves, which directly affects natural resource competition, and thus peace and security. This can be seen in countries such as Chad, Cameroon, the CAR and the DRC where the seasonal migration of pastoralists and their cattle is a source of friction and violent conflict. In recent years, these conflicts have worsened due to a multitude of drivers, including climate change, which shifts migration routes further south (ICG 2014).

Transhumance – the migration of herders and their cattle across and within national boundaries to exploit seasonally available resources – has also become increasingly interwoven with armed group dynamics as herders seek protection from armed groups and the latter gain economic profits from the cattle trade (de Brier et al. 2020). The securitisation of pastoralism has been institutionalised in many areas of the CAR through well-established systems of taxation as transhumance corridors are completely regulated by armed groups. In these cases, pastoralists are required to provide services to armed groups and become – sometimes against their will – associated with them. The spread of firearms among transhumant pastoralists and their alleged involvement in arms trafficking is further driving intercommunal hostility (Huchon et al. 2020).

In the past, when the region was relatively stable, people tended to follow designated migratory routes and specific protocols. For instance, if a herd caused damage to a field, village leaders and chief herders would typically negotiate an informal resolution based on established compensation norms. If this failed to address the issue, local authorities could intervene or pursue legal measures. However, since the onset of the civil war in 2013 in the region, exacerbated by the impacts of climate change, seasonal migration has become increasingly marred by acts of violence such as cattle theft, crop destruction, sexual assault, and even murder (Bah 2021).

#### **Displacement**

For several decades, multiple countries in Central Africa have been affected by displacement. Humanitarian crises in Chad, the CAR, Cameroon and the DRC have led to the internal and regional displacement of people. Over 90 per cent of refugees and asylum seekers from Central Africa are based in three countries: the DRC, Chad and Cameroon (UN DESA 2020). In addition, Chad has experienced the influx of migrants from around the region, many of whom attempt to enter Libya but

are expelled at the border. Chad also hosts returnees fleeing insecurity in northern Nigeria, as well as returnees and refugees fleeing inter-communal clashes in Sudan and the crisis in the CAR (IOM 2023). In mid-2023, the DRC had the largest population of IDPs (an estimated 6.2 million people) on the African continent, in addition to the more than 520,000 refugees hosted in the country. Meanwhile, other Central African countries with forcibly displaced persons include Cameroon (2.2 million IDPs and 469,000 refugees), Chad (381,000 IDPs and 715,000 refugees) and the CAR (488,000 IDPs and 31,000 refugees) (UNHCR 2023a).

Natural hazard-induced disasters, particularly droughts, storms, flooding and landslides, cause high levels of internal displacement in Central Africa. In 2020, the rainy seasons in countries such as Cameroon and the DRC were exceptionally intense and prolonged, flooding areas already affected by violence or other disasters, and consequently triggering secondary displacements. In the DRC, the number of people internally displaced due to natural hazard induced disasters increased from about 230,000 in 2019 to almost 900,000 in 2021 (IDMC 2023). In the Republic of the Congo, between late 2019 and January 2020, heavy rains led to severe flooding and landslides in Brazzaville, which affected nearly 50,000 people and resulted in widespread damage to infrastructure. In Gabon, between November and December 2019, the start of the rainy season was marked by severe flooding in the province of Moyen-Ogooué, while vast areas of Port-Gentil, the second largest city and an important hub for industries, was flooded in June 2020 (UNOCA 2022). Similarly, in Burundi, weather-related hazards including rains, strong winds, flooding and landslides internally displaced 87,000 people in 2021, an increase from 51,000 people in 2020 (IDMC 2023). Another example of climate-induced displacement can be found in the DRC and Burundi around Lake Tanganyika, where a rapid rise in the water level killed dozens of people, displaced thousands more and caused extensive damage to infrastructure along the shores (Davies 2021; Johri 2022).

People forcibly displaced by extreme and sudden climate shocks often become more vulnerable to food and livelihood insecurity, as well as discrimination and marginalisation. This negative cycle also makes people more vulnerable to harmful coping mechanisms such as criminality and enrolment into armed groups (Amakrane et al. 2023). Many Central African countries already host high

numbers of refugees or IDPs, as a result of conflict and disasters caused by natural hazards. When climate and environmental pressures increase, these populations are often the first to suffer from the consequences, leading to food and livelihood insecurity. However, host communities are often equally vulnerable, especially when natural resources are scarce due to demographic pressures caused by mass displacement. Under such circumstances, competition can escalate into conflicts around access to livelihoods and natural resources, but also regarding aid and development resources – including food distributions, especially when they are not fairly distributed between displaced persons and the host population (Vinke et al. 2023).

### **Rural-urban migration and borderlands**

Central African countries have some of the fastest growing populations in the world and urbanisation is expected to increase rapidly. Rural-urban migration patterns are already placing severe pressure on infrastructure, public services and people's livelihoods, with urban centres in Central Africa suffering from overpopulation. As climate change risks exacerbate these challenges, migration can also indirectly contribute to more poverty and marginalisation in urban centres, as well as increase urban crime and political instability (UNDESA 2022b).

Similarly, borderlands across Central Africa have become hotspots for climate migration, both as areas of out-migration in response to climate disruption and in terms of in-migration. The Great Lakes region, which spans the borders of the DRC, Burundi, Rwanda and Uganda, is already a dense cluster of migration and displacement, and climate change will likely draw a large number of additional arrivals. In the DRC, climate impacts are likely to drive substantial movements away from low-lying and flood-prone areas in the west, with people moving towards the borders with Rwanda and Uganda in the eastern highlands, and Lubumbashi in the south (Amakrane et al. 2023). However, as urban centres struggle to cope with increased demographic pressures, this migration poses serious risks to human security. For instance, the population of Bukavu in eastern DRC is projected to double by 2030 and triple by 2050, compared to 2016 estimations. However, physical and topographical conditions limit further expansion, and newcomers often tend to build and reside in areas that are not suitable for construction, exposing themselves to a high risk of landslides and flooding (Muhaya et al. 2022).

The borderlands between the CAR, Chad and Cameroon are specific hotspots for climate-induced migration and related insecurity. Many nomadic pastoralists lost their herds through a combination of droughts and conflicts with sedentary communities over shared transboundary habitat, pastures and water bodies (Sayan et al. 2020). In the Far North of Cameroon, in and around the Waza National Park, nomadic pastoralists have for generations migrated to the Waza-Logone flood plain, mostly coexisting peacefully with local farming communities. Traditional authorities from the region have established strong ties with nomadic pastoralists, attributing them grazing lands and even allowing them to settle more permanently and engage in agropastoral activities. However, with increased climatic and environmental pressures, fertile land has become extremely scarce, resulting into conflicts between local farmers, sedentary agropastoralists, transhumant pastoralists and wildlife. Increased climate variability and unpredictability further aggravates this as nomadic pastoralists often extend their stay beyond the season. With land and conservation efforts under pressure, authorities have called into question the established rules and practices (Huchon et al. 2020).

#### **LOSS OF BIODIVERSITY AND ENVIRONMENTAL DEGRADATION INTENSIFIES HUMAN INSECURITY AND VIOLENT CONFLICT, AND VICE VERSA**

Insecurity and violent conflict in Central Africa are deeply intertwined with and negatively affect the natural environment, including regarding conservation efforts, human-wildlife relations and extractive industries. These dynamics threaten the last net carbon sink in the world, the Congo Basin Rainforest. While these linkages are often less investigated in Central Africa, the natural environment can be considered both a driver of and a silent victim of armed conflict.

#### **The effects of violent conflict on the natural environment**

Violent conflicts have major direct and indirect negative impacts on ecosystems. For example, the use of weapons and military material damages ecosystems. Conflicts also reduce community and state conservation capacities, and lead to an increase in environmental crimes such as poaching, illegal deforestation and mining (Hillert 2023). Conflicts can directly lead to air, water and soil pollution, as well as the deliberate destruction of the environment and the use of natural resources as weapons of conflict. Conflict also hinders natural resource management and environmental protec-

tion, facilitating environmental crimes, such as poaching, and illegal logging and mining (Rüttinger et al. 2022). Areas that experience armed conflict and instability generally also count a higher number threatened fauna and flora (IUCN 2021).

Because of the role that environmental crimes and illegal resource extraction play in conflict economies, environmental defenders are often considered targets. This is especially of concern in the DRC, the African country with the highest number of attacks on environmental defenders. In 2020, at least 15 environmental defenders were killed in the country (Business and Human Rights Resource Centre 2021), including eight rangers working in Virunga National Park (Global Witness 2021). Indigenous community members are often victims of violence, which is particularly worrying given their generally positive role in conservation efforts. Evidence also suggests that nature and biodiversity degrade at a slower pace on indigenous lands (IPBES 2019).

These dynamics threaten critical ecosystems, such as the Lake Chad and Congo basins, which are both vital for livelihoods in the region. The latter, as one of the last remaining net carbon sinks in the world, is crucial for global climate mitigation efforts (Barbier and Burgess 2021). Climate change and environmental degradation pose a serious threat to the Congo Basin rainforest, as the impact of climate change combined with direct, human-made environmental pressures damages the ability of the forest to absorb CO<sub>2</sub>, which in turn drives further climate change (UNOCA 2022). Finally, long-term restoration projects, environmental research and the promotion of ecotourism are hindered by the conflict, resource exploitation and poverty-driven encroachment (Vinke et al. 2023).

#### **Conservation conflicts**

Central Africans often perceive protected areas as spaces that unnecessarily exclude human activities and do not generate any benefits for the communities living within or near them. Indeed, when protected areas generate economic activities, local populations rarely enjoy the benefits. Without buy-in from local communities, protected areas can become spaces of frustration and contestation (Tchoumba et al. 2021). Environmental conservation efforts in Central Africa have been plagued by human rights abuses and violations of ecoguards, park rangers and environmental officers against local and indigenous communities. Allegations have included beatings and physical violence



carried out by ecoguards in Boumba Bek, Nki and Lobeke national parks in southeastern Cameroon as early as 2008. Similarly, in the Salonga National Park in the DRC, investigations carried out in 2019 identified widespread allegations of extremely grave abuses perpetrated by ecoguards and Congolese army personnel, including multiple murders, rapes, torture and beatings (WWF 2022). Internationally funded and trained park guards in the DRC's Kahuzi-Biega National Park have reportedly killed, raped and terrorised indigenous Batwa living on their ancestral lands inside the park (Flummerfelt 2022).

Closely linked to human rights abuses and violations in Central Africa is the relatively recent phenomenon of "green militarisation," which refers to the use of military and paramilitary actors and approaches for conservation. This is especially visible in and around protected areas that are confronted with environmental crimes, such as poaching and illegal resource extraction (Lunstrum 2014). Collaborations between environmental actors and armed forces, as seen in the DRC and CAR, have fostered a convergence between environmental and security governance, often contributing to protected areas becoming contested spaces of violent conflict (Kujirakwinja et al. 2010; Lombard 2015). The Congo's Virunga National Park, which is located in the already conflict-ridden North-Kivu province, is an example of a conservation-stabilisation approach, with the DRC army and park rangers collaborating closely to expel armed groups and criminals from the park. However, research suggests that strict law enforcement, repression and an overly militarised approach to conservation might have the opposite effect, and fuel rather than mitigate the dynamics feeding armed mobilisation and violent competition over natural resources (Verweijen and Marijnen 2018).

### **Human-wildlife conflicts**

Another growing climate security challenge are human-wildlife conflicts, with incidents becoming more frequent, serious and widespread across Africa and particularly in Central Africa. In the past, most human-wildlife conflict research on the African continent focused on Southern and Eastern Africa. Nonetheless, human-wildlife conflict is a key issue in many Central African countries as well, occurring in both savanna and forest areas (Breuer and Ngama 2020). Such conflicts are often driven by demographic pressures, climate change and human-made environmental stressors, such

as agricultural expansion, infrastructure development, deforestation, pollution, poaching and other losses of biodiversity (Nyhus 2016; IUCN 2022).

The role of climate change is often underappreciated, although evidence suggests it is a critical amplifier of human-wildlife competition for space, water and food, as it exacerbates resource scarcity for both humans and wildlife, altering human and animal behaviours and distributions, and increasing potentially violent human-wildlife encounters (Abrahms et al. 2023). Changes in biodiversity, temperature or rainfall patterns can push both humans and animals into harmful or conflict-promoting coping mechanisms. For example, in Lopé National Park in Gabon, research suggests that a significant decline in fruiting due to climate change led to a decrease in the capacity of the ecosystem to support the fruit-dependent elephant population, pushing elephants out of the wood (Bush et al. 2020).

While there are numerous forms of human-wildlife conflicts, such as livestock predation by large carnivores, the most prevalent conflicts in Central Africa involve forest elephants, which have occurred for decades in countries such as the Republic of the Congo, Gabon, Cameroon, the DRC and the CAR (Tchamba and Foguekem 2012; Terada et al. 2021). Various types of violence between humans and forest elephants occur, including hunting, poaching and traditional killings, as seen among various indigenous communities such as the Baka and Aka tribes (Agam and Barkai 2018).

In the 1990s, Central Africa created more and more protected areas and increased measures of conservation, which also resulted in more elephants living closer to human settlements. The development of infrastructure and roads, immigration and expansion of people into forest lands, high poaching intensity, and an increase in farming activities have resulted in elephants migrating out of unsafe habitats, heightening the likelihood of confrontations with humans. New security issues have emerged with elephants raiding crops in farmlands and villages close to protected areas, destroying food stores and water sources, and directly threatening human life. Impacts on humans include crop loss, property destruction, and injury and death, as well as more hidden consequences such as loss of livelihoods, and increased expenditures and workload (Breuer and Ngama 2020). Furthermore, the increase in hostile encounters has pushed human

and elephant behaviour towards more hostility and aggression, fuelling a negative conflict spiral (Breuer et al. 2016; Tyukavina et al. 2018).

An important consequence of human-elephant conflicts in Central Africa is how it affects conservation and protection efforts more broadly. Losses and grievances associated with living with elephants can fuel resistance against conservation efforts, and in some cases even violent conflict between local communities, and park rangers and environmental officers. This is especially a risk if local communities not only fear damage caused by elephants, but also consider conservation as non-beneficial for local livelihoods, for example, if regulations limit options for agricultural production (Terada et al. 2021). Finally, forest communities often perceive their rights to be treated inferior to the protection of elephants, a perception that has worsened due to numerous cases of human rights violations against forest communities under the pretext of conservation work – an issue that has plagued Central Africa for decades (WWF 2022).

## Responses and good practices

The climate-conflict nexus is often considered a new topic in Central Africa, especially in comparison with neighbouring Western Africa and Eastern Africa. Nonetheless, the topic is emerging as a key priority area for Central African countries and for regional cooperation. Even though Central Africa has a less developed framework and established discourse on climate security, it is integrated throughout several initiatives at the regional, national and local levels.

### Regional approaches

The links between climate change, peace and security in Central Africa have been recognised by several regional actors. In 2018 and again in 2019, the UN Security Council requested the UNOCA to take into consideration climate change among various factors affecting the stability of Central Africa (S/PRST/2018/17 and S/PRST/2019/10). In 2019, ECCAS member states requested in a ministerial declaration that the UNOCA and UNEP support efforts in the region to address the impact of climate change on peace and security (UNOCA 2022).

Some of the key intergovernmental actors working on climate-related security issues in the region include ECCAS, as well as more thematically

focused initiatives such as the Central African Forests Commission (COMIFAC), the Congo Basin Forest Partnership (CBFP) and the Youth Network for Central African Forests. The Network of Central African Protected Areas was created in 2000 to support Central African countries conserve natural resources through protected areas. However, the activities of the initiative have ceased in recent years. The Lake Chad Basin Commission (LCBC) includes Central African countries such as Cameroon, the CAR and Chad.<sup>31</sup> Under the umbrella of COMIFAC, several partnership initiatives focusing on environmental conservation, climate adaptation, resilience-building and human development have been launched. Of note is the Conference on Dense and Moist Forest Ecosystems of Central Africa, launched in 1996 as the Brazzaville Process, which aims to provide a platform for dialogue and collaboration on the sustainable management of forestry resources (COMIFAC 2005).

Knowledge and governance of transhumance-related security issues in Central Africa, especially in comparison to Western and Central Africa, has remained underdeveloped with regard to spatial, ecological, political and socioeconomic dynamics. This is especially the case when linked with the effects of climate change (Huchon et al. 2020). However, in recent years, transhumance has increasingly become a topic for regional cooperation. In 2019, Chad hosted the first International Conference of Ministers on Transboundary Transhumance, which resulted in the N'Djamena Declaration. An international agreement around nine commitments for Western and Central African countries to improve cooperation around transhumance (CBFP 2019). A second conference of ministers on transhumance, protected areas and natural resources, development, peace, and security was held in Yaoundé, Cameroon, in July 2023. The conference focused on the operationalisation of international agreements, such as cross-border agreements, setting up transnational coordination mechanisms, and developing country action and investment plans (CBFP 2023). These promising developments were facilitated or initiated by regional organisations including CBFP, ECCAS and COMIFAC. However, due to the absence of land-use plans and limitations in terms of institutional capacities, many of these initiatives face enormous implementation challenges (Huchon et al. 2020).

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31 The activities of the LCBC are covered in the Western Africa chapter and the section on transboundary water issues.

For countries with a history of conflict, environmental conservation is often an easy-to-agree-upon common objective for peacebuilding that is less sensitive than, for instance, accessing high-value resources. The Greater Virunga Transboundary Collaboration – a conservation agreement between Virunga National Park in the DRC, Volcanoes National Park in Rwanda and Mgahinga Gorilla National Park in Uganda – has resulted in several conservation successes, with environmental peacebuilding playing a key part in this. Conflict-sensitive bottom-up approaches included shared agreements on landscape management, community conservation, tourism development and law enforcement (Refisch and Jensen 2016). Due to international collaboration and trust building around the conservation of mountain gorillas through the transboundary secretariat, the three countries are now also working on broader, shared environmental risks. For example, a history of violent conflicts between fishers in the DRC and Uganda led to a decision to include fisheries in the Transboundary Strategic Plan. In addition, the Greater Virunga Transboundary Collaboration plays a key role as a platform and intergovernmental facilitator for discussing contentious issues between the three countries, such as the transboundary exploitation of natural resources. Therefore, it remains a rare platform of engagement between countries that have historically had tense relations (Refisch 2022). Despite some positive outcomes, conservation efforts in Virunga National Park have led to the justification and financing of militarised approaches to protect revenues and goals, while simultaneously concealing defence interests in protecting national borders (Trogisch and Fletcher 2022). Similarly, the militarisation of nature conservation in Virunga has enabled elites to benefit from unauthorised exploitation of natural resources within the park borders (Marijnen 2017; Verweijen and Marijnen 2018).

In March 2023, the sixth edition of the One Planet Summit, entitled One Forest Summit, was held in Libreville, Gabon. Twenty countries representing the major forest basins throughout the world gathered to discuss the conservation and sustainable management of tropical forests, including of the Congo Basin, recognised as a critical factor in maintaining peace and stability in Central Africa. A key outcome was the creation of a EUR 100 million fund to invest in so-called positive conservation partnerships and a mechanism for compensating exemplary forested countries through biodiversity certificate. In addition, the fund aims

to create 10 million jobs in activities related to sustainable forest management, and value chains that benefit local and indigenous communities (FDA 2023).

Central Africa still has significant gaps in terms of data gathering and analytical capacities to inform decision-making. Some projects aim specifically to strengthen evidence generation to inform conservation efforts and environmental peacebuilding. One initiative is Project Canopy, which works with governments, development organisations, international and local non-profits to identify which opportunities may have the greatest impact. Project Canopy is a non-profit organisation that takes a data- and technology-driven approach to conservation, applying machine-learning to satellite imagery, identifying deforestation (by type) in real time, and investigating how environmental science can be aligned with law and policymaking. By providing decision-makers with the data and analytics they need, the project aims to improve conservation outcomes and increase funding for conservation efforts in the Congo Basin (Project Canopy 2023). In addition, the UNOCA has engaged with the Innovation Cell of the UN Department of Political and Peacebuilding Affairs to initiate a geospatial dashboard project and conflict modelling prototypes to create the UNOCA Climate Security Dashboard for use by desk officers, in-situ practitioners and decision-makers. The dashboard leverages environmentally purposed remote-sensing (satellite imagery) data with the mission to predict and prevent conflict, and enable self-reliant peacebuilding and peacekeeping (UNOCA 2023).

ECCAS is engaged in the development of a conflict-sensitive regional strategy on climate change and resilient development, and the completion of a regional protocol on transhumance, with the support of UNOCA and other partners. The overarching objective of these initiatives is to guide ECCAS member states and other stakeholders on the conceptualisation and implementation of collective measures to address the subregional impacts of climate change, and advance sustainable social and economic development (UNOCA 2023).

In addition, UNOCA and numerous other UN entities have initiated the establishment of a UN Working Group on Climate Change, Biodiversity, Security, Transhumance, Finance and Development in Central Africa. UNOCA continues to implement a cross-regional project on farmer-herder dynamics in Central and Western Africa in collaboration with

UNOWAS and the Office of the Special Coordinator for Development in the Sahel. This includes the establishment of a community of practice and the development of a handbook gathering good practices identified in the DRC, Cameroon, the CAR, Chad, Burkina Faso, Benin and the Gambia (UNOCA 2023).

### **National approaches**

Some national initiatives focus on linking conservation with climate resilience. For example, in the Mai-Ndombé province of the DRC, tropical rainforest covers over 80 per cent of the land area, but the past few decades have witnessed heavy deforestation rates, mainly due to slash-and-burn agricultural practices and overexploitation of forestry resources, including for charcoal production. In response, the government of the DRC and World Bank signed an agreement on the purchase of 10 million tonnes of CO<sub>2</sub>, which the DRC authorities aim to achieve through the implementation Mai-Ndombé PIREDD project. Through the National REDD+ Fund portfolio,<sup>32</sup> the DRC hopes to reduce CO<sub>2</sub> emissions by 27.7 million tonnes and at the same time improve livelihoods for 150,000 people from the area. The project illustrates how carbon credits can directly support conservation efforts and land use planning, climate-smart agricultural practices, the sustainable management of forestry resources and a reduction in the use of unsustainable energy sources (Central African Forest Initiative 2023).

Law enforcement and regulation have proven effective ways to reduce the negative effects of natural resource exploitation on the environment, especially in and around conservation areas. In the Trinationale Dja-Odzala-Minkébé and Sangha Tri-National complexes, Gabon has been one of the most active countries in addressing the issue of illegal mining. In 2011 and 2014, Gabonese authorities removed thousands of illegal gold miners from the park. However, without socioeconomic alternatives for miners or a legal framework in place, such measures often remain insufficient to address underlying issues such as poor climate resilience and livelihood insecurity. Linking regulation with livelihood opportunities for communities can allow ecosystems to recover, while also improving living conditions and earnings of miners, and ensuring that national economies receive their due (Tchoumba et al. 2021).

One of the unique characteristics of Gabon is that it still has a large, well-preserved forest ecosys-

tem, estimated to cover 88 per cent of its surface area. This exceptional natural heritage constitutes a major asset because of its carbon sequestration capability estimated at several hundred million tonnes of CO<sub>2</sub> per year, which the country plans to commercialise (Tan 2021). The DRC, which is home to the majority of the Congo Basin rainforest, considers itself a “solution country,” with the government aiming to link climate action, including adaptation, mitigation and resilience measures, with environmental protection and development (UN 2021). In the Republic of the Congo, the National Reforestation Program illustrates a government desire to diversify the national economy by establishing one million hectares of forestry and agroforestry plantations in collaboration with public and private partners. By signing a landmark agreement with the World Bank’s Forest Carbon Partnership Facility in 2021, the Republic of the Congo became one of the first countries in Africa to test REDD+ at scale, focusing on reducing emissions from deforestation and forest degradation, and increasing carbon sequestration. The programme includes an inclusive benefit sharing plan, developed through extensive stakeholder consultations at different levels to ensure that community members and indigenous peoples, and local beneficiaries that depend on forests for their livelihoods are recognised and rewarded for their role in reducing emissions (World Bank 2021f).

### **Local approaches**

Central Africa hosts a wide range of actors and initiatives that focus on building climate resilience and peace at the subregional and local levels. Programmes and projects often focus on thematic areas, such as transhumance, conservation, energy and climate-resilient livelihoods.

In the Salamat, Sila and Ouaddai provinces of Chad, the UN country team is working to strengthen resilience among communities affected by herder-farmer conflicts, particularly by strengthening social cohesion between pastoralists and farmers, and between pastoral communities. This includes supporting local and traditional committees to prevent conflicts and promote peace, as well as mediating between farmers and herders over

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<sup>32</sup> Countries established the REDD+ framework to protect forests as part of the Paris Agreement. REDD stands for reducing emissions from deforestation and forest degradation in developing countries. The “+” stands for additional forest-related activities that protect the climate, namely sustainable management of forests, and the conservation and enhancement of forest carbon stocks. Under the REDD+ framework of activities, countries can receive results-based payments for emission reductions when they reduce deforestation.

natural resource management, and facilitating local justice mechanisms to address grievances and manage conflicts (FAO et al. n.d.). Similarly, in the northwestern provinces of the CAR, organisations such as the FAO and the UN Population Fund (UNFPA) implemented a programme to support transhumance management, and foster intercommunal dialogue between farmers and herders, with the objective of improving inter-group perceptions, and changing attitudes and behaviours (FAO and UNFPA 2020).

Transhumant pastoralists are too often seen as a source of insecurity, and not enough as an essential line of defence against armed groups and criminal networks. They are often the first victims of armed groups, but given their access to remote areas they can play a vital role in monitoring and providing vital information to security actors. In the binational BSB Yamoussa complex, a protected area established in 2011 through a partnership between Chad and Cameroun, which includes the Sena-Oura and Bouba-Ndjida national parks, several studies have been undertaken to better map different dimensions of transhumance in the area. These studies informed a consultation process involving different actors to reconcile points of view and guide future cross-border interventions. By establishing positive relationships with pastoral groups through conservation efforts and natural resource management, they have contributed to addressing issues of poaching and illegal resource exploitation (Huchon et al. 2020).

The UNPBF has numerous projects that focus on the climate-conflict nexus in Central Africa. One initiative worth mentioning is the Kibira Peace programme. The programme leverages blended finance to support joint peacebuilding and conservation interventions that target the drivers of conflict and instability associated with the lack of protection for the Kibira National Park in Burundi. The programme supports the Burundian government in deploying a force of rangers and ecoguards managed by the National Park Authority, a REDD+ strategy aimed at reducing drivers of deforestation, accessing carbon market, providing alternative livelihood models that generate co-benefits for communities, and fostering durable conservation and peace (UNCDF 2023).

One as yet underdeveloped response area in Central Africa includes the linkages between green energy and peace. However, some innovative projects have looked into the peace benefits

of renewable energy. For example, an evaluation conducted by Energy Peace Partners in Goma in eastern DRC concluded that overall levels of peace were significantly higher in a neighbourhood that enjoyed street lightening powered by green energy compared to a neighbourhood with similar characteristics but lacked public lighting and widespread access to electricity. Along the same lines, the neighbourhood with street lighting showed heightened sense of security and feelings of safety, especially among women and girls (Energy Peace Partners 2022).

There are several examples of how conservation efforts can integrate climate adaptation and peacebuilding objectives at the very local level. For instance, in the Likouala Department of Northern Congo, the *Association des Jeunes pour l'éducation et la Sauvegarde des Éléphants au Congo* (AJSEC) aims to foster alternative income opportunities for local and indigenous communities with an emphasis on elephant poachers. By providing opportunities in agroforestry and beekeeping, the project helps to mitigate human-elephant conflicts that are highly prevalent in the region. Training and working with young forest hunters on environmental conservation enables the AJSEC to gain a deeper understanding of conflict drivers and opportunities to address existing risks, as well as develop more tailored approaches (Breuer and Ngama 2020). Based on lessons learned from a project implemented by the *Institut de Recherches Agronomiques et Forestières of the Centre National de la Recherche Scientifique et Technologique* in Gabon, beekeeping not only provides opportunities for alternative income generation, beehives can also directly protect plantations from crop-raiding elephants (Ngama et al. 2016).

Another example of how climate and environmental action, which can be directly linked not only with human development, but also with peace and security, can be found in Yobé-Sangha Prefecture in southwestern CAR. The Dzanga-Sangha Protected Areas (DSPA) complex encompasses a multi-use area, the Dzanga-Sangha Special Dense Forest Reserve and Dzanga Ndoki National Park. The DSPA has known relative peace and stability, despite the vast majority of the CAR being affected by insecurity and violent conflict. The DSPA's professional, well-trained rangers combined with the area's critical role in bolstering the local economy has contributed to this stable socioeconomic and political environment. Specific reasons for its success include support for community welfare and livelihoods, as well as health care and educa-

tion. For example, the DSPA runs a human rights centre for indigenous people, provides free medical services and job opportunities, and protects local livelihood systems by regulating multi-use areas. Inclusive management principles have provided historically marginalised indigenous peoples greater voice in the management of their land and resources (WWF 2022).

Similarly, within the Espace TRIDOM Interzone Congo area in the Republic of the Congo, the government has focused its efforts on empowering local communities to engage in free, prior and informed consent regarding conservation efforts. This has included the establishment of a community insurance system for human-wildlife conflict and a multi-stakeholder platform for natural resource management, composed of local communities, indigenous peoples, members of the private sector and government representatives. These initiatives have helped to maximise conservation efforts, while at the same time investing in human development, and peace and stability in the region (WWF 2022).

Addressing the human-wildlife conflicts occurring in many areas of Central Africa means linking conservation efforts to climate change as well as peacebuilding, since climate change is an increasingly important driver of human-wildlife conflicts (Abrahms et al. 2023). A diverse range of measures exist to address various elements of these conflicts, including reducing crop loss and ensuring income safety, developing technical solutions that focus on physical and spatial solutions, and promoting approaches to increase the willingness of local communities to tolerate and co-exist with wildlife (Breuer and Ngama 2020). Conservation and protection efforts reduce the risk of human-wildlife conflicts when they are supported by local communities, and, most critically, interwoven in local livelihoods and ecosystem services that benefit affected people, for example, by diversifying income resources (Terada et al. 2021). The integration of different administrative levels, and collaboration among different actors and stakeholders is key, including local knowledge and practices, and cultural relationships between people and elephants (Hoare 2015; Parathian et al. 2018). Protection and conservation efforts are, therefore, most effective when they focus on land-use planning, community conservation and participation, and integrate scenarios of climate change, population growth, human and wildlife mobility, and industrial expansion (König et al. 2020).

## Congo Rainforest Basin: The only remaining carbon sink under threat

The Congo Basin is home to the second-largest tropical rainforest on Earth.<sup>33</sup> It is one of the most important wilderness and biodiversity areas left on the planet. At 500 million acres, it spans six Central African countries in the Equatorial Afrotropics: Cameroon, the CAR, the DRC, the Republic of the Congo, Equatorial Guinea and Gabon (WWF 2023). However, the Congo Basin's transitional eco-regions, including the northern, southern and western Congolese forest-savanna mosaics, extend well beyond the six core countries of the Congo rainforest into Angola in Southern Africa; South Sudan, Rwanda and Uganda in Eastern Africa; and Nigeria in Western Africa (One Earth 2023).

For tens of millennia, people have resided in the Congo Basin. Presently, this diverse ecosystem sustains over 75 million people, providing food, medicine, water, materials and shelter. Moreover, the rainfall produced by the forest supports an additional 300 million rural Africans, extending to regions as distant as the Sahel and the Ethiopian highlands (White et al. 2021). Most of the Congo Basin's population continue to rely extensively on the forest for sustenance and essential resources, which serve as a supplementary source alongside agriculture (WWF 2023). The Congo Basin is not only a significant biodiversity hotspot, but also one of the world's most important carbon sinks. It is estimated to absorb about four per cent of global CO<sub>2</sub> emissions and thus constitutes a crucial line of defence against catastrophic climate change. With the intense deforestation of the Amazon, the Congo Basin rainforest is the only remaining net carbon sink in the world. Moreover, the Congo Basin is home to the world's largest tropical peatlands. The peat swamp forest of the Congo Basin stores around 29 billion tonnes of CO<sub>2</sub> – approximately equivalent to three years' worth of global GHG emissions – while the basin as a whole absorbs nearly 1.5 billion tonnes of CO<sub>2</sub> per year (UNEP 2023).

However, the Congo Basin is under increasing pressure. The forest edges of the forest-savanna mosaic bear the brunt of human impacts, along with the banks of the larger navigable rivers,



including the Congo and Ubangi rivers (WWF 2023). One of the key issues threatening the Congo Basin is deforestation, which can (in addition to biodiversity loss) lead to losses in livelihoods for local populations. Furthermore, deforestation can severely affect the climate equilibrium. For example, various models indicate that loss of tree cover will likely increase ground temperatures and lead to a reduction in rainfall. Further deforestation of the Congo Basin could severely affect the regional climate long term, as well as climates in neighbouring regions (Itsoua et al. 2021). Deforestation rates in many areas of Central Africa are among the highest in the world. The DRC, for example, has an estimated deforestation rate of 0.83 per cent per year, ranking just behind Brazil and ahead of Indonesia in terms of net forest loss for the period 2010–2020 (FAO 2020).<sup>34</sup>

Conflict plays an important role in the dynamics of environmental degradation in the Congo Basin. Many of the Congo Basin countries have been trapped in decades-long cycles of violence, including most notably the DRC, South Sudan, the CAR and Cameroon. This violence has primarily been driven by competition over natural

resources, such as fertile land, minerals and forestry. Indeed, the intensive exploitation of forest resources by non-indigenous people and poor governance have led to increased competition between communities, which threaten the future of the Congo Basin (WWF 2023).

Climate impacts and conflict converge in dangerous ways in the Congo Basin, creating a destructive feedback loop of increasing environmental degradation and conflict. Some of the key climate-related security risks include:

### **1. The proliferation of armed and criminal groups**

In several Congo Basin countries, armed groups focus on illegally exploiting natural resources, and maintain close links with transnational organised criminal networks involved in large-scale smuggling and money laundering (UNEP 2015a). The proliferation of armed groups in Central Africa is already a severe threat to human security and stability in the region, especially in areas where state authority is absent, weak, causing harm and actively contributing to instability. Climate change and environmental degradation exacerbate existing vulnerabilities, and facilitate the rise and growth of armed groups through two mechanisms. First, armed groups proliferate and can operate more easily in fragile and conflict-affected environments where the state has little to no authority and lacks legitimacy. The weakening of governance due to climate change can provide opportunities to actors seeking to undermine state authority. Second, livelihood insecurity caused by, among other factors, climate change makes people more vulnerable to recruitment into armed groups (Nett and Rüttinger 2016).

### **2. Conflict as a driver of environmental degradation**

Climate change and environmental degradation can drive violent conflict in various ways. However, at the same time, conflict itself has major negative impacts on ecosystems. For example, the use of weapons and military material damages ecosystems. In addition, conflict reduces community and state conservation capacities, and leads to an increase in environmental crimes such as poaching, illegal deforestation and mining (Hillert 2023). Long-term forestry projects, environmental research and the promotion of ecotourism are hindered by the many localised conflicts, resource exploitation as well as poverty-driven encroachment in the Congo Basin (Vinke et al. 2023).

### **3. The conservation-conflict nexus**

The various environmental conservation efforts occurring in the Congo Basin, particularly with regard to protected areas and national parks, can be a source of tension and even violent conflict, especially when perceived as unjust or harmful by local communities dependent on these ecosystems for their livelihoods. Rent-seeking behaviour among environmental protection officers and security forces has led to severe human right abuses and violations of local communities, which has fuelled grievances around conservation. Conflicts around conservation areas involve not only local communities, park rangers and security forces, but also armed groups that penetrate the area to illegally exploit natural resources (Tchoumba et al. 2021). Finally, Central Africa faces severe risks around human-wildlife conflicts, which are driven by climate change, environmental degradation and conservation efforts (Nyhus 2016; IUCN 2022).

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33 After the Amazon.

34 Net forest loss here includes all types of forests, dry and humid.









# Annex

## How to read the plots

The maps and plots included in this report provide an overview of projected climate change parameters and related sector-specific impacts in African regions until 2080 under two different climate change scenarios (RCPs). RCP2.6 represents a low emissions scenario that aims to keep global warming below 2°C above pre-industrial temperatures, while RCP6.0 represents a medium-to-high emissions scenario. Projections are provided up to 2080, with each year showing the mean value of a 31-year period.<sup>65</sup>

The **line plots** show climate impact projections averaged over the whole country, with the blue colour representing the RCP2.6 scenario and the red colour representing the RCP6.0 scenario. While the lines depict the best estimate (representing the multi-model median of 10 climate models), the shaded areas represent the likely range (strongly shaded area) and the very likely range (lightly shaded area), indicating the range of model agreement of at least 66 per cent and 90 per cent of all model projections, respectively.

## How to read the plots

	historical
	RCP2.6
	RCP6.0
	best estimate
	likely range (central 66%)
	very likely range (central 90%)

The **map plots** display regionally explicit climate information under RCP2.6 and RCP6.0, in a spatial resolution of approximately 50 x 50 km. While the leftmost column represents the baseline period as found in the model data, the other three columns represent future projections in comparison to that baseline period. The colour values depict the multi-model median of the underlying models at each grid cell. The presence of a dot means that at least

75 per cent of the models agree on the sign of change depicted for the specific grid cell and scenario (i.e. whether an increase or a decrease can be expected). Conversely, the absence of a dot represents the lack of model agreement on the predicted change.

## UNCERTAINTIES IN CLIMATE CHANGE PROJECTIONS

It is important to acknowledge that uncertainties are always part of climate change projections. Uncertainties arise from a variety of factors, including natural variabilities, uncertainties in GHG emissions scenarios and differences in the models use. Consequently, no future (climate change) projection comes without some level of uncertainty. The levels of (un)certainities, however, differ. We present the results of 10 different global models. To indicate the (un)certainty of the projections, we consider model agreement. The more these models agree the higher the certainty, the more they disagree the lower the certainty. For example, if different models project a similar result under the same scenario, the projected changes demonstrate low levels of uncertainty. However, if the models project very different changes (in terms of range and even direction) under the same scenario, then the projections are uncertain.

Line plots and map plots depict uncertainty differently and cannot be compared. The line plots indicate the level of certainty through the shaded areas, depicting the likely (central 66 per cent) and very likely (central 90 per cent) range of all model projections. Generally, the smaller the shaded areas, the more certain the projections. The map plots depict the level of certainty through the presence or absence of dots. If dots are present, at least 75 per cent of all models agree on the direction of change or, in other words, on an increasing or a decreasing trend. If the dots are absent in a specific region or scenario, then model agreement within this specific region and scenario is below 75 per cent.

To simplify the interpretation of the projections, all line plots and map plots that are subject to high levels of uncertainty are marked with a symbol ( ).

This does not imply that these plots have no informational value, but rather draws attention to the limitations of such projections for future planning. Consequently, they should be very carefully interpreted when they are used for planning measures. In the case of high uncertainty, additional information will be provided on how to interpret the data.

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